Atlantic States Marine Fisheries Commission

Shad and River Herring Management Board

February 6, 2014
9:45 – 10:45 a.m.
Alexandria, Virginia

Draft Agenda

The times listed are approximate; the order in which these items will be taken is subject to change; other items may be added as necessary.

1.	Welcome/Call to order (*T. Stockwell*)	9:45 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from February 2013	9:45 a.m.
3.	Public comment	9:50 a.m.
4.	Consider 2013 FMP Review and state compliance (*M. Hawk*) **Action**	10:00 a.m.
5.	Review of shad habitat plans for Amendment 3 **Action** • Overview and Technical Committee Report (*M. Dionne*) • Consider approval of state habitat plans	10:10 a.m.
6.	Update on NEFMC and MAFMC Actions (*L. Steele*)	10:30 a.m.
7.	Elect Vice Chair **Action**	10:40 a.m.
8.	Other business/Adjourn	10:45 a.m.

The meeting will be held at the Crowne Plaza Hotel Old Town, 901 N. Fairfax St, Alexandria, VA 703-683-6000

MEETING OVERVIEW

Shad & River Herring Management Board Meeting
February 6, 2014
9:45 – 10:45 a.m.
Alexandria, Virginia

Chair: Terry Stockwell (ME) Assumed Chairmanship: 01/14	Technical Committee Chair: Mike Dionne (NH)	Law Enforcement Committee Representative: Bridi
Vice Chair:	Advisory Panel Chair: Pam Lyons Gromen	Previous Board Meeting: February 19, 2013
Voting Members: ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, DC, PRFC, VA, NC, SC, GA, FL, NMFS, USFWS (19 votes)		

2. Board Consent
- Approval of Agenda
- Approval of Proceedings from February 19, 2013

3. Public Comment – At the beginning of the meeting public comment will be taken on items not on the agenda. Individuals that wish to speak at this time must sign-in at the beginning of the meeting. For agenda items that have already gone out for public hearing and/or have had a public comment period that has closed, the Board Chair may determine that additional public comment will not provide additional information. In this circumstance the Chair will not allow additional public comment on an issue. For agenda items that the public has not had a chance to provide input, the Board Chair may allow limited opportunity for comment. The Board Chair has the discretion to limit the number of speakers and/or the length of each comment.

4. Fishery Management Plan Review (10:00 -10:10a.m.) Action
Background • State Compliance Reports were due on July 1, 2013 • The Plan Review Team reviewed each state report and compiled the annual FMP Review
Presentations • Overview of the FMP Review Report by M. Hawk. **(Briefing CD)**
Board actions for consideration at this meeting • Approve 2013 FMP Review and State Compliance Report.

5. Shad Habitat Plans for Amendment 3 (10:10-10:30 a.m.) Action
Background • Amendment 3 required states to draft habitat plans for shad • The Technical Committee reviewed and discussed each state **(Briefing CD)**
Presentations • Overview and Technical Committee Report by M. Dionne
Board actions for consideration at this meeting • Consider approval of habitat plans

6. Update on New England Fishery Management Council and Mid-Atlantic Fishery Management Council Actions (10:30 – 10:40 a.m.)
Background • Both Councils have approved catch caps for fisheries in their jurisdiction • The Mid-Atlantic Council has directed the formation of a working group to address data gaps in the Squid, Mackerel, Butterfish fishery
Presentations • Report by L. Steele

7. Elect Vice Chair (10:40 -10:45 a.m.) Action
Background • Terry Stockwell assumes chairmanship January 2013 • The vice chair seat is now empty
Board actions for consideration at this meeting • Elect Vice Chair

8. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

SHAD AND RIVER HERRING MANAGEMENT BOARD

Crowne Plaza Hotel - Old Town
Alexandria, Virginia
February 19, 2013

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2. **Approval of Proceedings of October 24, 2012** by Consent (Page 1)

3. **Move to approve the Georgia American Shad Stocking Proposal with the modifications recommended by the technical committee** (Page 4). Motion by Pat Augustine; second by Tom Fote. Motion carried (Page 4).

4. **Move to adjourn by Consent** (Page 4).

ATTENDANCE

Board Members

Terry Stockwell, ME, proxy for P. Keliher (AA)
Willis Spear, ME, proxy for S. Train (GA)
Rep. Walter Kumiega, ME (LA)
Doug Grout, NH (AA)
Dennis Abbott, NH, proxy for Rep. Watters (LA)
G. Ritchie White, NH (GA)
Mike Armstrong, MA, proxy for P. Diodati (AA)
Bill Adler, MA (GA)
Rep. Sarah Peake, MA (LA)
Mark Gibson, RI, proxy for B. Ballou (AA)
Rick Bellavance, RI, proxy for Rep. Martin (LA)
Bill McElroy, RI (GA)
David Simpson, CT (AA)
Lance Stewart, CT (GA)
James Gilmore, NY (AA)
Pat Augustine, NY (GA)
Russ Allen, NJ, proxy for D. Chanda (AA)
Tom Fote, NJ (GA)
Loren Lustig, PA (GA)
Leroy Young, PA, proxy for J. Arway (AA)
Mitchell Feigenbaum, PA, proxy for Rep. Vereb (LA)
John Clark, DE, proxy for D. Saveikis (AA)
Roy Miller, DE (GA)
Tom O'Connell, MD (AA)
Russell Dize, MD, proxy for Sen. Colburn (LA)
Bill Goldsborough, MD (GA)
Rob O'Reilly, VA, proxy for J. Travelstead (AA)
Kyle Schick, VA, proxy for Sen. Stuart (LA)
Cathy Davenport, VA (GA)
Michelle Duval, NC, proxy for L. Daniel (AA)
Mike Johnson, NC, proxy for Sen. Jenkins (LA)
Ross Self, SC, proxy for R. Boyles (LA)
Sen. Ronnie Cromer, SC (LA)
Patrick Geer, GA, proxy for S. Woodward (AA)
Jim Estes, FL, proxy for J. McCawley (AA)
Jaime Geiger, USFWS
A.C. Carpenter, PRFC
John Bullard, NMFS
Bryan King, DC

(AA = Administrative Appointee; GA = Governor Appointee; LA = Legislative Appointee)

Ex-Officio Members

Pam Lyons Gromen, Advisory Panel Chair
Mike Dionne, Technical Committee Chair

Staff

Bob Beal
Kate Taylor
Toni Kerns

Guests

The Shad and River Herring Management Board of the Atlantic States Marine Fisheries Commission convened in the Presidential Ballroom of the Crowne Plaza Hotel Old Town, Alexandria, Virginia, February 19, 2013, and was called to order at 2:55 o'clock p.m. by Chairman Michelle Duval.

CALL TO ORDER

CHAIRMAN MICHELLE DUVAL: Welcome to first Shad and River Herring Board Meeting of 2013. For those who are new, my name is Michelle Duval. I am the proxy for Dr. Louis Daniel from North Carolina.

APPROVAL OF AGENDA

CHAIRMAN DUVAL: The first item on our agenda is actually approval of the agenda. Are there any additions to the agenda? Seeing none; the agenda stands approved.

APPROVAL OF PROCEEDINGS

CHAIRMAN DUVAL: The next item is the proceedings from our October 22nd meeting at the annual meeting. Are there any changes to those minutes? Seeing none; those minutes stand approved.

PUBLIC COMMENT

CHAIRMAN DUVAL: This is the point in our agenda where we take comment from the public on any items that are not on the agenda. Are there any members of the public that wish to address the board at this time? Okay, I don't see any hands in the audience; so with that I am actually going to turn things over to Kate to take us through a brief review of the possible ESA listing of river herring.

REVIEW OF THE POSSIBLE ESA LISTING OF RIVER HERRING

MS. KATE TAYLOR: As you are aware, NOAA Fisheries has been petitioned to list river herring under the ESA, and that occurred in August 2011. The Service published a positive 90-day finding that the petition act may be warranted. The Service conducted three workshops last summer to gather information for the status review.

Those workshops focused on stock structure, extinction risk and climate change. These workshop reports have been peer reviewed and the final report, the climate change one, was just published this last December and is available on the Service's website. The ASMFC has provided the river herring benchmark stock assessment and its associated datasets to NOAA Fisheries.

The workshop findings, our stock assessment and other submitted information are all being considered by the Service in the development of the status review. The proposed rule, if any, is supposed to publish as soon as possible, and staff will keep the board updated on any actions that may occur and any opportunities for public comment. Thank you, Madam Chair.

CHAIRMAN DUVAL: Are there any questions of Kate regarding the workshops or the potential listing? Mr. Adler.

MR. WILLIAM A. ADLER: Kate, refresh my memory; who filed the petition for the ESA?

MS. TAYLOR: That was the National Resources Defense Council.

CHAIRMAN DUVAL: I know this is something that we have kind of been in limbo on this particular issue for a while, so hopefully we will have a decision or something close to it by the time we meet again in May. Are there any other questions regarding this? Okay, if not, we're going to move on to an update of the Mid-Atlantic Council's Amendment 15 development.

UPDATE ON THE DEVELOPMENT OF THE MID-ATLANTIC COUNCIL AMENDMENT 15

MS. TAYLOR: In June of last summer the Mid-Atlantic Council initiated Amendment 15 to the Squid, Mackerel, Butterfish FMP, which proposes adding shad and river herring as a stock in the fishery to that FMP or alternatively the creation of a separate Council Shad and River Herring FMP. There was a scoping document on this action this last fall and winter, which the board submitted public comments. Those were included in your briefing material.

There were four public hearings that were held on the scoping documents. Comments given included questions on the effect of the potential ESA listing as the council goes forward with the development of the amendment. There were also comments that federal management would add resources to conserve shad and river herring; that there are significant benefits of the MSA; that cooperative approaches should be explored between the council and the commission.

Additionally, there had been recent improvements in shad and river herring runs and that the most appropriate management of shad and river herring is by individual run or on a state level or through the ASMFC. Written comments that the council received in support of going forward with the amendment included that Amendments 5 and 14 will not provide sufficient protection; that the stocks need the full suite of measures provided by MSA.

There needs to be a holistic or comprehensive approach of a federal FMP; that there needs to be cooperation between states and federal management authorities. There were comments that were submitted in opposition of going forward with the amendment. Those included that management by states is adequate; that there is not enough data to manage through the MSA; that an FMP will have no jurisdiction on the many other factors that affect shad and river herring populations; and also that Amendments 14 and 5 deal comprehensively with the incidental catch and so primary management should be retained through ASMFC since the majority of their lives is spent in state water.

The Mid-Atlantic Council's FMAT, which I am a member of, met in December and February to work towards going forward with the amendment. At the council meeting last week the council reviewed staff's approach to the development of Amendment 15 and the progress that the FMAT has made.

The council focused the objectives of the amendment by deciding not to include area-based management; a lower mackerel trip limit; a rebuilding plan or a joint Canadian management as management objectives within the amendment. However, if information arises during the development process or through the public comment period that suggests these objectives are important, then they may be added at a later date.

The FMAT is going forward to explore the full range of management that would be included in the FMP, which includes the status determination criteria, ACL/AMs, essential fish habitat designation, and any rebuilding, if appropriate. FMAT will be evaluating how the required provisions of the MSA could be met and which discretionary measures may also be appropriate.

There will be a join Council/AP meeting as well as coordination with the commission as the amendment develops. The timeline here that was included in the scoping document is that the council will be selecting the preferred alternatives and the Draft EIS submitted to NOAA Fisheries some time this summer with the public comment period for that in the fall and the potential final rule effective in January 2015. Thank you, Madam Chair.

CHAIRMAN DUVAL: Are there questions from the board for Kate regarding the development of Amendment 15?

MR. TERRY STOCKWELL: Kate, did the FMAT consider any collaboration with the New England Council?

MS. TAYLOR: Yes; the council has discussed collaboration with the South Atlantic and the Mid-Atlantic Councils as well as the commission and is still considering options to move forward with the most reasonable approach.

MR. TERRY STOCKWELL: So if I refer to your slide that said there is going to be coordination with the commission in April; would that be including the other two councils at that timeline as well?

MS. TAYLOR: Yes; the coordination with the council is referring to all of the councils as well as the commission.

MR. ADLER: Does this mean that if the National Marine Fisheries Service or the councils develop a management plan for shad and river herring that we are now going to have another situation where we have their plan and we have our plan, and we have to figure out how to do it together. Just like we do sometimes with dogfish and herring; are we going to run into that situation where there are two separate plans and trying to get it all the same. Is that what we're going to do into if that happens?

CHAIRMAN DUVAL: I will let Kate jump in here as well, but it seems to that would be one of the options that would be explored within the document that the FMAT is going to be put together is whether or not it would be a complementary plan at the council level or a plan that would be joint with ASMFC.

MS. TAYLOR: We have looked into the different options that are available. The council received numerous other comments recommending that there be considerable consideration between the two management authorities. The council has mentioned that they will try to include the commission as they move forward with the development of the amendment, but there has been no determination on what the final measures will be.

MR. ADLER: What comes to mind is, of course, is our cooperation with our partners, which has sometimes been a little bit scary when we're dealing with the herring or the dogfish or any of the other ones where is just seems to be that we have to agree with them or else. I will leave that one, which I hit every meeting. Thank you.

CHAIRMAN DUVAL: Thanks for that cautionary note, Bill. I think everyone around the table appreciates some of the complications that can occur when you have either a joint management plan or complementary management plans and trying to ensure that things work smoothly and that none of our constituents gets disadvantaged. Are there other comments for Kate on the Mid-Atlantic Council Amendment 15?

Okay, seeing none, the next item on our agenda is actually consideration of a shad stocking plan of the state if Georgia, and I think our Technical Committee Chair Mike Dionne is going to going to take us through that.

PROPOSED GEORGIA STOCKING PLAN FOR AMERICAN SHAD

MR. MIKE DIONNE: I'm going to discuss a proposed Georgia American Shad Stocking Plan. The Georgia Department of Natural Resources has submitted a proposal for initiation of an American Shad Stocking Program in the Altamaha River Basin in Georgia. As required by Amendment 1 in the FMP, any new stocking program requires technical committee review and board approval.

The technical committee requested additional information on a few items via e-mail; the number of sites that would be stocked; the location of the stocking sites; existing spawning runs; brood fish collection method; young-of-the-year sample and mortality associated with downstream migration over dams; creation of fish passage; and qualifying the effects of the program.

The technical committee appreciates the information that was provided by the Georgia DNR staff. What the technical committee is requesting is the additional information that they provided to us be incorporated into the final plan. The technical committee recommends that the Georgia Department of Natural Resources staff participate also in an OTC Marking Task Force Committee run by Mike Hendricks of Pennsylvania Fish and Boat Commission.

I believe the Georgia DNR has already taken steps to take part in the OTC Marking Task Force. Also, I should note the compliance requirement for states to submit updates on any stocking program, so they would have to submit updates on the progress of the stocking program. Thank you, Madam Chair.

CHAIRMAN DUVAL: Just to be clear; did the technical committee recommend approval of the stocking plan?

MR. DIONNE: Yes; the technical committee recommended approval of the stocking plan with the modifications that were provided via Georgia DNR staff.

CHAIRMAN DUVAL: Thank you. Pat Geer, I didn't know if you wanted to make any other comments to the board regarding the department stocking plan.

MR. PATRICK GEER: No; this is what our Wildlife Resource Division – Don Harrison is heading this up. Mike, the one question I have is do the updates go in the compliance report?

MS. TAYLOR: States with a stocking program have to provide information on the number of fish that are released and the assessment on the rivers where the fry are released as to the percent stocked versus natural fish.

MR. GEER: Okay; and we will be participating in the OTC Workshops annually. Thank you for the consideration of this, too.

CHAIRMAN DUVAL: Are there any questions of either Mike or Pat regarding the stocking program? Leroy.

MR. LEROY YOUNG: Madam Chair, I just have one question. The dams that are involved here; are they hydro dams and are there turbine mortality issues that you have to deal with here?

CHAIRMAN DUVAL: Pat, do you know?

MR. GEER: I don't think they're turbine dams. I don't really think they are. Most of these are small low-profile dams.

CHAIRMAN DUVAL: Does that answer your question, Leroy? Okay; I think at this time, unless anyone has any other comments, I would entertain a motion for approval of Georgia's American Shad Stocking Plan. Mr. Gibson.

MR. MARK GIBSON: I wasn't going to make a motion. I had one question that just came up. I see in number six, the agency states that they had sampled juvenile shad before and couldn't demonstrate any relationship between – you know, successfully sampled them and couldn't demonstrate that it had any relationship to number of adults that came back.

I'm wondering why they think that producing juveniles out of a hatchery would influence the number of adult returns. Did the technical committee talk about that at all why they thought with this item six that there hadn't been any demonstrated relationship between spawners and coming back from the juveniles that were definitely produced naturally in the river?

MR. DIONNE: Yes; that was discussed some. Another goal of the stocking of the hatchery fry is to evaluate the downstream migration of these juveniles. It also could tell us whether or not we really have good quality habitat above these barriers. If the fish are moving downstream, there is a good chance we might have some habitat that could be used in the future.

CHAIRMAN DUVAL: Are there any other questions or comments? Mr. Augustine.

MR. PATRICK AUGUSTINE: Madam Chair; do you want the motion?

CHAIRMAN DUVAL: If no one else has any other questions, I would love a motion.

MR. AUGUSTINE: **With the modifications noted by the technical committee, I recommend that the board consider approval of the Georgia American Shad Stocking Proposal.** Should we not include with the modifications as noted by the technical committee so it covers it all?

CHAIRMAN DUVAL: Yes, I agree. The motion reads move to approve the Georgia American Shad Stocking Proposal with the modifications recommended by the technical committee. Motion by Mr. Augustine; second by Tom Fote. Is there any discussion on the motion?

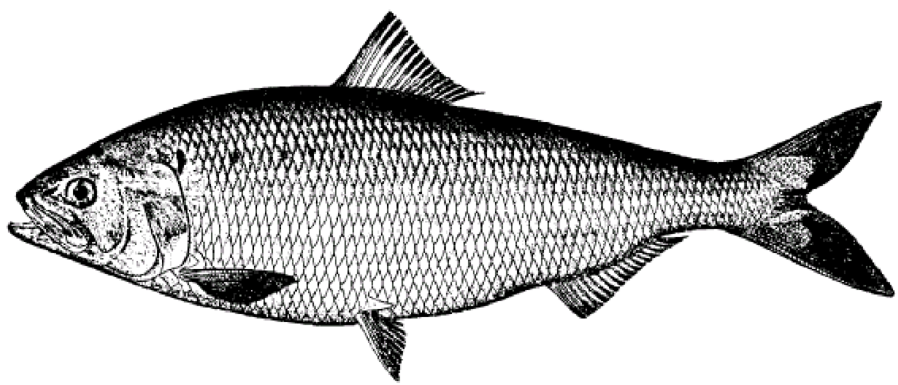
Now, we do take a roll call vote on all final actions and this is a final action, but I am just going to ask if there are any objections to this motion; and if there are none, we can probably dispense with the roll call vote. Are there any objections to this motion? **I see none; therefore, the motion passes unanimously.**

ADJOURNMENT

Okay, if there is no other business to come before the Shad and River Herring Board, this is probably the shortest board meeting I think we've had on record. It is a little bit frightening. If there is nothing else; we're going adjourn.

(Whereupon, the meeting was adjourned at 3:14 o'clock p.m. February 19, 2013.)

DRAFT REVIEW OF THE
ATLANTIC STATES MARINE FISHERIES COMMISSION
FISHERY MANAGEMENT PLAN FOR
SHAD AND RIVER HERRING *(Alosa spp.)*
2012



January 2013

<u>Shad & River Herring Plan Review Team</u>
Marin Hawk, Atlantic States Marine Fisheries Commission (Chair)
Claire Enterline, Maine Division of Marine Resources
Cheri Patterson, New Hampshire Fish and Game Department
Heather Corbett, New Jersey Division of Fish and Wildlife
Phil Edwards, Rhode Island Division of Fish and Wildlife
Genine Lipkey, Maryland Department of Natural Resources
Sara Winslow, North Carolina Division of Marine Fisheries
Chris Harper, Georgia Department of Natural Resources
Steve Meyers, NOAA Fisheries

DRAFT REVIEW OF THE ASMFC FISHERY MANAGEMENT PLAN FOR SHAD AND RIVER HERRING *(Alosa spp.)*

I. Status of the Fishery Management Plan

<u>Date of FMP Approval</u>: October 1985

<u>Amendments</u>: Amendment 1 (April 1999)
Amendment 2 (August 2009)
Amendment 3 (February 2010)

<u>Addenda:</u> Technical Addendum #1 (February 2000)
Addendum I (August 2002)

<u>Management Unit</u>: Migratory stocks of American shad, hickory shad, alewife, and blueback herring from Maine through Florida

<u>States With Declared Interest</u>: Maine through Florida, including the Potomac River Fisheries Commission and the District of Columbia

<u>Active Boards/Committees</u>: Shad & River Herring Management Board, Advisory Panel, Technical Committee, Stock Assessment Subcommittee, Plan Review Team, Plan Development Team

The 1985 Fishery Management Plan (FMP) for Shad and River Herring was one of the very first FMPs developed at the ASMFC. In 1994, the Management Board determined that the original 1985 FMP was no longer adequate for protecting or restoring the remaining shad and river herring stocks. As a result, Amendment 1 was adopted in October 1998. Amendment 1 required specific American shad monitoring programs, and also recommended member states and jurisdictions to initiate fishery-dependent and fisheries-independent monitoring programs for river herring and hickory shad, in order to improve stock assessment capabilities. Furthermore, Amendment 1 contains specific measures to control exploitation of American shad populations while maintaining the status quo in other alosine fisheries. The amended goal of the FMP is to protect, enhance, and restore East Coast migratory spawning stocks of American shad, hickory shad, and river herring (collectively alewife and blueback herring) in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass. The Plan further specifies four (4) management objectives as follows:

1) Prevent overfishing of American shad stocks by constraining fishing mortality below F_{30}
2) Develop definitions of stock restoration, determine appropriate target mortality rates and specify rebuilding schedules for American shad populations within the management unit
3) Maintain existing or more conservative regulations for hickory shad and river herring fisheries until new stock assessments suggest changes are necessary
4) Promote improvements in degraded or historic alosine habitat throughout the species' range

In the fall of 1999, the Technical Committee reviewed both state annual reports and fishing recovery plans. After doing so, the Technical Committee compiled a report that identified a number of technical errors requiring correction and/or clarification in Tables 2 and 3 of Amendment 1. Upon review by the Shad and River Herring Management Board, the Board concurred with the Technical Committee's report and suggested that a technical addendum be developed to address modifications to the states' fishery-dependent and independent monitoring program for American shad. The Board approved Technical Addendum #1 to Amendment 1 of the Interstate Fishery Management Plan for Shad and River Herring.

In February 2002, the Plan Review Team and the Technical Committee recommended several changes to both Amendment 1 and Technical Addendum #1. The Management Board approved the changes and directed the Commission staff to develop an addendum to both Amendment 1 and Technical Addendum #1. Addendum I does the following: changes the conditions for marking hatchery-reared alosines; clarifies the definition and intent of *de minimis* status for the American shad fishery; and modifies and clarifies the fishery-independent and dependent monitoring requirements of Tables 2 and 3 of Technical Addendum #1. These measures went into effect on January 1, 2003.

In August 2009, the Shad and River Herring Management Board approved Amendment 2, which deals only with river herring management. The Amendment prohibits commercial and recreational river herring fisheries in state waters beginning January 1, 2012, unless a state or jurisdiction has a sustainable management plan reviewed by the Technical Committee and approved by the Management Board. The Amendment defines a sustainable fishery as "a commercial and/or recreational fishery that will not diminish the potential future stock reproduction and recruitment." Submitted plans must clearly demonstrate that the state's or jurisdiction's river herring fisheries meet this new definition of sustainability through the development of sustainability targets which must be achieved and maintained. Amendment 2 required states to implement fisheries-dependent and independent monitoring programs similar to current requirements for American shad, and contains recommendations to member states and jurisdictions to conserve, restore, and protect critical river herring habitat. Sustainable fishery management plans have been approved by the Management Board for Maine, New Hampshire, New York, North Carolina and South Carolina (Table 1).

In February 2010, the Shad and River Herring Management Board approved Amendment 3, which revised American shad regulatory and monitoring programs. The Amendment was developed in response to the 2007 American shad stock assessment, which found that most American shad stocks were at all time lows and did not appear to be recovering. The Amendment requires similar management and monitoring as developed in Amendment 2. Specifically, Amendment 3 prohibits shad commercial and recreational fisheries in state waters beginning January 1, 2013, unless a state or jurisdiction has a sustainable management reviewed by the Technical Committee and approved by the Management Board. The Amendment defines a sustainable fishery as "a commercial and/or recreational fishery that will not diminish the potential future stock reproduction and recruitment." Submitted plans must clearly demonstrate that the state's or jurisdiction's American shad fisheries meet this new definition of sustainability through the development of sustainability targets which must be achieved and maintained. The Amendment allows any river systems to maintain a catch and release recreational fishery. Sustainable fishing plans have been approved by the Management Board for Florida, Georgia, South Carolina, North Carolina, the Potomac River Fisheries Commission, and the Delaware River Basin Fish and Wildlife Management Cooperative (on behalf of New York, Delaware, New Jersey, and Pennsylvania) and Connecticut (Table 1). All states and jurisdictions are also required to identify local significant threats to American shad critical habitat and develop a plan for mitigation and restoration.

Table 1. States with approved sustainable fishery management plans (SFP) for river herring or shad.

State	River Herring SFP	Shad SFP
Maine	Approved	
New Hampshire	Approved	
Massachusetts		
Connecticut		Approved
Rhode Island		
Pennsylvania		Approved
New York	Approved	Approved
New Jersey		Approved
Delaware		Approved
PRFC		Approved
Maryland		
Virginia		
North Carolina	Approved	Approved
South Carolina	Approved	Approved
Georgia		Approved
Florida		Approved

II. Status of the Stocks

While the FMP addresses four species including American shad, hickory shad, alewife, and blueback herring, lack of comprehensive and accurate commercial and recreational fishery data for the latter three species make it difficult to ascertain the status of these stocks. A stock assessment for American shad was completed in 1997 and submitted for peer review in early 1998 based on new information and Management Board recommended terms of reference. The 1998 assessment estimated fishing mortality rates for nine shad stocks and general trends in abundance for 13 shad stocks.

A coastwide American shad stock assessment was completed and accepted in August 2007. The 2007 assessment found that American shad stocks are currently at all-time lows and do not appear to be recovering. Recent declines of American shad were reported for Maine, New Hampshire, Rhode Island, and Georgia stocks, and for the Hudson (NY), Susquehanna (PA), James (VA), and Edisto (SC) rivers. Low and stable stock abundance was indicated for Massachusetts, Connecticut, Delaware, the Chesapeake Bay, the Rappahannock River (VA), and some South Carolina and Florida stocks. Stocks in the Potomac and York Rivers (VA) have shown some signs of recovery in recent years. Data limitations and conflicting data precluded the report from indicating much about the current status or trend of many of the stocks from North or South Carolina.

The 2007 report identified primary causes for stock decline as a combination of overfishing, pollution, and habitat loss due to dam construction. In recent years, coastwide harvests have been on the order of 500-900 metric tons, nearly two orders of magnitude lower than in the late 19th century. Given these findings, the peer review panel recommended that current restoration actions need to be reviewed and new ones need to be identified and applied. The peer review panel suggested considering a reduction of fishing mortality, enhancement of dam passage and mitigation of dam-related fish mortality, stocking, and habitat restoration.

A river herring stock assessment was completed in 1990 and looked at 15 river specific stocks. It concluded that five of the stocks were overfished and recruitment failure was apparent, and another four stocks were not overfished but had declined in recent years. In 2008, a new river herring stock assessment was initiated by the Management Board in response to concern over population decline and the impact of ocean bycatch. The stock assessment report concluded that, of the 52 stocks of alewife and blueback herring for which data were available, 23 were depleted relative to historic levels, one stock was increasing, and the status of 28 stocks could not be determined because the time-series of available data was too short. Estimates of abundance and fishing mortality could not be developed because of the lack of adequate data. The “depleted” determination was used instead of “overfished” and “overfishing” because of the many factors that have contributed to the declining abundance of river herring, which include not just directed and incidental fishing, but also habitat loss, predation, and climate changes.

III. Status of the Fisheries

American shad, hickory shad, and river herring formerly supported important commercial and recreational fisheries throughout their range. Fisheries are executed in rivers (both freshwater and saltwater), estuaries, tributaries, and oceans. Although recreational harvest data are scarce, most harvest is believed to come from the commercial industry. Commercial landings for all these species have declined dramatically from historic highs. Following is a summary of fisheries by species:

AMERICAN SHAD:

Total combined river and ocean commercial landings decreased from a high of 2,364,263 pounds in 1985 to a low of 1,390,512 pounds in 1999, but increased in 2000 to 1,816,979 pounds. The closure of the ocean-intercept fishery has lowered the coastwide total landings of American shad. The 2012 total landings reported in ASMFC Compliance Reports from individual states and jurisdictions in 2011 was 635,960 pounds, which is a 1% decrease from landings in 2011 (642,535 pounds).

Landings from North Carolina and South Carolina accounted for 37% and 47% of the commercial harvest, respectively, in 2012. The remainder of the harvest came from Connecticut, New York, New Jersey, PRFC, and Virginia. In 2012 New Hampshire, Massachusetts, Rhode Island, Pennsylvania, Delaware, Maryland, District of Columbia and Florida reported no directed shad harvest in their state Compliance Reports.

Table 2. American shad and river herring in-river commercial and ocean bycatch landings (in pounds) provided by states, jurisdictions and the NOAA Fisheries for 2012.

	American Shad	River Herring	Hickory Shad
Maine[4]		1,606,535	
New Hampshire		2,681	
Massachusetts			
Rhode Island			
Connecticut	61,623		
New York[1]	1,485	16,965	
New Jersey[2]	28,120	84	924
Pennsylvania			
Delaware			
Maryland		290	
D.C.			
PRFC	4,742		446
Virginia	4,601		999
North Carolina	235,861	678	65,645
South Carolina[3]	299,528	163,076	
Georgia[4]			
Florida			
Total	**635,960**	**1,790,309**	**68,014**

[1]New York American shad landings are from ocean bycatch
[2]Includes in-river and coastal harvest
[3]American shad landings include hickory shad
[4]Georgia & Maine (shad) landings are confidential

Substantial shad recreation fisheries occur on the Connecticut (CT and MA), Hudson (NY), Delaware (NY, PA and NJ), Susquehanna (MD), Santee and Cooper (SC), Savannah (GA), and St. Johns (FL) Rivers. Shad recreational fisheries are also pursued on several other rivers in Massachusetts, Virginia, North Carolina, South Carolina, and Georgia. In 2011, recreational creel limits ranged from zero to 10 fish per day. The exception to this is the Santee River (SC), which is permitted to have a 20 fish per day creel limit due to the approval of a conservation equivalency plan in 2000. Tens of thousands of shad are caught by hook and line from large east coast rivers each year, but detailed creel surveys are generally not available. Actual harvest (catch and removal) may amount to only about 20-40% of total catch, but hooking mortality could boost this "harvest" value substantially. Several comprehensive angler use and harvest surveys are planned or have been recently completed. In October 2006, the Management Board suspended the requirement to monitor the recreational fishery.

As of 2009, MRFSS data are no longer provided for American shad. This is a result of the unreliable design of MRFSS that focuses on active fishing sites along coastal and estuarine areas. In previous years the proportional standard error (PSE) has ranged from 0-100.

HICKORY SHAD:

In 2012, New Jersey, PRFC, Virginia and North Carolina reported hickory shad landings. North Carolina accounts for a vast majority of the landings with 97%. The coastwide commercial landings were 68,041 pounds in 2012, a 27% decrease from 2011 landings (93,334 pounds) (Table 2).

As of 2009, MRFSS data are no longer provided for hickory shad. This is a result of the unreliable design of MRFSS that focuses on active fishing sites along coastal and estuarine areas. In previous years the proportional standard error (PSE) has ranged from 0-100.

RIVER HERRING (BLUEBACK HERRING/ALEWIFE COMBINED):

Commercial landings of river herring declined 95% from over 13 million pounds in 1985 to about 700 thousand pounds in 2005. In 2012, river herring landings were reported from Maine, New Hampshire, New York, New Jersey, Delaware, Maryland, the Potomac River Fisheries Commission, Virginia, North Carolina, and South Carolina, totaling 1,790,309 pounds.

As of 2009, MRFSS data are no longer provided for river herring (alewife or blueback herring). This is a result of the unreliable design of MRFSS that focuses on active fishing sites along coastal and estuarine areas. In previous years the proportional standard error (PSE) has ranged from 0-100.

IV. Status of Research and Monitoring

Under Amendment 2 (2009) and Amendment 3 (2010), fishery-independent and fishery-dependent monitoring programs are now mandatory for American shad and river herring. Juvenile abundance index (JAI) surveys, annual spawning stock surveys (Table 3), and hatchery evaluations are required for states and jurisdictions. All States are required to calculate mortality and/or survival estimates, and monitor and report data relative to landings, catch, effort, and bycatch. States must submit annual reports including all monitoring and management program requirements, on or before July 1 of each year.

Table 3. American shad and river herring passage counts at select rivers along the Atlantic Coast in 2012.

State/River	Shad	River Herring
Maine		
Androscoggin	11	170,191
Saco	6404	27,858
Kennebec	5	179,357
Sebasticook	163	1,703,520
St. Croix		36,168
New Hampshire		
Cocheco		27,608
Oyster		2,573
Lamprey		86,862
Exeter		378
Taylor		92
Winnicut		5
Massachusetts		
Merrimack	21,396	
Rhode Island		
Gilbert Stuart		107,901
Nonquit		60,132
Buckeye Brook		90,625
Pennsylvania/Maryland/Delaware		
Susquehanna (Conowingo)	23,629	52
Susquehanna (Holtwood)	4,238	
South Carolina		
St. Stephen Dam	150,082	
Total 2012	205,928	
Total 2011	307,793	

In addition to the mandatory monitoring requirements stipulated under Amendments 2 and 3, some states and jurisdictions continue important research initiatives for these species. For example, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, and USFWS are actively involved in shad restoration using hatchery-cultured fry and fingerlings. All hatchery fish are marked with oxytetracycline marks on otoliths to allow future distinction from wild fish. During 2012, several jurisdictions from reared American shad, hickory shad, and alewife, stocking a total of 15,727,734 American shad and 380,663 alewife (Table 4).

Table 4. Stocking of Alosines in State Waters, 2012.

State	American Shad	Alewife
Maine		
Androscoggin		138,941
Kennebec		88,092
Union River		153,630
Massachusetts		
Merrimack	2,100,000	
Charles River	3,300,000	
Pennsylvania		
Susquehanna	3,438,500	
Lehigh	301,112	
Schuykill	200,429	
North Carolina		
Roanoke River	4,800,118	
South Carolina		
Edisto River	2,465	
Santee River	1,585,110	
Total	**15,727,734**	**380,663**

V. Status of Management Measures

All state programs must implement commercial and recreational management measures or an alternative program approved by the Management Board. The current status of each state's compliance with these measures is provided in the Shad and River Plan Review Team Report.

As noted in Section I, the Management Board determined that the original FMP and its lack of mandatory measures were insufficient for protecting and restoring alosine stocks along the East Coast. Accordingly, the 1985 FMP was amended in 1999. The Plan Development Team (PDT) developed Amendment 1 to expedite recovery of American shad populations and maintain current regulations in the hickory shad and river herring fisheries. In addition, the Management Board voted to phase out all ocean intercept fisheries for American shad within five years of Amendment 1 implementation. All states have closed their ocean-intercept fisheries as of January 1, 2005. For recreational fisheries, the states voted to implement a 10 fish combined daily creel limit for American and hickory shad. In October of 2000, the Board approved a 10 fish per day creel limit (combined American and hickory shad) for all waters of South Carolina except the Santee River, which will have a 20 fish, combined daily limit.

In 2009 the Board approved Amendment 2, which was initiated in response to concerns over river herring stock. The Amendment prohibits state waters commercial and recreational fisheries beginning January 1, 2012, unless a state or jurisdiction has a sustainable management plan reviewed by the Technical Committee and approved by the Management Board and requires states to implement fisheries-dependent and independent monitoring programs. The monitoring requirements in Amendment 2 go into effect January 1, 2010. Sustainable fishery management plans have been approved by the Management Board for Maine, New Hampshire, New York, North Carolina and South Carolina.

In 2010, the Board approved Amendment 3, which revised American shad regulatory and monitoring programs under Amendment 1. The Amendment was developed in response to the 2007 American shad stock assessment, which found that most American shad stocks were at all time lows and did not appear to be recovering. The Amendment requires similar management and monitoring as developed in Amendment 2, specifically the development of a Sustainable Fishing Management Plan (SFP) for any jurisdiction that will maintain a commercial or recreational fishery after January 1, 2013 (with the exception of catch and release recreational fisheries). The monitoring requirements under Amendment 3 go into effect January 1, 2011. SFPs have been approved by the Management Board for Florida, Georgia, South Carolina, North Carolina, the Potomac River Fisheries Commission, Connecticut and the Delaware River Basin Fish and Wildlife Management Cooperative (on behalf of New York, Delaware, New Jersey, and Pennsylvania).

V. Prioritized Research Needs

Fishery-Dependent Priorities

High

- Expand observer and port sampling coverage to quantify additional sources of mortality for alosine species, including bait fisheries, as well as rates of bycatch in other fisheries to reduce uncertainty.[1]

Moderate

- Identify directed harvest and bycatch losses of American shad in ocean and bay waters of Atlantic Maritime Canada.

Low

- Identify additional sources of historical catch data of the US small pelagic fisheries to better represent earlier harvest of river herring and improve model formulation.

Fishery-Independent Priorities

Moderate

- Develop demersal and pelagic trawl CPUE indices of offshore river herring biomass.

Modeling / Quantitative Priorities

High

- Conduct population assessments on river herring, particularly in the south.[2]
- Analyze the consequences of interactions between the offshore bycatch fisheries and population trends in the rivers.
- Quantify fishing mortality for major river stocks after ocean closure of directed fisheries (river, ocean bycatch, bait fisheries).
- Improve methods to develop biological benchmarks used in assessment modeling (fecundity-at-age, sex specific mean weight-at-age, partial recruitment vector/maturity schedules) for river herring and American shad of both semelparous and iteroparous stocks.
- Improve methods for calculating M.

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[1] A prior statistical study of observer allocation and coverage should be conducted (see Hanke et al. 2012).

[2] A peer reviewed river herring stock assessment was completed in 2012 by the ASMFC.

Moderate

- Consider standardization of indices with a GLM to improve trend estimates and uncertainty characterization.
- Explore peer-reviewed stock assessment models for use in additional river systems as more data become available.

Low

- Develop models to predict the potential impacts of climate change on river herring distribution and stock persistence.

Life History, Biological, and Habitat Priorities

High

- Conduct studies to quantify and improve fish passage efficiency and support the implementation of standard practices.
- Assess the efficiency of using hydroacoustics to repel alosines or pheromones to attract alosines to fish passage structures. Test commercially available acoustic equipment at existing fish passage facilities. Develop methods to isolate/manufacture pheromones or other alosine attractants.
- Investigate the relationship between juvenile river herring/American shad and subsequent year class strength, with emphasis on the validity of juvenile abundance indices, rates and sources of immature mortality, migratory behavior of juveniles, and life history requirements.
- Develop an integrated coastal remote telemetry system or network that would allow tagged fish to be tracked throughout their coastal migration and into the estuarine and riverine environments.
- Verify tag-based estimates of American shad.
- Continue studies to determine river herring population stock structure along the coast and enable determination of river origin of catch in mixed stock fisheries and incidental catch in non-targeted ocean fisheries. Spatially delineate mixed stock and Delaware stock areas within the Delaware system. Methods to be considered could include otolith microchemistry, oxytetracycline otolith marking, genetic analysis, and/or tagging.[3]
- Validate the different values of M for river herring and American shad stocks through shad ageing techniques and repeat spawning information.
- Continue to assess current ageing techniques for river herring and American shad, using known-age fish, scales, otoliths, and spawning marks. Conduct biannual ageing workshops to maintain consistency and accuracy of ageing fish sampled in state programs.[4]
- Summarize existing information on predation by striped bass and other species. Quantify consumption through modeling (e.g., MSVPA), diet, and bioenergetics studies.
- Refine techniques for tank spawning of American shad. Secure adequate eggs for culture programs using native broodstock.

Moderate

- Determine the effects of passage barriers on all life history stages of American shad and river herring. Conduct studies on turbine mortality, migration delay, downstream passage, and sub-lethal effects.

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[3] Genetic research currently underway in combination with otolith chemistry.
[4] River herring ageing workshop to occur in 2013.

- Evaluate and ultimately validate large-scale hydroacoustic methods to quantify river herring and American shad escapement in major river systems.
- Conduct studies of egg and larval survival and development.
- Conduct studies on energetics of feeding and spawning migrations of American shad on the Atlantic coast.
- Resource management agencies in each state shall evaluate their respective state water quality standards and criteria and identify hard limits to ensure that those standards, criteria, and limits account for the special needs of alosines. Primary emphasis should be on locations where sensitive egg and larval stages are found.
- Encourage university research on hickory shad.
- Develop better fish culture techniques, marking techniques, and supplemental stocking strategies for river herring.

Low

- Characterize tributary habitat quality and quantity for Alosine reintroductions and fish passage development.
- States should identify and quantify potential shad and river herring spawning and nursery habitat not presently utilized, including a list of areas that would support such habitat if water quality and access were improved or created, and analyze the cost of recovery within those areas. States may wish to identify areas targeted for restoration as essential habitat.[11]
- Investigate contribution of landlocked versus anadromous produced river herring.

VII. PRT Recommendations

State Compliance

All states with a declared interest in the management of shad and river herring have submitted reports and have regulations in place that meet the requirements of the Interstate Fisheries Management Plan for Shad and River Herring. The PRT notes, however, that some states were not able to complete the required fishery independent monitoring due to budgetary restrictions.

1. Several of the states did not report all of the monitoring requirements listed under Amendments 2 and 3 (see PRT Report). The states should take note of the required monitoring programs that were not reported and make concerted effort to report all monitoring programs in forthcoming annual reports (most common omissions were: variance, length frequency, age frequency and degree of repeat spawning).

2. The PRT requests that for those states and jurisdictions that share monitoring should report who was responsible for the required monitoring in lieu of not including the information.

3. The PRT requests the Board task the TC with the following tasks:
    a. Review of recreational compliance and the ability of states to provide recreational data. A majority of states rely on MRIP for catch estimates and do not have survey data of their own.
    b. Review methods to ensure states submit data that were previously unavailable (if a state is still completing sampling when the compliance report is turned in, a follow-up version should be sent when the sampling is completed).

De Minimis Status

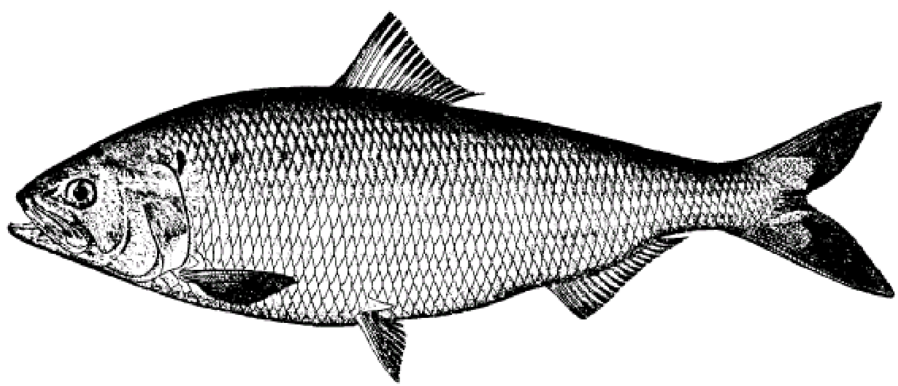
Maine, New Hampshire and Massachusetts have requested *de minimis* status for the 2013 American shad fisheries. New Hampshire and Massachusetts also requested *de minimis* status for the 2013 river herring fisheries. These states continue to meet the standards for commercial *de minimis* as defined in Amendment 2 and Amendment 3. The following states had landings that were reported to be less than 1% of the coast-wide commercial landings for American shad: Maine, New Hampshire, Massachusetts, Rhode Island, New York, Pennsylvania, Delaware, Maryland, PRFC, D.C., Virginia, and Florida. All of the above states except Maine and New York also had landings that were reported to be less than 1% of the coast-wide commercial landings for river herring. Connecticut, New Jersey and North Carolina also qualify for *de minimis* status for river herring.

Atlantic States Marine Fisheries Commission
Report to the American Shad and River Herring Management Board

2013 REVIEW OF SHAD & RIVER HERRING

ANNUAL STATE COMPLIANCE REPORTS

FOR 2012 FISHING YEAR



January 2014

Shad & River Herring Plan Review Team

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REVIEW OF SHAD AND RIVER HERRING ANNUAL COMPLIANCE REPORTS

INTRODUCTION

In accordance with the Shad and River Herring Fishery Management Plan, the states are required to submit an annual compliance report by July 1st of each year. The Plan Review Team reviewed all state reports for compliance with the mandatory measures in Amendments 2 (River Herring) and 3 (American shad). The following report provides an evaluation of each state program.

STATE-BY-STATE REVIEW

MAINE

De minimis

- The state of Maine requests *de minimis* for the commercial fishing year 2013 in the American shad fishery.

Comments or trends highlighted in state report:

- American shad recreational catch estimates = 17,620 fish and 0 harvest (MRIP).
- Comparing the juvenile CPUE to past years, American shad CPUE were above average in Merrymeeting Bay, the Cathance, Abbagaadasset, Eastern, and lower Kennebec rivers, but below average in the Androscoggin and upper Kennebec rivers.
- 1,370,154 pounds of river herring reported harvested by towns. Fisheries dependent sampling not available.
- MRIP estimates for alewife = 16,781 caught and 4,737 harvested and no blueback caught or harvested.
- Comparing the JAI CPUE to past years, alewife CPUE was above average only in the lower Kennebec River (where it was also the highest on record), but below average in all other river portions
- River herring run counts were above average for Saco, Androscoggin, Kennebec and Sebasticock rivers and below average in the St. Croix river

Unreported information / Compliance Issues:

- Both shad and river herring JAI variance was not reported
- 30 American shad scale samples taken but not analyzed by compliance report due date; these samples should be sent to FMP Coordinator as soon as data are available

Sturgeon bycatch report:

- There was no known bycatch of Atlantic or shortnose sturgeon within the recreational fishery.

NEW HAMPSHIRE

***De minimis*:**

- The state of New Hampshire requests *de minimis* status for the commercial and recreational fishing year 2013 for the American shad and river herring fisheries.

Comments or trends highlighted in state report:

- River herring SFMP target met for 2011 – exploitation rate <20% (4.7%) and returns >72,293 fish (117,518 fish).
- 2,681 pounds river herring reported harvested from New Hampshire waters through mandatory coastal harvest reports
- Recreational harvest estimates for river herring were 6,679 fish through the NHF&G Marine Recreational Survey (MRIP)

- A few tickets were issued for harvest of river herring on closed days.
- Since 2007 JAI for alewife and blueback herring have been declining.
- Zero shad were harvested form New Hampshire waters in 2012

Unreported information / Compliance Issues:

- None identified

Sturgeon bycatch report:

- No protected species were reported taken as bycatch from New Hampshire's coastal harvest program.

MASSACHUSETTS

***De minimis*:**

- The Commonwealth of Massachusetts requests *de minimis* for the commercial fishing year 2013 for the American shad and river herring fisheries.

Comments or trends highlighted in state report:

- Dealer reporting = 10 pounds of shad landed by otter trawl.
- MRIP estimates = 0 shad caught with 0 harvest.
- 5 reports of violations for illegal possession and illegal possession and use of shad as bait

Unreported information / Compliance Issues:

- JAI survey information was not available/completed for shad or river herring.

Sturgeon bycatch report:

- No sturgeon interactions were reported in 2012.

RHODE ISLAND

Comments or trends highlighted in state report:

- None identified.

Unreported information / Compliance Issues:

- None identified.

Sturgeon bycatch report:

- No sturgeon interactions were reported in 2012.

CONNECTICUT

Comments or trends highlighted in state report:

- The preliminary 2012 landings are 61,623 pounds (13,168 fish) of American shad from drift gillnets through harvester catch reporting.
- Shad spawning population relies on a few age classes and low rates of repeat spawners.

Unreported information / Compliance Issues:

- Why are the 2012 numbers (shad) still preliminary?
- Estimation of shad effort is unclear.
- No length or age for losses in the shad commercial fishery.
- Table 1 harvest and losses do not match up with text (research losses)

- Did not calculate variance for river herring JAI and there is no mention of spawning stock assessment or annual mortality
- No characterization of recreational directed harvest for 2012, no creel survey conducted

Sturgeon bycatch report:
- A total of 9 sturgeons (species unclassified) were reported as caught and released by shad fishermen in 2011.

NEW YORK

Comments and trends highlighted in state report:
- Commercial and recreational shad fishery closed in 2010.
- Mandatory reporting of river herring harvest = 7,264 pounds landed in Hudson River.
- ~29,000 pounds bycatch of unclassified herring reported through ACCSP; the portion of river herring is unknown
- River herring spawning stock survey – 74:24 male:female alewife and 48:52 male:female blueback herring.

Unreported Information / Compliance Issues:
- No information given on other losses, although this should have been reported
- Scales were taken in the river herring commercial fishery but no ages were provided
- No recreational sampling in 2012 (river herring).
- Other losses were not addressed for river herring.

Sturgeon bycatch report:
- No data collected due to fishery closure.

NEW JERSEY

Comments or trends highlighted in state report:
- 752 pounds shad reported landed through mandatory commercial logbooks. Virtually no effort since directed fishery in coastal waters was closed.

Unreported Information / Compliance Issues:
- No biological samples were taken from the shad or river herring commercial fishery.
- No recreational information provided for river herring.
- Need to include more information on river herring.
- No biological data given (except for length frequencies) for shad or river herring from the ocean trawl surveys for coastal stocks

Sturgeon bycatch report:
- See Delaware Cooperative.

PENNSYLVANIA

Comments or trends highlighted in state report:
- No commercial fishery for shad or river herring on Susquehanna; recreational fishery prohibited in 2011 for river herring; no recreational fishery for shad in Susquehanna.

Unreported Information / Compliance Issues:
- No mention of management plan

- Annual mortality rates only up to 2007 for shad
- No biological sampling for river herring because of low catches

Sturgeon bycatch report:
No data collected due to fishery closure.

DELAWARE BASIN F&W COOPERATIVE

Comments or trends highlighted in state report:

- Commercial landings in the Delaware Estuary and Bay as reported to New Jersey in their directed fishery (27,368 pounds) increased over landings reported for 2009-2011, but remained below the ten year average (71,261 pounds) reported in the 2000's (2000 – 2009).
- Landings of American shad as bycatch in their striped bass fishery reported to Delaware declined in 2012 (2,618 pounds) to the lowest level since 1985.
- Adult American shad abundance in the Delaware River estimated in 2012 continued an increasing trend since 2009, based on gill net CPUE (14.7 shad/foot-hr) at Smithfield Beach (RM 218).
- Commercial catches of river herring were 39 pounds in New Jersey. The river herring fishery was closed in the State of Delaware jurisdictional waters. No estimates of angler use and harvest of recreational river herring or hickory shad catches were available for 2012.

Unreported information / Compliance Issues:

- Other losses for shad not characterized
- No biological data for commercial river herring fishery
- Fishery independent data for shad are given, but the variance values were not explicitly stated, requiring PRT members to do the calculations
- No estimation of effort for river herring
- No characterization for other losses for river herring recreational or commercial
- No information on spawning stock assessment given for river herring

Sturgeon bycatch report:

- According to logbooks collected from New Jersey commercial shad fishers there were 11 Atlantic sturgeon caught as bycatch during 2012 in Delaware Bay. All sturgeon were released alive at the time of tending the net.

MARYLAND

Comments or trends highlighted in state report:

- American shad and river herring commercial fishery is closed; catch and release only
- Catch and release mortality estimated at 144 shad.
- No trend in Nanticoke and Patuxent Rivers shad JAI; increasing in Upper CB and Potomac River.
- Choptank River 92% hatchery origin (shad)
- Conowingo Dam tailrace population estimated at 111,550 shad.
- Alewife and blueback JAI CPUE decreased in 2012

Unreported / Compliance Issues:

- No spawning stock data for river herring collected in 2012; program currently being developed for 2014

Sturgeon bycatch report:

- The Atlantic sturgeon bycatch for Maryland's American shad ocean intercept fishery has been zero since this fishery was closed in 2005.

DISTRICT OF COLUMBIA

Comments or trends highlighted in state report:

- River herring and shad directed fisheries are closed

Unreported information / Compliance Issues:

- No ageing has been done for American shad or river herring, thus age frequency, degree of repeat spawning and mortality estimates have not been reported.
- **Overall lack of information led to several required elements missing**.

Sturgeon bycatch report:

- There were no documented sturgeon captures reported in the District of Columbia during 2012.

POTOMAC RIVER FISHERIES COMMISSION

Comments or trends highlighted in state report:

- The PRFC established a moratorium on river herring for recreational and charter fishing.
- Commercial fishing for river herring and shad was prohibited in 2012.
- American shad restoration target (31.1) was exceeded for the second year in a row in 2012 (36.6)
- 2012 JAI indices for American shad are significantly higher than the 2011 indices

Unreported information / Compliance Issues:

- Please include information in the report, even if it is also contained in another report
- Variances for juvenile shad indices are missing

Sturgeon bycatch report:

- In 2012, there were no Atlantic sturgeon captures in the Potomac River

VIRGINIA

Comments or trends highlighted in state report:

- River herring and shad fisheries closed to both commercial and recreational fishing
- The strength of the James River catch index continues to rely on the prevalence of hatchery fish.

Unreported information / Compliance Issues:

- Due to lack of available funding, the annual spawning stock survey, biological sampling, and resulting calculation of mortality and/or survival estimates were not performed in 2012 for river herring. This is also expected for 2013.

Sturgeon bycatch report:

- Atlantic sturgeon is taken as bycatch in the staked gill nets used by VIMS to monitor abundance of adult American shad in the James, York, and Rappahannock rivers. In 2012, a total of 4 Atlantic sturgeon were caught as bycatch, all in the James River.

NORTH CAROLINA

Comments and trends highlighted in state report:

- 235,861 pounds of shad were reported landed ($257,748) through the trip ticket program primarily from gill nets (99%+).
- Juvenile American and hickory shad catches have been consistently low since the survey began in 1972.

Unreported information / Compliance Issues:

- Characterization of other losses for shad was lacking
- No recreational or commercial gear data for shad were collected
- No incidence of repeat spawning
- Missing sturgeon bycatch information

Sturgeon bycatch report:

- Did not provide information. In the future, please include the sturgeon bycatch in the Shad and River Herring Compliance report.

SOUTH CAROLINA

Comments and trends highlighted in state report:

- 299,528 pounds shad reported through NOAA Fisheries (100% in-river)
- In 2012, observed sex ratios were 35.6 females per males in the Santee River and 2.6 per males in the Waccamaw River. The high occurrence of females in these samples is most likely due to the marketability of females vs. males.

Unreported information / Compliance Issues:

- Spawning stock assessment data rely on 1985 data; data is likely not relatable to current conditions; why are these data not collected?

Sturgeon bycatch report:

- Atlantics – 205 total with 38% from Santee, 32% from the Winyah Bay, 25% from the Waccamaw River and 5% from Savannah. Shortnose – 35 total with 12 from the Santee, 1 from the Winyah Bay, 6 from the Waccamaw River and 16 from Savannah River.

GEORGIA

Comments and trends highlighted in state report:

- In 2012 American shad commercial landing were confidential.
- A creel survey was not conducted in 2012.
- The population of American shad in the Altamaha River in 2012 was 313,427 shad, a 12% increase from 2011.

Unreported information / Compliance Issues:

- Need to report updated requirements from Amendment 3
- Need to report variance for JAI .
- Length frequency for spawning stock assessment not reported.

Sturgeon bycatch report:

- Atlantic and shortnose sturgeon are caught in gill nets. In drift nets, essentially 100% of the sturgeon can be released unharmed. During 15 field days of tagging adult shad in 2012, 24 Atlantic and 9 shortnose sturgeon were captured in drift gill nets. All sturgeon were released unharmed.

FLORIDA

Comments and trends highlighted in state report:

- No commercial fishery exists for shad or river herring.

Unreported information / Compliance Issues:

- No data for other losses
- No mortality estimates\
- Length frequency for spawning stock assessment not reported

Sturgeon bycatch report:

- No netting is allowed for shad, so no sturgeon bycatch is expected.

State of Maine Annual State Compliance Report 2012

ASMFC American Shad and River Herring Interstate Plan

Prepared by the Maine Department of Marine Resources

1. American Shad / Hickory Shad

Commercial Fishery

Effective May 19, 1998, the Maine Department of Marine Resources (MDMR) closed all state waters to commercial fishing for American shad. Hickory shad may be present in Maine's coastal waters during the spring, summer, or fall. Confirmed catches of hickory shad in the commercial sector, recreational fishery, or state sponsored semi-annual trawl surveys conducted in Maine have not occurred in several years.

Characterization of Directed Harvest

There is no directed commercial harvest of American shad in Maine waters. Based on commercial landings data collected through VTR datasheets, when trips did report American shad bycatch, the shad bycatch made up <1% of the total catch 99.6% of the time, and <10% in all cases.

Characterization of Bycatch

There was American shad bycatch in commercial fisheries in state waters during 2012. The total number and weight are difficult to assess due to the low number of sampling visits, misreporting on VTR's or landings forms, and misidentification by harvesters. Bycatch of American shad occurs in the near shore fish trap/weir fisheries, the near shore stop and purse seine fisheries targeting Atlantic herring and Atlantic mackerel, as well as offshore gill nets targeting groundfish.

The National Marine Fisheries Service compiles all ocean bycatch for American shad in EEZ waters. Gill net, trap net and trawl fisheries take American shad in nearshore fisheries while targeting other species. Reports of shad catches are increasing since Maine closed near shore waters to the commercial harvest of all groundfish species during the months of April, May, and June. The largest proportion of shad take in the commercial fishery occurs in the offshore groundfish gill net fishery, though some also occurs in bottom trawl net fisheries. Most American shad bycatch occurs between the months of June and September.

Shad landings were omitted due to confidentiality rules.

Since the moratorium on directed American shad fishing was established in 1998, the average amount of American shad kept has been 465 lbs, the highest was 2,078 lbs in 2009, and the lowest was 18 lbs in 2004. The average amount discarded has been 1,953 lbs, the highest 8,683 lbs in 2011 and the lowest 2 lbs in 2008 (Table 1.2). Despite the increase in the amount of shad discards, the relative amount of shad caught compared to the total catch during these trips remained a very low (2012 average 2.48% shad compared to total catch, min = 0.06%, max = 6.98%).

In addition to information about American shad from landings data, the Department of Marine Resources worked with three near-shore fisherman in 2011-2012 to develop gear modifications to reduce American shad and river herring bycatch in floating pound net traps targeting Atlantic mackerel. Floating pound nets are set in very near-shore areas, typically no further than 300 meters from shore. Nets fish passively, are non-discriminatory regarding species catch, and are hauled on a daily basis at the same time each day in the early morning. Trials were conducted at three locations in southern Maine: Richmond Island in Cape Elizabeth (net dimensions, surface: 70’ x 90’; depth: 30’; 1.6” mesh); Bailey Island in Harpswell (surface: 60’ x 90’; depth 30’; 1.6” mesh); and Hermit Island in Phippsburg (70’ x 90’; depth: 30’; 1.6” mesh). Five gear manipulations were tested: a large (8’x8’) mesh panel (2” mesh size), a small (2’x4’) mesh panel (3” mesh size), two vertical bar grates (1/2” and 3/8” bar spacing), and a 6” mesh size leader. Sampling hauls generally alternated between gear manipulation and control trials on a three-day rotation. During each trip, a portion of the total catch was sampled for species composition and length was recorded for a sub-sample of each species.

The primary objective of the project was to determine if bycatch of juvenile (age 1-3) alewife, blueback herring, and American shad could be reduced by manipulating fishing gear, while maintaining target species catches. Of all gear manipulation types, the large (8’x8’) mesh panel consistently reduced the catch of American shad bycatch while statistically maintaining mackerel catch. However, while the mackerel catch was not statistically different between control and gear manipulation hauls, the average catch using the panel was less than control trials (231.0 < 389.8). The 6” mesh size leader trials also showed reduced American shad catch and increased mackerel catches, however, comparisons between control trials and 6” mesh leader trials were performed in different years and therefore differences in catch may be due more to inter-annual variability. Results are shown in Table 1.2.

Recreational Fishery

Effective May 19, 1998:

It is unlawful for any person to possess more than two (2) American shad per day taken from the coastal waters of Maine.

It is unlawful to fish for or take American shad from the coastal waters of the state by any method other than hook and line.

Closed Areas. It is unlawful to fish for any species within 150 feet of any dam with a fishway.

Anglers must first register as a saltwater recreational fisher with the State of Maine through either the Dept. of Inland Fish and Wildlife or the Dept. of Marine Resources.

Characterization of Directed Recreational Fishery

The Marine Recreational Information Program (MRIP) program records recreational catch and effort for Maine waters. The estimated catch of American shad from the MRIP in 2012 was 17,620 fish with a PSE of 67.0 (Table 1.3). The estimated harvest was zero fish with no estimation of PSE.

Maine’s Department of Marine Resources has no program to monitor recreational catches of American shad or river herring in Maine’s coastal waters. American shad, alewife, and blueback herring data collected is ancillary to striped bass data collected during the MRIP survey.

Characterization of Other Recreational Fishery Losses

Not determined.

Other Losses (fish passage mortality, research, etc.)

There were few losses of American shad resulting from mortalities in fish passage facilities, hatcheries, research, etc. Limited mortality occurred at the Cataract Project on the Saco River: 71 American shad mortalities were observed below the east channel fishlift, representing 1.2% of the total number of American shad passed at the Cataract Project (Table 1.5).

Harvest and Losses Table

Harvest and losses as bycatch in commercial fisheries is shown in Tables 1.1 and 1.2.
Harvest and catches (caught and released) as part of the recreational fishery are shown in Table 1.4.
Mortality that occurred as part of fishway passage or sampling is shown in Table 1.5.

Protected Species

Since the American shad recreational fishery is restricted to a hook and line fishery, there was no known bycatch of Atlantic or shortnose sturgeon.

Required Fishery-Independent Monitoring

Required Work Under Amendment 3

Required for the Androscoggin River and Saco River:

1) Annual spawning stock survey and representative sampling for biological data.

2) Calculation of mortality and/or survival estimates.

3) Juvenile index
Notrequired, but conducted for the Kennebec River.

4) Hatchery evaluation.

Work Performed

Spawning stock

Fisheries personnel monitor American shad during their spawning migration at the Brunswick Fishway on the Androscoggin River (vertical slot constructed in 1982), the Cataract Project on the Saco River (Denil on west channel, fish lift on east channel; both operational June 1993), the Lockwood Dam on the Kennebec River in Waterville (operational 2006), and at the Benton Falls fishlift on the Sebasticook River (operational 2006).

Calculation of mortality and/or survival estimates

From each of these fishways (Brunswick fishway, Cataract Project, Lockwood fishlift, and Benton Falls fishlift), biological sampling (length, weight, sex, and scale sample) is not performed on

American shad because the run levels continue to be extremely low, and any handling may cause mortality. Sampling is performed on American shad that have experienced fish passage mortality, however because no passage mortality has occurred at the Brunswick fishway, Lockwood fishlift, or Benton Falls fishlift in 2012 or many previous years, it is not possible to calculate mortality/survival estimates.

On the Saco River Cataract Project, NextEra biologists only collect biological data from adult shad that die during fish lift operations or during transport. The Maine Department of Marine Resources (DMR) made this management decision in 1993 when the size of the run was unknown. Since that time, the Saco River shad run remains at levels below expectations and any additional handling may increase the mortality of spawning fish. The only scale samples collected come from mortalities resulting in trucking shad to spawning habitat upstream of a series of hydropower dams and fish lift operations. Because of this, scale samples are taken from too few fish to reliably calculate mortality estimates using either the Chapman-Robson, Heineken, or catch curve analysis methods.

Juvenile alosine index

In 1979, MDMR established the Juvenile Alosine Survey for the Kennebec/Androscoggin estuary to monitor the abundance of juvenile alosines at 14 permanent sampling sites. Four sites are on the upper Kennebec River, three on the Androscoggin River, four on Merrymeeting Bay, one each on the Cathance, Abadagasset, and Eastern rivers. These sites are in the tidal freshwater portion of the estuary. Since 1994, MDMR added six additional sites in the lower salinity-stratified portion of the Kennebec River.

Hatchery evaluation

There was no hatchery evaluation conducted in 2011. The hatchery closed in 2009 with no plans to reopen the hatchery due to funding and current management of American shad along the East Coast.

Results

Spawning Stock Assessment

Fisheries personnel counted all adults captured at four hydropower sites. In 2012, fishway personnel counted and passed upstream 11 American shad in the trap at the Brunswick Fishway on the Androscoggin River, and 163 at the Benton Falls fishlift on the Sebasticook River. At the Lockwood Dam on the Kennebec River, 5 American shad were captured, a fin clip taken from the upper caudal fin, and then released downstream (Table 1.6).

On the Saco River NextEra biologists counted a total of 6,404 American shad (6,221 passing the East Channel Dam, and 183 passing the West Channel Dam). In addition to the 6,221 American shad successfully passing through the Cataract East Channel fishway, a total of 68 shad mortalities were noted. This represents a total fishway mortality of 1.2 %, which is similar to past years: 1995 (3.5%), 1996 (4.8%), 1997 (2.7%), 1998 (3.5%), 1999 (2.6%), 2000 (2.7%), 2001 (2.4%), 2002 (2.8%), 2003 (2.5%), 2004 (3.0%), 2005 (2.6%), 2006 (2.8%), 2007 (3.0%), 2008 (2.9%), 2009 (4.8%), 2010(1.9%), 2011 (2.1%). Scale samples from 30 shad mortalities will be aged and are not available at this time. The majority of the mortalities drifted downstream and were discovered at the end of the upper flume area on the water diffusion screen. These fish can only be sampled when the upper flume is drained. As a result, many of these fish are in various stages of decomposition and biological data collection was difficult.

Calculation of mortality and/or survival estimates

From each of these fishways (Brunswick fishway, Cataract Project, Lockwood fishlift, and Benton Falls fishlift), biological sampling (length, weight, sex, and scale sample) is not performed on American shad because the run levels continue to be extremely low, and any handling may cause mortality. Sampling is performed on American shad that have experienced fish passage mortality, however because no passage mortality has occurred at the Brunswick fishway, Lockwood fishlift, or Benton Falls fishlift in 2012 or many previous years, it is not possible to calculate mortality/survival estimates.

On the Saco River Cataract Project, NextEra biologists only collect biological data from adult shad that die during fish lift operations or during transport. The Maine Department of Marine Resources (DMR) made this management decision in 1993 when the size of the run was unknown. Since that time, the Saco River shad run remains at levels below expectations and any additional handling may increase the mortality of spawning fish. The only scale samples collected come from mortalities resulting in trucking shad to spawning habitat upstream of a series of hydropower dams and fish lift operations. Because of this, scale samples are taken from too few fish to reliably calculate mortality estimates using either the Chapman-Robson, Heineken, or catch curve analysis methods.

Juvenile Indices

In 1979, MDMR established the Juvenile Alosine Survey for the Kennebec/Androscoggin estuary to monitor the abundance of juvenile alosines at 14 permanent sampling sites. Four sites are on the upper Kennebec River, three on the Androscoggin River, four on Merrymeeting Bay, one each on the Cathance, Abadagasset, and Eastern rivers. These sites are in the tidal freshwater portion of the estuary. Since 1994, MDMR added six additional sites in the lower salinity-stratified portion of the Kennebec River.

A total of 1,139 American shad were caught in the 2012 juvenile survey – 532 were caught at the standard stations while 607 American shad were caught at the experimental stations. The highest catch per unit effort (CPUE, number of shad caught per total number of hauls within each river portion) among river portions was in the Eastern River, and the lowest in the Androscoggin River (Table 1.7). Comparing the CPUE to past years, American shad CPUE were above average in Merrymeeting Bay , the Cathance, Abbagaadasset, Eastern, and lower Kennebec rivers, but below average in the Androscoggin and upper Kennebec rivers. The CPUE for the Eastern and lower Kennebec rivers were the highest recorded at those sites, and fourth highest for the Cathance River (Table 1.8). Combining all river portions, the highest CPUE for American shad was in August. Considering river portions separately, the highest CPUE in July was in the Eastern River, in August in the Lower Kennebec River, in September in Merrymeeting Bay, and in October in the Abbagadasset River (Table 1.9).

Adult striped bass were once again scarce in the Kennebec River during 2011. Several other species of interest were captured in 2012: Atlantic tomcod, bluefish, rainbow smelt, and flounder were captured primarily in the lower Kennebec while nonnative largemouth bass, smallmouth bass, a northern pike, and black crappie were caught primarily in the upper Kennebec and Androscoggin River.

Hatchery Evaluation

There are no hatcheries in Maine culturing American shad or river herring.

2. River Herring

Harvest and Losses

Commercial Fishery

Characterization of Directed Harvest

Based on the following sustainability guidelines and Maine laws and regulations, eighteen municipal directed river herring harvests were approved by DMR in 2012 – these municipal harvests were approved by ASMFC in 2011. These river herring runs have remained robust enough that a percentage of the fish can be taken by harvest while escapement remains high enough to support strong populations. From the catches or by direct count, the DMR ensures that at least 35 fish per surface acre of spawning habitat are passing the harvest and making it to their spawning grounds. This management number was determined using historical records to estimate the population sizes at various locations.

Sustainability Guidelines:

1. Harvest populations must be self-sustaining and not supplemented by outside stocking. If a run had been stocked, no harvest will be allowed for at least one generation post-stocking (4-years) to determine that river herring are returning successfully on their own.
2. The total river herring count must be demonstrated to equal or exceed the estimated adult production of the spawning lake or pond for a multi-year period. DMR uses a production estimate of 235 fish/surface acre.
3. The run must be demonstrated to have a healthy spawning stock biomass, with a high survival rate (low mortality rate) and good representation of older age classes.
4. The run must have a demonstrated high repeat spawning ratio, where a proportion of adult spawning fish have spawned in previous years.

These sustainability guidelines are determined by the Commissioner and are in addition to all legislation and regulations governing the take and use of river herring. Under Maine law 12 M.R.S. §6001 (paraphrased):

- The commissioner shall grant the right to take river herring to any other municipality provided:
    - Any municipality that has had the right to take river herring must approve the action through its legislative body and file a copy of this action with the commissioner prior to April 20th or lose that right for the remaining part of that year;
    - Municipal rights that are not exercised for 3 consecutive years lapse;
    - At its annual meeting the municipality may determine by vote whether river herring fishing will be operated by the municipality through the municipal officers or a committee or sold by the municipal officers or committee;
    - Any municipality engaged in harvesting river herring shall submit a written harvesting plan to the commissioner prior to April 20th of each calendar year. All harvesting plans must set forth in detail the exact conditions under which river herring may be taken, all in accordance with good conservation practices.
    - The commissioner may modify the harvest plan for the conservation of river herring and other anadromous fish.
- Limitations. The following limitations apply to any grant.
    - It is unlawful to take river herring from 6 a.m. each Thursday morning until 6 a.m. Sunday morning. Municipalities that make other provisions for escape of spawning river herring that are approved by the commissioner may be allowed a shorter weekly

    - closure period. For example, some fisheries are required to pass the minimum escapement number before commencing harvest, and are allowed a two-day closure period.
    - It is unlawful for any municipality or purchaser or lessee of the municipal right to take river herring in any manner except as provided in the approved river herring harvesting plan.
- In any river or stream not managed under a lease agreement, there is a 72-hour closed period on the taking of river herring and obstruction of the watercourse to allow the free passage of fish from 6 a.m. on Thursday to 6 a.m. the following Sunday.
- If the commissioner determines after investigation that the municipality is not following its river herring harvesting plan, the commissioner shall notify the municipality. Any municipality that fails to take corrective action within 48 hours of notification loses its river herring fishing privilege for that calendar year. Upon further notification by the commissioner of loss of river herring fishing privileges, the municipality or its agents shall cease all fishing activity and immediately remove all traps, weirs, seines or other river herring fishing gear from their river herring waters.

Marine Resources Regulations Chapter 30 states that (paraphrased):

- Beginning January 1, 2012 it shall be unlawful for any person to take, possess, harvest or sell river herring in the State of Maine or in waters under the jurisdiction of the State of Maine.
    - Exceptions:
        - A municipality or an individual with existing river herring harvest rights granted by the Commissioner in accordance with 12 M.R.S. §6131 are not subject to Chapter 30, after submission of a sustainable fisheries management plan for that fishery by the Department, which is approved by the Atlantic States Marine Fisheries Commission (ASMFC) Management Board.
        - Individuals may possess, buy, or sell river herring if they have the appropriate dealer license. All harvesters must obtain the commercial Pelagic license and report all harvest.
    - Tolerance for river herring as bycatch in fisheries conducted inside and outside Maine territorial waters:
        - No person may possess fish where more than 5% of the total by count is comprised of river herring. The 5% tolerance by count will be determined by examination of ½ bushel chosen at random by marine patrol from the bulk pile.
    - Recreational fishing limit:
        - Beginning January 1, 2012 an individual may take up to 25 river herring per day for recreational or personal use. If a municipality or individual has obtained exclusive river herring harvesting rights under 12 M.R.S. §6131, an individual may only take river herring for recreational or personal use if it is in accordance with the municipal harvest plan. Methods for taking river herring are limited to hook and line and dip net. The possession limit is 25 fish per individual. Individuals must be properly registered or licensed.

Commercial Catch Characterization

<u>Landings and method of estimation</u>

Landings of alewife and blueback herring are reported through the requirements of the Commercial Pelagic License (required for all directed fisheries), and through VTR reports (recorded as bycatch in commercial fisheries targeting other species).

In 2012, harvester reports indicate that 1,325,911 lbs of alewife and 43,981lbs of blueback herring were kept. Dealer reports indicate that 1,606,535 lbs of river herring were sold for a value of $426,320.36 (Table 2.1). Dealer reporting for the approved directed municipal harvests is through the municipalities. All municipalities must report to the DMR the amount harvested and value before August of each year, however harvesters are not required to report through their Pelagic License until they renew the license. This may explain the disparity between harvester and dealer reported landings for 2012. The DMR will continue to pursue harvesters in non-compliance with reporting to correct this disparity. As such, the harvested reported landings numbers should be considered preliminary.

The majority of river herring landings were reported using the following gear types: trap (623,862 lbs kept and 187 lbs discarded), dip net (437,010 lbs), weir (168,200 lbs), non-specified "other" gear (104,350 lbs), and by hand (36,470 lbs). Bottom otter trawls also encountered river herring (75 lbs) as a non-target species. Table 2.2 reports pounds kept and discarded by gear type separated by alewife, bluebach herring, and for river herring combined.

Catch composition

In 2008, MDMR began a project with harvesters in which harvesters collect 100 scale samples (25/week) randomly from their catches. The project is voluntary. Some harvesters also collect additional information about length and sex. In 2010, MDMR began supplementing the harvesters' project by collecting additional samples from the commercial catches for additional information including species, length, weight, age, and sex ratios. The entire dataset is not available at this time, but portions were available for the 2012 ASMFC River Herring Assessment, and the preliminary 2008-2011 data were provided to the National Marine Fisheries Services staff as supplemental information during the Endangered Species Act consideration.

This summary describes the 2012 data compiled from the samples collected by the nineteen harvesters. Most harvesters send in only scale samples, but some also include length and sex information. Because of the large amount of collected samples (over 4000 were taken in 2012), the DMR supplementary samples are still in the process of being aged and entered. All data presented here are preliminary and the DMR should be contacted and the data updated before use in any ASMFC analysis.

Using scale samples collected by harvesters, the species composition of all harvests is predominantly alewife, with blueback herring consisting of 5.17% of the total catch for all towns combined. No blueback herring were found in the random sampling at 10 of the 16 harvest sites in which harvester sampling was conducted. Where blueback herring were found in commercial catches, the percentage ranged from 1.0% at on the Sheepscot River to 40.0% at Winnegance Lake in Bath (Table 2.3).

All harvests are composed primarily of age-4 river herring, though age-3 to age-5 occur regularly in all harvests. Most harvests also contained age-6 and age-7 river herring, though in lower proportions (Table 2.4). The Orland River harvest also encountered juvenile river herring (age 1-2) at the end of the harvest period (first week of June). The location of the Orland River harvest is below a tidal dam in a saltwater tidal area. The town is currently discussing dam removal and harvest site relocation.

The mean length for alewives was 274.5 mm (TL) and for blueback herring was 264.2 mm (TL) for all harvest sites and all ages combined (Table 2.5). The largest site-specific mean length for alewife was on the St. George River in Warren, ME (293.5 mm TL), and the smallest at the Orland River in Orland (172.5 mm TL) where some juveniles were observed. Because few blueback herring were measured by harvesters, comparison of mean blueback herring length between harvest sites is not appropriate.

The sex ratio for alewives for all harvests combined was fairly even (51.5% female; 48.5% male), though varied between sites. Females composed the largest proportion of the harvest on the St. George River, Warren (66.7% female), while females composed only 39.4% of the harvest on the Dyer River, Jefferson (Table 2.6). Of the blueback herring for which sex was recorded by the harvester, there was a larger proportion of females on average (63.3% for all harvests), though the proportions varied widely among harvests. Because few blueback herring were caught in runs where the sex was recorded and because the harvests are required to end before the blueback herring run peaks, the sex ratios should not be interpreted to represent the entire blueback run.

The degree of repeat spawning varied among harvest locations, however in all cases the majority of sampled fish had not spawned in previous years (80.8% of all sampled alewives). The average rate at which alewives had spawned in one previous year was 15.3% of all sampled alewives, 3.2% in two previous years, 0.6% in three previous years, and 0.1% in four previous years. For bluebacks, the majority of samples also showed no repeat spawn checks (63.3%), but higher proportions of repeat spawners compared to alewives – the average rate at which blueback herring had spawned in one previous year was 21.1% of all sampled bluebacks, 13.3% in two previous years, 1.1% in three previous years, and 1.1% in four previous years (Table 2.7).

Estimation of effort

For most harvest locations, there are no quantitative estimates evaluating effort for the directed commercial fisheries other than counting open vs. closed days during the fishing season. Many towns do allow continual escapement during the open fishing days either by passing fish through a fishway in addition to taking fish for harvest, or by fishway and harvest site design, or simply by fishing gear inefficiency. At two harvest locations (Damariscotta Mills and Nequasset Lake in Woolwich), the harvest location is downstream of the fishway, and fish ascending into the fishway have free ability to either swim into the harvest trap or ascend the fishway, thus allowing for continuous escapement. At Benton Falls on the Sebasticook River, harvest is accomplished by dip-netting for river herring below the dam, away from the continually operating fish lift – thus the only fish harvested are those that did not originally find the fish lift. At many other locations where harvest occurs at the top of narrow fishways and total harvest would be possible, many harvesters also release fish on open days when they are only fishing to fulfill specific bait orders. Harvest weir traps in some towns are 100% efficient, however, there are periods of high flow that either requires the gear be removed from the stream to prevent damaging the fishing gear. During these periods of high flow it is unlikely that fish pass upstream in the smaller rivers and tributaries.

Characterization of Other Losses (poaching, bycatch)

In non-directed fisheries, alewife and blueback herring were reported for only 7 trips. Of these, they made up less than 5% of the total catch 57.14% of the time (5 of 7 reported trips). The two trips that observed higher than 5% river herring bycatch were part of study performed by the Dept. of Marine Resources and three near-shore fishermen to use gear modifications to reduce river herring bycatch. This study was pre-approved by the ASMFC, and was allowed to take higher than the 5% river herring bycatch as part of study trials. In all 5 trips that recorded river herring bycatch that were not associated with this study, river herring bycatch was less than 5% of the total catch on all occasions.

The Department of Marine Resources worked with three near-shore fisherman in 2011-2012 to develop gear modifications to reduce American shad and river herring bycatch in floating pound net traps targeting Atlantic mackerel. Floating pound nets are set in very near-shore areas, typically no further than 300 meters from shore. Nets fish passively, are non-discriminatory regarding species catch, and are hauled on a daily basis at the same time each day in the early morning. Trials were conducted at three locations in southern Maine: Richmond Island in Cape Elizabeth (net dimensions, surface: 70’ x 90’; depth: 30’; 1.6” mesh); Bailey Island in Harpswell (surface: 60’ x 90’; depth 30’; 1.6” mesh); and Hermit Island in Phippsburg (70’ x 90’; depth: 30’; 1.6” mesh, Figure 2). Five gear manipulations were tested: a large (8’x8’) mesh panel (2” mesh size), a small (2’x4’) mesh panel (3” mesh size), two vertical bar grates (1/2” and 3/8” bar spacing), and a 6” mesh size leader. Sampling hauls generally alternated between gear manipulation and control trials on a three-day rotation. During each trip, a portion of the total catch was sampled for species composition and length was recorded for a sub-sample of each species.

The primary objective of the project was to determine if bycatch of juvenile (age 1-3) alewife, blueback herring, and American shad could be reduced by manipulating fishing gear, while maintaining target species catches. Of all gear manipulation types, the large (8’x8’) mesh panel consistently reduced the catch of river herring bycatch while statistically maintaining mackerel catch. However, while the mackerel catch was not statistically different between control and gear manipulation hauls, the average catch using the panel was less than control trials (231.0 < 389.8). The 6” mesh size leader trials also showed reduced river herring catch and increased mackerel catches, however, comparisons between control trials and 6” mesh leader trials were performed in different years and therefore differences in catch may be due more to inter-annual variability. While the small (2’x4’) mesh panel also proved capable in reducing blueback herring catch, there were not enough data to strongly demonstrate effective reduction in bycatch. Results are shown in Table 2.8.

Recreational Fishery

Fishing for river herring is limited by both state laws and regulations and, in some cases, municipal ordinances. Where it is allowed, recreational fishing for river herring is limited to 25 fish per person per day in both freshwater and tidal and marine waters, for personal use only, using only a dip net or hook-and-line. Recreational fishing is not allowed weekly from sunrise Thursday to sunrise Sunday. Anglers must first register as a saltwater recreational fisher with the State of Maine through either the Dept. of Inland Fish and Wildlife or the Dept. of Marine Resources.

Below is a list of towns in which recreational fishing for river herring (both alewife and blueback herring) was not permitted in 2012. In some towns, only certain waters are closed, and some only for a certain time period, these are listed as well. It is unlawful to fish for any species within 150 feet of any dam with any fishway within the State of Maine.

Town	Waters Closed to Recreational Fishing	Closure Time Period
Arrowsic	All town waters	
Boothbay Harbor	West Bay Harbor and Pond, Campbell Creek	
Bremen	All town waters	
Bristol	All town waters	
Gouldsboro	Jones Stream and Pond, Chicken Mill Stream	
Lincolnville	Ducktrap River	
Mount Desert	All town waters	
Newcastle	Sherman Lake, Damariscotta River north of Damariscotta Bridge	April 20 - June 15
Nobleboro	Damariscotta River north of Damariscotta Bridge	April 20 - June 15
Northport	Ducktrap River	
Phippsburg	Center Pond	
South Berwick	All town waters	
Surry	All town waters	
Tremont	Seal Cove Harbor and Pond	
Warren	All town waters - must get prior permission of Warren Fish Committee	
West Bath	New Meadows	

Characterization of Directed Recreational Harvest

There is no ongoing program to monitor recreational catches in Maine and there are no plans to initiate sampling programs. The MRIP survey recorded recreational catches of alewife and blueback herring (Table 2.9). The number of alewives caught by recreational anglers in 2012 was estimated at 16,781 with a PSE of 65.5, and an estimated harvest of 4,737 with a PSE of 69.6. No blueback herring were reported to be caught or harvested in 2012.

Characterization of Other Recreational Fishery Losses (poaching bycatch)

Not determined, though it is likely that poaching does occur at locations where significant numbers of river herring congregate. Most poached fish are used by the commercial fishing industry as bait for commercial gear.

Other Losses (fish passage mortality, brood stock)

There were few losses of river herring resulting from mortalities in fish passage facilities, hatcheries, research, etc. Weekly samples taken at the fishways for length, weight, sex, age, and species information also contribute minor mortality (600). Limited fish passage mortality occurred at the Cataract Project on the Saco River; 171 mortalities were observed below the east channel fishlift, representing 0.7% of the total number of river herring passed at the Cataract Project (100) of these mortalities were used as the biological sample for the Saco River for 2012). Limited alewife mortalities (133) from fish passage at DMR managed fishways occurred (Table 2.10).

Harvest and Losses Table

Harvest and losses as bycatch in commercial fisheries is shown in Tables 2.1 and 2.2.
Harvest and catches (caught and released) as part of the recreational fishery are shown in Table 2.9.
Mortality that occurred as part of fishway passage or sampling is shown in Table 2.10.

Required Fishery-Independent Monitoring

Required Work Under Amendment 2

1) Estimate number of adult river herring returning to fishways on the Saco, Androscoggin and St. Croix Rivers; collect samples for length, age, and sex.

2) Report number of adult alewives stocked in each lake/impoundment for the Kennebec, Androscoggin, and Union Rivers; collect samples for length, age, and sex for the Androscoggin River.

3) Conduct Juvenile Alosine Index Survey on the Kennebec and Androscoggin Rivers.

Work Performed

Spawning stock

Fisheries personnel capture river herring during their spawning migration at the Brunswick Fishway (vertical slot constructed in 1982), the Cataract Project on the Saco River (Denil on west channel, fish lift on east channel; both operational June 1993), the Lockwood Dam on the Kennebec River in Waterville (operational 2006), and at the Benton Falls fishlift on the Sebasticook River (operational 2006), and the Milltown Dam on the St. Croix River (operational 1982). Fisheries personnel count all adult river herring captured at these five hydropower projects as the fish pass upstream. Additionally, river herring passing the Brunswick Fishway on the Androscoggin River and Benton Falls Dam on the Sebasticook River are also counted and sampled.

Stocking Efforts

The MDMR stocks lakes in various watersheds from the Brunswick Fishway on the Androscoggin River and the Lockwood fishlift on the Kennebec River to initiate restoration programs or to supplement existing spawning escapement. The Town of Ellsworth and Pennsylvania Power and Light maintain the Union River alewife resource by truck stocking.

Juvenile alosine index

The MDMR established the Juvenile Alosine Survey in the Kennebec/Androscoggin estuary in 1979 to monitor the abundance of juvenile alosines at 14 permanent sampling sites. Four sites are on the Upper Kennebec River, three on the Androscoggin, four on Merrymeeting Bay, one on the Cathance, one on the Abadagasset, and one on the Eastern; these sites are in the tidal freshwater portion of the estuary. In 1994, MDMR added six additional sample sites in the lower salinity-stratified portion of the Kennebec River.

Results

Spawning stock assessment

River herring are counted annually at the Brunswick Fishway on the Androscoggin River, the Cataract Dam on the Saco River, the Lockwood Dam on the Kennebec River, the Benton Falls fishlift on the Sebasticook River, and the Milltown Dam on the St. Croix River. In 2012, counts were above average on the Androscoggin (run count = 171,191 river herring), Saco (27,858), Sebasticook (1,703,520), and Kennebec rivers (179,357), and below average on the St. Croix River (36,168; Table 1.6).

Stocking alewives is used as a restoration tool in Maine, where alewives are stocked both within-basin at spawning habitat upstream of impassable dams, as well into out-of-basin spawning habitat that has recently been opened due to fishway improvements or dam removals. Three sources are used for stocking: BFW, Lockwood Dam, and the Union River below an impassable dam.

In 2012, at Brunswick fishway on the Androscoggin River 118,178 alewives were passed into the Brunswick Dam headpond, 20,763 alewives were trucked to spawning lakes/ponds within the Androscoggin watershed, and 17,216 alewives were stocked into out-of-basin spawning/lakes ponds as part of restoration efforts, 15,789 were received by the USFWS and New Hampshire Fish and Game Department to stock Winnesquam Lake in New Hampshire (Table 2.11).

At Lockwood fishlift on the mainstem Kennebec River, 88, 092 alewives were trucked to spawning locations upstream of Lockwood Dam in the Kennebec watershed, 39,665 were stocked into spawning habitat in the Penobscot watershed, 4,702 were stocked in out-of-basin restoration sites not associated with the Penobscot restoration project, 24,000 were stocked into the Sebasticook River watershed, 6,000 were received by the USFWS and New Hampshire Fish and Game Department to stock Winnesquam Lake in New Hampshire, 165 alewives were given to the DMR run Maine State Aquarium in Boothbay Harbor, and 16,743 were passed back downstream (Table 2.12). Because it is not possible to pass fish upstream at Lockwood fishlift, alewives must either be trucked or sent downstream – if staff or stocking trucks are unavailable, this unfortunately becomes the only option.

At the Ellsworth Dam Project on the Union River was operated between May 5 and June 20, 2012 in conformance with the Comprehensive Fishery Plan and with in-season guidance from both DMR and Maine Dept. of Inland Fisheries and Wildlife. The 2012 run was the largest on record – 1,219,927 were trapped, of which 153,630 were trucked to spawning area above the Ellsworth Project dam. Between May 5-13, 2012, the first 100,000 alewives entering the trap were trucked to Graham Lake. The remaining trucked alewives (53,630) were spread out to ensure that the escapement represented all constituents of the run. The last trucking date in 2012 was June 9. No blueback herring were found in the 2012 samples. Harvest, escapement, and total run numbers 1972-2012 are shown in Table 2.13.

Population and species composition

At Brunswick fishway, the run was dominated by age-4 alewife, though age-3 through age-6 were observed. Fifty fish samples were collected weekly over the course of the run, the first collected on May 11, 2012, and the last sample on May 29, 2012. The mean length for all alewife was 281.9 mm (TL), decreasing from the first week's mean length of 293.0 mm (TL) to the last week's mean length of 271.8 mm (TL; both sexes combined). The mean weight was 195.8 g, decreasing from the first week's mean weight of 229.0 g to the last week's mean weight of 166.5 (both sexes combined). The last sample was composed entirely of age-3 and age-4 fish, while the first two samples contained age-3 through age-6 fish. In all samples and ages, females were larger (length and weight) than males. Inter-annual repeat spawning checks were observed on 31 fish (out of 200 fish). Of these, the majority (30) had returned in only one previous year at age-4 (14 fish), age-5 (14 fish) and age-6 (2 fish), and only one fish had returned in two previous years (female age-6). All data are shown in Table 2.14.

At Benton Falls fishlift, the alewife run was dominated by age-4 fish, though age-3 through age-6 were observed. Fifty fish biosamples were collected weekly over the course of the run, the first sample collected on May 8, 2012, and the last sample on June 11, 2012. The mean length for all alewife was 273.6 mm (TL), decreasing from the first week's mean length of 279.8 mm (TL) to the last week's mean length of 269.3 mm (TL; both sexes combined). The mean weight was 176.26 g, decreasing from the first week's mean weight of 186.9 g to the last week's mean weight of 162.0 g (both sexes combined). The last sample was composed entirely of age-4 alewife – only the first sample contained age-3 through age-6 fish. In all samples and ages, females were larger (length and weight) than males. Inter-annual repeat spawning checks were observed on 14 alewives (out of 74 aged fish). Of these, all returned only one previous year at age-4 (4 fish), age-5 (9 fish) and age-6 (1 fish). All data are shown in Table 2.15.

While no blueback herring are found in Brunswick samples, they do ascend the Benton Falls fishlift and compose an increasing portion of the run as the run progresses (highest blueback proportion was 38% of a sub-sample collected June 11, 2012), however, limited sampling towards the later part of the run does not fully capture the age and length-at age trends for these fish. Of the blueback herring aged, age-3 through age-6 were observed. The mean length for all blueback herring was 243.5 mm (TL), decreasing from the first week's mean length of 264.0 mm (TL) to the last week's mean length of 246.4 mm (TL; both sexes combined). The mean weight was 118.2 g, decreasing from the first week's mean weight of 162.7 g to the last week's mean weight of 117.6 g (both sexes combined). In all samples and ages, females were larger (length and weight) than males. Inter-annual repeat spawning checks were observed on 8 blueback herring (out of 15 aged fish). Of these, one fish returned only one previous year (age-4 female), while 7 returned in two previous years (6 fish at age-5 and 1 fish at age-6). All data are shown in Table 2.16.

Juvenile Indices

In 1979, MDMR established the Juvenile Alosine Survey for the Kennebec/Androscoggin estuary to monitor the abundance of juvenile alosines at 14 permanent sampling sites. Four sites are on the upper Kennebec River, three on the Androscoggin River, four on Merrymeeting Bay, one each on the Cathance, Abadagasset, and Eastern rivers. These sites are in the tidal freshwater portion of the estuary. Since 1994, MDMR added six additional sites in the lower salinity-stratified portion of the Kennebec River.

A total of 2,487 alewife and 303 blueback herring were caught in the 2012 juvenile survey – 673 alewife and 99 blueback herring were caught at the standard stations while 1814 alewife and 204 blueback herring were caught at the experimental stations.

The highest catch per unit effort (CPUE, number of shad caught per total number of hauls within each river portion) among river portions for alewife was in the lower Kennebec River and for blueback herring was in the Abbagadasset River, the lowest CPUE for alewife was in the upper Kennebec River and for blueback herring was in the Androscoggin and upper Kennebec rivers (Table 2.17). Comparing the CPUE to past years, alewife CPUE was above average only in the lower Kennebec River (where it was also the highest on record), but below average in all other river portions (Table 2.18). Blueback herring CPUE was above average also only in the lower Kennebec River portion, and was below average in all other river segments (Table 2.19). Combining all river portions, the highest CPUE for alewife and blueback herring was in August. Considering river portions separately, for alewife the highest CPUE in July was in the Eastern River, in August in the Lower Kennebec River, and in September and October in the Abbagadasset River. For blueback herring, the highest

CPUE in July and August was in the Abbagadasset River, in September in the Cathance River, and in October in the Abbagadasset River (Table 1.9).

Adult striped bass were once again scarce in the Kennebec River during 2011. Several other species of interest were captured in 2012: Atlantic tomcod, bluefish, rainbow smelt, and flounder were captured primarily in the lower Kennebec while nonnative largemouth bass, smallmouth bass, a northern pike, and black crappie were caught primarily in the upper Kennebec and Androscoggin River.

Hatchery evaluation

There are currently no efforts to quantitatively determine the effect of stocking for either within-basin efforts or out-of-basin (restoration) efforts. All stocked fish are of wild origin and stocked as adult pre-spawning individuals; no hatchery origin fish are stocked in Maine.

Tables

American Shad

	American Shad		
	Gear Type	**Pounds Kept**	**Pounds Discarded**
Harvest Reported	Floating Gill Net		
	Sink Gill Net		
	Bottom Otter Trawl		
	Trap		
	Total		
Dealer Reported		0	0

Table 1.1. Data omitted due to confidentiality rules.

	American Shad		**Hickory Shad**	
Year	**Pounds Kept**	**Pounds Discarded**	**Pounds Kept**	**Pounds Discarded**
1996				
1997				
1998				
1999				
2000				
2001				
2002				
2003				
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011				
2012				

Table 1.2. Data omitted.

Bycatch Reduction Gear Type	*American Shad* Total No. Caught	Avg. No. Caught	Avg. Length (TL mm)
Large (8'x8') Mesh Panel (2" mesh size)	33	5.5	270.32
Control	183	22.9	168.56
Small (2'x4') Mesh Panel (3" mesh size)	1	1.0	173.00
Control	1	1.0	178.00
1/2" Veritcal Bar Grate	124	12.4	178.73
Control	27	6.8	170.48
3/8" Vertical Bar Grate	14	2.8	113.08
Control	4	4.0	125.75
6" Leader	2	2.0	168.50
Control	35	17.5	220.31
Total	39	10.9	185.23

Table 1.3. The total number, average catch, and average length of American shad caught during a 2011-2012 bycatch reduction gear study testing five different gear manipulations in three floating pound nets targeting Atlantic mackerel.

Year	Total Catch	Catch PSE	Total Harvest	Harvest PSE
1987	84458	58.4	84458	58.4
1992	1149	70.7	574	100
1996	1170	77.1	0	.
1998	461	70.5	231	99.5
1999	1065	74.2	701	100
2000	1137	70.7	552	100
2001	1661	59	0	.
2002	438	100	0	.
2003	1367	100	0	.
2004	1545	100	0	.
2006	8566	74.8	1428	106.5
2007	4480	84	0	.
2008	4812	66.9	303	98.2
2009	19095	59.3	843	72.9
2010	9423	66.2	0	.
2011	4295	60.6	0	.
2012	17620	67	0	.

Table 1.4. Recreational catch of American shad by hook-and-line in Maine as reported by the NMFS MRIP survey. Data represent all areas combined (note that data are the same when only Maine state waters are queried) and all modes combined (shore fishing, charter boat, etc.).

	Fish Passage	Broodstock (Out of Basin Stocking)	Trucking Losses	Health Inspection	Research
Androscoggin River	0	0	0	0	0
Saco River	73	0	0	0	0
Kennebec River	0	0	0	0	0
Sebasticook River	0	0	0	0	0
Combined Losses	**73**	**0**	**0**	**0**	**0**

Table 1.5. Losses of river herring associated with fishway passage, sampling, and out of basin stocking (non-lethal, stocked live) from major fishways for 2012.

	American Shad				River Herring				
	Androscoggin	**Saco**	**Kennebec**	**Sebasticook**	**Androscoggin**	**Saco**	**Kennebec**	**Sebasticook***	**St. Croix**
2012	11	6,404	5	163	170,191	27,858	179,357	1,703,520	36,168
2011	0	3,338	12	54	54,886	39,597	37,846	2,751,473	25,124
2010	22	3,663	39	2	39,689	19,258	76,947	1,626,872	58,776
2009	0	278	0	8	42,759	2,012	45,754	1,327,915	10,424
2008	1	1,588	0		92,359	22,563	93,775	401,331	12,261
2007	6	1,428	18		60,662	16,084	3,448	461,412	1,294
2006	3	953	0		34,239	7,994	4,094	45,960	11,829
2005	0	744			25,846	388			22
2004	12	1,668			113,686	32,801			1,299
2003	7	1,227			53,732	26,760			7,901
2002	11	1,014			104,520	20,198			900
2001	26	2,570			18,196	66,890			5,202
2000	88	1,323			9,551	25,136			8,569
1999	87	4,994			8,909	31,070			25,327
1998	5	1,374			25,189	16,078			177,317
1997	2	1,052			5,540	2,137			22,521
1996	2	826			10,198	9,162			645,978
1995	3	580			32,002	9,820			215,133
1994	1	399			19,190	2,240			362,930
1993	1	881			5,202	831			289,720
1992	0				45,050				203,750
1991	0				77,511				358,410
1990	1				95,574				1,339,050
1989					100,895				1,164,860
1988					74,341				2,590,750
1987					63,523				2,624,700
1986					35,471				1,984,720
1985					26,895				368,900
1984					2,530				152,900
1983					601				151,952
1982					233,102				
1981					169,620				
Max (Year)	88 (2000)	6,404 (2012)	39 (2010)	163 (2012)	233,102 (1982)	66,890 (2001)	179,354 (2012)	2,751,473 (2011)	2,624,700 (1987)
Min (Year)	0 (multiple)	287 (2009)	0 (multiple)	2 (2010)	601 (1983)	388 (2005)	3,448 (2007)	45,960 (2006)	22 (2005)
Average	13	1,815	11	57	57,864	18,944	63,032	1,188,355	428,623
Total	289	36,304	74	227	1,851,659	378,877	441,221	8,318,483	12,858,687

* both alewives and blueback herring

Table 1.6. American shad and river herring passage in 1981-2012 in major fishways. The highest and lowest counts are given at the bottom of the table with the year in which they occurred, as well as the average over time.

Juvenile American Shad Catch per Unit Effort and Variance by River Segment					
River Segment	**Total Catch All Hauls (No. of Fish)**	**No. Hauls**	**No. sampling sites in river segment**	**Site CPUE (No. fish / No. hauls)**	**Site Variance**
Abbagadasset R.	78	6	1	13.00	
Androscoggin R.	1	18	3	0.06	0.01
Cathance R.	48	6	1	8.00	
Eastern River	118	6	1	19.67	
Lower Kennebec	607	36	6	16.86	1587.08
Merrymeeting Bay	257	23	4	11.17	15.39
Upriver Kennebec	30	23	4	1.30	5.21
All Sites	1139	118	20	9.65	473.07
					Between Site Variance 54.90

Table 1.7. Juvenile American shad catch per unit effort and variance for each sampling site for 2012.

Juvenile American Shad Catch per Unit Effort by River Segment 1979-2013								
Year	Upper Kennebec River	Merrymeeting Bay	Androscoggin River	Cathance River	Abagadasset River	Eastern River	Mid Kennebec River	Lower Kennebec River
1979	0.16	0.00	0.00	0.00		0.00		0.00
1980	0.00	0.36	0.29	0.00		0.00		0.00
1981	1.08	0.85	0.29	0.50		0.00	0.17	0.00
1982	0.00	0.33	0.17	0.00		0.00	0.63	0.00
1983	0.15	0.20	2.18	3.00		0.00		
1984	0.90	0.46	0.00	2.00		0.67		
1985	0.69	1.53	0.40	6.50		7.00		
1986	0.10	0.15	0.08	1.00		0.50		
1987	0.15	8.05	0.17	1.25	0.50	0.00		
1988	0.11	1.36	0.00	0.00	0.33	0.51		
1989	1.25	0.29	1.29	0.48	0.00	0.00		
1990	3.50	2.46	0.83	6.83	0.33	4.20		
1991	1.21	0.00	0.00	0.67	1.67	1.17		
1992	0.10	0.67	0.67	3.67	0.00	0.00		
1993	0.00	0.29	3.63	0.00	0.00	0.00		
1994	0.00	0.35	1.00	0.00	0.17	0.50		
1995	0.21	0.39	1.89	0.17	0.60	0.33		
1996	4.15	0.25	0.00	0.20	0.33	0.50		
1997	0.00	0.88	0.80	0.00	0.40	0.00		
1998	0.00	1.67	0.00	0.00	0.00	0.00		
1999	0.00	20.46	0.00	42.67	33.00	0.00		
2000	15.14	0.33	0.14	0.33	0.33	1.33		1.58
2001	0.57	3.14	2.57	0.43	0.00	0.20		0.05
2002	1.96	2.18	0.18	1.86	22.86	2.43		0.19
2003	74.13	3.63	0.00	2.17	0.67	5.33		0.42
2004	48.21	6.67	0.00	0.67	3.00	0.50		0.39
2005	24.96	3.42	0.06	2.83	10.00	2.40		3.72
2006	38.79	25.30	0.00	0.67	16.50	8.33		5.44
2007	33.38	24.13	0.00	0.67	19.00	16.83		1.40
2008	3.95	12.88	0.00	3.00	34.17	3.67		1.38
2009	4.29	16.38	0.20	4.17	31.67	5.17		1.27
2010	45.63	8.25	0.39	11.00	15.33	7.17		1.03
2011	0.63	11.25	0.00	25.33	94.17	9.17		1.73
2012	1.30	11.17	0.06	8.00	13.00	19.67		16.86
Average	9.02	4.99	0.51	3.83	11.46	2.87	0.40	2.09

Table 1.8. CPUE index for juvenile American shad by river section for 1979- 2012. The length & depth of the seine were increased in 1983; a bag was also added & the method of seining was changed, although the area sampled remained the same.

		July CPUE	August CPUE	September CPUE	October CPUE	Average CPUE
American Shad	*All River Portions*	*11.85*	*19.95*	*1.49*	*1.44*	*9.65*
	Abbagadasset	14.00	27.00	3.50	3.00	13.00
	Androscoggin River	0.00	0.00	0.00	0.33	0.06
	Cathance River	26.00	7.50	3.50	0.00	8.00
	Eastern River	100.00	4.33	2.50		19.67
	Lower Kennebec River	0.17	49.08	0.50	1.83	16.86
	Merrymeeting Bay	18.00	20.71	3.63	2.75	11.17
	Upper Kennebec River	6.00	0.22	0.57	0.00	1.30
Alewife	*All River Portions*	*25.60*	*47.41*	*0.62*	*0.39*	*21.08*
	Abbagadasset	63.00	5.00	2.00	5.00	13.67
	Androscoggin River	0.67	0.00	0.00	0.00	0.11
	Cathance River	72.00	1.00	0.50	0.00	12.50
	Eastern River	81.00	26.00	0.00		26.50
	Lower Kennebec River	5.00	147.42	1.08	0.33	50.39
	Merrymeeting Bay	65.75	12.00	0.75	0.00	15.35
	Upper Kennebec River	0.25	0.11	0.00	0.00	0.09
Blueback Herring	*All River Portions*	*1.45*	*6.59*	*0.05*	*0.11*	*2.57*
	Abbagadasset	17.00	19.50	0.00	2.00	9.67
	Androscoggin River	0.00	0.00	0.00	0.00	0.00
	Cathance River	0.00	2.00	0.50	0.00	0.83
	Eastern River	0.00	3.67	0.00		1.83
	Lower Kennebec River	0.00	17.00	0.00	0.00	5.67
	Merrymeeting Bay	3.00	1.71	0.13	0.00	1.09
	Upper Kennebec River	0.00	0.00	0.00	0.00	0.00

Table 1.9. CPUE index for juvenile alewives, unidentified alosines, American shad, blueback herring, and striped bass by river section and month for 2011.

Upper Kennebec River = from the Augusta Dam to the Richmond Bridge
Merrymeeting Bay = Richmond Bridge to Chops Point, excluding tributaries
Androscoggin River = from the Brunswick Dam to southern tip of Mustard Island
Cathance River = from the confluence with Merrymeeting Bay to head-of-tide
Abadagasset River = from the confluence with Merrymeeting Bay to head-of-tide
Eastern River = from the confluence with Merrymeeting Bay to head-of-tide
Mid Kennebec River = Chops Point to Doubling Point
Lower Kennebec River = Doubling Point to Bay Point

River Herring

	Alewife		Blueback Herring		Total All River Herring	
	Pounds Kept	Pounds Discarded	Pounds Kept	Pounds Discarded	Pounds Kept	Pounds Discarded
Harvester Reported	1,325,911	70	43,981	192	1,369,892	262
Dealer Reported					1,606,535 Value $ 426,320.36	

Table 2.1. River herring take by directed commercial fishery in Maine coastal waters and as bycatch within and outside of state waters. Harvester and dealer reported pounds kept/sold are shown. Note harvesters report by species whereas dealers did not make a distinction between alewife and blueback herring. Data are preliminary and reported s as of 6/12/13.

	Alewife		Blueback Herring		Total All River Herring	
Gear Type	Pounds Kept	Pounds Discarded	Pounds Kept	Pounds Discarded	Pounds Kept	Pounds Discarded
Dip Net	437,010				437,010	
Hand	36,470				36,470	
Other Gear	104,350				104,350	
Bottom Otter Trawl		65		10		75
Trap	621,931	5	1,931	182	623,862	187
Weir	126,150		42,050		168,200	
Total	1,325,911	70	43,981	192	1,369,892	262

Table 2.2. River herring take by gear type within and outside of Maine waters as reported by harvesters. Data are preliminary and reported s as of 6/12/13.

Species Composition by Proportion of Total Samples Collected				
Harvest Location	**Alewife**	**Blueback Herring**	**River Herring (undetermined species)**	**Sample Size (n)**
Alna: Coopers Mills	99.0%	1.0%		100
Bath: Winnegance Lake	60.0%	40.0%		100
Benton: Sebasticook Falls	90.0%	10.0%		100
Dresden: Mill Creek	95.0%	5.0%		100
East Machias: Gardiner Lake	100.0%			125
Ellsworth: Union River	100.0%			100
Franklin: Grist Mill Stream	100.0%			100
Gouldsboro: West Bay Pond	100.0%			73
Jefferson: Dyer River	100.0%			100
Newcastle: Damariscotta Mills	100.0%			103
Orland: OrlandRiver	91.4%	1.9%	6.7%	98
Perry : Little River	100.0%			100
Sullivan: Flanders Stream	100.0%			100
Vassalboro: Webber Pond	100.0%			75
Warren : St. George River	79.4%	20.6%		155
Woolwich: Nequasset	100.0%			105
All Harvests	**94.4%**	**5.2%**	**0.4%**	**1634**

Table 2.3. River herring species composition for State and ASMFC approved municipal river herring harvests. Species determination made by DMR staff using harvester collected scales.

Age Distribution by Harvest Location and Species													
	Alewife								**Blueback Herring**				
	Age							**Sample**	**Age**				**Sample**
Harvest Location	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Size (n)**	**3**	**4**	**5**	**7**	**Size (n)**
Alna: Coopers Mills			1.0%	79.8%	19.2%			99			100.0%		1
Bath: Winnegance Lake			21.7%	66.7%	10.0%		1.7%	60	65.0%	32.5%			40
Benton: Sebasticook Falls			21.1%	64.4%	13.3%	1.1%		90	40.0%	40.0%	20.0%		10
Dresden: Mill Creek			8.4%	68.4%	17.9%	3.2%	2.1%	95		60.0%	40.0%		5
East Machias: Gardiner Lake			3.0%	77.8%	12.1%	6.1%	1.0%	99					
Ellsworth: Union River			13.0%	75.0%	10.0%	2.0%		100					
Franklin: Grist Mill Stream				64.0%	28.0%	7.0%	1.0%	100					
Gouldsboro: West Bay Pond			1.4%	53.4%	41.1%	4.1%		73					
Jefferson: Dyer River			4.0%	52.0%	34.0%	9.0%	1.0%	100					
Newcastle: Damariscotta Mills			3.9%	64.1%	25.2%	4.9%	1.9%	103					
Orland: OrlandRiver	16.7%	1.0%	1.0%	60.4%	16.7%	4.2%		96	50.0%	50.0%	0.0%		2
Perry : Little River			10.1%	78.8%	9.1%	1.0%	1.0%	99					
Sullivan: Flanders Stream			4.0%	79.0%	16.0%	1.0%		100					
Vassalboro: Webber Pond			17.3%	72.0%	8.0%	2.7%		75					
Warren : St. George River				32.5%	51.2%	9.8%	6.5%	123	3.1%	46.9%	34.4%	6.3%	32
Woolwich: Nequasset			2.9%	61.9%	34.3%	1.0%		105					
All Harvests	1.1%	0.1%	6.4%	65.2%	22.4%	3.8%	1.1%	**1517**	35.6%	40.0%	17.8%	2.2%	**90**

Table 2.4. Age distribution as percentage of sample size shown for each harvest and for all harvests combined. Species and age determination made by DMR staff using harvester collected scales.

Length Distribution by Harvest Location and Species													
	Alewife								**Blueback Herring**				
	Age								**Age**				
Harvest Location	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**All Ages**	**3**	**4**	**5**	**7**	**All Ages**
Alna: Coopers Mills													
Bath: Winnegance Lake													
Benton: Sebasticook Falls													
Dresden: Mill Creek			240.6	269.9	280.5	271.0	301.5	270.0		249.7	273.0		259.0
East Machias: Gardiner Lake			254.3	273.4	295.0	303.7	324.0	277.3					
Ellsworth: Union River			243.2	264.5	289.4	311.0		265.2					
Franklin: Grist Mill Stream				268.9	284.9	293.7	305.0	275.5					
Gouldsboro: West Bay Pond			216.0	268.3	280.9	287.7		273.5					
Jefferson: Dyer River													
Newcastle: Damariscotta Mills			242.8	270.6	301.9	313.4	319.0	280.4					
Orland: OrlandRiver	121.1	190.0	203.0		305.0	320.3		172.5					
Perry : Little River			256.3	276.3	296.0	304.0	321.0	276.9					
Sullivan: Flanders Stream													
Vassalboro: Webber Pond													
Warren : St. George River				277.5	297.7	305.9	322.3	293.5	241.0	258.1	264.5	292.0	265.1
Woolwich: Nequasset													
All Harvests	**121.1**	**190.0**	**245.1**	**271.0**	**291.7**	**302.3**	**317.9**	**274.5**	**241.0**	**256.7**	**265.8**	**292.0**	**264.2**

Table 2.5. Mean length by age shown for each harvest and for all harvests combined. Species and age determination made by DMR staff using harvester collected scales, length as recorded by the harvester at time of sample collection.

Sex Ratio by Harvest and Species						
	Alewife			Blueback Herring		
	Sex		Sample	Sex		Sample Size
Harvest Location	**Female**	**Male**	**Size (n)**	**Female**	**Male**	**(n)**
Alna: Coopers Mills						
Bath: Winnegance Lake						
Benton: Sebasticook Falls	51.1%	48.9%	90	20.0%	80.0%	10
Dresden: Mill Creek	48.4%	51.6%	95	60.0%	40.0%	5
East Machias: Gardiner Lake	56.5%	43.5%	124			
Ellsworth: Union River	49.0%	51.0%	100			
Franklin: Grist Mill Stream	50.0%	50.0%	100			
Gouldsboro: West Bay Pond	47.2%	52.8%	72			
Jefferson: Dyer River	39.4%	60.6%	99			
Newcastle: Damariscotta Mills	49.5%	48.5%	103			
Orland: OrlandRiver	44.3%	55.7%	79	50.0%	50.0%	2
Perry : Little River	42.0%	58.0%	100			
Sullivan: Flanders Stream	56.4%	43.6%	94			
Vassalboro: Webber Pond	52.0%	48.0%	75			
Warren : St. George River	66.7%	33.3%	123	78.1%	21.9%	32
Woolwich: Nequasset	59.0%	41.0%	105			
All Harvests	51.4%	48.5%	**1359**	63.3%	36.7%	**49**

Table 2.6. Sex ratio as percentage of sample size shown for each harvest and for all harvests combined. Species determination made by DMR staff using harvester collected scales, sex information as recorded by the harvester at time of sample collection.

Repeat Spawning Propotions by Harvest and Species												
	Alewife						Blueback Herring					
	No. Repeat Spawn Checks					Sample	No. Repeat Spawn Checks					Sample
Harvest Location	**0**	**1**	**2**	**3**	**4**	**Size (n)**	**0**	**1**	**2**	**3**	**4**	**Size (n)**
Alna: Coopers Mills	91.9%	8.1%				99			100.0%			1
Bath: Winnegance Lake	90.0%	6.7%	1.7%	1.7%		60	95.0%	2.5%	2.5%			40
Benton: Sebasticook Falls	88.9%	8.9%	2.2%			90	50.0%	30.0%	20.0%			10
Dresden: Mill Creek	71.6%	21.1%	5.3%	2.1%		95	20.0%	60.0%	20.0%			5
East Machias: Gardiner Lake	85.6%	10.4%	3.2%	0.8%		125						
Ellsworth: Union River	90.0%	8.0%	2.0%			100						
Franklin: Grist Mill Stream	68.0%	26.0%	6.0%			100						
Gouldsboro: West Bay Pond	78.1%	19.2%	2.7%			73						
Jefferson: Dyer River	66.0%	28.0%	5.0%		1.0%	100						
Newcastle: Damariscotta Mills	73.8%	19.4%	6.8%			103						
Orland: OrlandRiver	88.5%	7.3%	4.2%			96	50.0%	50.0%	0.0%			2
Perry : Little River	92.0%	7.0%	1.0%			100						
Sullivan: Flanders Stream	89.0%	11.0%				100						
Vassalboro: Webber Pond	86.7%	10.7%	2.7%			75						
Warren : St. George River	56.9%	32.5%	5.7%	4.9%		123	37.5%	34.4%	21.9%	3.1%	3.1%	32
Woolwich: Nequasset	84.8%	14.3%	1.0%			105						
All Harvests	80.8%	15.3%	3.2%	0.6%	0.1%	**1544**	63.3%	21.1%	13.3%	1.1%	1.1%	**90**

Table 2.7. Repeat spawning occurrence shown by age as percentage of sample size shown for each harvest and for all harvests combined. Determination of species, age, and number of repeat spawning marks made by DMR staff using harvester collected scales.

Bycatch Reduction Gear Type	*Alewife* Total No. Caught	Avg. No. Caught	Avg. Length (TL mm)	*Blueback Herring* Total No. Caught	Avg. No. Caught	Avg. Length (TL mm)
Large (8'x8') Mesh Panel (2" mesh size)	146	20.9	254.69	61	7.6	219.61
Control	344	43.0	171.97	2134	194.0	148.86
Small (2'x4') Mesh Panel (3" mesh size)				1	1.0	159.00
Control	1	1.0	139.00	479	479.0	146.67
1/2" Veritcal Bar Grate	398	36.2	174.24	272	24.7	180.54
Control	130	18.6	173.15	276	34.5	158.14
3/8" Vertical Bar Grate	4	4.0	127.00			
Control	1	1.0	121.00			
6" Leader	37	9.3	147.05	16	8.0	171.38
Control	92	18.4	208.52	144	24.0	213.38
Total	1153	25.6	188.17	3383	70.5	168.59

Table 2.8. The total number, average catch, and average length of alewife and blueback herring caught during a 2011-2012 bycatch reduction gear study testing five different gear manipulations in three floating pound nets targeting Atlantic mackerel.

Year	Alewife Total Catch	Catch PSE	Total Harvest	Harvest PSE	Blueback Herring Total Catch	Catch PSE	Total Harvest	Harvest PSE
1987	344166	60.9	344166	60.9				
1989	5599	81.7	0	.				
1990	3574	100	3574	100				
1991	434	100	434	100				
1992	2716	85.8	2716	85.8				
1993	3523	79.1	3523	79.1				
1996	390	100	0	.				
1997	1014	100	0	.				
1998	53728	58.7	231	100				
1999	728	100	0	.				
2000	70743	86.7	61388	99.6	2392	100	0	.
2001	27359	65.4	26225	68.1				
2002	2437	60.8	0	.				
2003	13502	50.3	7982	64.6				
2004	5409	58.6	4894	63.9				
2006	8632	104.6	0	.				
2007	6514	82.3	6514	82.3	317	102.1	317	102.1
2008	94227	69.5	73049	84.9	6917	100.4	6917	100.4
2009	62151	48.3	49470	57.7				
2010	21987	54.6	21262	56.4				
2011	13368	55.6	5922	61.3	2212	98.3	2212	98.3
2012	16781	65.5	4737	69.6				

Table 2.9. Recreational catch of river herring by hook-and-line in Maine (NMFS MRIP data). Data represent all areas combined (note that data are the same when only Maine state waters are queried) and all modes combined (shore fishing, charter boat, etc.).

	Fish Passage	Broodstock (Out of Basin Stocking)	Trucking Losses	Health Inspection	Research
Androscoggin River	41	17,216	0	0	200
Saco River	71	200	0	0	100
Kennebec River	21	68,357	0	0	0
Sebasticook River	0	0	0	0	300
Combined Losses	**133**	**85,773**	**0**	**0**	**600**

Table 2.10. Losses of river herring associated with fishway passage, sampling, and out of basin stocking (non-lethal, stocked live) from major fishways for 2012.

No. of alewives passed upstream or stocked within Androscoggin Watershed *Name of Stocked Spawning Habitat*		**No. of alewives stocked outside of the Androscoggin Watershed** *Name of Stocked Spawning Habitat*	
Little Sabattus Pond	888	Sewell Pond (lower Kennebec R. watershed)	500
Lower Range Pond	1617	Whiskeag Creek (lower Kennebec R. watershed)	435
Marshall Pond	1454	Washington Pond (Medomak R. watershed)	1059
No Name Pond	518	Center Pond (lower Kennebec R. watershed)	1415
Sabattus Pond	11968	Webber Pond (Medomak R. watershed)	1811
Taylor Pond	4318	Marsh Pond (Coastal Penobscot watershed)	862
Total trucked within basin	20763	Pleasant Pond (Kennebec R. watershed)	11134
Brunswick Dam headpond	118178	NH Winnisquam Lake (Merrimac R. watershed)	15789
Total passed upstream or stocked within Androscoggin Watershed	**138941**	**Total stocked outside of watershed**	**33005**

Table 2.11. Passage and stocking at Brunswick Fishway on the Androscoggin River in 2012.

No. of alewives stocked upstream of Lockwood Dam *Name of Stocked Spawning Habitat*		**No. of alewives stocked in Sebastiscook River Watershed** *Name of Stocked Spawning Habitat*	
Fairfield (Kennebec R.)	10,250	Douglas Pond	12,000
Shawmut headpond	52,380	Lovejoy Pond	6,000
Togus Ponds	12,500	Pattee Pond	6,000
Wesserunsett Lake	12,962		
Total stocked upstream	**88,092**	**Total stocked in Sebasticook Watershed**	**24,000**
No. of alewives stocked in Penobscot R. Watershed *Name of Stocked Spawning Habitat*		**No. of alewives stocked in other out-of-basin locations** *Name of Stocked Spawning Habitat*	
Chemo Pond	3,000	Fresh Pond (North Haven)	3,000
Litle Pushaw Pond	1,500	Saccarappa headpond (Presumpscot R.)	1,702
Mattamiscontis Lake	3,264		
Mud Pond	1,750		
Pushaw Lake	30,141		
Total stocked in Penobscot Watershed	**36,655**	**Total stocked in other out-of-basin locations**	**4,702**

Table 2.12 Receiving locations of stocked alewives originating from Lockwood fishlift on the mainstem Kennebec River 2012.

Year	Harvest	Escapement (Trucked to Graham Lake)	Total run
1972		1,000	1,000
1973		600	600
1974		600	600
1975		6,000	6,000
1976		2,400	2,400
1977		1,000	1,000
1978	81,600		81,600
1979			
1980			
1981	29,200	22,200	51,400
1982	60,200	12,720	72,920
1983	4,700	4,560	9,260
1984	71,300	6,600	77,900
1985	832,900	17,520	850,420
1986	1,026,200	12,720	1,038,920
1987	460,400	13,440	473,840
1988	515,151	11,760	526,911
1989	543,176	16,500	559,676
1990	348,120	20,280	368,400
1991	173,400	19,320	192,720
1992	375,210	15,000	390,210
1993	98,313	12,826	111,139
1994	100,702	16,456	117,158
1995	159,131	24,503	183,634
1996	258,458	42,792	301,250
1997	233,000	46,145	279,145
1998	392,243	49,680	441,923
1999	213,840	63,585	277,425
2000	258,120	104,490	362,610
2001	342,765	104,085	446,850
2002	562,342	104,625	666,967
2003	222,277	104,220	326,497
2004	89,303	104,220	193,523
2005	93,757	101,520	195,277
2006	592,110	101,250	693,360
2007	125,685	101,385	227,070
2008	410,670	104,490	515,160
2009	347,490	104,760	452,250
2010	320,760	129,330	450,090
2011	415,125	151,875	450,090
2012	1,066,297	153,630	1,219,927
Total	10,823,945	1,910,087	12,617,122
Average	327,998	50,265	323,516
Min (year)	4,700 (1983)	600 (1973, 1974)	600 (1973, 1974)
Max (year)	1,066,297 (2012)	153,630 (2012)	1,219,927 (2012)

Table 2.13. Union River alewife run data 1972-2012. The 2012 run was the largest on record –1,219,927 were trapped, of which 153,630 were trucked to spawning area above the Ellsworth Project dam. Between May 5-13, 2012, the first 100,000 alewives entering the trap were trucked to Graham Lake. The remaining trucked alewives (53,630) were spread out to ensure that the escapement represented all constituents of the run. The last trucking date in 2012 was June 9. No blueback herring were found in the 2012 samples.

Brunswick Fishway 2012 Age Distribution by Sex and Sample Date

	Age 3	4	5	6	All Ages
5/11/2012	***3***	***26***	***19***	***2***	***50***
Female		14	10	1	25
Male	3	12	9	1	25
5/17/2012	***4***	***36***	***9***	***1***	***50***
Female	1	17	2	1	21
Male	3	19	7		29
5/22/2012	***11***	***36***	***3***		***50***
Female	5	17	2		24
Male	6	19	1		26
5/29/2012	***32***	***18***			***50***
Female	12	9			21
Male	20	9			29
All Samples	**50**	**116**	**31**	**3**	**200**

Brunswick Fishway 2012 Mean Weight for Each Age by Sex and Sample Date

	Age 3	4	5	6	All Ages
5/11/2012	***179.3***	***221.7***	***245.1***	***245.0***	***229.0***
Female		235.3	270.0	266.0	250.4
Male	179.3	205.8	217.3	224.0	207.5
5/17/2012	***168.3***	***193.5***	***210.6***	***264.0***	***196.0***
Female	166.0	205.6	245.0	264.0	210.3
Male	169.0	182.7	200.7		185.6
5/22/2012	***181.3***	***190.0***	***251.7***		***191.8***
Female	194.6	208.4	270.0		210.7
Male	170.2	173.5	215.0		174.3
5/29/2012	***157.8***	***181.9***			***166.5***
Female	180.4	198.1			188.0
Male	144.3	165.8			150.9
All Samples	**165.1**	**196.9**	**235.7**	**251.3**	**195.8**

Brunswick Fishway 2012 Mean Length for Each Age by Sex and Sample Date

	Age 3	4	5	6	All Ages
5/11/2012	***272.3***	***291.0***	***298.2***	***299.5***	***293.0***
Female		294.9	306.5	310.0	300.2
Male	272.3	286.5	289.0	289.0	285.8
5/17/2012	***272.3***	***282.8***	***289.8***	***313.0***	***283.8***
Female	270.0	287.6	300.5	313.0	289.2
Male	273.0	278.5	286.7		279.9
5/22/2012	***273.6***	***278.9***	***302.7***		***279.2***
Female	278.0	286.4	311.5		286.7
Male	270.0	272.3	285.0		272.2
5/29/2012	***266.3***	***281.6***			***271.8***
Female	278.0	289.9			283.1
Male	259.3	273.2			263.6
All Samples	**268.7**	**283.3**	**296.2**	**304.0**	**281.9**

Brunswick Fishway 2012 Repeat Spawning Checks by Sex

	No. Repeat Spawn Checks 0	1	2	All
Female	***79***	***11***	***1***	***91***
3	18			18
4	54	3		57
5	7	7		14
6		1	1	2
Male	***90***	***19***		***109***
3	32			32
4	48	11		59
5	10	7		17
6		1		1
All Samples	**169**	**30**	**1**	**200**

Table 2.14. Biological sampling data from alewives collected from the Brunswick Fishway on the Androscoggin River in 2012. Only alewives have been found at this site, no bluebacks have been observed in any samples. Tables show age distribution, mean length (TL mm) and mean weight (g) by sex and sampling date, and the number of repeat spawning checks seen on scales. Data are preliminary and have not undergone thorough quality assurance checks.

Benton Falls 2012 Alewife Mean Length (TL mm) for Each Age by Sex and Sampling Date

Age	3	4	5	6	No Age Given	All Samples
5/8/2012		*275.00*	*293.00*	*309.00*	*278.24*	*279.78*
Female		276.00	300.50	309.00	281.57	283.27
Male		273.75	288.00		275.90	276.93
5/11/2012	*245.00*	*277.40*	*297.75*		*279.83*	*280.08*
Female		279.20	297.00		287.20	286.27
Male	245.00	275.60	298.50		274.30	275.21
5/17/2012	*254.00*	*276.92*	*284.00*		*272.74*	*273.76*
Female	254.00	279.40	284.00		272.57	274.92
Male		268.67			272.88	272.25
5/24/2012	*244.00*	*266.60*	*295.00*		*264.61*	*264.58*
Female		269.00			270.79	270.56
Male	244.00	265.00	295.00		255.00	258.20
5/29/2012	*244.67*	*267.13*	*286.00*		*268.86*	*266.82*
Female	249.00	272.50			270.22	269.36
Male	242.50	261.75	286.00		267.92	265.05
6/11/2012		*274.11*			*267.36*	*269.32*
Female		284.67			274.42	276.47
Male		268.83			258.90	262.63
All Samples	**245.86**	**273.81**	**293.42**	**309.00**	**273.01**	**273.56**

Benton Falls 2012 Alewife Age Distribution by Sex and Sampling Date

Age	3	4	5	6	No Age Given	All Samples
5/8/2012		*9*	*5*	*1*	*34*	*49*
Female		5	2	1	14	22
Male		4	3		20	27
5/11/2012	*1*	*10*	*4*		*35*	*50*
Female		5	2		15	22
Male	1	5	2		20	28
5/17/2012	*1*	*13*	*1*		*31*	*46*
Female	1	10	1		14	26
Male		3			17	20
5/24/2012	*2*	*5*	*1*		*23*	*31*
Female		2			14	16
Male	2	3	1		9	15
5/29/2012	*3*	*8*	*1*		*22*	*34*
Female	1	4			9	14
Male	2	4	1		13	20
6/11/2012		*9*			*22*	*31*
Female		3			12	15
Male		6			10	16
All Samples	**7**	**54**	**12**	**1**	**167**	**241**

Benton Falls 2012 Alewife Mean Weight (g) for Each Age by Sex and Sampling Date

Age	3	4	5	6	No Age Given	All Samples
5/8/2012		*176.32*	*212.60*	*261.30*	*183.72*	*186.89*
Female		184.68	232.60	261.30	195.11	199.16
Male		165.88	199.27		175.75	176.90
5/11/2012	*139.20*	*180.16*	*224.33*		*186.19*	*187.09*
Female		188.82	223.40		204.48	202.64
Male	139.20	171.50	225.25		172.47	174.88
5/17/2012	*134.00*	*183.12*	*184.80*		*177.84*	*178.53*
Female	134.00	189.64	184.80		180.24	182.25
Male		161.40			175.85	173.69
5/24/2012	*124.60*	*159.92*	*203.70*		*161.47*	*160.20*
Female		177.10			171.98	172.62
Male	124.60	148.47	203.70		145.11	146.95
5/29/2012	*123.03*	*170.85*	*217.10*		*173.38*	*169.63*
Female	129.60	189.20			181.16	179.77
Male	119.75	152.50	217.10		168.00	162.53
6/11/2012		*167.39*			*159.75*	*161.97*
Female		198.47			173.18	178.24
Male		151.85			143.63	146.71
All Samples	**127.36**	**174.85**	**213.83**	**261.30**	**175.56**	**176.26**

Benton Falls 2012 Alewife Repeat Spawn Checks by Sex and Age

No. RS Checks	0	1	Grand Total
Female	*32*	*5*	*37*
3	2		2
4	28	1	29
5	2	3	5
6		1	1
Male	*28*	*9*	*37*
3	5		5
4	22	3	25
5	1	6	7
All Samples	**60**	**14**	**74**

Table 2.15. Biological sampling data from alewives collected from the Benton Falls fishlift on the Sebasticook River in 2012. Tables show age distribution, mean length (TL mm) and mean weight (g) by sex and sampling date, and the number of repeat spawning checks seen on scales. Data are preliminary and have not undergone thorough quality assurance checks.

Benton Falls 2012 Blueback Herring Mean Length (TL mm) for Each Age by Sex and Sampling Date

Age	3	4	5	6	No Age	All Ages
5/8/2012					*264.00*	*264.00*
Male					264.00	264.00
5/17/2012					*256.25*	*256.25*
Female					266.00	266.00
Male					253.00	253.00
5/24/2012	*252.00*	*244.67*	*263.00*	*268.00*	*243.92*	*247.74*
Female	252.00	246.50	263.00	268.00	257.00	256.73
Male		241.00			234.57	235.38
5/29/2012	*229.50*		*258.00*		*228.46*	*230.44*
Female					251.00	251.00
Male	229.50		258.00		221.70	225.69
6/11/2012	*226.00*	*264.00*	*265.33*		*242.50*	*246.37*
Female	226.00	264.00	265.33		261.86	259.92
Male					223.14	223.14
All Samples	**234.25**	**249.50**	**263.33**	**268.00**	**240.48**	**243.46**

Benton Falls 2012 Blueback Herring Age Distribution by Sex and Sampling Date

Age	3	4	5	6	No Age	All Ages
5/8/2012					*1*	*1*
Male					1	1
5/17/2012					*4*	*4*
Female					1	1
Male					3	3
5/24/2012	*1*	*3*	*2*	*1*	*12*	*19*
Female	1	2	2	1	5	11
Male		1			7	8
5/29/2012	*2*		*1*		*13*	*16*
Female					3	3
Male	2		1		10	13
6/11/2012	*1*	*1*	*3*		*14*	*19*
Female	1	1	3		7	12
Male					7	7
All Samples	**4**	**4**	**6**	**1**	**44**	**59**

Benton Falls 2012 Blueback Herring Mean Weight (g) for Each Age by Sex and Sampling Date

Age	3	4	5	6	No Age	All Ages
5/8/2012					*162.70*	*162.70*
Male					162.70	162.70
5/17/2012					*142.70*	*142.70*
Female					182.00	182.00
Male					129.60	129.60
5/24/2012	*124.80*	*114.57*	*159.80*	*161.80*	*117.56*	*124.24*
Female	124.80	115.00	159.80	161.80	136.84	138.22
Male		113.70			103.79	105.03
5/29/2012	*98.90*		*132.60*		*101.19*	*102.87*
Female					142.83	142.83
Male	98.90		132.60		88.70	93.65
6/11/2012	*82.30*	*151.70*	*136.03*		*113.73*	*117.59*
Female	82.30	151.70	136.03		144.50	137.80
Male					82.96	82.96
All Samples	**101.23**	**123.85**	**143.38**	**161.80**	**114.82**	**118.21**

Benton Falls 2012 Blueback Herring Repeat Spawn Checks by Sex and Age

No. RS Checks	0	1	2	All
Female	*4*	*1*	*6*	*11*
3	2			2
4	2	1		3
5			5	5
6			1	1
Male	*3*		*1*	*4*
3	2			2
4	1			1
5			1	1
All Samples	**7**	**1**	**7**	**15**

Benton Falls 2012 Species Composition by Date

	Alewife	Blueback Herring	Sample Size
5/8/2012	49	1	50
5/11/2012	50		50
5/17/2012	46	4	50
5/24/2012	31	19	50
5/29/2012	34	16	50
6/11/2012	31	19	50
All Samples	**241**	**59**	**300**

Table 2.16. Biological sampling data from blueback herring collected from the Benton Falls fishlift on the Sebasticook River in 2012. Tables show age distribution, mean length (TL mm) and mean weight (g) by sex and sampling date, and the number of repeat spawning checks seen on scales. Data are preliminary and have not undergone thorough quality assurance checks.

Alewife					
River Segment	**Total Catch All Hauls (No. of Fish)**	**No. Hauls**	**No. sampling sites in river segment**	**Site CPUE (No. fish / No. hauls)**	**Site Variance**
Abbagadasset R.	82	6	1	13.67	
Androscoggin R.	2	18	3	0.11	0.04
Cathance R.	75	6	1	12.50	
Eastern River	159	6	1	26.50	
Lower Kennebec	1814	36	6	50.39	14636.43
Merrymeeting Bay	353	23	4	15.35	152.74
Upriver Kennebec	2	23	4	0.09	0.03
All Sites	2487	118	20	21.08	4325.39
				Between Site Variance 301.74	

Blueback Herring					
River Segment	**Total Catch All Hauls (No. of Fish)**	**No. Hauls**	**No. sampling sites in river segment**	**Site CPUE (No. fish / No. hauls)**	**Site Variance**
Abbagadasset R.	58	6	1	9.67	
Androscoggin R.		18	3	0.00	0.00
Cathance R.	5	6	1	0.83	
Eastern River	11	6	1	1.83	
Lower Kennebec	204	36	6	5.67	192.67
Merrymeeting Bay	25	23	4	1.09	0.70
Upriver Kennebec		23	4	0.00	0.00
All Sites	303	118	20	2.57	59.59
				Between Site Variance 13.12	

Table 2.17. Juvenile alewife and blueback herring catch per unit effort and variance for each sampling site for 2012.

Juvenile Alewife Catch per Unit Effort by River Segment								
Year	Upper Kennebec River	Merrymeeting Bay	Androscoggin River	Cathance River	Abagadasset River	Eastern River	Mid Kennebec River	Lower Kennebec River
1979	7.91	25.60	2.24	647.00	43.72	157.17	8.44	0.00
1980	0.10	3.67	12.29	5.11	12.50	38.70	3.25	0.00
1981	0.58	7.62	1.57	4.50	6.67	14.17	3.50	0.17
1982	0.67	1.83	0.08	38.33	1.62	3.00	1.63	0.29
1983	16.95	43.58	33.29	40.45	0.21	0.33		
1984	0.13	1.94	0.56	133.76	4.00	27.00		
1985	0.10	1.48	2.13	54.67	8.25	13.33		
1986	0.46	3.32	0.80	22.33	6.29	13.83		
1987	2.17	18.04	0.33	59.00	24.00	7.17		
1988	0.21	11.93	14.73	17.50	117.50	9.63		
1989	2.00	15.77	0.85	52.83	58.00	1.43		
1990	0.25	41.46	0.48	8.43	98.00	14.43		
1991	5.26	41.50	0.72	461.57	12.29	0.00		
1992	1.08	83.92	1.22	99.83	53.33	80.00		
1993	9.63	9.44	23.75	2.33	70.33	0.00		
1994	0.55	18.40	0.73	1.60	26.00	7.50		
1995	7.25	45.57	3.06	10.50	43.33	90.17		
1996	1.05	35.20	0.20	0.00	62.20	9.00		
1997	7.88	23.21	9.80	0.00	9.33	85.00		
1998	2.33	55.04	1.83	1.40	2.67	4.00		
1999	18.48	58.13	15.13	67.50	1.83	10.83		
2000	60.29	560.04	2.33	199.33	777.50	19.50		7.03
2001	0.36	63.11	12.10	6.86	15.29	22.00		1.14
2002	0.38	25.43	1.24	16.00	10.14	8.43		11.21
2003	11.08	109.13	140.17	9.00	151.83	3.33		23.19
2004	11.67	75.63	46.44	5.33	31.00	3.33		14.92
2005	10.57	22.67	0.28	1.83	33.67	1.00		6.36
2006	3.92	111.35	0.39	1.67	174.67	7.33		3.42
2007	4.96	31.17	0.00	23.00	18.33	5.33		7.06
2008	1.52	19.50	0.17	0.17	63.67	29.50		7.18
2009	1.25	11.42	9.53	2.17	16.67	12.50		7.07
2010	2.21	26.96	6.61	0.67	47.00	284.17		14.10
2011	0.75	10.96	11.89	9.17	88.17	2.67		6.55
2012	0.09	15.35	0.11	12.5	13.67	26.5		50.39
Average	5.71	47.92	10.50	59.30	61.87	29.77	4.21	9.42

Table 2.18. CPUE index for juvenile alewife by river section for 1979- 2012. The length & depth of the seine were increased in 1983; a bag was also added & the method of seining was changed, although the area sampled remained the same.

Juvenile Blueback Herring Catch per Unit Effort by River Segment							
Year	Upper Kennebec River	Merrymeeting Bay	Androscoggin River	Cathance River	Abagadasset River	Eastern River	Lower Kennebec River
1992	0.00	0.79	20.78	111.50	0.00	2.50	
1993	0.00	0.00	0.00	9.50	0.00	0.00	
1994	0.00	5.20	0.00	0.00	11.60	26.50	
1995	3.13	22.57	0.67	6.83	17.00	37.50	
1996	0.00	29.45	0.20	0.00	2.80	5.25	
1997	1.42	2.38	0.00	0.00	1.33	83.00	
1998	2.08	16.92	0.72	6.80	0.83	5.50	
1999	0.61	21.29	0.00	37.50	0.50	17.67	
2000	0.00	1.00	0.00	175.00	0.33	0.83	0.14
2001	0.46	5.61	0.71	10.29	0.00	3.20	0.00
2002	19.46	24.57	0.06	27.29	4.86	1.29	1.60
2003	0.04	49.38	0.00	6.50	36.67	0.67	11.69
2004	0.08	64.88	12.78	109.50	122.17	1.00	4.44
2005	0.00	27.08	4.11	56.17	58.50	0.20	5.19
2006	0.00	84.48	0.00	4.50	94.33	0.00	0.75
2007	0.04	8.79	0.00	154.00	11.67	1.67	0.11
2008	0.05	6.42	0.00	5.33	5.67	0.50	0.59
2009	0.00	0.67	0.00	0.17	8.00	0.00	0.03
2010	0.00	3.08	0.11	2.67	0.83	2.50	0.33
2011	0.08	1.42	0.00	12.67	11.67	0.33	0.00
2012	0.00	1.09	0.00	0.83	9.67	1.83	5.67
Average	1.31	17.96	1.91	35.10	18.97	9.14	2.35

Table 2.19. CPUE index for juvenile blueback herring by river section for 1979- 2012. The length & depth of the seine were increased in 1983; a bag was also added & the method of seining was changed, although the area sampled remained the same.

New Hampshire
Fish and Game Department

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January 10, 2014

Marin Hawk
Atlantic States Marine Fisheries Commission
1050 N. Highland Street
Suite 200 A-N
Arlington, VA 22201

Dear Marin,

New Hampshire Fish and Game Department is resubmitting this cover letter of the American shad and river herring annual compliance report for 2012 to clarify its *de minimis* status.

The State of New Hampshire would like to petition to the ASMFC Shad and River Herring Board for *de minimis* status under Amendment's 2 and 3 to the Interstate Fishery Management Plan for Shad and River Herring. As indicated from Table 1 below, New Hampshire's shad and river herring commercial harvest is below the one percent threshold level of the total Atlantic coast's commercial landings of each species as outlined in Section 5.3 in Amendment 2 and Section 7.1.3 in Amendment 3.

Table 1. New Hampshire's American shad and river herring commercial harvest and percentage of New Hampshire's harvest compared to Atlantic coast harvest, 2010-2012.

Year	American Shad Commercial Landings				River Herring Commercial Landings			
	NH Landings (lbs)		Atlantic Coast Harvest (lbs) (Source ACCSP)	NH%	NH Landings (lbs)		Atlantic Coast Harvest (lbs) (Source ACCSP)	NH%
	NH	EEZ			NH	EEZ		
2012	0	0	613,797	0	2,681	0	1,653,921	0.16%
2011	0	0	660,174	0	4,094	0	1,292,271	0.32%
2010	0	0	611,392	0	7,466	0	2,295,783	0.33%

If there are further questions or concerns Mike Dionne or Kevin Sullivan can be reached at (603) 868-1095.

Sincerely,

Douglas E. Grout

Douglas E. Grout
Chief of Marine Fisheries

DEG/KMS/mad
Enclosure

New Hampshire
Fish and Game Department

Region 3

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Glenn D. Normandeau
Executive Director

July 1, 2013

Kate Taylor
Atlantic States Marine Fisheries Commission
1444 Eye St., N.W., 6th Floor
Washington, DC 20005

Dear Kate,

New Hampshire Fish and Game Department is submitting the following American shad and river herring annual report for 2012 as requested by the Atlantic States Marine Fisheries Commission's Interstate Fishery Management Plans for Shad & River Herring.

The State of New Hampshire would also like to request continued de minimis status under Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring. As indicated from the table below, New Hampshire's commercial and recreational harvest is below the one percent requirement as outlined in Section 7.1.3.

New Hampshire's American shad commercial and recreational harvest and percentage of New Hampshire's harvest compared to Atlantic Coast harvest, 1998-2012.

YEAR	NH LANDINGS			TOTAL HARVEST-ATLANTIC COAST		NH %	
	COMMERCIAL (NH)	COMMERCIAL (EEZ)	RECREATIONAL (MRIP)	COMMERCIAL (NMFS)	RECREATIONAL (MRIP)	COMMERCIAL	RECREATIONAL
2012	0	0	31	613,797	36,271	0.0	<0.01
2011	0	0	0	660,174	3,194	0	0
2010	0	0	2	611,392	11,114	0	<0.01
2009	0	10	0	465,657	843	<0.01	0
2008	0	0	0	459,835	5,157	0	0
2007	0	0	0	687,826	11,389	0	0
2006	0	0	0	540,399	26,061	0	0
2005	0	25	0	617,774	16,888	<0.01	0
2004	0	0	0	1,177,676	86	0	0
2003	0	0	0	1,504,848	4,056*	0	0
2002	0	0	0	1,607,634	2,281*	0.00	0
2001	109	811	0	1,418,791	35,120*	<0.01	0
2000	0	5,942	0	1,605,990	4,277*	<0.01	0
1999	0	3,674	0	1,390,173	1,461*	<0.01	0
1998	0	15,169	0	2,141,871	1,375*	<0.01	0

* - Harvest based on MRFSS estimates 1997-2003

If there are further questions or concerns Mike Dionne or Kevin Sullivan can be reached at (603) 868-1095.

Sincerely,

Douglas Grout
Chief Marine Fisheries

DEG/KMS/mad
Enclosure

New Hampshire's 2012 Annual Report for American Shad and River Herring

River Herring:
New Hampshire's Sustainable Fishing Plan (SFP) for river herring was approved by ASMFC in 2011. The SFP has two separate targets, one fishery-dependent and one fishery-independent. The fishery-dependent target will be a harvest level that results in a harvest percentage (exploitation rate) that does not exceed 20% in the 'Great Bay Indicator Stock', providing an 80% escapement level. Specifically, a three year running average of the total annual river herring harvest from throughout Great Bay Estuary will be compared to a three year running average of minimum annual counts of spawning river herring returns documented via fish ladder counts on four rivers in Great Bay Estuary plus annual harvest of river herring throughout the estuary system. The harvest percentage, or exploitation rate, for 2012 was below the 20% target at 4.7%.

The New Hampshire fishery independent target for river herring returns is 350 fish per acre of available spawning habitat. This currently equates to a return of 72,293 fish. This target is slightly above 50% of the mean annual river herring return to the Great Bay Estuary since 1990. This target is an interim target until the upcoming ASMFC stock assessment for river herring is completed and peer reviewed. Results of the stock assessment will then be reviewed for potential alternatives for this target. The New Hampshire river herring return for 2012 was 117,518 fish. This is the sixth consecutive year the target has been exceeded. The only management change that occurred in 2012 is the closure of the Oyster River to the taking of river herring by any method in response to a decline in returns. Current monitoring will continue in 2013.

American Shad:
There currently is no specific target set for American shad. There were no changes to management in 2012 and none planned for 2013. Current monitoring will continue in 2013.

1. Harvest and losses
    A. Commercial fishery
        1. Characterization of fishery

            American shad:
            New Hampshire's rules and regulations state any American shad caught has to be immediately released.

            River herring (alewives and blueback herring):
            The directed fishery (coastal harvesting) for river herring is primarily for bait in lobster traps or for striped bass fishing. The majority of the harvesters recreationally obtain these fish for personal use although a few do sell their harvest.

        2 Characterization of directed harvest for all alosines
            a. Landings and method of estimation

            American shad:
            There are no recorded commercial landings from a directed fishery for American shad from within New Hampshire's coastal or estuarine waters (Table 1).

River herring (alewives and blueback herring):

The directed fishery (coastal harvesting) for river herring is primarily for bait in lobster traps or for striped bass fishing. The majority of the harvesters obtain these fish for personal use although a few do sell their harvest.

b Catch composition

American shad:

There was no catch to evaluate.

River herring (alewives and blueback herring):

The catch composition of harvested river herring is not directly evaluated. Most of the river herring harvest by coastal netters and anglers occurs a short distance below monitored fishways. The harvested fish can be characterized by those that are sampled in the fishways located directly above these fisheries.

c. Estimation of effort

American shad:

No directed fishery to evaluate.

River herring (alewives and blueback herring):

The effort involved from New Hampshire's coastal harvest of river herring is shown in Table 2.

3. Characterization of other losses (poaching, bycatch, etc.)

a. Estimate and method of estimation

American shad:

Bycatch of American shad can be determined as it is one of the data elements collected from the coastal harvest reports. In 2012, there were no American shad, hickory shad, or gizzard shad reported as bycatch from the coastal harvest fishery harvesting river herring in state waters.

There was no reported bycatch of shad recorded in New Hampshire's landings from commercial fishing in federal waters (Table 3).

In 2012, law enforcement had no recorded violations or warnings pertaining to American shad in state waters.

River herring (alewives and blueback herring):

Bycatch of river herring by coastal harvesters can be determined as it is one of the data elements collected from the coastal harvest reports.

Table 12 shows the reported catch of river herring recorded in New Hampshire's landings from commercial fishing in federal waters since 1957. In 2012, 2,681 lbs of river herring were reported as landed in New Hampshire.

b Estimate of composition (length and/or age)

American shad:

New Hampshire has not sampled American shad bycatch from federal waters or from state waters. Any shad caught as bycatch within the coastal harvest fishery can be characterized by those that are sampled in the fishways located directly above these fisheries.

River herring (alewives and blueback herring):

New Hampshire has not sampled river herring bycatch from federal waters or from state waters. Any river herring caught as bycatch within the coastal harvest fishery can be characterized by those that are sampled in the fishways located directly above these fisheries.

B. Recreational fishery

1. Characterization of fishery (seasons, cap, regulations)

American shad:

New Hampshire's rules and regulations state that any American shad caught has to be immediately released.

River herring (alewives and blueback herring):

Recreational harvest of river herring occurring in New Hampshire is primarily through state-permitted coastal netters harvesting fish for personal use, such as bait. Upon all water bodies in New Hampshire harvest of river herring is prohibited on Wednesdays and no daily limit exists. Netting in the Exeter/Squamscott River is further limited to Saturdays and Mondays only between April 1 and June 30, and harvest is limited to one tote per person per day. The Oyster and Taylor rivers are closed to the taking of river herring by any method.

A fishing license is required and currently there are no regulations establishing a length limit or daily bag limit for recreational angling on either alewives or blueback herring within any water body of the state. There are no closed seasons to the taking of river herring by recreational angling, except that the harvesting of river herring is prohibited Wednesdays.

2. Characterization of directed harvest

a. Landings and method of estimation

American shad:

The Marine Recreational Survey (MRS) conducted in New Hampshire indicated no American shad were harvested in New Hampshire during 2012 (Table 14).

River herring (alewives and blueback herring):

The Marine Recreational Survey (MRS) conducted in New Hampshire indicated 6,641 alewives and 38 blueback herring were harvested in New Hampshire during 2012 by recreational anglers (Table 14). In addition, 2,481 fish classified as herring genus were harvested during 2012. The herring catch that is unidentifiable to species occurs when a herring has previously been used for bait and is not present for inspection and identification during the creel surveys, but nearly all are landed in very close proximity to head-of-tide dams often associated with fish ladders. Not all of this catch can be positively identified as being river herring, but the fact that they are harvested from inland rivers greatly reduces the likelihood of being Atlantic herring.

All persons using nets or pots to harvest finfish in state waters are required to obtain a Harvest Permit from New Hampshire Fish and Game. Mandatory monthly reporting of catch and effort is a condition of the permit. The 2012 river herring harvest derived from NH coastal harvest reports totaled 5,362 pounds.

b. Catch composition

i. Age frequency

American shad:
Not applicable

River herring (alewives and blueback herring):
The catch composition of recreationally harvested river herring is not directly evaluated for age frequency. Most of the river herring harvest by coastal netters and anglers occurs a short distance below monitored fishways. The age frequency of harvested fish can be characterized by those that are sampled in the fishways located directly above these fisheries.

ii Length frequency (legal and sub-legal catch)

American shad:
Not applicable

River herring (alewives and blueback herring):
The catch composition of recreationally harvested river herring is not directly evaluated for length frequency. Most of the river herring harvest by coastal netters and anglers occurs a short distance below monitored fishways. The length frequency of harvested fish can be characterized by those that are sampled in the fishways located directly above these fisheries.

c Estimation of effort

American shad:

Not applicable, since there is no directed effort for shad in New Hampshire.

River herring (alewives and blueback herring):

Total annual effort, measured in recreational angler trips, is monitored using the Marine Recreational Survey (MRS). The time series of effort estimates since 1990 are shown in Table 13. There were an estimated 298,714 angler trips in New Hampshire in 2012.

3. Characterization of other losses (poaching, hook/release mortality, etc.)

a. Estimate and method of estimation

American shad:

Currently there are no studies involving hook and release mortality of American shad in New Hampshire waters.

In 2012, law enforcement had no recorded violations or warnings pertaining to the recreational fishery of American shad in state waters.

River herring (alewives and blueback herring):

Currently there are no studies involving hook and release mortality of river herring in New Hampshire waters.

In 2012, law enforcement issued a very small number of minor infractions to recreational anglers for the illegal taking of river herring on days in which the fishery was closed. Infractions were generally anglers ‘snagging’ river herring for use as bait and most incidents only resulted in the illegal harvest of less than 10 fish per incident. The exact number of river herring harvested from poaching is not known, but is currently at a minimal level.

b Estimate of composition (length and/or age)

American shad:

Not applicable

River herring (alewives and blueback herring):

Not applicable

C Other losses (fish passage mortality, discarded males, brood stock capture, research losses, etc.)

American shad:

Not applicable

River herring (alewives and blueback

herring): Not applicable

D Harvest and losses – including all above estimates in numbers and weight (pounds) of fish and mean weight per fish for each gear type

American shad:
See Table 3

River herring (alewives and blueback herring):
See Tables 1, 2, 12, & 14. A mean weight of 0.5 lbs is used to determine harvest weights from numbers of fish.

E Protected species:

No protected species were reported taken as bycatch from New Hampshire's coastal netters.

II. Required fishery independent monitoring

A Description of requirement as outlined in Amendment 1, Table 2

American shad:
NHFG is required to conduct an annual spawning stock survey for American shad in the Exeter River. Biological sampling, calculation of mortality and/or survival estimates, and the recording of visibly marked shad are required to depict the spawning population in this river.

River herring (alewives and blueback herring):
NHFG is required to conduct an annual spawning stock survey and representative sampling for biological data for river herring in the Cocheco, Exeter, Oyster, Lamprey, and Taylor Rivers. Calculation of mortality and/or survival estimates are required for the Exeter River only.

B Brief description of work performed

American shad:
NHFG currently monitors the Exeter River fishway during the spring spawning runs of alosids. Biological sampling (scales, lengths and sex) is conducted on all returning American shad unless high water temperatures make it too stressful to handle the fish. Mortality/survival estimates on spawning shad that returned to the Exeter fishway can be conducted using catch curve analysis if shad return to the fishways in sufficient numbers. Any visibly tagged fish encountered will be recorded, although there has been no tagged fish encountered to date.

River herring (alewives and blueback herring):
NHFG currently monitors fishways on five coastal rivers (Cocheco River, Exeter River, Oyster River, Lamprey River, Taylor River) during the spring spawning runs of alosids. Biological sampling (scales, lengths and sex) is conducted throughout the river herring run on each of the five rivers. The

biological samples are used to monitor age, length, sex, and species frequencies and distributions to characterize the spawning runs of each river.

C. Results

1. Juvenile indices

American shad:

Not applicable

River herring (alewives and blueback herring):

A beach seine survey is conducted annually on a monthly basis from June to November at 15 fixed stations in New Hampshire's estuaries. A single seine haul is made at each station during the months of June through November. All fish captured are identified, enumerated, and measured. An annual index of relative abundance is determined using the geometric mean catch-per-seine-haul. This relative annual index can be used to determine successful occurrence of river herring spawning activity between years. Table 11 shows the catch, arithmetic mean, and geometric mean catch values of alewife and blueback herring from the beach seine survey between 1997 and 2012.

Geometric means for both juvenile alewives and blueback herring were relatively high in both 2006 and 2007 despite poor adult returns due to flood conditions. High flows may have resulted in conditions favorable for both adult spawning and good juvenile survival in the tidal waters below preferred freshwater habitat. Since 2007 juvenile abundance for both alewives and blueback herring has been declining.

2 Spawning stock assessment

American shad:

The American shad returns for the New Hampshire coastal fish ladders from 2003-2012 are characterized in Table 4. Annual returns of shad to New Hampshire have ranged from 4-22 fish in the last five years. The return of four American shad to New Hampshire's coast is the lowest return since 1990.

River herring (alewives and blueback herring):

The numbers of river herring returning to New Hampshire coastal fish ladders from 1978 to 2012 are shown in Table 6. After low return years in 2005 and 2006, adult river herring return numbers have stabilized with an average return of just under 100,000 fish over the last five years. The length, age, and sex characterization of the spawning runs are determined from biological sampling (Table 7, Table 8, Table 9, Table 15, & Table 16). In general there were a slightly higher percentage of males returning to the Oyster and Lamprey Rivers and slightly higher percentage of females returning to the Cocheco and Exeter Rivers in 2012. The majority of the fish returning in 2012 were age 5 with the exception of the Oyster River where the run was dominated by age 4 fish. Mean length of returning adults has remained stable over the last several years. The largest mean lengths are seen in the Cocheco River and the smallest in the Oyster River. No biological samples were collected in 2012 at the Taylor River and Winnicut River. The Taylor River fish ladder has had low returns over the last several years and no way to trap returns for sampling. The Winnicut River dam/fish ladder was removed in late-2009 making capture of returning adults very difficult.

3 Annual mortality rate calculation

American shad:

Previously calculated mortality rates are shown in Table 5. Given the low number of American shad returning to the Exeter River, these calculations are not feasible for 2012. If in forthcoming years, the number of American shad returning increase to a level sufficient to provide accurate estimates, they will be determined.

River herring (alewives and blueback herring):

Estimates of total instantaneous mortality with standard errors for river herring in coastal New Hampshire rivers, using Chapman-Robson, Heinecke, and catch curve methods based on age, separated by species and sex are shown in Table 10. In the Cocheco River mortality for both male and female alewives has been decreasing over the last several years and continued with a slight decrease in 2012. Blueback herring were not sampled in the Cocheco in 2012. Mortality for both male and female alewives in the Exeter River increased from 2011 levels in 2012. In general, mortality in the Exeter River has been increasing slightly each year since 2006. Mortality for alewives in the Oyster River has not been calculated prior to 2011. Mortality for blueback herring has remained relatively stable for the last several years. Both male and female alewives in the Lamprey River had relatively stable mortality in 2012 from 2011 levels. There were insufficient blueback herring returns in the Lamprey for mortality estimates. No fish were sampled in the Taylor or Winnicut Rivers in 2012 and therefore no mortality was calculated.

4 Hatchery evaluation (%wild vs. hatchery juveniles)

American shad:

No hatchery raised American shad were stocked in New Hampshire in 2012.

River herring (alewives and blueback herring):

No hatchery raised river herring were stocked in New Hampshire in 2012.

Table 1. New Hampshire's landings of American shad and river herring (alewife and blueback herring) from 1988 to 2012.

Year	Landed weight in pounds	
	American shad[a]	river herring[b]
1988	45,938	14,219
1989	30,604	20,348
1990	38,206	15,513
1991	18,924	8,402
1992	9,903	9,772
1993	6,549	2,131
1994	21,724	1,940
1995	30,561	5,138
1996	35,561	4,003
1997	25,436	9,168
1998	15,169	25,993
1999	3,674	19,049
2000	5,942	22,141
2001	920	14,129
2002	0	13,617
2003	0	16,516[c]
2004	0	9,093[c]
2005	25	1,514
2006	0	1,716
2007	0	1,408
2008	0	7,669
2009	[d]	9,439
2010	0	7,466
2011	0	4,094[c]
2012	0	2,681

[a]- American shad harvested from federal waters - from NMFS.
[b]- River herring harvested by New Hampshire coastal harvesters for personnel use and for sale.
[c]- River herring harvested by New Hampshire coastal harvesters for personnel use and for sale plus NMFS reported landings from federal waters.
[d]- Not available for release to public due to confidentiality.

Table 2. The monthly harvested weight, effort and catch per unit effort (CPUE) by gear of coastal harvesters in NH coastal and estuarine waters of river herring in 2012.

Species	Month							
River Herring	Apri		May		June		July	
Weight of Harvest (lbs.)	150.0		2,303.0		227.5		0.0	
Gear	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE
Cast Net	1.50	100	68.50	22.16	12.25	18.49	-	-
Dip Net	-	-	-	-	-	-	-	-
Gill Net	-	-	9.25	2.27	-	-	-	-
Wire Basket	-	-	-	-	-	-	-	-
Seine	-	-	-	-	-	-	-	-
Weir	-	-	672.00	1.04	-	-	-	-

*- Gear effort is measured in hours fished with the exception of gill nets, which are measured by the following: (Net Area/100)*Hours Fished.

Table 3. The harvest and losses (number and weight in pounds) of American shad in New Hampshire in 2012.

Harvest/Method	# American shad	Weight	Mean Weight (lbs)
Commercial:			
Estuarine/State waters-bycatch	0	0	
Federal waters/bycatch	0	0	
Recreational:			
Non-directed (poaching, hook & release, etc.)	0	0	
Other - Fish passage mortality.	0	0	

Table 4. American shad returns, beginning and ending dates of returns and summary of biological data collected from shad in New Hampshire coastal fish ladders, 2003-2012.

River	Year	Return No's	Run Dates	Mal %	Mal Mean Length	Femal %	Femal Mean Length	Age II	Age I	Age V	Age VI	Age VI	Age VII	Age IX	Sample Size
COCHECO	2012	4*	-	-	-	-	-	-	-	-	-	-	-	-	-
	2011	6	5/22 – 6/1	50	42.	50	53.								6
	2010	2	4/23 - 5/18	50	45.	50	48.				2				2
	2009	1	5/29 - 6/25	60	46.	40	52.			3	5	1	1		1
	2008	7	6/3 - 6/18	100	43.	0%					2	3			5
	2007	7	5/24 - 6/1	71	47.	29	53.			3	2	1	1		7
	2006	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	2005	8	5/31 - 6/26	71	48.	29	51.			1	5	2			8
	2004	1	5/13 - 6/17	78	49.	22	54.			6	2	1			9
	2003	6	5/30 - 6/19	50	47.	50	50.		3	2		1			6
EXETER	2012	0													
	2011	2	6/8 – 6/10	0%	NA	100%	54.6								2
	2010	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	2009	7	5/28 - 6/20	43	52.	57	49.		1	2	2	1		1	7
	2008	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	2007	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	2006	2	5/7 - 6/4		48.					1	1				2
	2005	3	5/30 - 6/4	33	49.	67	54.				1	2			3
	2004	2	5/25 - 7/2	52	49.	48	54.			8	9	3			2
	2003	3	5/22 - 6/24	82	48.	18	53.	1	5	14	1	2			3
LAMPREY	2012	0													
	2011	1	6/1	10	51.	0%	NA								1
	2010	4	5/23 - 6/21	75	47.	25	48.				1	2			3
	2009	4	5/29 - 6/6	75	45.	25	48.			1	2	1			4
	2008	4	5/29 - 6/10	100	41.	0%			1	1	1	1			4
	2007	4	5/26 - 6/1	100	47.	0%	N		1	1	2				4
	2006	6	5/27 - 6/4	67	49.	33	53.				2		2		4
	2005	1	5/25 - 6/29	75	49.	25	52.			2	4	2			8
	2004	3	6/7 - 7/16	35	48.	65	54.			8	1	6	2		2
	2003	2	5/30 - 6/25	76	49.	24	53.		5	6	9	4	1		2

* - Data not analyzed.

Table 5. Three year running average of annual instantaneous total mortality rates (Z) and annual sample sizes (N) for American shad in the Exeter River, 1993-2012.

	Exeter River	
Year	Number of Fish (N)	Mortality Rate (Z)
1993	19	0.53
1994	*	NC
1995	13	0.87
1996	50	0.69
1997	25	0.73
1998	32	0.73
1999	126	0.99
2000	151	1.02
2001	38	1.06
2002	40	0.74
2003	33	0.61
2004	22	0.58
2005	3	0.60
2006	2	0.14
2007	0	0.0
2008	0	0.0
2009	7	0.12
2010	0	NC
2011	2	NC
2012	4	NC

* - Fishway operated as swim through, no samples obtained.
NC – Not calculated due to minimal sample size.

Table 6 Numbers of river herring returning to fishways on coastal New Hampshire rivers from 1978 - 2012.

Year	Cocheco River	Exeter River	Oyster River	Lamprey River	Taylor River	Winnicut River	Annual Total
1978	1,925	205	419	20,461	168,256	3,229++	194,495
1979	586	186	496	23,747	375,302	3,410++	403,727
1980	7,713	2,516	2,921	26,512	205,420	4,393++	249,475
1981	6,559	15,626	5,099	50,226	94,060	2,316++	173,886
1982	4,129	542	6,563	66,189	126,182	2,500++	206,105
1983	968	1	8,866	54,546	151,100	+	215,481
1984	477		5,179	40,213	45,600	+	91,469
1985	974		4,116	54,365	108,201	+	167,656
1986	2,612	1,125	93,024	46,623	117,000	1,000++	261,384
1987	3,557	220	57,745	45,895	63,514	+	170,931
1988	3,915		73,866	31,897	30,297	+	139,975
1989	18,455		38,925	26,149	41,395	+	124,924
1990	31,697		154,588	25,457	27,210	+	238,952
1991	25,753	313	151,975	29,871	46,392	+	254,304
1992	72,491	537	157,024	16,511	49,108	+	295,671
1993	40,372	278	73,788	25,289	84,859	+	224,586
1994	33,140	*	91,974	14,119	42,164	+	181,397
1995	79,385	592	82,895	15,904	14,757	+	193,533
1996	32,767	248	82,362	11,200	10,113	+	136,690
1997	31,182	1,302	57,920	22,236	20,420	+	133,060
1998	25,277	392	85,116	15,947	11,979	219	138,930
1999	16,679	2,821	88,063	20,067	25,197	305	153,132
2000	30,938	533	70,873	25,678	44,010	528	172,560
2001	46,590	6,703	66,989	39,330	7,065	1,118	167,795
2002	62,472	3,341	58,179	58,065	5,829	7,041	194,927
2003	71,199	71	51,536	64,486	1,397	5,427	194,116
2004	47,934	83	52,934	66,333	1,055	8,044	176,383
2005	16,446	66	12,882	40,026	233	2,703	72,356
2006	4,318	16	6,035	23,471	147	822	34,809
2007	15,815	40	17,421	55,225	217**	7,543	96,261
2008	30,686	168	20,780	36,247	976	8,359	97,214
2009	36,165	513	11,661	42,425	***	4,974	95,737
2010	32,654	69	19,006	33,327	675	576+++	86,307
2011	43,090	256	4,755	50,447	59	72+++	99,338
2012	27,608	378	2,573	86,862	92	5+++	117,518

* - Due to damage to the fish trap, fishway became a swim through operation.

** -Due to fish counter malfunction there was up to two weeks where passing fish were not enumerated.

*** - Fishway operated but not monitored due to staffing constraints.

\+ - Fishway unable to pass fish until modifications in 1997.

++ - Fish netted below and hand passed over Winnicut River dam.

+++ - Minimum estimate based on time counts, fishway/dam removed in fall 2009.

Table 7 Percent of male and female river herring, mean total length (mm), and total sampled river herring during spawning returns to the first dam on the Cocheco, Exeter, Oyster, Lamprey, Taylor, and Winnicut rivers, New Hampshire, 1994-2012.

	Cocheco River– Combined Species					Exeter River– Combined Species					Oyster River– Combined Species				
	%		Mean Length		Total	%		Mean Length		Total	%		Mean Length		Total
Year	Male	Female	Male	Female	N	Male	Female	Male	Female	N	Male	Female	Male	Female	N
1994	56.5	44.5	274	274	462	*	*	*	*	*	63.2	36.8	262	277	450
1995	48.8	51.2	279	287	450	66.5	33.5	271	284	520	53.0	47.0	264	277	450
1996	50.7	49.3	282	290	402	54.8	45.2	278	284	221	61.4	38.6	258	270	446
1997	63.7	36.3	267	278	452	59.2	40.8	262	266	1075	60.7	39.3	261	272	448
1998	52.4	47.6	271	280	475	64.5	35.5	268	278	386	48.2	51.8	261	273	506
1999	52.4	47.6	277	288	458	65.8	34.2	267	278	403	57.4	42.6	261	273	453
2000	61.5	38.5	272	285	455	66.0	34.0	273	280	259	59.0	41.0	263	277	446
2001	54.1	45.9	278	286	458	59.7	40.3	277	288	454	60.8	39.2	269	283	449
2002	59.6	40.4	273	287	453	63.1	36.9	272	282	160	69.0	31.0	259	270	474
2003	49.3	50.7	275	280	454	62.7	37.3	283	291	67	51.7	48.3	260	272	447
2004	42.4	57.6	282	288	450	57.7	42.3	277	286	78	58.0	42.0	263	275	452
2005	50.4	49.6	285	294	347	66.2	33.8	278	289	77	60.5	39.5	257	273	343
2006	60.0	40.0	281	295	300	43.8	56.2	281	295	16	79.1	20.9	251	273	448
2007	62.8	37.2	272	285	457	60.0	40.0	268	283	40	64.7	35.3	254	267	453
2008	59.0	41.0	266	279	454	58.3	41.7	268	278	168	65.8	34.2	248	263	453
2009	58.3	41.7	273	282	456	56.3	43.8	276	283	336	76.6	23.4	251	265	299
2010	66.7	33.3	275	278	450	60.4	39.6	263	277	48	66.3	33.7	256	266	457
2011	56.7	43.3	276	287	354	64.4	35.6	267	279	230	56.9	42.9	258	269	149
2012	47.8	52.2	290	299	320	40.2	58.7	283	294	328	50.4	49.6	252	273	454

*-Sampling did not occur.

Table 7 Continued.

	Lamprey River– Combined Species					Taylor River– Combined Species					Winnicut River– Combined Species				
	%		Mean Length		Total	%		Mean Length		Total	%		Mean Length		Total
Year	Male	Female	Male	Female	N	Male	Female	Male	Female	N	Male	Female	Male	Female	N
1994	51.9	48.1	274	281	447	*	*	*	*	*	*	*	*	*	*
1995	52.6	47.4	279	293	450	*	*	*	*	*	*	*	*	*	*
1996	51.0	49.0	281	294	398	*	*	*	*	*	*	*	*	*	*
1997	46.7	53.3	284	297	304	*	*	*	*	*	*	*	*	*	*
1998	56.3	43.7	279	289	339	70.4	29.6	253	274	125	84.8	15.2	254	271	79
1999	52.3	47.7	279	289	453	61.9	38.1	253	269	181	82.6	17.4	257	271	218
2000	52.3	47.7	279	290	608	44.9	55.1	261	274	247	79.8	20.2	248	265	450
2001	58.2	41.8	286	294	452	*	*	*	*	*	71.8	28.2	262	273	464
2002	58.2	41.8	292	306	459	38.5	61.5	269	288	26	73.7	26.3	255	265	453
2003	57.2	42.8	284	296	449	*	*	*	*	*	85.4	14.6	253	264	444
2004	53.0	47.0	285	290	453	63.8	36.2	255	275	80	79.0	21.0	260	269	453
2005	57.2	42.8	290	298	402	71.4	28.6	256	263	14	78.4	21.6	247	266	343
2006	55.3	44.7	289	303	333	*	*	*	*	*	89.5	10.5	251	264	124
2007	59.6	40.4	282	303	411	61.1	38.9	287	279	18	88.0	12.0	257	270	443
2008	47.5	52.5	274	283	453	*	*	*	*	*	81.4	18.6	259	274	457
2009	60.3	39.7	282	291	451	*	*	*	*	*	82.1	17.9	256	277	452
2010	60.7	39.3	272	296	369	*	*	*	*	*	*	*	*	*	*
2011	56.2	43.8	274	286	450	*	*	*	*	*	*	*	*	*	*
2012	55.1	44.9	287	298	470	*	*	*	*	*	*	*	*	*	*

*-Sampling did not occur.

Table 8 Number-at-age of river herring collected from the coastal rivers of New Hampshire, 1996-2012.

Cocheco River– Combined Species																	
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	45	45	29	6	61	2	17	6	1	2	0	0	6	1	5	2	1
4	78	49	65	62	36	61	54	89	15	29	13	31	27	75	13	16	16
5	63	34	50	47	27	43	45	29	69	47	21	55	57	48	28	32	19
6	3	1	15	20	7	9	2	7	26	4	25	54	44	42	19	19	17
7+	2	3	1	5	0	9	6	5	8	1	2	1	12	8	7	6	10
Total	223	145	169	140	131	142	146	136	119	125	85	159	146	186	72	75	63

Exeter River– Combined Species																	
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	6	82	6	23	53	8	2	2	0	2	0	3	2	3	6	6	1
4	1	112	44	88	37	45	15	30	6	25	1	9	6	1	17	24	13
5	5	52	3	38	5	47	2	14	31	26	6	15	4	119	12	27	30
6	0	2	1	7	2	3	1	6	18	8	4	1	1	39	3	6	12
7+	0	4	6	0	0	1	0	3	2	3	5	2	3	5	0	1	3
Total	2	272	172	156	97	141	54	55	57	64	16	40	146	313	38	64	59

Oyster River– Combined Species																	
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	32	64	36	44	61	21	12	32	20	22	6	9	4	3	29	51	12
4	61	50	58	84	56	48	54	62	17	38	46	71	48	64	23	43	40
5	37	28	44	15	25	39	37	43	69	45	46	68	38	22	32	21	38
6	3	7	1	2	1	2	2	7	21	2	32	22	11	13	10	6	17
7+	0	1	2	0	0	1	1	5	4	0	9	9	6	3	6	3	5
Total	133	150	151	145	143	142	142	149	131	125	139	179	149	135	100	124	112

Table 8 Continued.

Lamprey River– Combined Species																	
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	26	15	18	15	50	11	3	8	7	0	3	2	9	6	1	5	1
4	60	18	30	44	68	49	28	53	26	25	13	21	25	44	21	25	24
5	35	35	46	53	44	52	39	41	63	55	42	42	52	79	27	34	30
6	5	2	3	35	26	26	42	17	45	44	36	54	37	60	25	15	16
7+	0	4	1	1	7	7	2	2	21	4	30	3	20	12	9	5	8
Total	126	96	135	160	195	145	139	143	162	128	124	151	143	201	92	84	79

Taylor River– Combined Species																	
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	*	*	4	4	31	*	1	*	2	1	*	0	3	*	*	*	*
4	*	*	3	1	47	*	1	*	1	1	*	1	4	*	*	*	*
5	*	*	2	4	14	*	6	*	1	0	*	1	0	*	*	*	*
6	*	*	6	5	5	*	1	*	7	0	*	6	0	*	*	*	*
7+	*	*	6	0	0	*	6	*	5	0	*	2	0	*	*	*	*
Total	*	*	1	6	97	*	30	*	68	1	*	19	7	*	*	*	*

Winnicut River– Combined Species																	
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	*	*	4	4	60	42	29	36	3	48	9	5	5	3	*	*	*
4	*	*	2	6	70	64	61	88	58	52	41	56	29	65	*	*	*
5	*	*	4	1	3	25	30	21	66	38	34	60	71	40	*	*	*
6	*	*	4	4	1	1	21	2	7	1	1	32	37	49	*	*	*
7+	*	*	2	0	2	1	6	0	2	1	5	1	8	25	*	*	*
Total	*	*	7	1	178	146	147	147	136	152	105	169	150	209	*	*	*

* data not available for selected year

Table 9 Mean total length-at-age (TL, mm) of river herring returning to New Hampshire rivers, 1994-2012.

Cocheco River– Combined Species																			
Mean Length (mm) at Age																			
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Age																			
3	260	268	272	253	258	258	268	271	248	262	266	258			236	249	255	246	244
4	273	282	282	262	269	273	277	280	266	274	274	273	265	261	257	266	273	263	284
5	292	290	292	286	280	284	295	288	284	285	282	284	280	268	271	281	293	273	283
6		307	296	305	293	294	304	292	300	294	300	300	291	285	277	292	297	301	301
7+			311	309	314	314		309	306	305	311	315	298	312	290	312	306	311	317

Exeter River– Combined Species																			
Mean Length (mm) at Age																			
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Age																			
3	*	271	2	253	257	259	270	272	266	252		236		245	252	250	253	255	244
4	*	283	2	268	270	269	283	274	273	283	271	272	273	261	270	275	265	268	276
5	*	296	3	282	280	279	293	285	281	289	277	283	284	271	279	280	285	281	287
6	*	317		289	288	297	306	287	287	295	288	301	285	289	282	286	290	285	295
7+	*			315	312			287		314	311	322	300	306	310	291			317

Oyster River– Combined Species																			
Mean Length (mm) at Age																			
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Age																			
3	253	262	257	255	254	258	261	260	250	254	249	241	235	243	238	249	250	245	238
4	273	270	265	267	269	269	271	271	252	261	264	256	245	250	248	255	260	263	255
5	288	283	269	280	278	281	280	276	268	275	270	272	258	264	262	269	269	280	274
6	293	308	274	292	293	296	281	281	276	286	276	280	277	271	273	275	274	293	288
7+				318	307			287	284	298	290		291	288	281	286	282	285	291

Table 9 Continued.

Lamprey River– Combined Species																			
Mean Length (mm) at Age																			
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Age																			
3	269	274	278	263	261	253	273	272	262	264	259		247	247	261	250	254		256
4	279	285	287	274	266	268	281	282	279	276	271	273	261	268	269	272	261	258	267
5	292	297	296	296	281	281	295	292	294	288	284	290	285	279	277	285	288	275	285
6	308	314	300	305	292	296	304	299	304	298	294	301	302	299	287	295	303	294	304
7+	329			316	304	312	312	306	311	319	313	324	310	313	305	307	309	314	318

Taylor River– Combined Species																			
Mean Length (mm) at Age																			
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Age																			
3	*	*	*	*	2	2	263	*	236	*	247	2	*		2	*	*	*	*
4	*	*	*	*	2	2	267	*	266	*	258	2	*	264	2	*	*	*	*
5	*	*	*	*	2	2	274	*	275	*	267		*	276		*	*	*	*
6	*	*	*	*	2	2	291	*	284	*	281		*	295		*	*	*	*
7+	*	*	*	*	2			*	291	*	296		*	308		*	*	*	*

Winnicut River– Combined Species																			
Mean Length (mm) at Age																			
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Age																			
3	*	*	*	*	2	2	239	254	250	247	232	233	229	239	235	237	*	*	*
4	*	*	*	*	2	2	253	262	252	256	258	248	242	247	254	254	*	*	*
5	*	*	*	*	2	2	269	272	266	269	266	268	252	258	263	265	*	*	*
6	*	*	*	*	2	2	274	281	272	280	274	268	275	270	278	279	*	*	*
7+	*	*	*	*	3		289	268	291		277	263	281	292	287	289	*	*	*

*data not available for selected year

Table 10 Estimates of total instantaneous mortality (Z) with standard errors for river herring in coastal New Hampshire rivers, using Chapman-Robson, Heinecke, and catch curve methods based on age, separated by species and sex, 2012.

						Chapman-Robson		Heinecke		Catch Curve	
River	Species	Sex	Year	Data	Ages	Z Estimate	SE	Z Estimate	SE	Z Estimate	SE
Cocheco River	Alewife	Male	2012	age	5-7	0.90	0.195	0.65	0.138	0.65	0.259
Cocheco River	Alewife	Female	2012	age	4-8	0.53	0.095	0.37	0.067	0.39	0.088
Cocheco River	Blueback	Male	2012	NA	NA	NA	NA	NA	NA	NA	NA
Cocheco River	Blueback	Female	2012	NA	NA	NA	NA	NA	NA	NA	NA
Exeter River	Alewife	Male	2012	age	5-6	1.61	0.390	1.44	0.341	NA	NA
Exeter River	Alewife	Female	2012	age	5-8	0.97	0.206	0.88	0.184	0.92	0.079
Exeter River	Blueback	Male	2012	NA	NA	NA	NA	NA	NA	NA	NA
Exeter River	Blueback	Female	2012	NA	NA	NA	NA	NA	NA	NA	NA
Lamprey River	Alewife	Male	2012	age	5-7	1.00	0.208	0.92	0.190	0.66	0.147
Lamprey River	Alewife	Female	2012	age	5-8	0.91	0.174	0.73	0.138	0.93	0.127
Lamprey River	Blueback	Male	2012	NA	NA	NA	NA	NA	NA	NA	NA
Lamprey River	Blueback	Female	2012	NA	NA	NA	NA	NA	NA	NA	NA
Oyster River	Alewife	Male	2012	age	4-7	0.69	0.147	0.57	0.121	0.66	0.307
Oyster River	Alewife	Female	2012	age	5-7	0.88	0.215	0.69	0.167	0.55	0.083
Oyster River	Blueback	Male	2012	age	4-5	1.10	0.231	0.73	0.150	NA	NA
Oyster River	Blueback	Female	2012	age	5-7	1.30	0.338	1.22	0.316	1.24	0.083
Taylor River	Alewife	Male	2012	NA	NA	NA	NA	NA	NA	NA	NA
Taylor River	Alewife	Female	2012	NA	NA	NA	NA	NA	NA	NA	NA
Taylor River	Blueback	Male	2012	NA	NA	NA	NA	NA	NA	NA	NA
Taylor River	Blueback	Female	2012	NA	NA	NA	NA	NA	NA	NA	NA
Winnicut River	Alewife	Male	2012	NA	NA	NA	NA	NA	NA	NA	NA
Winnicut River	Alewife	Female	2012	NA	NA	NA	NA	NA	NA	NA	NA
Winnicut River	Blueback	Male	2012	NA	NA	NA	NA	NA	NA	NA	NA
Winnicut River	Blueback	Female	2012	NA	NA	NA	NA	NA	NA	NA	NA

Table 11 Annual juvenile abundance index of river herring seined in Great Bay Estuary, New Hampshire, 1997-2012.

Year	Alewife Catch	Alewife Arithmetic Mean	Alewife Geometric Mean	Blueback Catch	Blueback Arithmetic Mean	Blueback Geometric Mean
1997	16	0.18	0.07	295	3.31	0.49
1998	14	0.16	0.04	1821	20.23	0.66
1999	660	7.33	0.27	11838	131.53	0.97
2000	71	0.79	0.26	5092	56.58	0.74
2001	119	1.24	0.13	1476	15.38	0.88
2002	164	1.82	0.34	261	2.90	0.26
2003	899	9.99	0.32	1812	20.13	0.76
2004	35	0.39	0.14	124	1.38	0.22
2005	29	0.32	0.11	2146	23.84	0.35
2006	1471	16.34	0.32	432	4.80	0.42
2007	203	2.26	0.21	1503	16.70	0.50
2008	39	0.43	0.15	37	0.41	0.13
2009	32	0.36	0.10	182	2.02	0.20
2010	14	0.16	0.08	79	0.88	0.17
2011	21	0.24	0.08	7	0.07	0.05
2012	6	0.07	0.02	29	0.32	0.08

Table 12 Reported harvest (metric tons and pounds) of river herring in New Hampshire from the NMFS, 1957-2012.

Year	Metric Tons	Pounds
1957	34	75,000
1958	27.2	60,000
1959	36.3	80,000
1960	43.1	95,000
1961	45.4	100,000
1962	56.7	125,000
1963	68	150,000
1964	34	75,000
1965	56.7	125,000
1966	34	75,000
1967	29.5	65,000
1968	18.4	40,600
1969	17	37,500
1970	14.1	31,000
1971	11.3	25,000
1972	10.9	24,000
1973	9.8	21,500
1977	95.3	210,000
1978	74.8	165,000
1982	51.9	114,500
1983	52.3	115,216
1984	40.8	90,000
1985	27.8	61,300
1986	12.2	26,990
1987	8.9	19,550
1988	5.5	12,087
1989	5.1	11,200
1992	4.4	9,802
1993	1.2	2,676
1998	11.8	25,994
2007	0.6	1,408
2008	3.7	8,132
2009	4.3	9,439
2010	3.4	7,466
2011	1.9	4,094
2012		2,681
Grand Total	952.3	2,098,041

Table 13 Number of estimated annual angler trips and associated proportional standard error values for New Hampshire from the Marine Recreational Survey, 1990-2012.

Year	Number of Angler Trips (MRFSS)	PSE for MRFSS Weighted Angler Trips	Number of Angler Trips (MRIP)	PSE for MRIP Weighted Angler Trips
1990	312,389	15.0		
1991	262,703	22.0		
1992	191,575	17.8		
1993	197,081	13.5		
1994	314,034	23.1		
1995	299,763	15.5		
1996	265,065	12.4		
1997	337,836	11.4		
1998	276,670	11.1		
1999	285,303	13.4		
2000	367,899	9.4		
2001	360,098	7.9		
2002	318,430	8.0		
2003	415,763	8.5		
2004	360,359	12.3	343,160	12.6
2005	520,433	9.3	504,774	10.7
2006	546,952	7.9	501,320	9.0
2007	537,684	8.0	501,517	8.8
2008	348,590	7.2	332,539	7.7
2009	414,337	7.7	400,587	8.0
2010	251,969	8.6	243,075	8.7
2011	294,566	*	296,570	11.2
2012	*	*	298,714	11.3

* - Data no longer available

Table 14 Estimates of total catch and harvest of American shad and river herring in New Hampshire from the Marine Recreational Survey, 1990-2012.

	American Shad		Alewife		Blueback Herring		Herring Genus		Herring Family	
Year	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest
1990										
1991										
1992									421	
1993									1,481	196
1994										
1995	121		209	209					162	129
1996									333	333
1997									24	
1998	444									
1999							3,398			
2000	170								156	
2001			6,875	6,875	196	196				
2002	242									
2003					3,015	3,015	18,627	18,627		
2004					623		11,107	10,553		
2005			8,812		79	58			20	20
2006							2,417	2,417		
2007			36,402	30,829			1,415			
2008			31,835	31,835					74	
2009			993	993	540	429			176	176
2010	26	26	2,184	2,184			2,852	2,852	326	107
2011							12,539	12,539		
2012	31		6,641	6,641	38	38	2,481	2,481	4,557	

Table 15 Degree of Total Repeat Spawners for River Herring in New Hampshire 2000-2012

		Cocheco			Exeter			Oyster		
Alewife	Year	Scale Samples	Repeat Spawners	Percentage of Repeat Spawners	Scale Samples	Repeat Spawners	Percentage of Repeat Spawners	Scale Samples	Repeat Spawners	Percentage of Repeat Spawners
	2000	106	34	32%	94	10	11%			
	2001	117	51	44%	56	21	38%			
	2002	93	43	46%	52	10	19%	1	1	100%
	2003	111	34	31%	54	21	39%			
	2004	102	71	70%	44	16	36%	3	0	0%
	2005	120	65	54%	64	14	22%			
	2006	77	39	51%	16	6	38%			
	2007	93	29	31%	40	7	18%			
	2008	98	29	30%	134	12	9%	4	2	50%
	2009	88	19	22%	307	36	12%	15	9	60%
	2010	72	47	65%	32	6	19%	22	6	27%
	2011	75	32	43%	63	7	11%	62	22	35%
	2012	63	37	59%	59	20	34%	50	17	34%

		Lamprey			Taylor			Winnicut		
Alewife	Year	Scale Samples	Repeat Spawners	Percentage of Repeat Spawners	Scale Samples	Repeat Spawners	Percentage of Repeat Spawners	Scale Samples	Repeat Spawners	Percentage of Repeat Spawners
	2000	195	90	46%				21	5	24%
	2001	145	85	59%				87	39	45%
	2002	139	88	63%				79	31	39%
	2003	140	72	51%				70	25	36%
	2004	162	89	55%	1	0	0%	92	61	66%
	2005	128	66	52%				100	40	40%
	2006	122	73	60%				32	12	38%
	2007	140	80	57%	19	6	32%	139	86	62%
	2008	143	47	33%				134	87	65%
	2009	145	72	50%				116	64	55%
	2010	81	51	63%						
	2011	84	40	48%						
	2012	79	36	46%						

Table 15 Continued

Blueback	Year	Cocheco Scale Samples	Cocheco Repeat Spawners	Cocheco Percentage of Repeat Spawners	Exeter Scale Samples	Exeter Repeat Spawners	Exeter Percentage of Repeat Spawners	Oyster Scale Samples	Oyster Repeat Spawners	Oyster Percentage of Repeat Spawners
	2000	25	11	44%	3	0	0%	143	50	35%
	2001	25	10	40%	85	52	61%	144	93	65%
	2002	53	11	21%	2	1	50%	141	51	36%
	2003	25	6	24%	1	0	0%	149	76	51%
	2004	17	7	41%	13	8	62%	128	89	70%
	2005	5	1	20%				126	63	50%
	2006	8	1	13%				141	60	43%
	2007	67	21	31%				179	68	38%
	2008	48	18	38%	12	3	25%	145	40	28%
	2009	2	1	50%	6	3	50%	86	32	37%
	2010				6	3	50%	78	41	53%
	2011				1	0	0%	62	29	47%
	2012							62	35	56%

Blueback	Year	Lamprey Scale Samples	Lamprey Repeat Spawners	Lamprey Percentage of Repeat Spawners	Taylor Scale Samples	Taylor Repeat Spawners	Taylor Percentage of Repeat Spawners	Winnicut Scale Samples	Winnicut Repeat Spawners	Winnicut Percentage of Repeat Spawners
	2000				97	30	31%	157	37	24%
	2001							59	24	41%
	2002				30	28	93%	68	16	24%
	2003	3	3	100%				77	30	39%
	2004				67	20	30%	44	26	59%
	2005				14	1	7%	52	11	21%
	2006	2	0	0%				73	20	27%
	2007	11	6	55%				30	18	60%
	2008				7	0	0%	16	9	56%
	2009	1	1	100%				33	4	12%
	2010	11	8	73%						
	2011									
	2012									

Table 15 Continued

Combined	Year	Cocheco Scale Samples	Cocheco Repeat Spawners	Cocheco Percentage of Repeat Spawners	Exeter Scale Samples	Exeter Repeat Spawners	Exeter Percentage of Repeat Spawners	Oyster Scale Samples	Oyster Repeat Spawners	Oyster Percentage of Repeat Spawners
	2000	131	45	34%	97	10	10%	145	50	34%
	2001	142	61	43%	141	73	52%	146	94	64%
	2002	146	54	37%	54	11	20%	142	52	37%
	2003	136	40	29%	55	21	38%	149	76	51%
	2004	119	78	66%	57	24	42%	131	89	68%
	2005	125	66	53%	64	14	22%	126	63	50%
	2006	85	40	47%	16	6	38%	141	60	43%
	2007	160	50	31%	40	7	18%	179	68	38%
	2008	146	47	32%	146	15	10%	149	42	28%
	2009	90	20	22%	314	39	12%	101	41	41%
	2010	72	47	65%	38	9	24%	100	47	47%
	2011	75	32	43%	64	7	11%	124	51	41%
	2012	63	37	59%	59	20	34%	112	52	46%

Combined	Year	Lamprey Scale Samples	Lamprey Repeat Spawners	Lamprey Percentage of Repeat Spawners	Taylor Scale Samples	Taylor Repeat Spawners	Taylor Percentage of Repeat Spawners	Winnicut Scale Samples	Winnicut Repeat Spawners	Winnicut Percentage of Repeat Spawners
	2000	195	90	46%	97	30	31%	179	42	23%
	2001	145	85	59%				146	63	43%
	2002	139	88	63%	30	28	93%	147	47	32%
	2003	143	75	52%				147	55	37%
	2004	162	89	55%	68	20	29%	136	87	64%
	2005	128	66	52%	14	1	7%	152	51	34%
	2006	124	73	59%				105	32	30%
	2007	151	86	57%	19	6	32%	169	104	62%
	2008	143	47	33%	7	0	0%	150	96	64%
	2009	146	73	50%				149	68	46%
	2010	92	59	64%						
	2011	84	40	48%						
	2012	79	36	59%						

Table 16 Total Length Frequency (TL, cm) for river herring in New Hampshire 1994-2012

Cocheco-Alewife																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	4	1	0	3	0	0	0	0	0	0	0	0	0	1	1	3	7	5	1
25	8	1	3	11	0	2	1	0	1	2	0	1	3	1	3	9	20	22	0
26	27	2	15	9	10	4	11	3	7	4	3	6	5	2	15	14	24	57	7
27	37	11	22	9	27	20	25	20	10	29	14	16	5	13	26	21	18	134	30
28	26	34	33	8	44	29	26	30	22	36	20	27	13	27	26	18	16	121	108
29	10	41	47	7	15	37	18	34	21	25	28	28	22	21	17	17	7	66	147
30	5	17	39	11	9	10	18	19	21	8	21	24	18	12	8	5	3	28	115
31	2	4	25	8	5	6	7	8	7	4	13	10	8	8	2	1	0	14	34
32	0	1	3	2	3	2	0	3	3	3	2	7	1	4	0	0	0	3	7
33	0	0	1	2	2	1	0	0	1	0	0	1	2	3	0	0	0	0	1
34	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	119	112	190	70	115	111	106	117	93	111	102	120	77	93	98	88	96	450	450

Table 16 Continued

Exeter-Alewife																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
23	0	0	0	1	0	3	0	0	0	0	0	1	0	1	0	0	0	4	0
24	0	0	0	1	1	2	0	0	0	0	0	1	0	0	1	1	2	4	1
25	0	0	0	7	5	3	3	0	0	0	0	2	0	4	7	3	8	28	2
26	0	11	0	14	8	13	9	1	6	1	0	4	1	9	27	20	5	66	8
27	0	27	2	19	18	41	29	6	11	7	10	14	2	7	33	73	5	70	27
28	0	48	8	29	33	20	29	18	19	16	15	17	1	9	43	131	3	47	46
29	0	24	5	21	18	15	17	20	11	20	12	16	7	6	18	58	2	10	56
30	0	11	3	14	5	6	6	10	5	5	3	4	4	2	3	17	0	2	26
31	0	5	1	3	4	2	1	1	0	3	3	2	0	1	1	4	1	0	9
32	0	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1
33	0	0	0	1	0	0	0	0	0	1	0	1	1	1	0	0	0	1	1
34	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	127	20	111	92	105	94	56	52	54	44	64	16	40	134	307	26	233	178

Table 16 Continued

Oyster-Alewife																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3
25	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	5	16	10	11
26	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	6	13	24	13
27	0	1	2	0	0	0	0	0	0	0	0	0	0	0	1	2	15	55	17
28	0	3	2	0	0	0	0	0	0	0	2	0	0	0	1	0	5	32	12
29	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	20	12
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	5	12
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	8	5	0	0	0	0	0	1	0	3	0	0	0	4	15	54	149	83

Table 16 Continued

Lamprey-Alewife																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
24	0	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0	2	6	2
25	9	2	2	1	6	6	5	0	1	2	6	1	5	5	5	1	6	42	9
26	12	1	8	9	22	8	17	5	3	20	13	4	9	7	17	6	14	87	19
27	30	22	12	11	27	27	30	12	12	13	22	9	11	10	39	24	10	119	54
28	47	32	25	10	30	35	36	39	18	22	37	24	6	18	24	45	3	77	91
29	25	36	41	13	28	27	47	40	28	26	32	38	23	27	31	32	1	49	136
30	12	14	24	30	16	22	27	30	35	28	19	24	31	30	13	26	0	43	90
31	4	8	10	14	5	11	23	12	23	12	23	20	24	18	9	7	1	20	42
32	1	3	5	4	0	3	7	6	12	13	5	4	9	11	5	3	0	4	6
33	1	1	1	1	0	1	2	1	5	3	3	3	4	9	0	1	0	2	0
34	0	0	0	0	0	0	1	0	2	0	2	1	0	3	0	0	0	0	1
35	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	141	119	128	94	135	141	195	145	139	140	162	128	122	140	143	145	37	450	450

Table 16 Continued

Taylor-Alewife																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
26	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
29	0	0	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	3	0	0	0	0	0	1	0	0	19	0	0	0	0	0

Table 16 Continued

Winnicut-Alewife																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	1	8	1	1	0	1	0	0	0
23	0	0	0	0	0	1	1	0	0	0	0	16	5	8	3	3	0	0	0
24	0	0	0	0	1	4	8	8	5	11	4	21	7	19	8	15	0	0	0
25	0	0	0	0	0	17	4	19	21	17	11	14	5	25	14	17	0	0	0
26	0	0	0	0	1	21	3	25	23	24	34	16	1	40	37	18	0	0	0
27	0	0	0	0	2	11	3	21	17	11	29	17	3	24	37	27	0	0	0
28	0	0	0	0	1	10	2	11	6	6	9	5	3	9	21	14	0	0	0
29	0	0	0	0	0	2	0	3	5	1	4	2	3	7	9	17	0	0	0
30	0	0	0	0	0	1	0	0	1	0	0	0	3	3	4	2	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	0	0	0
32	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	5	67	21	87	79	70	92	100	32	139	134	116	0	0	0

Table 16 Continued

Cocheco-Blueback																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	1	0	0	2	0	0	0	0	3	0	0	0	0	0	3	1	7	0	0
24	4	0	0	8	3	0	2	0	10	0	0	0	1	1	7	0	10	0	0
25	10	0	8	18	15	0	6	1	14	7	0	0	0	17	9	0	26	0	0
26	1	8	5	20	14	9	9	5	7	11	7	3	2	18	13	0	8	0	0
27	4	8	14	10	15	16	4	8	6	5	7	2	1	21	8	0	1	0	0
28	2	4	8	10	6	4	2	11	7	2	1	0	2	5	7	1	0	0	0
29	1	3	4	5	1	0	2	0	5	0	2	0	2	5	1	0	0	0	0
30	0	2	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	23	25	42	75	54	29	25	25	53	25	17	5	8	67	48	2	53	0	0

Table 16 Continued

Exeter-Blueback																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0
24	0	0	0	22	2	0	0	0	0	0	0	0	0	0	2	1	0	0	1
25	0	5	0	40	23	3	0	0	0	1	0	0	0	0	4	2	1	0	0
26	0	11	0	34	31	15	1	9	0	0	3	0	0	0	3	2	0	0	0
27	0	9	0	27	16	22	0	26	1	0	6	0	0	0	0	1	0	0	0
28	0	14	0	25	4	7	1	20	0	0	4	0	0	0	0	0	0	0	0
29	0	12	1	11	3	2	0	16	1	0	0	0	0	0	1	0	0	0	0
30	0	7	1	1	0	0	1	13	0	0	0	0	0	0	0	0	0	0	0
31	0	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	61	2	161	80	51	3	85	2	1	13	0	0	0	12	6	1	0	1

Table 16 Continued

Oyster-Blueback																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
22	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	3	27
23	4	0	2	2	0	1	0	0	1	0	0	1	8	3	16	0	8	26	41
24	15	1	5	15	8	4	5	1	11	5	5	20	23	30	43	13	66	82	33
25	30	10	23	24	16	13	17	6	43	23	19	11	38	35	25	33	153	76	72
26	28	39	37	36	34	39	30	25	21	53	30	28	25	45	29	22	112	68	80
27	24	32	31	35	33	44	51	48	30	32	39	22	11	37	20	10	44	33	64
28	18	16	25	15	35	34	21	41	21	15	23	31	19	20	9	7	12	11	44
29	20	10	4	15	17	8	17	14	11	15	9	9	13	8	2	1	3	2	4
30	8	8	0	5	6	2	2	8	2	5	3	0	2	1	0	0	0	0	0
31	0	3	1	1	2	0	0	1	1	1	0	0	1	0	0	0	0	0	0
32	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	147	120	128	150	151	145	143	144	141	149	128	126	141	179	145	86	398	301	367

Table 16 Continued

Lamprey-Blueback																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0
25	0	0	0	1	0	7	0	0	0	0	0	0	0	2	0	0	18	0	0
26	0	0	0	0	0	7	0	0	0	2	0	0	0	2	0	0	10	0	0
27	0	2	0	0	0	2	0	0	0	1	0	0	1	5	0	1	1	0	0
28	0	3	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0
29	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	13	0	2	0	19	0	0	0	3	0	0	2	11	0	1	32	0	0

Table 16 Continued

Taylor-Blueback																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	2	3	0	0	0	0	1	0	0	0	2	0	0	0	0
24	0	0	0	0	21	12	2	0	1	0	8	0	0	0	4	0	0	0	0
25	0	0	0	0	35	11	8	0	0	0	19	6	0	0	1	0	0	0	0
26	0	0	0	0	22	18	28	0	1	0	13	5	0	0	0	0	0	0	0
27	0	0	0	0	16	12	29	0	3	0	9	3	0	0	0	0	0	0	0
28	0	0	0	0	10	5	19	0	11	0	9	0	0	0	0	0	0	0	0
29	0	0	0	0	4	3	9	0	11	0	4	0	0	0	0	0	0	0	0
30	0	0	0	0	4	2	2	0	3	0	3	0	0	0	0	0	0	0	0
31	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	115	67	97	0	30	0	67	14	0	0	7	0	0	0	0

Table 16 Continued

Winnicut-Blueback																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	4	0	0	0	0	0	2	0	0	0	0	0	0
23	0	0	0	0	1	3	17	0	1	3	1	4	12	4	0	3	0	0	0
24	0	0	0	0	13	8	28	2	9	15	5	16	16	4	3	0	0	0	0
25	0	0	0	0	27	16	40	14	29	21	13	10	16	6	1	12	0	0	0
26	0	0	0	0	18	24	28	12	14	21	9	10	15	7	6	15	0	0	0
27	0	0	0	0	9	13	21	15	8	14	10	5	4	3	4	2	0	0	0
28	0	0	0	0	2	3	14	10	5	2	6	6	4	5	1	1	0	0	0
29	0	0	0	0	2	2	3	5	2	1	0	1	3	0	1	0	0	0	0
30	0	0	0	0	1	0	2	1	0	0	0	0	0	1	0	0	0	0	0
31	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	74	69	157	59	68	77	44	52	73	30	16	33	0	0	0

Table 16 Continued

Cocheco-Combined																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	2	0	0	1	0	0	0	0	0	0	5	0	0	0	0
23	0	0	0	11	5	0	3	2	19	1	3	0	0	1	14	5	8	0	0
24	0	0	0	63	19	4	25	0	39	15	6	0	8	19	28	12	23	5	1
25	0	0	0	83	43	24	49	23	43	34	20	10	23	50	55	32	67	22	0
26	0	0	0	97	105	75	90	56	54	71	55	30	31	86	99	75	73	57	7
27	0	0	0	60	132	98	115	120	58	125	94	58	34	111	103	139	74	134	30
28	0	0	0	39	97	125	55	123	76	120	88	62	59	103	87	110	77	121	108
29	0	0	0	40	40	79	52	69	75	60	86	97	70	48	41	63	67	66	147
30	0	0	0	33	13	47	43	48	64	16	60	62	49	18	19	13	46	28	115
31	0	0	0	19	12	0	18	13	20	10	26	20	14	12	3	5	11	14	34
32	0	0	0	6	5	3	5	3	5	2	7	6	10	6	0	2	2	3	7
33	0	0	0	1	1	2	0	0	0	0	5	2	2	2	0	0	0	0	1
34	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
35	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	452	475	458	455	458	453	454	450	347	300	457	454	456	450	450	450

Table 16 Continued

Exeter-Combined

TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	2	0	3	0	1	0	0	0	0	0	0	0	0	0	1	0
23	0	0	0	42	2	4	0	0	0	0	0	2	0	1	2	0	0	4	0
24	0	0	0	233	22	11	4	0	6	1	0	0	0	3	7	3	4	4	2
25	0	0	0	251	66	50	21	11	18	1	1	4	0	6	21	11	11	28	2
26	0	0	0	158	86	120	65	66	31	2	11	9	1	7	37	45	14	66	8
27	0	0	0	164	95	120	73	124	37	14	29	24	2	7	55	129	8	70	27
28	0	0	0	126	69	62	61	129	36	27	19	15	7	9	29	99	5	47	46
29	0	0	0	67	33	24	24	91	25	15	13	15	4	4	12	38	3	10	56
30	0	0	0	24	7	6	8	26	6	4	3	4	1	1	2	9	2	2	26
31	0	0	0	5	4	2	2	5	1	1	2	1	0	1	2	2	1	0	9
32	0	0	0	1	0	1	1	1	0	2	0	1	1	0	1	0	0	0	1
33	0	0	0	1	2	0	0	0	0	0	0	2	0	1	0	0	0	1	1
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	1075	386	403	259	454	160	67	78	77	16	40	168	336	48	233	179

Table 16 Continued

Oyster-Combined																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22	0	0	0	0	1	1	3	0	1	0	1	7	8	1	11	0	0	3	27
23	0	0	0	11	15	4	4	1	15	0	5	17	49	31	98	13	8	26	43
24	0	0	0	72	46	20	33	6	123	42	31	40	136	98	99	91	71	84	36
25	0	0	0	74	91	105	78	41	86	107	85	63	106	106	83	120	171	86	83
26	0	0	0	113	137	147	112	116	75	136	133	90	53	126	87	46	126	92	93
27	0	0	0	93	109	111	111	130	96	87	110	71	49	62	49	19	60	88	81
28	0	0	0	62	60	52	69	98	46	40	53	44	26	20	22	7	17	43	56
29	0	0	0	16	38	11	30	42	29	28	28	11	19	7	2	3	3	22	16
30	0	0	0	4	5	2	6	12	3	6	5	0	2	2	2	0	0	5	12
31	0	0	0	3	3	0	0	3	0	1	1	0	0	0	0	0	1	1	1
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	448	506	453	446	449	474	447	452	343	448	453	453	299	457	450	450

Table 16 Continued

Lamprey-Combined																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
24	0	0	0	2	3	2	6	0	0	0	6	1	4	20	5	2	23	6	2
25	0	0	0	11	18	21	36	7	5	31	19	2	13	31	40	13	56	42	9
26	0	0	0	37	50	66	72	31	20	54	49	21	18	27	90	35	66	87	19
27	0	0	0	45	71	100	128	78	37	54	100	49	18	44	128	99	29	119	54
28	0	0	0	35	80	97	150	113	68	91	88	98	47	70	80	144	42	77	91
29	0	0	0	56	58	99	92	118	107	78	59	94	78	66	60	100	62	49	136
30	0	0	0	60	34	45	79	71	103	77	65	83	79	60	26	37	53	43	90
31	0	0	0	47	18	13	30	25	79	39	46	32	52	48	18	13	24	20	42
32	0	0	0	9	6	7	11	7	30	19	11	16	16	30	3	5	12	4	6
33	0	0	0	2	1	3	3	2	7	4	6	6	6	12	3	1	1	2	0
34	0	0	0	0	0	0	0	0	2	1	4	0	1	2	0	2	1	0	1
35	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	304	339	453	608	452	459	449	453	402	333	411	453	451	369	450	450

Table 16 Continued

Taylor-Combined																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	7	14	2	0	1	0	4	0	0	0	4	0	0	0	0
24	0	0	0	0	35	29	6	0	0	0	20	1	0	0	3	0	0	0	0
25	0	0	0	0	33	45	58	0	0	0	19	8	0	0	0	0	0	0	0
26	0	0	0	0	16	49	70	0	3	0	12	3	0	3	0	0	0	0	0
27	0	0	0	0	18	25	66	0	7	0	8	2	0	5	0	0	0	0	0
28	0	0	0	0	9	11	33	0	7	0	10	0	0	3	0	0	0	0	0
29	0	0	0	0	5	3	8	0	8	0	6	0	0	4	0	0	0	0	0
30	0	0	0	0	1	1	3	0	0	0	1	0	0	2	0	0	0	0	0
31	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	125	181	247	0	26	0	80	14	0	18	7	0	0	0	0

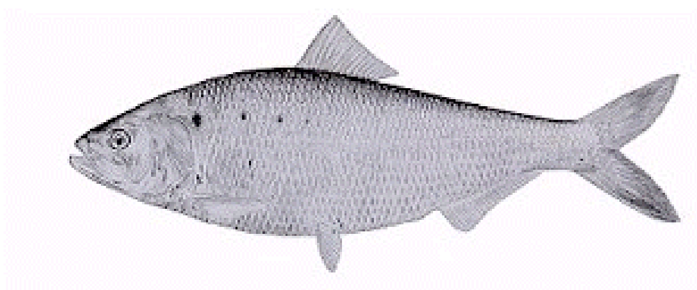
Table 16 Continued

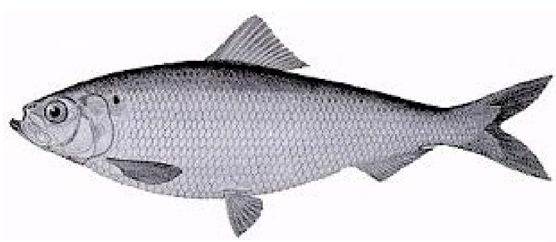
Winnicut-Combined																			
TL(CM)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
20	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
21	0	0	0	0	0	0	2	0	0	0	0	7	2	0	0	0	0	0	0
22	0	0	0	0	0	2	26	0	2	1	1	26	5	7	6	3	0	0	0
23	0	0	0	0	0	6	87	6	25	32	13	74	30	35	29	47	0	0	0
24	0	0	0	0	0	36	98	50	109	138	59	65	31	75	64	91	0	0	0
25	0	0	0	0	0	70	107	119	145	127	116	64	16	135	98	98	0	0	0
26	0	0	0	0	0	64	62	126	90	99	149	46	14	106	128	88	0	0	0
27	0	0	0	0	0	26	43	91	49	37	80	38	11	52	75	62	0	0	0
28	0	0	0	0	0	9	17	57	22	7	29	19	6	18	37	42	0	0	0
29	0	0	0	0	0	2	7	13	7	2	5	4	7	8	15	18	0	0	0
30	0	0	0	0	0	2	1	2	3	1	0	0	1	7	3	0	0	0	0
31	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	3	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	218	450	464	453	444	453	343	124	443	457	452	0	0	0

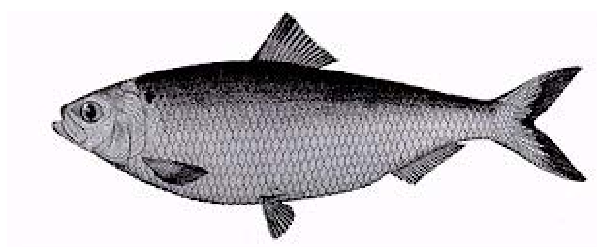
MASSACHUSETTS AMERICAN SHAD AND RIVER HERRING COMPLIANCE REPORT: 2012

To The

ATLANTIC STATES MARINE FISHERIES COMMISSION







Prepared by

John J. Sheppard and Bradford C. Chase
Massachusetts Division of Marine Fisheries

July 2013

Massachusetts Division of Marine Fisheries
American Shad Annual Compliance Report -- 2012

1. Harvest and losses
   A. Commercial Fishery and Ocean Intercept Fisheries: None

      1. Characterization of fishery

Fisheries in Territorial Sea and Adjoining EEZ waters.

The Massachusetts Division of Marine Fisheries (*MarineFisheries*) within the Department of Fish and Game under the Executive Office of Energy and Environmental Affairs is responsible for the management of the Commonwealth's living marine resources. Among these resources are the anadromous American shad, *Alosa sapidissima* and river herring, alewife *Alosa pseudoharengus* and blueback herring *Alosa aestivalis*.

At this time no commercial ocean intercept fisheries for anadromous alosids are conducted in Commonwealth waters, Territorial Seas or adjoining Exclusive Economic Zone (EEZ) waters. Under current regulations no commercial fishery for American shad presently operates within the Commonwealth of Massachusetts. Under Massachusetts Marine Fisheries Laws, MGL Chapter 130: and Title 322: CMR, American shad may be taken by hook and line only. Section 4.12 of the CMR prohibits the landing of net caught shad, even when taken outside of Massachusetts waters in the EEZ or in the territorial seas of another state.

322 CMR: (1987)

4.12: <u>Use of Nets for Taking Striped Bass (*Morone saxatalis*) or Shad (*Alosa sapidissima*).</u>

(1) It is unlawful to off-load onto any vessel within waters under the jurisdiction of Massachusetts or to off-load onto any pier, wharf or other structure within Massachusetts any striped bass or shad which was harvested, caught or taken by any net.

(2) It is unlawful for any vessel registered under the laws of the state as that term is defined in M.G.L.c.130, § 1 to harvest, catch or take any striped bass or shad by any net in any waters under the jurisdiction of Massachusetts or in those waters within the United States 200 mile EEZ bounded in such a way that the inner boundary is a line drawn in such a manner that each point on it is 200 nautical miles from the baseline from which the territorial sea is measured, as depicted on nautical charts of the National Oceanic and Atmospheric Administration.

2. Characterization of Directed Harvest. None

Pursuant to section 4.12 of Title 322: Code of Massachusetts Regulations CMR, there is no directed harvest in the territorial seas and adjoining EEZ waters of the Commonwealth.

3. Characterization of Other Losses

A. Estimate and method of estimation

Reported Massachusetts's landings 1990 through 2012 are presented in Table 1. The NMFS figures reported are landed illegally and not a directed fishery in accordance with CMR 322 section 4.12. Massachusetts dealers reported 215 lbs of shad landed by otter trawl in 2011 and 10 lbs of shad landed by otter trawl in 2012.

B. Estimates of composition (length and/or age)

As outlined in section 4.8 of the Management plan landings from 1990 – 2012 are such that Massachusetts qualifies for ***De minimis*** status (Table 2).

B. Recreational Fishery

1. Characterization of Fishery

Recreational angling for shad occurs primarily in the two largest rivers in Massachusetts, the Connecticut and Merrimack rivers. Shad are also targeted in the North and South rivers of Pembroke and Marshfield, the Palmer River of Rehoboth, at low levels of catch and effort. Coastal runs of American shad in the state are relatively small compared to other New England systems and the Mid and South Atlantic regions. Fisheries are predominantly catch and release. River systems with the largest potential (Connecticut and Merrimack Rivers) to support American shad runs are considered to be in the ongoing process of restoration. Both systems have multi-state and multi agency anadromous fish management and restoration plans in effect.

MarineFisheries drafted its Shad Sustainable Fishery Plan in 2012 with input from Massachusetts Division of Fisheries and Wildlife (*MassWildlife*). The state's plan proposed to make all shad fishing in the state catch and release, except for the fisheries on the Merrimack and Connecticut Rivers where the daily per angler bag limit would be reduced from six shad to three shad. This was proposed because none of the state's shad runs, except for the Merrimack and Connecticut Rivers, have ongoing monitoring programs to help determine sustainable harvest. The Merrimack and Connecticut Rivers have long-term fish lift counts to serve as indices of population abundance and demonstrated the state could allow a small retention fishery. The ASMFC approved this plan in October 2012 and the MFC agreed to take this to public hearing at its December 2012 business meeting.

A public comment period was held from March 15, 2013 through April 26, 2013 with a public hearing on April 25, 2013. These regulations were unanimously approved by the Marine Fisheries Advisory Commission (MFC) on May 16, 2013. The following is a summary of the revised regulations for recreational shad fishing in Massachusetts inland waters:

a. Possession Limits.

i. Merrimack and Connecticut Rivers. No fisherman may possess more than 3 shad taken from the Connecticut or Merrimack River.

ii. All Other Waters of the Commonwealth. It shall be unlawful for any fishermen to possess any American shad taken from any waters other than the Connecticut and Merrimack Rivers. All fishing for American shad in these waters shall be limited to catch and release only.

2. Characterization of Directed Harvest

a. Landings and method of estimation

In 2012, Marine Recreational Information Program (MRIP) reported no shad caught or harvested by recreational anglers in Massachusetts waters. The estimate is regarded as highly imprecise due to the incomplete spatial coverage of the MRIP for American shad.

b. Catch composition

1. Age Frequency: Not Available
2. Length frequency: Not Available

c. Estimation of effort

MRFSS estimated that recreational shore anglers took 954,040 trips in Massachusetts state waters during the 3rd wave (May-June) period of 2012. This represents a decrease in effort from the same wave period in 2011 (726,725) and in 2010 (810,003). The number of trips directed for American shad is not available from posted information. However, the number of anglers targeting American shad is believed to be limited relative to angler shore trips for marine species during this wave.

3. Characterization of Other Losses (poaching, hook/release, etc.)

a. Estimate and method of estimation

At this time there are no studies involving hook and release mortality of American shad in Massachusetts's waters.

The Massachusetts Division of Environmental Law Enforcement reported five civil violations pertaining to American shad in coastal state waters in 2012. One violation involved illegal possession and four citations involved illegal possession and use of shad as bait.

b. Brood Stock Captures and Research Losses

Stock captures: approx. 5,000 American shad
Research losses: approx. 1,200 American shad

A summary of all shad harvest and losses for 2003 to 2012 is provided in Table 3, using data from the National Marine Fisheries Service (NMFS), Resource Statistics Division, Woods Hole, and *MarineFisheries*.

E. Protected species: Atlantic Sturgeon.

Under the authority of the Massachusetts Endangered Species Act, M.G.L.c.131A. Species Regulations 321 CMR 10.00 the Atlantic sturgeon (*Acipenser oxyrhynchus*) is listed as an Endangered Species in Massachusetts. No reports have been made of Atlantic sturgeon catches in fisheries or during monitoring for American shad or river herring from 2002 through 2012.

II. Fisheries Independent Monitoring.

A. Description of requirements outlined in Amendment 1, Table 2.

Massachusetts is required to conduct fisheries independent monitoring of the Merrimack River including: annual spawning stock survey and representative sampling for biological data, calculation of mortality and or survival estimates and recovery of any visibly marked fish. Most biological data are collected at a fish lift at the lowermost dam on the river, Essex Dam, Lawrence, 48 rkm.

B. Program Description.

Efforts for the restoration of the Merrimack River American shad population have been ongoing since 1969. The most recent performance report prepared by Slater (2013a) covers monitoring results from March 1, 2012 through February 28, 2013. Restoration efforts are overseen by the U.S. Fish and Wildlife Service (USFWS), Central New England Fisheries Resources Complex, Central New England Anadromous Fish Program.

Efforts for the restoration of the Connecticut River American shad population have been ongoing since 1967. The most recent performance report prepared by Slater (2013b) covers monitoring results from March 1, 2012 through February 28, 2013. Restoration efforts are overseen by the U.S. Fish and Wildlife Service (USFWS), Connecticut River Coordinator’s Office in partnership with the Connecticut River Atlantic Salmon Commission.

During the 2012 spring spawning run 243 adult shad were sacrificed from the Merrimack River over 19 separate collection days from May 17th to July 6th for sex composition, total and fork length, wet body weight, and age data. No tagged fish were observed passing above the Essex dam through the Lawrence fish lift.

C. Results

1. Juvenile indices: Not Available
2. Spawning stock assessment (Merrimack River)

The American shad fish passage counts at the Essex Dam fish-lift from 1983 – 2012 are presented in Table 4. Annual monitoring indicates an average of 22,702 (median: 15,987; range: 1,205 – 76,717) shad passing during this period. Counts peaked in 2001 but have declined since. The low counts in 2005 and 2006 were excluded from the series statistics because they did not reflect the true abundance of the stock as high flows caused the lift to be inoperable for much of the spawning run.

In 2011, 405 shad were trapped and trucked to the USFWS Nashua Fish Hatchery for spawning where 5.8 million fry were produced of which 2.9 million were stocked in the Charles River and 2.9 million stocked in the Merrimack River. In addition, 144 shad were trapped and trucked to the USFWS North Attleboro Fish Hatchery for spawning where 1.4 million fry were produced, of which 1.1 million were stocked in the Charles River and 300,000 were stocked in the Pawcatuck River, RI. A total of 848 shad were trapped and trucked by New Hampshire Fish and Game for stocking in New Hampshire waters.

In 2012, 568 shad were trapped and trucked to the USFWS Nashua Fish Hatchery for spawning where 5.4 million fry were produced of which 3.3 million were stocked in the Charles River and 2.1 million stocked in the Merrimack River. In addition, 176 shad were trapped and trucked to the USFWS North Attleboro Fish Hatchery for spawning where 3.7 million fry were produced and stocked in the Charles River.

a. Length Frequency

Length frequency data by sex for years 2001-2012 American shad and plots of wet weight on Fork length are presented in Figures 1, 2, 3 & 4. Mean size for both sexes is shown in Table 5. Early in the time series an increasing trend in mean size of females was seen with a peak in 2003 (499 mm FL; 1.92kg). Mean size of females has declined since 2003 (mean: 462 mm FL; 1.5 kg throughout the monitoring period). Mean size of males has been variable throughout the monitoring period (mean: 422 mm FL; 1.1 kg) with a time-series low of 404 mm FL (0.91 kg) in 1995 and in 2012 (422 mm FL; 0.95 kg).

b. Age Frequency

In 2012, 243 scale samples were mounted on glass slides for aging. Samples collected from 2004 through 2012 were processed and aged with NMFS/AFC funding provided to conduct an annual study to characterize shad and river herring populations in various rivers in Massachusetts. Age information from several past spawning runs is presented in Table 6.

Mean age of females is variable throughout the monitoring period (mean: 5.9 years) with a peak in 2003 (6.7 years) and a time-series low of 5.0 years in 1993. Mean age of males is variable throughout the monitoring period (mean: 5.2 years) with a peak in 2001 (6.0 years) and time-series lows in 1992 and 2007 (4.4 years). It should be noted that sample sizes in the early 1990s were too low to provide detailed age information.

c. Sex Ratio

The sex ratio of fish collected at the Essex Dam fish-lift is shown in Table 6. Throughout the monitoring period, ratios of males to females have been relatively stable with a mean ratio of 1.0:1.0.

d. Degree of repeat spawning

Reading of 2012 scales indicated 66% of males and 71% of females were virgin spawners on their first spawning run. Of the remaining 34% of the male shad; 21% had one check, 7% had two checks, 5% had three checks, and ~ 1% or two fish had four checks. Of the remaining 29% of the female shad; 22% had one check and 6% had two checks.

3. Annual Mortality Rate

The annual survival rate (S) was estimated using the Chapman-Robson method on pooled age data. The Chapman-Robson method is a non-regression probability-based estimator that has been shown to be more accurate and less biased than the standard linear regression-based “catch curve” (Chapman and Robson 1960, Jensen 1996, Murphy 1997) especially when the sample size is small. Ages 5 through 9 were used in the analysis. Using shad collected and aged from 2012 , Z estimated using the catch curve method was 0.93 (S = 0.39), and the Chapman-Robson method estimated Z at 1.00 (S = 0.37).

4. Hatchery evaluation (% wild vs. hatchery)

In 2004, the Commonwealth of Massachusetts began a partnership with the USFWS to develop an experimental hatchery operation for American shad of the Merrimack River system. The Massachusetts American Shad Propagation project was formed with the objective to restore shad populations to the Charles River and secondarily the Neponset River, and to create local in-river sport fisheries. The project includes the development of a shad fry stocking program in conjunction with fish passage improvements. Broodstock shad for this effort are obtained from the Merrimack River, Essex Dam fish lift, Lawrence, MA.

Pilot hatchery production began for the project in 2005 at the North Attleboro National Fish Hatchery with shad collected at the Essex Dam on the Merrimack River (Ferry 2006). Shad fry were first released in the Charles River in 2006 following immersion in an oxytetracycline (OTC) bath to mark their otoliths. Shad fry were released in June and July and juveniles with oxytetracycline marks at their otoliths were collected the following September during an electrofishing survey. In September 2007, juvenile shad were again detected during an electrofishing survey in the vicinity of the stocking site. A sub-sample of 15 fish was examined for otolith marks and all juveniles sampled had marked otoliths. Refinements of hatchery and field components of the project have continued since 2007 with results reported in Table 7.

In 2011, 405 shad were trapped and trucked to the USFWS Nashua Fish Hatchery for spawning where over 5.7 million fry were produced of which 2,912,317 were stocked in the Charles River and the balance were released into the upper Merrimack River. In addition, 138 shad were trapped and trucked the USFWS North Attleboro Fish Hatchery for spawning. A total of 1,079,534 fry were produced from the USFWS North Attleboro Fish Hatchery and stocked in the Charles River. The combined total released into the Charles River is 3,991,851 fry.

Monitoring for spawning adults returning to the Charles River continued during the spring of 2011. The trap was installed at the exit of the Watertown Dam and fishway and was tended daily to detect the presence of adult shad. Monitoring was conducted between 1 May and 15 July, with no adults observed in 76 sampling trips. In late June and early July, electrofishing trips were made with the USFWS below the Watertown Dam. These trips yielded a total of nine adult American shad. All adult shad were retained and the length (TL), weight, and sex were recorded. The otoliths of each adult were removed and examined along with scales to determine age. The otoliths were also examined under ultraviolet light for the presence of an OTC mark. Of the nine adults, seven were age-5 fish and four of those fish were marked with OTC. These results indicate that the four marked age-5 fish were part of the initial 2006 stocking in the Charles River for this project.

In 2012, restoration efforts continued through stocking of age-0 fish, with over 3.3 million individuals transplanted from Merrimack River broodstock to the Charles River. To determine marking success and age-0 growth attempts were made to sample the river in mid-September. Unfortunately, no shad or river herring young-of-the-year were observed. It is suspected that due to low flows and high in-river temperatures during the summer age-0 alosines moved down river to estuarine habitats earlier than normal.

After failing to capture any adult individuals in the fishway in 2011 but experiencing some success late in the run using an electrofishing boat, both methods were employed for the duration of the run in 2012. The combined efforts led to the capture of 30 adult shad (1 trap, 29 electrofishing). These fish were ages 3-8, meaning they were from the 2004-2009 year-classes. Of the 30 fish collected, 5 were from year-classes prior to 2006. These adults were likely part of a remnant run of shad in the river but may have strayed from other rivers. Otolith analysis determined that 15 of the 25 fish that could have potentially been products of restoration efforts (2006-2009 year-classes) were marked with an oxytetracycline (OTC) ring at the core of the structure. The 10 unmarked fish, as with the pre-2006 year-class individuals, could have been strays, naturally produced Charles River fish, or fish that did not incorporate an OTC mark.

The Charles River is the primary target for restoration due to (a) the availability of spawning/rearing habitat, (b) the availability of functioning fishways that are suitable for shad at river obstructions, (c) the historical significance of shad in this system, and (d) intermittent observations of low numbers of adult shad in the Charles River by DMF biologists during the 1980s and 1990s. The secondary target, the Neponset River, once supported a shad population, but lack of fish passage at the first two dams and contaminated water and bottom sediments have impeded restoration. Efforts are currently underway to remove these dams and remove or contain PCB contaminated sediments. Dam removal in the Neponset would open up approximately 17 miles of spawning/rearing habitat for shad. *MarineFisheries* will initiate shad restoration in the Neponset, with successful passage restoration.

5. Spawning stock assessment (Connecticut River)

The American shad fish passage counts at the Holyoke Dam fish-lift from 1967–2012 are presented in Table 6. Annual monitoring indicates an average of 251,670 (median: 254,740; range: 19,000 – 720,000) shad passing during this period. Counts peaked in 1992 but have since indicated a declining trend until increasing to 249,480 in 2011 and increasing further to 490,431 in 2012.

Since 2006 approximately two to five thousand American shad have been collected at the Holyoke lift on the Connecticut River for within basin restoration efforts. In 2011, fishlift personnel trapped a total of 2,182 shad for within basin restoration efforts. In 2012, fishlift personnel trapped and trucked a total of 4,072 shad for restoration efforts. Of which, 1,358 were transferred within basin, and the balance were transferred out-of-basin (1,890 to Rhode Island waters, 421 to New Hampshire waters and 393 to Connecticut waters).

Table 1. Massachusetts landings of American shad and river herring (alewife and blueback herring) from 1990 - 2012.

Year	Landings weight in pounds American Shad	River Herring
1990	5,605	20,700
1991	638	20,300
1992	308	18,700
1993	423	18,900
1994	286	NCR
1995	454	NCR
1996	134	NCR
1997	752	180
1998	1,765	238
1999	223	NCR
2000	268	NCR
2001	1,051	70
2002	424	NCR
2003	1,109	NCR
2004	530	NCR
2005	0	8,952
2006	102	NCR
2007	44	NCR
2008	31	1,740*
2009	0	NCR
2010	0	NCR
2011	215	NCR
2012	10	NCR

Data from National Marine Fisheries Service Resource Statistic Division
NCR = No catch reported

* River herring "landings" in 2008 must be regarded with caution. Upon further investigation by *MarineFisheries* and NMFS Northeast Regional Office personnel, it was determined that landings were not reported correctly by the dealer. According to Vessel Trip Report (VTR) and dealer landings data, the port of landing was New Bedford, Massachusetts. However, the dealer reporting the landings is located in New York.

Table 2. *De minimis* status: MA shad landings in pounds as percentage of Atlantic States shad landings (1990 – 2011)*

Year	MA Landings	Other Atlantic States	MA % American Shad
1990	5,605	3,553,473	0.16
1991	638	2,808,898	0.02
1992	308	2,435,127	0.01
1993	423	2,105,863	0.02
1994	286	1,493,906	0.02
1995	454	1,653,322	0.03
1996	134	1,583,079	0.01
1997	752	1,837,170	0.04
1998	1,765	2,174,226	0.08
1999	223	1,067,312	0.02
2000	268	890,624	0.03
2001	1,051	722,178	0.14
2002	424	1,471,850	0.03
2003	1,109	1,509,898	0.07
2004	530	1,136,527	0.05
2005	0	302,435	0.00
2006	102	193,855	0.05
2007	44	168,993	0.03
2008	31	100,901	0.03
2009	0	88,165	0.00
2010	0	105,477	0.00
2011	215	94,833	0.23
2012	10	118,189	0.01

American Shad landings in Massachusetts during the past decade were an order of magnitude or more below the level of *De minimis* status (less than 1% of coast-wide commercial landings).

*Data Personal Communication, NMFS Fisheries Statistic and Economic Division

Table 3. Harvest and Losses of American Shad by Commercial and Recreational Fisheries in Massachusetts*

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Commercial	0	0	0	0	0	0	0	0	0	0
Recreational MRFSS*	0	1,693	0	•55,232	0	0	0	0	0	0
Illegal Harvest	370	179	0	34	15	10	0	1	72	3
Scientific studies	250	300	300	900	1,700	1,400	1,200	1,000	750	1,200
Stocking	4,000	4,000	2,000	2,000	4,000	4,000	6,200	4,100	3,600	5,000

MRFSS Type A+B1+B2 Harvest

*Values are in Number of fish.

Illegal Harvest = pounds/ 3lb average weight Merrimack River shad.

• Records are questionable

Table 4. Merrimack River American shad counts at the Essex Dam Fish Lift, Lawrence, Massachusetts, 1983 – 2012.

Year	American Shad
1983	5,629
1984	5,497
1985	12,793
1986	18,173
1987	16,909
1988	12,359
1989	7,875
1990	6,013
1991	16,098
1992	20,796
1993	8,599
1994	4,349
1995	13,857
1996	11,322
1997	22,586
1998	27,891
1999	56,465
2000	72,781
2001	76,717
2002	54,586
2003	55,620
2004	36,593
2005	6,382
2006	1,205
2007	15,876
2008	25,116
2009	23,199
2010	10,442
2011	13,835
2012	21,396

Table 5. American Shad Age, Growth, and Sex Information for Adult Returns from the Merrimack River (1991 – 2012).

Year	Sample #	N (male)	N (Female)	% Male	% Female	Ratio (M:F)	Mean Age		Mean FL (mm)		Mean Wgt (kg)		L - S		C - R	
							Male	Female	Male	Female	Male	Female	Z	s	Z	s
1991	107	61	46	57	43	1.3:1.0	4.7	5.3	434	475	1.13	1.59	Unk	Unk	Unk	Unk
1992	48	23	25	46	54	0.9:1.0	4.4	5.2	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk
1993	32	6	26	19	81	0.2:1.0	4.5	5.0	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk
1995	160	101	59	63	37	1.7:1.0	Unk	Unk	404	465	0.91	1.5	Unk	Unk	Unk	Unk
1999	212	146	66	69	31	2.2:1.0	4.8	5.6	406	450	0.91	1.32	Unk	Unk	Unk	Unk
2000	217	103	114	47.5	52.5	0.9:1.0	4.7	5.6	422	467	1	1.5	Unk	Unk	Unk	Unk
2001	204	115	89	56.4	43.6	1.3:1.0	6.0	6.6	427	471	1.04	1.47	1.31	0.27	0.87	0.42
2002	199	79	120	39.7	60.3	0.8:1.0	5.7	6.3	432	482	1.1	1.69	1.29	0.27	0.95	0.39
2003	115	39	76	39.7	60.3	0.5:1.0	5.9	6.7	439	499	1.16	1.92	0.59	0.55	0.75	0.47
2004	257	152	119	45.5	54.5	1.3:1.0	5.8	6.5	433	482	1.08	1.59	0.84	0.44	0.79	0.45
2005	200	105	95	52.5	47.5	1.1:1.0	5.9	6.1	443	477	1.11	1.51	1.18	0.30	1.02	0.36
2006	178	79	99	44.4	55.6	0.8:1.0	4.9	5.7	407	468	0.96	1.49	0.92	0.41	0.87	0.42
2007	212	99	113	46.7	53.3	0.9:1.0	4.4	5.1	429	464	1.16	1.55	0.77	0.45	0.81	0.45
2008	227	113	114	49.8	50.2	1.0:1.0	5.4	5.6	427	464	1.1	1.43	1.35	0.25	0.95	0.38
2009	214	96	118	44.9	55.1	0.8:1.0	5.9	6.5	429	461	1.08	1.38	0.92	0.40	0.85	0.43
2010	181	65	116	36	64	0.6:1.0	5.1	5.6	412	455	1.04	1.53	1.03	0.36	0.88	0.41
2011	258	148	110	57	43	1.3:1.0	5.7	6.6	408	452	1.01	1.39	0.65	0.52	0.76	0.47
2012	243	155	88	63.8	36.2	1.8:1.0	5.1	5.5	404	436	0.95	1.28	0.93	0.39	1.00	0.37

Table 6. Connecticut River American shad counts at the Holyoke Dam Fish Lift, Holyoke, Massachusetts, 1967 – 2012.

Year	American shad
1967	19,000
1968	25,000
1969	45,000
1970	66,000
1971	53,000
1972	26,000
1973	25,000
1974	53,000
1975	110,000
1976	350,000
1977	200,000
1978	140,000
1979	260,000
1980	380,000
1981	380,000
1982	290,000
1983	530,000
1984	500,000
1985	480,000
1986	350,000
1987	270,000
1988	290,000
1989	350,000
1990	360,000
1991	520,000
1992	720,000
1993	340,000
1994	170,000
1995	190,000
1996	280,000
1997	300,000
1998	320,000
1999	190,000
2000	225,000
2001	270,000
2002	370,000
2003	280,000
2004	192,000
2005	116,511
2006	156,352
2007	163,466
2008	156,492
2009	160,649
2010	164,439
2011	249,480
2012	490,431

Table 7. American shad fry production by year and hatchery. The number of broodstock shad include both males and females and hatchery mortalities. Fry were stocked in the Charles River

in Waltham. ND refers to no data available.

Year	Hatchery	No. Broodstock	No. Eggs Produced	Viability of eggs (%)	No. Fry Hatched	% Fry Survival	Total Released
2006	Nashua NFH	911	4,342,376	50.7	2,149,906	83.0	1,785,622
2007	Nashua NFH	1,155	3,801,201	19.7	747,369	89.4	668,048[1]
2008	Nashua NFH	619[2]	2,144,859	34.7	744,183	78.4	583,642
2008	N. Attleboro NFH	154	1,807,498	36.0	ND	ND	610,442
2009	Nashua NFH	259	ND	ND	5,200,000[3]	ND	3,900,000
2009	N. Attleboro NFH	123	ND	ND	622,000	ND	237,000[3]
2010	Nashua NFH	386 (361)[4]	1,998,712	63.0	1,988,384	99.0	1,988,384[5]
2010	N. Attleboro NFH	171 (157)[6]	1,137,115	52.0	1,003,687	88.0	1,003,687
2011	Nashua NFH	405 (361)[7]	5,903,537	68%	5,768,264	98%	3,991,851
2011	N. Attleboro NFH	138	1,090,583	54%	1,090,583	99%	1,079,534
2012	Nashua NFH	568[8]	5,527,294	67%	5,400,162	98%	5,391,502
2012	N. Attleboro NFH	176	4,952,042	79%	3,695,564	95%	3,695,564

[1]Several thousand fry were retained and sent to the New England Aquarium for exhibit.
[2]Although 619 total broodstock were obtained for spawning, 202 fish were released live back to the Merrimack following nearly one month in the hatchery without spawning. Thus, 417 shad (including hatchery mortalities) were used for active spawning.
[3] Of the total fry produced in 2009: 1.3 million were transplanted back into the Merrimack River from the Nashua NFD and 385,000 from the N. Attleboro NFH.
[4] Of the 386 total broodstock collected, 25 mortalities occurred during transportation.
[5] Of the total fry released from the Nashua Fish Hatchery in 2010: 1,002,360 were released back into the Merrimack River, and the balance (986,024) were released into the Charles River.
[6] Of the 171 total broodstock collected, 14 mortalities occurred during transportation.
[7] Of the 405 total broodstock collected, 4 mortalities occurred during transportation and 361 spawned successfully.
[8] Of the 171 total broodstock collected, 5 mortalities occurred during transportation.

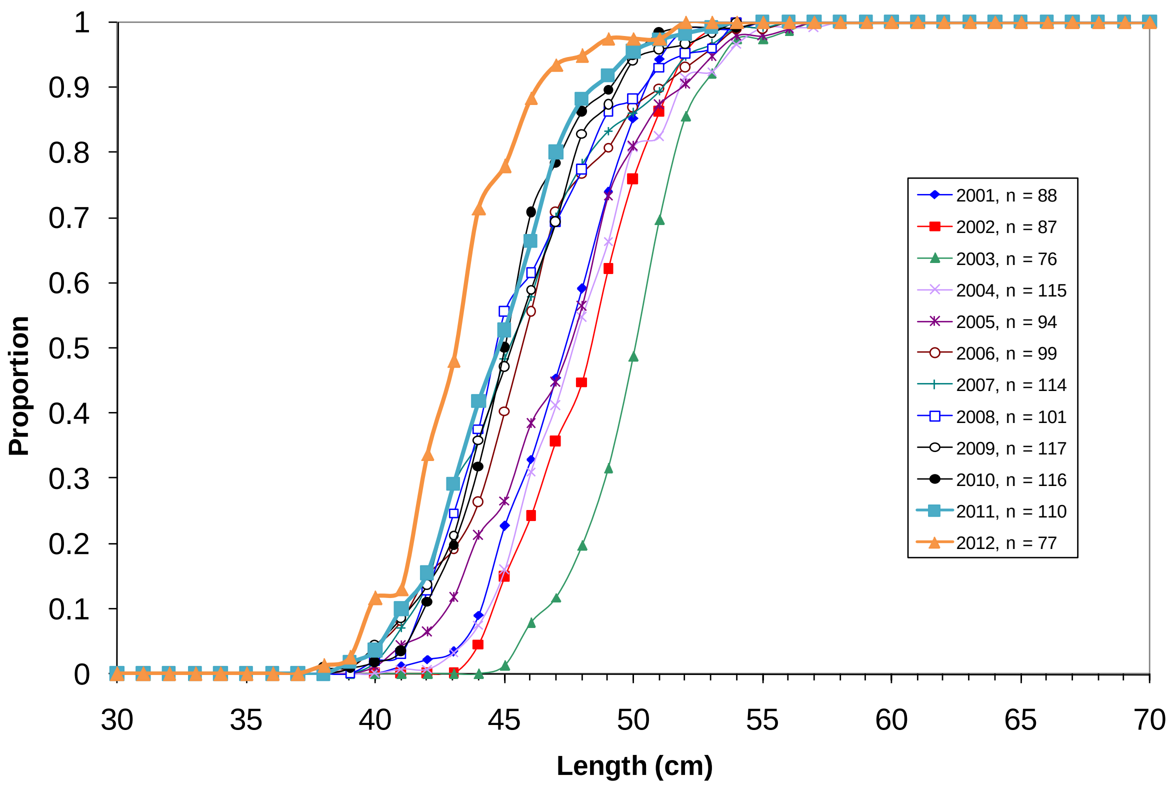


Figure 1. Cumulative length-frequencies for female American shad from the Merrimack River (2001 – 2012).

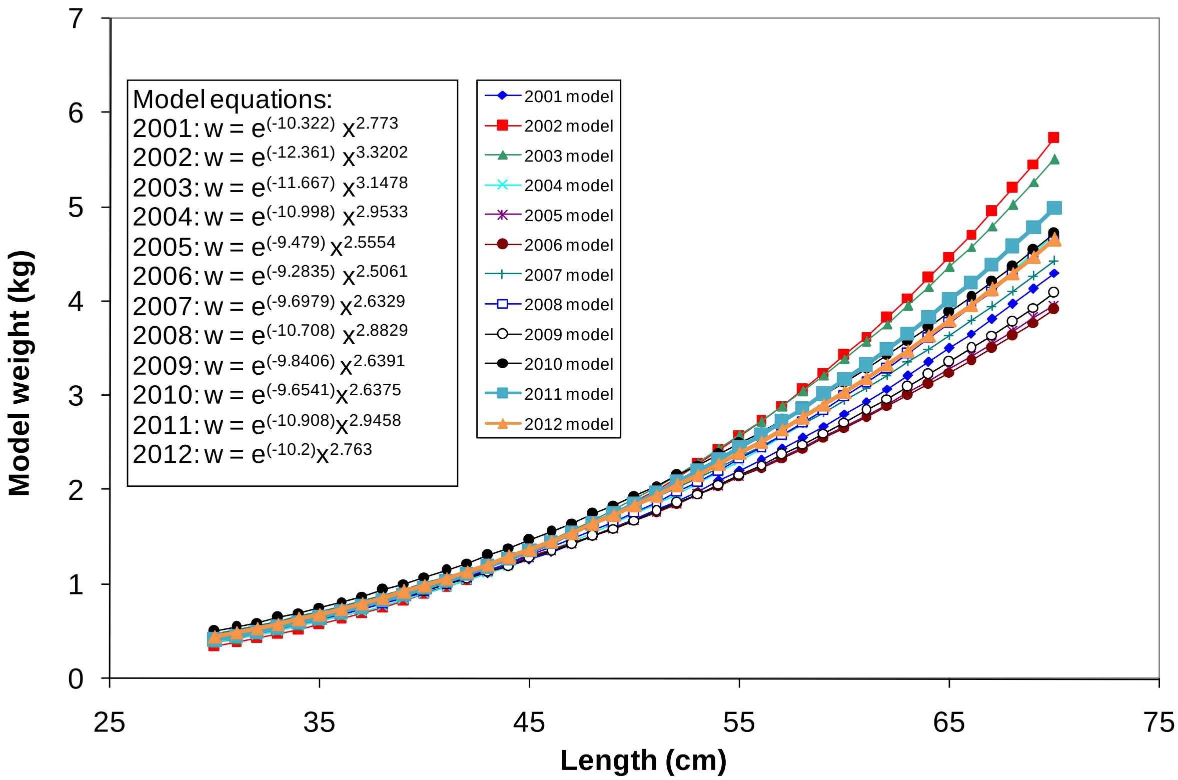


Figure 2. Modeled length-weight relationship for female American shad from the Merrimack River (2001 – 2012).

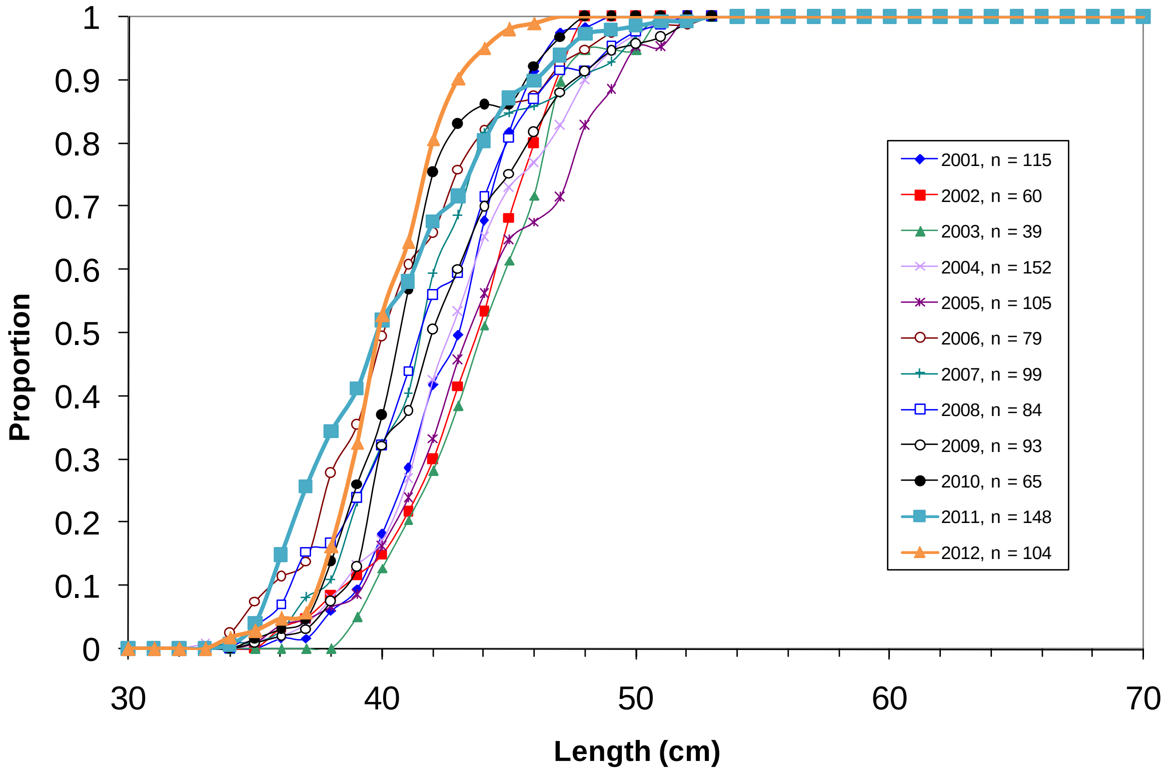


Figure 3. Cumulative length-frequencies for male American shad from the Merrimack River (2001 – 2012).

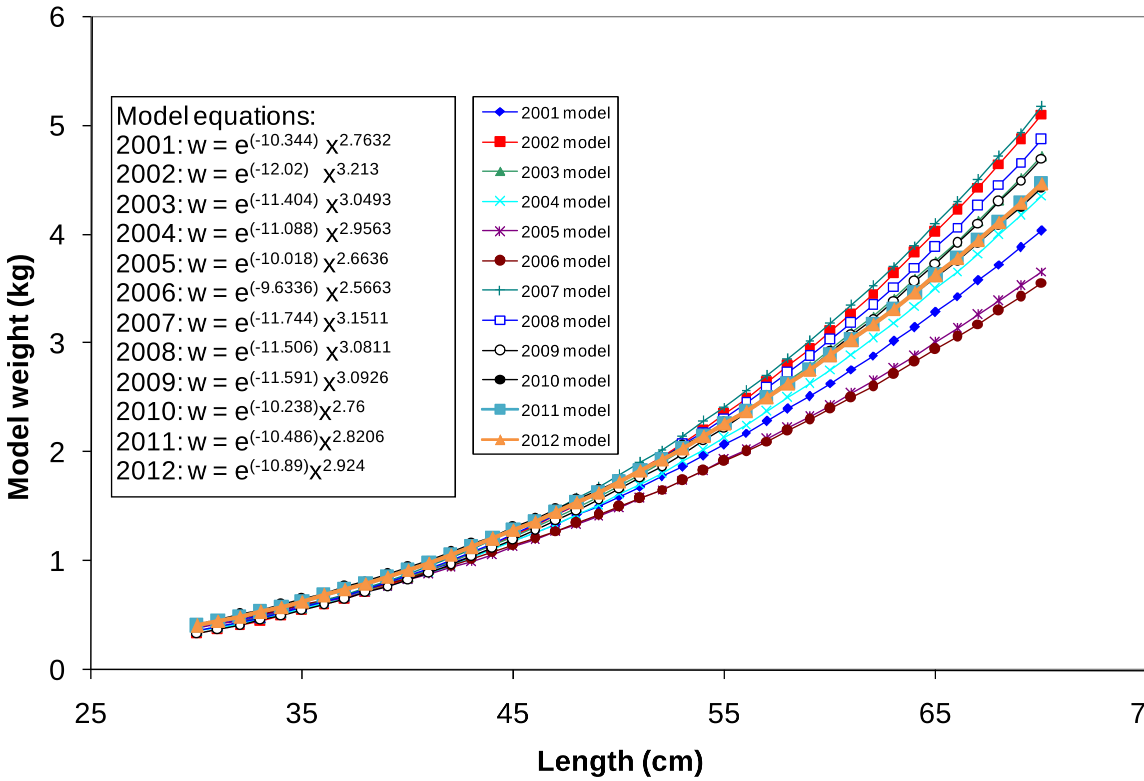


Figure 4. Modeled length-weight relationship for male American shad from the Merrimack River (2001 – 2012).

Massachusetts Division of Marine Fisheries
River Herring Annual Compliance Report -- 2012

Massachusetts General Laws in Chapter 130 establish the Director of the Division of Marine Fisheries (*MarineFisheries*) as responsible for regulation river herring resources and fisheries of the Commonwealth. Subsequently, river herring regulations were established to protect river herring populations and manage river herring fisheries. These regulations set catching days, daily catch limits and gear restrictions. Regulations are as follows:

Section 6.17 of CMR 322: River Herring

(1) Purpose. 322 CMR 6.00 is promulgated to establish consistent state management of river herring fisheries.

(2) Definitions.

(a) River Herring means those species of fish known as alewives (*Alosa pseudoharengus*) and bluebacks (*Alosa aestivalis*).
(b) Batch means all fish in any separate container.
(c) Container means any box, tote, bag, bucket or other receptacle containing loose fish which may be separated from the entire load or shipment.
(d) Land means to transfer or offload fish from a vessel onto any dock, pier, wharf or other artificial structure used for the purpose of receiving fish.

(3) Taking and Possession of River Herring in Waters under the Jurisdiction of the Commonwealth. It shall be unlawful for any person to harvest, possess or sell river herring in the Commonwealth or in the waters under the jurisdiction of the Commonwealth.

(4) Exceptions. The Director may authorize the harvest and possession of river herring from a particular spawning run for personal use based on documentation that the spawning run from which herring are harvested is not depleted.

(5) Tolerance for bait fisheries. A person may possess or land a batch of bait fish where up to 5% of the total batch is comprised of river herring species, by count, provided that the bait fishery is conducted in federal waters.

(a) Exemption. A bait fish vessel or processor may possess river herring in excess of 5% the total batch, provided the possession is post-sorting and the fish was caught and landed in accordance with 322 CMR 6.17(5). (1) Purpose. 322 CMR 6.00 is promulgated to establish consistent state management of river herring fisheries.

(6) Expiration. These measures remain in effect indefinitely until further notice.

The harvest, possession or sale of river herring in the Commonwealth or in the waters under the jurisdiction of the Commonwealth by any person is prohibited. To accommodate the bait harvesting fisheries, the Massachusetts Marine Fisheries Commission (MFC) approved a tolerance (up to 5%, by count, of a batch of fish may be comprised of river herring species). The first three-year prohibition was approved at a business meeting on November 9, 2005 by the MFC, effective until January 1, 2009. The MFC has twice extended the 3-year prohibition since that time with the present ban due to expire on January 1, 2015. In 2012, a total of 39 civil violations and one criminal violation were reported by the Division of Environmental Law Enforcement involving illegal possession of river herring.

I. Harvest and Losses

With the prohibition of possession and harvest of river herring, the harvest and loss is limited to Native American harvest for sustenance, monitoring collections, and the bycatch tolerance in the marine small pelagic fishery.

A. Native American Harvest

A Memorandum of Understanding has been approved by the State Attorney General and signed by the Mashpee Wampanoag Tribe and *MarineFisheries* to recognize the tribe's aboriginal right to harvest river herring for sustenance purposes with no allowance for commercial sale and reporting requirements. Records have been kept since 2010 on dip net harvests at 4-5 rivers in Southeastern Massachusetts. The harvest in 2010 was 3,434 individual river herring and in 2011 was 2,275 river herring. In 2012 the harvest was reported as over 17.5 bushels which is approximately 3,857 river herring using a project based conversion of 214 river herring per bushel.

B. *MarineFisheries* River Herring Monitoring Losses

During the 2011 spring spawning run 2,623 adult river herring (1,734 alewives; 889 blueback herring) were sacrificed from six rivers for sex composition, total and fork length, wet body weight, and age data. During the 2012 spring spawning run 3,016 adult river herring (1,802 alewives; 1,214 blueback herring) were sacrificed from eight rivers for sex composition, total and fork length, wet body weight, and age data.

C. Bycatch Tolerance Harvest

The *MarineFisheries* Fisheries Dependent Investigations (FDI) program is conducting a port sampling study to quantify landings and characterize the Atlantic sea herring and Atlantic mackerel mid-water trawl fishery. Port sampling of this fishery has been conducted by *MarineFisherie*s staff since 2008 in the Massachusetts ports of Gloucester and New Bedford. In 2010, through a grant funded by the National Fish and Wildlife Foundation, sampling intensity was increased from approximately 16% to the target of over 50% of all trips landed in Massachusetts. For all trips landed in Massachusetts the captains complete a *MarineFisherie*s trip log, which records tow locations and weights. Data elements collected include expanded trip weights for all species landed, plus individual lengths for priority species, genetic samples, and whole samples for age and growth research.

In 2012 98 trips and 24,354 metric tons (mt) of Atlantic sea herring and Atlantic mackerel were port sampled. From management areas where river herring bycatch occurs (Management Areas 1A, 1B, and 2) *MarineFisherie*s sampled 48 out of 95 trips, which covered approximately 51% by trip and 66% by weight. In 2012 78% of the Atlantic herring caught by midwater trawl vessels from these areas were landed in Massachusetts ports, and were subject to port sampling (NOAA VTR, 2013). *MarineFisherie*s samplers recorded 1.2 tons of river herring from basket subsamples and took over 2800 river herring lengths. Through a collaborative effort between the University of Massachusetts School for Marine Science and Technology and *MarineFisherie*s, results of the 2010 - 2012 port sampling study have been analyzed and a manuscript titled: "Characterization of river herring bycatch in the Atlantic herring and mackerel mid-water trawl fleet" has been submitted to a peer reviewed journal for publication.

II. Fisheries Independent Monitoring

A. Biological Monitoring of Spawning Runs

In 2004, *MarineFisheries* initiated a study to examine biological characteristics of river herring (alewife and blueback herring) populations in coastal streams in the Commonwealth. The populations were selected to cover most major coastal drainages in Massachusetts, and where possible, to match biological sampling to sites with herring run counts. Sampling was conducted weekly at each river and the following parameters (species ID, sex, total length, fork length, weight and age) were collected from each individual and are summarized in Table 1.

The mean size of male alewives in all rivers studied declined from 2004 through 2006, then exhibited an increasing trend from 2007 to 2011. In 2012, mean size of males increased in the Mystic river and Town Brook, however, declines in mean size were observed in the Monument River and Nemasket River. Mean size of females in all rivers studied declined from 2004 through 2006. Since 2006, mean size of females has been variable. The overall trend for mean age of for males and females for the nine year time series is a modest decline.

Overall mean size of blueback herring in all rivers studied declined for both sexes between 2004 and 2009. Mean size has indicated an increasing trend for both sexes between 2009 and 2012. No trend appeared evident in the mean age of males. Overall, mean age of females has exhibited a decreasing trend during the monitoring period.

Four rivers were monitored each year from 2004 – 2012 (Monument River, Mystic River, Nemasket River and Town Brook), and the following results will focus on size, age and mortality data from these primary rivers. Exploratory sampling of two additional rivers was made in 2004 and 2007, and one additional river was sampled in 2006 and 2011. In 2012, the project selected three new sampling sites to represent coastal drainage areas that were not covered. These sites and the original four will be maintained annually.

In the Monument River, overall mean length and weight of alewives (sexes combined) decreased from 2004 to 2012. Mean age for both sexes increased to a time-series high (4.4 years) in 2009, then decreased to a time-series low (3.4 years) in 2012. Overall mean size of blueback herring (sexes combined) decreased from 2004 to 2012. Overall mean age of blueback herring increased from 4.0 years (2004) to 4.1 years (2006), then decreased to 3.5 years in 2011 and 2012.

In the Nemasket River, overall mean size of alewives (sexes combined) decreased from 2004 to 2012. There has been an overall decline in mean age from 2004 (5.1 years) to 2006 (4.1 years). However, mean age of alewives increased to 4.2 years in 2007 and increased further to 4.7 years in 2009, then declined to a time-series low (3.6 years) in 2012.

Overall mean size of alewives in Town Brook increased 2004 to 2012. Conversely, overall mean age of alewives (sexes combined) in Town Brook declined from 2004 to 2012 (4.2 years in 2004 to 3.9 years in 2006. Mean age increased to 4.1 years in 2007 and increased further to 4.7 years in 2009, then declined to 4.0 years in 2012).

Alewife sample sizes from the Mystic River were small in 2005 and 2006 which complicates comparisons. Only TL measurements were recorded from herring collected in 2007 and 2008 which further complicates comparisons. Mean size for both sexes increased from 2009 through 2012. Overall mean age for both sexes varied between years, with but generally increased from 3.9 years (2004) to 4.3 years (2009) before declining to 3.8 years in 2011 and 2012.

No blueback herring were observed in samples in 2004 and total length measurements collected in 2007 and 2008 complicate length and weight comparisons between years. Overall mean age for both sexes was stable at 3.9 years between 2005 through 2008, declined to 3.3 years in 2009 and 2010, then increased to 3.8 years in 2011 and 2012.

Estimates of instantaneous mortality rates (Z) and survivorship (s) were derived mainly from regression estimates. Where appropriate, estimates were derived from the Robson-Chapman method based on available data. Annual estimates of mortality are high ($Z_{LS} \geq 1.0$) for river herring populations in all rivers studied. Annual mortality was found only a few cases to be slightly below 1.0. Mean estimates of instantaneous mortality rates throughout the time series (nine-year means) are high for all systems studied ($Z_{LS} \geq 1.0$). Mean estimates for alewives are highest in the Monument River and the Nemasket River (mean $Z_{LS} = 1.43$) and similar in Town Brook (mean $Z_{LS} = 1.42$). Z-estimates of blueback herring from the Monument River and Mystic River are high ($Z_{LS} \geq 1.0$) in most years studied. The lowest annual Z-estimate in the time series occurred at the Monument River in 2005 ($Z_{LS} = 0.7$).

A comprehensive stock assessment of river herring stocks based on current and historical data (enumeration of run size, basic biological data including sex, size and age data, and age-based population modeling) from various Massachusetts coastal rivers was conducted by *MarineFisheries* biologists. This report (TR-46, Nelson *et. al*. 2011) is available on the *MarineFisheries* website: http://www.mass.gov/dfwele/dmf/publications/technical.htm.

B. Census Counts of Spawning Runs

In 2012, a total of nine rivers were monitored using census methods in Massachusetts. Monitoring occurred in eight towns representing five major drainage areas. Population estimates, monitoring methods and duration of spawning runs per each system is listed and summarized in Table 2. Six runs were monitored using electronic counting systems (one in combination using a fish trap). Two runs were monitored using fish lifts (one in combination with a video system). Results indicated increases in run size of six rivers compared to estimates in 2011. Three runs (Acushnet River, Acushnet, Town River, Bridgewater, and the Connecticut River, Holyoke) experienced decreases in run size compared to estimates in 2011.

III. Bycatch Monitoring and Reduction

As required by Amendment 2 and Amendment 3 to the Interstate Fishery Management Plan for shad and river herring, states and jurisdictions will be required to annually monitor bycatch and discard of American shad and river herring in fisheries that operate in state waters. In spring of 2008 *MarineFisheries* initiated a port-side sampling program to sample the landings and bycatch of all species (including American shad and river herring) of the Northwest Atlantic herring and mackerel small mesh fisheries, primarily in MA ports. Multiple ports and gear types have been sampled, but single and pair mid-water trawl vessels landing in Massachusetts ports were sampled as a priority. Some landings from NH, ME and RI were also sampled when time allowed or landings were concentrated elsewhere.

In August 2010, *MarineFisheries* along with UMass Dartmouth School for Marine Science and Technology (SMAST) and the industry group Sustainable Fisheries Coalition (SFC), was awarded a grant by National Fish and Wildlife Foundation (NFWF) to fund a study that would address river herring bycatch in the mid-water trawl Atlantic herring fishery. The goal of the funded research was to create a river herring bycatch avoidance system that would provide fleet-wide advisories informing vessels of potential areas of high river herring abundance. *MarineFisheries* port sampling data was used as the basis of the system and a sample target rate of 50% of all mid-water trawl trips landed in Massachusetts ports was established.

When port sampling identified a high river herring bycatch event, communications were disseminated to the entire SFC membership (which included all mid-water trawl vessels). To assist in the implementation of the system, *MarineFisheries* and SMAST held numerous meetings with SFC and industry members. After over two years of operation the grant has been well-received and shows good potential in achieving its primary goals.

During November 2011, a group of small-mesh bottom trawl (SMBT) herring fishermen from Rhode Island reached out to *MarineFisheries* and SMAST, seeking inclusion into the river herring bycatch avoidance system. Funding was provided by The Nature Conservancy, and protocols and strategies were established, meetings with industry were held, and a second river herring avoidance system was created. The fishery began in December 2011. Approximately 64 out of 133 (48.1%) trips by participating vessels were sampled, 10 in-season advisories were issued, and several formal and in-formal meetings were held with industry members.

In 2012 *MarineFisheries* sampled 12 of the 13 vessels that landed in Massachusetts ports, and 103 out of 171 trips (60.2%). Monthly coverage rates were varied between 36% and 83%, with a maximum of 29 trips sampled in the most active fishing month, January 2012. During the winter herring fishery of December 2011 through February 2012 SMAST and *MarineFisheries* provided six advisories to the mid-water trawl fleet. During the fall region 1A fishery, one pre-season advisory was sent to the fleet and subsequent clean fishing did not necessitate any more advisories.

MarineFisheries designed and maintains an Access relational database that houses all data and information collected from these studies. Boatracs e-mails continue to be an effective way to communicate with industry, but efforts are still being made to streamline the process. Collaboration with outside agencies continues to be very helpful for this study. In addition, *MarineFisheries* is able to provide biological data and samples of commonly caught species to a number of internal and external research projects and agencies.

In the upcoming 2013 season, both the mid-water trawl herring fishery landing in Massachusetts ports and the Rhode Island-based small-mesh bottom trawl fleet will be sampled and advised of river herring bycatch through the end of June. Collaboration with the Northeast Fisheries Observer Program, the Northeast Fisheries Science Center's Study Fleet and Maine Department of Marine Resources has been developed to increase the amount of information incorporated into the avoidance system. However, after June 1st both funding sources are scheduled to expire and unless an alternate funding is identified, both studies will be discontinued.

Table 1. Biological parameters collected from alewives and blueback herring from select rivers

in coastal Massachusetts from 2004 – 2012.

River	Year	Sample Size	Sex Ratio (M:F)	FL (mm)		Weight (gram)		Mean Age		L - S		C - R	
				Male	Female	Male	Female	Male	Female	Z	s	Z	s
Nemasket (Alewives)	2004	268	1.1:1.0	250	258	200	230	4.9	5.3	1.3	0.3	1.2	0.3
	2005	277	1.1:1.0	242	249	181	205	4.7	4.8	1.4	0.2	1.4	0.3
	2006	324	1.6:1.0	235	244	178	208	4.0	4.2	1.4	0.2	1.2	0.3
	2007	650	1.5:1.0	242	252	186	221	4.1	4.4	1.6	0.2	1.4	0.2
	2008	504	1.2:1.0	239	250	178	213	4.6	5.0	1.9	0.1	1.6	0.2
	2009	504	1.6:1.0	237	246	176	205	4.6	5.0	1.1	0.3	0.8	0.4
	2010	507	1.3:1.0	240	249	178	213	4.1	4.4	1.4	0.2	1.1	0.3
	2011	502	1.3:1.0	243	254	189	225	4.1	4.3	1.6	0.2	1.2	0.3
	2012	383	1.5:1.0	239	251	186	226	3.5	3.8	1.2	0.3	0.9	0.4
Monument (Alewives)	2004	166	1.3:1.0	233	240	169	190	4.1	4.2	1.4	0.3	N/A	N/A
	2005	150	1.2:1.0	230	235	159	179	4.2	4.3	1.7	0.2	1.3	0.3
	2006	119	1.1:1.0	214	234	142	177	3.7	4.3	1.3	0.3	1.3	0.3
	2007	404	1.2:1.0	228	237	153	180	3.7	3.9	1.4	0.3	1.6	0.2
	2008	512	1.5:1.0	224	233	153	177	4.0	4.5	1.5	0.2	1.1	0.3
	2009	315	1.0:1.0	227	235	154	177	4.3	4.5	1.1	0.3	1.2	0.3
	2010	480	1.2:1.0	229	240	159	187	3.9	4.4	1.5	0.2	1.1	0.3
	2011	283	1.3:1.0	229	238	155	184	3.8	4.2	1.6	0.2	1.7	0.2
	2012	263	1.4:1.0	226	238	155	187	3.2	3.5	1.4	0.2	1.2	0.3
Monument (Bluebacks)	2004	99	1.0:1.0	218	228	134	155	3.8	4.2	1.3	0.3	N/A	N/A
	2005	92	1.2:1.0	216	225	124	142	4.0	4.1	0.7	0.5	1.3	0.3
	2006	122	1.2:1.0	210	220	120	141	4.0	4.2	0.9	0.4	N/A	N/A
	2007	150	1.2:1.0	210	222	117	142	3.5	4.0	1.7	0.2	N/A	N/A
	2008	146	1.1:1.0	207	217	112	129	3.7	4.2	1.4	0.2	1.7	0.2
	2009	172	1.2:1.0	210	216	114	129	3.8	4.1	1.9	0.2	1.4	0.2
	2010	147	1.2:1.0	207	217	106	125	3.3	3.7	1.0	0.4	1.1	0.3
	2011	227	1.3:1.0	206	219	106	127	3.6	3.9	2.9	0.1	N/A	N/A
	2012	197	1.5:1.0	209	219	114	131	3.3	3.7	1.1	0.3	1.1	0.3
Mystic (Alewives)	2004	136	1.3:1.0	223	240	142	170	3.8	4.1	1.6	0.2	1.6	0.2
	2005	21	0.9:1.0	233	246	163	205	4.3	4.7	N/A	N/A	N/A	N/A
	2006	52	0.7:1.0	210	227	131	175	3.5	4.4	N/A	N/A	N/A	N/A
	2007	273	1.0:1.0	219	229	137	164	3.6	3.9	1.4	0.2	1.8	0.2
	2008	186	1.8:1.0	221	228	139	158	3.8	4.3	1.0	0.4	1.3	0.3
	2009	124	1.1:1.0	220	228	133	154	4.3	4.4	1.0	0.4	1.2	0.3
	2010	39	0.5:1.0	221	220	134	135	3.6	3.6	1.0	0.4	1.0	0.4
	2011	314	1.6:1.0	223	234	144	176	3.7	4.0	1.2	0.3	1.3	0.3
	2012	316	1.2:1.0	227	238	159	190	3.7	4.0	1.7	0.2	1.6	0.2
Mystic (Bluebacks)	2005	119	1.0:1.0	222	208	151	117	3.6	4.1	1.7	0.2	2.0	0.1
	2006	162	3.9:1.0	204	217	104	135	3.7	4.4	1.8	0.2	1.6	0.2
	2007	456	1.1:1.0	210	218	117	142	3.8	4.0	1.7	0.2	1.4	0.2
	2008	211	5.8:1.0	205	221	99	135	3.8	4.5	1.2	0.3	1.2	0.3
	2009	482	2.2:1.0	206	215	104	126	3.2	3.6	1.4	0.3	1.2	0.3
	2010	405	2.4:1.0	210	217	114	132	3.3	3.4	1.2	0.3	1.4	0.3
	2011	329	1.3:1.0	211	220	113	136	3.7	4.0	2.5	0.1	N/A	N/A
	2012	292	1.6:1.0	212	224	128	162	3.6	4.0	0.9	0.4	0.8	0.5
Town (Alewives)	2004	180	0.9:1.0	229	240	158	185	4.0	4.4	1.7	0.2	1.3	0.3
	2005	297	1.1:1.0	226	236	152	175	4.0	4.3	1.8	0.2	1.5	0.2
	2006	268	1.0:1.0	225	234	154	178	3.8	4.0	1.4	0.2	N/A	N/A
	2007	556	1.3:1.0	232	241	176	189	4.0	4.2	1.4	0.2	1.5	0.2
	2008	504	1.2:1.0	230	237	160	184	4.5	4.8	1.4	0.2	0.9	0.4
	2009	457	1.2:1.0	229	238	159	183	4.6	4.9	0.9	0.4	0.8	0.4
	2010	505	1.2:1.0	231	241	158	184	4.2	4.6	1.3	0.3	0.9	0.4
	2011	504	1.1:1.0	233	243	164	191	4.1	4.3	1.4	0.2	1.3	0.3
	2012	421	1.2:1.0	235	247	171	207	3.8	4.1	1.5	0.2	1.2	0.3
Mashpee (Alewives)	2012	164	2.2:1.0	226	235	149	178	3.5	3.7	1.2	0.3	1.0	0.4
Mashpee (Bluebacks)	2012	109	1.6:1.0	206	217	112	135	3.2	3.4	1.8	0.2	1.4	0.2
Parker (Alewives)	2011	16	1.8:1.0	[-	Sample	size	too	small	-]	N/A	N/A	N/A	N/A
	2012	248	2.3:1.0	† 261	† 277	162	209	3.6	4.0	1.3	0.3	1.9	0.1
Parker (Bluebacks)	2011	248	5.4:1.0	† 248	† 258	123	140	3.4	3.4	1.4	0.2	1.3	0.3
	2012	286	2.9:1.0	† 254	† 268	136	173	3.8	4.1	1.7	0.2	1.9	0.1
Charles (Bluebacks)	2012	330	6.3:1.0	† 231	† 252	99	139	2.5	3.7	0.7	0.5	0.9	0.4

† Only total length (TL) was collected from Parker River herring samples.

Table 2: Population estimates, method and run duration for each river monitored using census methods in Massachusetts in 2012.

Drainage Area	River	Method	Pop. Est.	Increase/Decrease
Buzzards Bay	Acushnet R.	Fish Trap/Counter	3,220	Decrease
Buzzards Bay	Agawam R.	Counter	73,186	Increase
Buzzards Bay	Mattapoisett R.	Counter	28,447	Increase
Buzzards Bay	Wankinco R.	Counter	24,764	Increase
Connecticut	Connecticut R.	Fish Lift	42	Decrease
Merrimack	Merrimack R.	Fish Lift/Video	8,992	Increase
South Coastal	Monument R.	Counter	180,082	Increase
South Coastal	Town Brook	Counter	171,141	Increase
Taunton	Town R.	Counter	42,038	Decrease

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State of Rhode Island
Department of Environmental Management
Division of Fish and Wildlife

Annual Compliance Report to the Atlantic States Marine Fisheries Commission
American Shad Technical Committee: 2012

Submitted 2013

Report by: Phil Edwards

Table 5. 2012 RI Annual State Report for American Shad & River Herring

Introduction: In 2012, the taking of American shad and river herring in Rhode Island fresh and marine waters remained closed. American shad returns monitored at the Potter Hill fishway trap showed a slight increase, and the spawning stock size estimates for river herring increased on the majority of RI river systems. Rhode Island Fish and Wildlife continued to partner on numerous new fish passage projects and to enhance these restored systems, the division transplanted adult river herring and American shad broodstock into several river systems. There were no significant changes in monitoring, regulations or harvest in 2012.

Request for de minimis: NA

Previous year's fishery and management program:

The taking of river herring and American shad in Rhode Island marine and freshwaters was closed in 2012, therefore fishery dependent and bycatch data is unavailable for either species.

Rhode Island's Fish and Wildlife freshwater and marine sections continued with several fishery-independent monitoring activities during the 2012 season. American shad surveys included estimating spawning stock sizes at the Potter Hill fish trap on the Pawcatuck River and conducting the Pawcatuck River seine survey to calculate juvenile abundance indices. River herring surveys included the use of electronic fish counters and volunteer based counting methods to estimate spawning stock sizes on several RI rivers. JAI's were also calculated for juvenile river herring sampled at Gilbert Stuart, Nonquit, and the Pawcatuck River. In addition to the freshwater surveys, the marine section continued monitoring all size classes of river herring by conducting two marine seine surveys and a trawl survey.

Regulations that were in effect in 2012 are listed below.

Rhode Island biologists have begun implementing habitat recommendations and submitting an example threat to ASMFC.

Marine Regulations:

7.17 American Shad – The commercial harvesting, landing, or possession of American Shad (*Alosa sapidissima*) within the State of Rhode Island and its territorial waters is prohibited. RIMF REGULATIONS [Penalty – Part 3.3 (RIGL 20- 1-16)]

7.19 Atlantic Herring (*Clupea harengus*)

7.19.1 Commercial

7.19.1-1 Season and Possession Limits - The season for Atlantic herring begins annually on January 1. The possession limit is 2,000 pounds per vessel per day, unless the vessel holds a permit issued pursuant to sub-section 7.19.1-2. When the Atlantic Herring quota has been harvested as determined by the National Marine Fisheries Service (NMFS), the season will close. Any modifications made by the Division of Fish and Wildlife to the possession limit as set forth above will be promulgated in Part III, section 3.2.1-3

7.19.1-2 State Waters Atlantic Herring Fishing Permit - An Atlantic Herring fishing permit issued annually by the Division of Fish and Wildlife (RIDFW) is required for vessels engaged in the fishing and/or processing of over 2,000 pounds of Atlantic Herring in Rhode Island state waters.

(a) Issuance of the RIDFW state waters Atlantic herring fishing permit is contingent on fishing vessel captains attending a meeting with RIDFW staff where they are required to give proof that:

(1) The vessel and its captain(s) have obtained all necessary and applicable authorizations to fish for Atlantic herring in RI waters (license, endorsements(s), and vessel declarations).

(2) The vessel captain(s) have provided a valid email address to RIDFW at which the captain can accessed while fishing for the purpose of receiving advisories pertaining to river herring.

(3) The vessel captain(s) have received from RIDFW a chart of fixed commercial fishing gear locations in Rhode Island waters and will have said chart in his/her possession while engaged in the fishing and/or processing of Atlantic Herring in RI waters.

(4) The vessel captain(s) have received from RIDFW a copy of all applicable regulations governing the commercial harvest of Atlantic herring in Rhode Island waters.

(b) RIDFW Atlantic herring fishing permits are valid for one calendar year from January 1 to December 31.

(c) Initial issuance or renewal of the RIDFW Atlantic herring fishing permit will be subject to a background check to determine if the applicant captain or vessel has been assessed a criminal or administrative penalty in the past three years of RIMF regulation sections 7.19 (Atlantic herring) or 7.20 (river herring) or more than one marine fisheries violation.

7.19.1-3 River Herring Bycatch Allowance - Vessels possessing a federal Atlantic herring permit fishing in federal waters may transit Rhode Island state waters and make a landing in possession of alewives, *Alosa pseudoharengus* or blueback herring, *Alosa aestivalis* (river herring) provided that the count of the combined river herring is 5% or less than the count of Atlantic herring onboard the vessel.

(a) Vessels transiting state waters must have all of the fish harvesting gear on board the vessel and stowed while in state waters.

(b) Vessels landing in Rhode Island must possess an applicable RIDEM landing permit or be operated by the holder of an applicable RIDEM commercial fishing license as defined in RIDEM Commercial and Recreational Saltwater Fishing Licensing Regulations sections 6.8, 6.9 and 6.10.

(c) The percentage of river herring in the catch will be assessed by sorting and counting a batch of fish taken from the catch of Atlantic herring on board the vessel or being

landed by the vessel. This determination as to the percentage of river herring in the catch shall be accomplished by filling a container as defined pursuant to section 7.19.1-3(e) with a portion of the catch and examining the contents of said container. The percentage of river herring in said container shall be deemed to be representative of the percentage of river herring in the catch as a whole for purposes of a determination as to whether a vessel is in compliance with the requirements of this section.
(d) A batch of fish is defined as all fish in a separate container.
(e) A container is defined as any box, tote, bag, bucket or other receptacle capable of retaining at least 25 gallons of loose fish which may be separated from the total catch of Atlantic herring being landed.
7.20 River Herring – No person shall land, catch, take, or attempt to catch or take any alewives, *Alosa pseudoharengus* or blueback herring *Alosa aestivalis,* from any marine waters of the State of Rhode Island. Possession of any alewives or blueback herring at any time is prohibited and shall be evidence that said herring was taken in violation of this section. RIMF REGULATIONS [Penalty – Part 3.3 (RIGL 20-1-16)]

Freshwater Regulations:

2.3 No person shall take any American shad, (*Alosa sapidissima*) from the fresh waters of the state.

2.1 No person shall land, catch, take, or attempt to catch or take any alewives (Alosa pseudoharengus) or blueback herring (Alosa aestivalis) from any fresh waters of the state of Rhode Island. Possession of any alewives or blueback herring, at any time, is prohibited and shall be evidence, prima facie, that said herring was taken in violation of this section.

Planned management programs for the current calendar year:

Regulations for 2013 will be the same as in 2012, except for the proposed rule change listed below. All monitoring programs conducted in 2012 will be continued during the 2013 season and no changes are planned at this time.

7.17 American Shad – The ~~commercial~~ harvesting, landing, or possession of American Shad (*Alosa sapidissima*) within the State of Rhode Island and its territorial waters is prohibited. RIMF REGULATIONS [Penalty – Part 3.3 (RIGL 20- 1-16)]

I. Harvest and losses

A. Commercial fishery

1. Characterization of fishery

Prior to 2005, Rhode Island had an indirect ocean fishery and no commercial in-river fishery.

- Season: closed
- Location: Atlantic Ocean, Narragansett Bay
- Gear: gillnets, traps, trawls
- Regulations: Closed January 1, 2005

2. Characterization of directed harvest for all alosines.

a. Ocean landings are shown in Table 1.

Table 1. - American shad ocean landings

Year	Total (lbs)
1992	13,292
1993	40,552
1994	17,938
1995	27,950
1996	14,225
1997	36,760
1998	33,590
1999	44,252
2000	17,315
2001	67,851
2002	87,197
2003	31,424
2004	14,665

b. Catch composition: An ocean-intercept sampling program was initiated in 1999 to collect biological data on American shad. During the 2012 season, port agents did not observe any American shad because of the closure.

c. Estimation of effort

The majority of the American Shad commercial landings were from a trap net fishery. Prior to 2005, the nine trap nets were fished 24 hours a day, 7 days a week during the months from May to October. These were fixed gear with constant fishing effort. Complete closure January 1, 2005.

3. Characterization of other losses (poaching, bycatch, etc.)

Data is not available but considered to be negligible.

B. Recreational fishery

1. Characterization of fishery

Rhode Island regulations do not allow possession of American shad taken from the fresh waters of the state.

- Season: closed
- Location: Pawcatuck River
- Gear: rod and reel
- Regulations: catch and release only

2. Characterization of directed harvest for all alosines.

There is no recreational harvest of American shad.

3. Characterization of other losses (poaching, bycatch, etc.).

Data is not available, but considered negligible.

C. Other losses (fish passage mortality, discarded males, brood stock capture, research losses). None.

D. Harvest and losses-including all above estimates in numbers and weight (pounds) of fish and mean weight per fish per gear.

Data is not available. Closed fishery and no losses reported.

E. Protected species I Atlantic sturgeon bycatch estimates.

The NOAA Fisheries Observer Program in combination with the NOAA Fisheries At-Sea Monitoring Program monitors catches from commercial trawl and gillnet fisheries in federal and state waters. We requested the 2012 data for NOAA Statistical Areas 538, 539, and 611, which to some degree encompass Rhode Island waters. From those three (3) NOAA Statistical Areas four (4) sturgeon were observed; however, only one (1) of the four (4) were verified as Atlantic

Sturgeon whereas the other three could only be identified as 'sturgeon'. Note that none (0) of these four (4) observations occurred in state waters; thus, no sturgeon (Atlantic or Shortnose) were observed by the NOAA Fisheries Observer Program or At-Sea Monitoring Program in RI states waters during 2012 (E. Schneider – RI F&W, personal communication).

II. Required fishery independent monitoring

A. Description of requirement as outlined in Amendment 1, Table 2.

Rhode Island is required to conduct an annual spawning stock survey for American shad in the Pawcatuck River. Biological sampling and calculation of mortality/survival estimates are required. A juvenile index of abundance is calculated for the Pawcatuck River.

B. Brief description of work performed

Rhode Island biologists have monitored a fishway trap at the first dam on the Pawcatuck system since 1979. All shad migrating upstream were retained in the trap, enumerated, and sub-sampled for biological data. All shad are released.

C. Results

1. Juvenile Index of Abundance

Weekly seining for juvenile shad was conducted in the lower Pawcatuck River from 1 August to 1 November 2012. The five standard seine stations were sampled each week using the protocol established by O'Brien (1986). A total of one juvenile shad was collected in 70 seine hauls. The geometric mean of the CPUE is presented in Table 2.

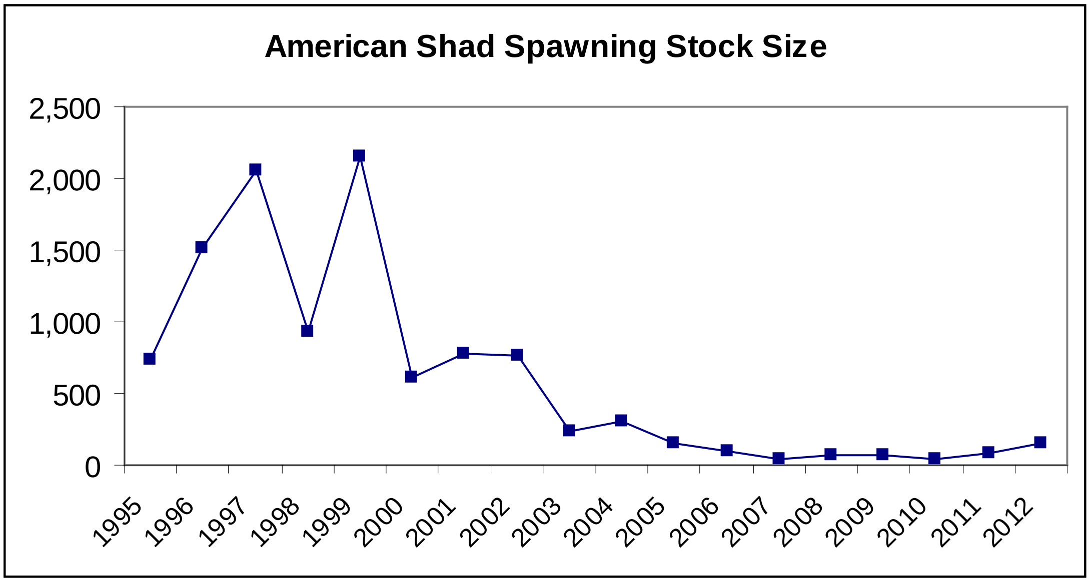
Table 2. - Juvenile Abundance Index for American shad

	Geometric Mean	Lower 95% CL	Upper 95% CL
2000	1.30	0.86	1.83
2001	0.09	0.00	1.19
2002	0.47	0.29	0.97
2003	0.33	0.18	0.63
2004	1.12	0.87	1.36
2005	0.32	0.16	0.52
2006	0.05	0.01	0.11
2007	0.75	0.66	1.71
2008	0.17	0.02	0.37
2009	0.00	0.00	0.00
2010	0.05	-0.01	0.12
2011	0.19	0.05	0.34
2012	0.01	-0.01	0.03

2. Spawning stock assessment

A total of 156 American shad passed through the fishway in 2012. Shad first appeared on April 20th when the water temperature was 17.8°C, and the last shad was captured on June 9th when the water temperature was 20.0°C. During the 2012 run, adult shad were examined to determine sex, size, and age. All fish were returned to the river after examination.

Figure 1 and Table 3 - Spawning Stock Size counted at the Potter Hill Fishway.



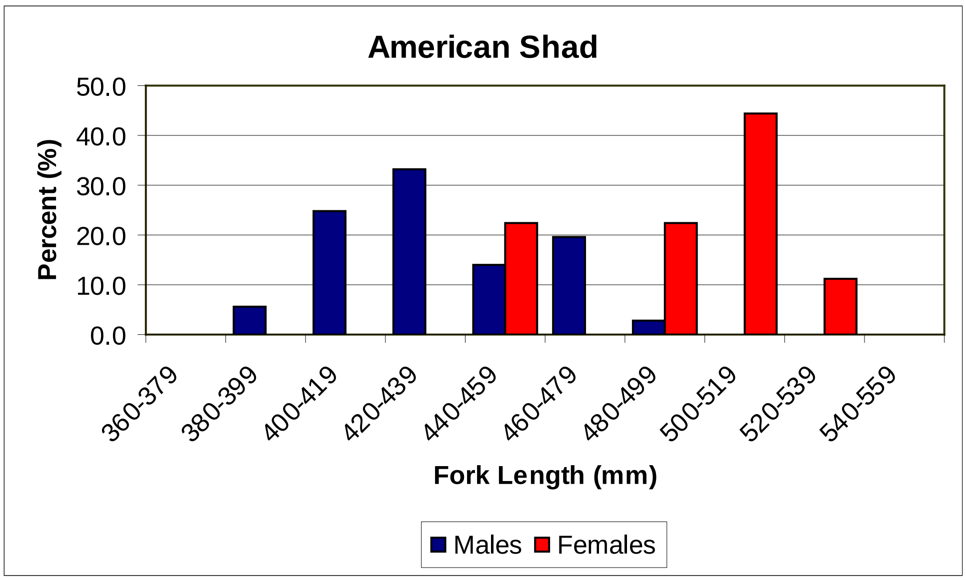
Year	SSS
1995	740
1996	1,508
1997	2,061
1998	936
1999	2,149
2000	608
2001	774
2002	768
2003	243
2004	301
2005	151
2006	92
2007	44
2008	70
2009	69
2010	44
2011	78
2012	156

a. Length frequency

Potter Hill Fishway

Mean fork lengths for female American shad sampled in 2012 were 480.7 (S.E ± 14.6) and for males was 432.5 mm (S.E. ± 3.5). Length frequency distributions of the shad examined at the Potter Hill fishway are shown in figure 2.

Figure 2.- Pawcatuck River spawning stock length frequency.



b. Age frequency: Results are shown in Table 4.

American shad sampled in 2012 ranged between the age 4 and 6, which is similar to shad sampled during the past few years. Results continue to show very few age 7 and 8 shad compared to fish sampled in the 1990’s.

c. Sex ratio: 4.1 males : 1 female

d. Degree of repeat spawning: Results are shown in Table 4.

Table 4.- Pawcatuck River age and repeat spawning data.

Gender	**Repeat Spawning**	**Age**				
		3	**4**	**5**	**6**	**7**
Males	0		16	11		
	1 mark			6		
Females	0		3	2	1	
	1 mark			2		
Total	-	**-**	**19**	**21**	**1**	**-**

3. Annual mortality rate calculation: Results are shown in Table 5.

Table 5.- Catch Curve Results

Age	*** Frequency**	**Catch Curve Results**
3	-	Intercept = 9.357
4	19	x variable = -1.472
5	21	
6	1	Z = 1.472
7	-	S = 0.229

* Low sample size due to decrease in spawning stock size.

4. Hatchery evaluation

During the 2012 season, 691 adult American shad broodstock were stocked into the Pawcatuck River from the Connecticut River. In addition, adults were transplanted to the North Attleboro National Fish Hatchery, where they were allowed to spawn and eggs were collected. A total of 2,157,162 American shad fry were stocked into the Pawcatuck River and 1,796,790 were stocked into the Pawtuxet River during the 2012 season.

III. Ocean Fishery Phase Out Plan

In 2003, Rhode Island approved and adopted the closure of all fishing for American Shad in state waters during the period from June 18 - December 31. RIMFC Regulations 7-17. Complete closure January 1, 2005.

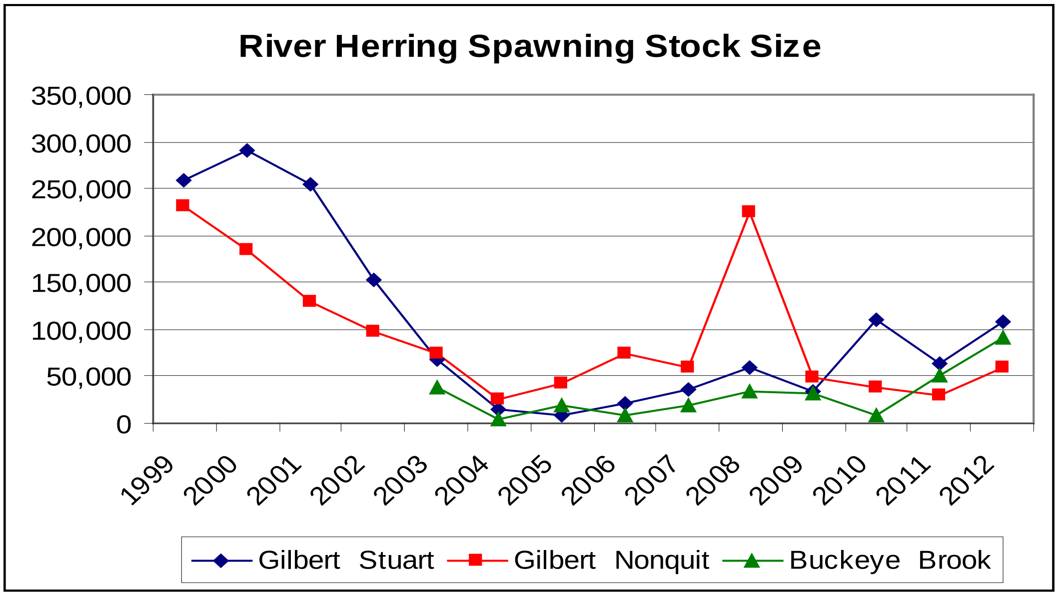
IV. River herring Update

Since March 22, 2006 Rhode Island passed regulations for the moratorium on the harvest of river herring (alewives and bluebacks) in marine and fresh waters of the state. Prior to 2006, the freshwater daily river herring limit in Rhode Island was 12 fish per day with closures on Sunday, Monday, and Tuesday and no marine regulations in place. River herring spawning stock size is monitored each spring by electronic fish counters or direct count methods. During the 2012 season, 107,901 river herring passed through the Gilbert Stuart fishway, 60,132 passed through the Nonquit fishway and 90,625 were counted at Buckeye Brook (Figure 3). The instantaneous mortality (Z) rates were calculated through 2010, using the repeat spawning method (Crecco and Gibson 1988) and results are presented in Figure 4. In 2012, scale samples from Gilbert Stuart and Nonquit were collected and processed but not aged, therefore 2012 estimates of mortality were not completed. Sampling is planned for 2013.

During the 2012 run, 78 adult river herring were sampled at Gilbert Stuart for biological data. Fifty-three (67.9%) were males and twenty-five (32.1%) were females. Mean fork lengths for males were 219.5mm (S.E.± 2.48) and 237.9mm (S.E.± 3.68) for females. Also in 2012, 107 adult river herring were sampled at the Nonquit fishway. Sixty-two (62%) were males and thirty-eight (38%) were females. Mean fork lengths for males were 227.1 mm (S.E.± 1.33) and 235.5 mm (S.E. 1.41) for females.

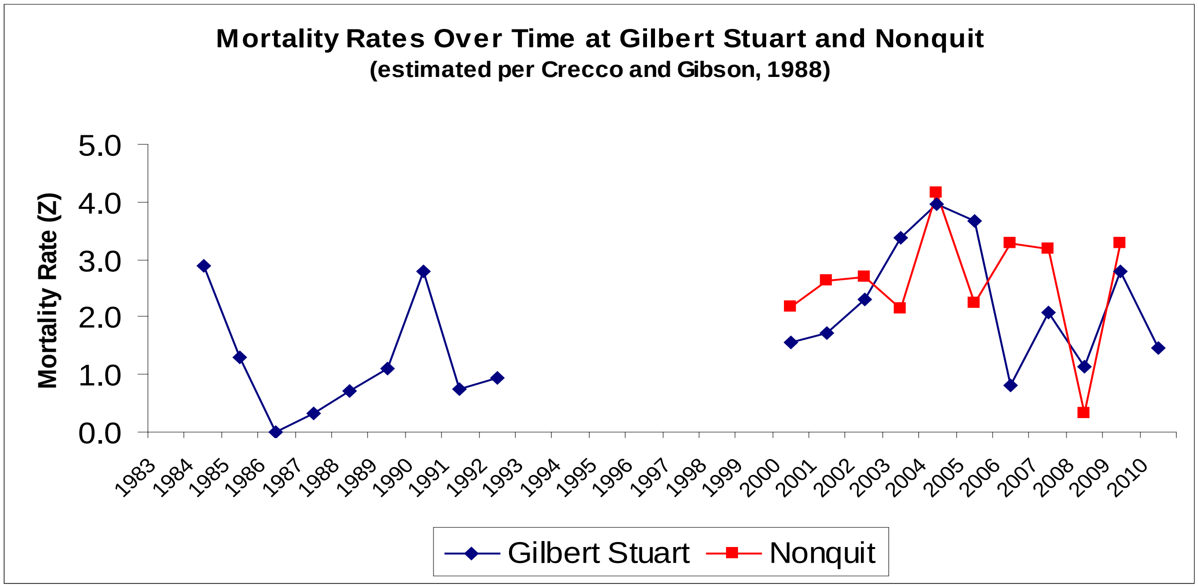
Juveniles are monitored on the Pawcatuck River via a seine survey, and at Gilbert Stuart and Nonquit by utilizing trap nets. The Pawcatuck River seine survey is conducted at five fix sites once per week from August to November. A fishway trap is installed at the Nonquit fishway and a weir trap is installed below the Gilbert Stuart Dam. Both traps are set once a week for one hour from mid-June to November. Juveniles are enumerated and sub-sampled for length data. Juvenile sampling results are shown in Tables 6 and 7.

Figure 3. - River herring counted at Gilbert Stuart, Nonquit and Buckeye Brook.



	Gilbert Stuart	Nonquit	Buckeye Brook
1999	259,336	230,853	
2000	290,814	185,524	
2001	254,948	129,518	
2002	152,056	97,444	
2003	67,172	74,998	38,949
2004	15,376	25,417	5,010
2005	7,776	42,192	18,707
2006	21,744	74,902	9,428
2007	36,864	59,380	18,587
2008	58,640	224,506	34,629
2009	34,835	49,841	31,697
2010	110,287	38,516	8,299
2011	64,500	30,126	50,517
2012	107,901	60,132	90,625

Figure 4. Total mortality rate (Z) for Gilbert Stuart and Nonquit river herring.



	Gilbert Stuart	Nonquit
1983		
1984	2.89	
1985	1.29	
1986	0	
1987	0.34	
1988	0.73	
1989	1.09	
1990	2.79	
1991	0.76	
1992	0.94	
1993		
1994		
1995		
1996		
1997		
1998		
1999		
2000	1.56	2.19
2001	1.73	2.63
2002	2.29	2.70
2003	3.38	2.13
2004	3.95	4.14
2005	3.68	2.24
2006	0.81	3.29
2007	2.08	3.17
2008	1.15	0.34
2009	2.79	3.27
2010	1.46	*

2011 & 2012 river herring scale samples processed but not aged.
2011 & 2012 mortality (Z) estimates are incomplete.

Table 6. Pawcatuck River JAI results for river herring (1993-2012).

Year	Number of Hauls	Number of Fish	Geometric Mean YOY	LL 95%CL	UL 95%CL	Zero Hauls	Arithmetic Mean	SE
1993	35	520	0.37	-0.05	0.97	28	7.09	1.23
1994	25	43	0.31	-0.07	0.85	22	1.72	1.34
1995	30	240	0.90	0.14	2.17	23	8.00	4.21
1996	30	145	0.31	-0.08	0.87	26	4.83	4.60
1997	40	5	0.08	-0.02	0.18	35	0.13	0.09
1998	55	1122	1.51	0.63	2.87	36	20.40	12.57
1999	45	10	0.18	0.05	0.32	38	0.43	0.09
2000	65	527	2.03	1.20	3.17	27	8.11	1.01
2001	65	35	0.21	0.06	0.39	56	0.54	0.23
2002	50	500	2.34	1.30	3.86	19	19.61	10.47
2003	54	226	0.67	0.24	1.24	41	4.19	2.13
2004	60	533	1.43	0.68	2.50	37	8.88	4.09
2005	57	27	0.08	-0.04	0.22	54	0.47	0.44
2006	67	184	0.27	0.03	0.55	60	2.75	2.02
2007	70	186	0.30	0.05	0.61	62	2.66	1.44
2008	60	10	0.08	-0.01	0.17	56	0.17	0.11
2009	60	0	0.00	0.00	0.00	60	0	0
2010	55	17	0.15	0.03	0.28	48	0.309	0.15
2011	60	12	0.067	-0.026	0.169	58	0.20	0.13
2012	70	11	0.05	-0.026	0.122	68	0.16	0.14

Table 7. Gilbert Stuart and Nonquit juvenile river herring mean catch rates.

Gilbert Stuart	Catch/Hr	SE	GM	LL95%CL	UL95%CL
1988	112.07	46.81			
1989	79.13	40.26			
1990	152.25	71.34			
1991	163.30	59.50			
1992	343.30	125.30			
2007	94.90	86.50			
2008	97.25	75.54			
2009	6.60	4.47			
2010	10.89	6.79			
2011	12.11	8.84	1.34	0.10	3.96
2012	16.53	9.78	2.23	0.22	7.54
Nonquit	Catch/Hr	SE	GM	LL95%CL	UL95%CL
2001	161.25	83.40			
2002	66.57	7.90			
2003	415.04	242.58			
2004	2,110.33	1,906.33			
2005	887.91	451.73			
2006	62.39	40.80			
2007	110.15	71.49			
2008	2,219.58	1,954.64			
2009	40.67	9.59			
2010	31.87	25.57			
2011	578.32	485.64	4.88	0.39	23.78
2012	400.65	410.36	0.93	-0.26	4.03

Marine Surveys

The Marine Division of Rhode Island Fish and Wildlife conducts a trawl survey, a Narragansett Bay seine survey, and coastal pond seine survey in Narragansett Bay, Block Island Sound and surrounding coastal ponds. All three surveys collect river herring and CPUE results are shown in Figure 5 and Table 9. Total catch for each method is shown in Table 8. Length frequency results for alewives and blueback herring are shown in Tables 10 and 11.

Table 8. -Number of alosids sampled in marine waters each month by trawl survey (Olszewski, 2012).

Cruise 2012	Alewife	Blueback	American Shad	Hickory Shad
January	2,323	14	8	0
February	3,312	22	11	0
March	458	14	3	0
April	1,782	24	178	0
May	35	266	12	1
June	3	0	0	1
July	0	1	0	1
August	57	0	0	0
September	410	0	0	0
October	1	0	11	0
November	1,975	1	28	1
December	1,112	49	57	0
Total	11,468	391	308	4

Figure 5. Marine Survey Indices-Annual mean catch per tow or seine haul (arithmetic mean)

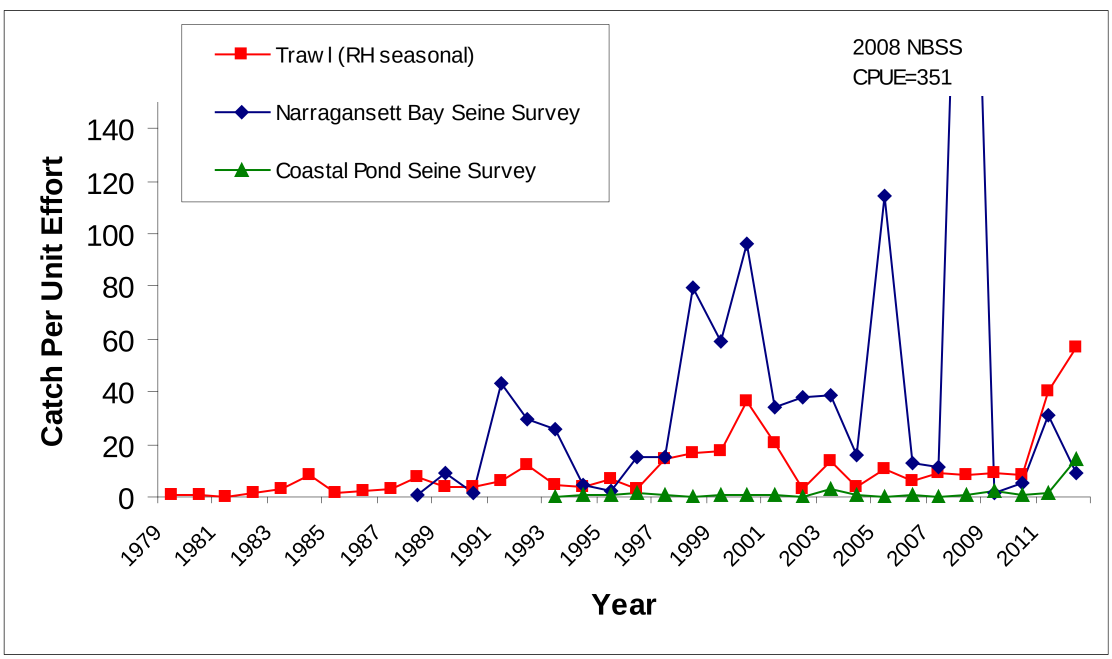


Table 9.-Marine Indices for River Herring
(Lake 2012, McNamee 2012, and Olszewski 2012).

Year	Trawl Survey	Narragansett Bay Seine Survey	Coastal Pond Seine Survey
1979	1.000		
1980	0.590		
1981	0.044		
1982	1.568		
1983	3.187		
1984	8.341		
1985	1.317		
1986	2.278		
1987	2.786		
1988	7.200	0.51	
1989	3.536	9.05	
1990	3.690	1.51	
1991	5.914	43.41	
1992	11.857	29.36	
1993	4.433	25.43	0.102
1994	3.707	4.45	1.122
1995	6.643	2.46	0.946
1996	2.907	15.03	1.840
1997	14.707	15.20	0.583
1998	16.780	79.89	0.251
1999	17.771	59.10	1.051
2000	36.346	95.88	0.843
2001	20.785	33.92	0.409
2002	3.259	38.24	0.051
2003	13.855	38.54	3.247
2004	4.139	15.77	0.411
2005	10.783	114.23	0.092
2006	6.179	13.02	0.720
2007	8.793	11.57	0.000
2008	8.560	350.67	0.789
2009	8.905	1.68	2.023
2010	8.706	5.67	0.926
2011	40.480	31.02	1.490
2012	56.74	9.37	14.34

Table 10.- 2012 Trawl survey length data for alewife (Olszewski, 2012).

FL (cm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	1	1
6	0	0	0	0	0	0	0	0	0	0	27	0	27
7	23	0	3	1	0	0	0	0	0	0	279	132	438
8	76	28	200	26	0	0	0	1	1	0	393	310	1035
9	27	29	179	199	0	0	0	48	4	0	31	107	624
10	3	64	22	155	2	0	0	8	82	1	27	4	368
11	21	41	30	207	10	0	0	0	240	0	71	22	642
12	190	5	0	367	1	0	0	0	43	0	242	40	888
13	660	571	1	474	2	0	0	0	40	0	391	96	2235
14	950	2237	11	133	3	0	0	0	0	0	243	118	3695
15	244	309	3	123	0	0	0	0	0	0	125	97	901
16	69	4	0	2	8	0	0	0	0	0	40	86	209
17	12	1	0	21	0	0	0	0	0	0	43	21	98
18	12	1	0	8	0	0	0	0	0	0	32	14	67
19	6	2	1	5	0	0	0	0	0	0	4	18	36
20	27	6	1	1	1	0	0	0	0	0	0	16	52
21	3	4	1	3	0	0	0	0	0	0	0	10	21
22	0	2	0	12	2	0	0	0	0	0	0	8	24
23	0	2	1	20	3	1	0	0	0	0	27	6	60
24	0	3	3	22	2	1	0	0	0	0	0	2	33
25	0	2	1	2	0	1	0	0	0	0	0	4	10
26	0	1	1	1	0	0	0	0	0	0	0	0	3
27	0	0	0	0	1	0	0	0	0	0	0	0	1
28	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2323	3312	458	1782	35	3	0	57	410	1	1975	1112	11468

Table 11.-Trawl survey length data for blueback herring (Olszewski, 2012).

FL (cm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	1	2	4	0	0	0	0	0	0	0	0	4	11
8	1	2	2	3	0	0	0	0	0	0	0	16	24
9	3	5	5	4	1	0	0	0	0	0	0	4	22
10	1	4	2	4	128	0	0	0	0	0	0	0	139
11	0	0	1	3	136	0	0	0	0	0	0	0	140
12	0	3	0	6	1	0	0	0	0	0	0	0	10
13	0	2	0	4	0	0	1	0	0	0	0	0	7
14	0	2	0	0	0	0	0	0	0	0	0	1	3
15	1	0	0	0	0	0	0	0	0	0	0	0	1
16	2	2	0	0	0	0	0	0	0	0	1	5	10
17	4	0	0	0	0	0	0	0	0	0	0	6	10
18	1	0	0	0	0	0	0	0	0	0	0	5	6
19	0	0	0	0	0	0	0	0	0	0	0	5	5
20	0	0	0	0	0	0	0	0	0	0	0	2	2
21	0	0	0	0	0	0	0	0	0	0	0	1	1
22	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	14	22	14	24	266	0	1	0	0	0	1	49	391

V. Hickory shad Update

There are no known spawning stocks of hickory shad in Rhode Island freshwaters. During the 2012 season, the Division monitored catches from trawl surveys in Rhode Island marine waters (Table 8). Table 12 and 13 shows the length frequency of American shad and hickory shad sampled during the 2012 RI coastal trawl survey.

Table 12.-Trawl survey length data for American shad (Olszewski, 2012).

FL (cm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0	0	0	4	0	5
11	0	3	0	21	0	0	0	0	0	0	1	0	25
12	0	2	1	0	0	0	0	0	0	0	1	0	4
13	2	2	0	23	0	0	0	0	0	0	1	0	28
14	1	1	0	71	7	0	0	0	0	0	0	0	80
15	0	2	1	8	2	0	0	0	0	0	0	1	14
16	1	0	1	6	2	0	0	0	0	0	0	0	10
17	1	0	0	24	0	0	0	0	0	0	0	0	25
18	0	1	0	25	0	0	0	0	0	0	0	0	26
19	1	0	0	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	1	0	0	0	0	1	0	3	5
21	0	0	0	0	0	0	0	0	0	6	8	8	22
22	0	0	0	0	0	0	0	0	0	3	8	33	44
23	0	0	0	0	0	0	0	0	0	1	3	10	14
24	1	0	0	0	0	0	0	0	0	0	1	2	4
25	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	1	0	1
40	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	8	11	3	178	12	0	0	0	0	11	28	57	308

Table 13.-Trawl survey length data for hickory shad (Olszewski, 2012).

FL (cm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	1	0	0	0	0	0	0	0	1
29	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	1	0	1
33	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	1	0	0	0	0	0	1
36	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	1	0	0	0	0	0	0	1
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	1	1	1	0	0	0	1	0	4

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State of Connecticut
Compliance Report for American Shad and River Herring in 2012
Submitted to the Atlantic States Marine Fisheries Commission

American Shad

I. Harvest and losses.

A. Commercial Fishery

1. Characterization of fishery (seasons, caps, gears, regulations)**:**

Seasons

The Connecticut American shad gill net season for commercial license holders is from April 1 through June 15. The closed season for the taking of American shad for commercial purposes shall be June sixteenth to March thirty-first inclusive and no shad shall be taken for commercial purposes from Friday night at sundown to Sunday night at sundown.

Caps

There are no caps on harvest in the Connecticut River. In 2013, the commercial and recreational shad fishery will be managed under the Connecticut River Sustainable Fishery management Plan. The Sustainable Fishery Plan for the Connecticut River utilizes juvenile recruitment, Holyoke lift numbers (as a proxy for run size) and total commercial harvest to monitor stock health.

Gears

The following are prohibited: Use of gill nets constructed of single or multiple strand monofilament from sunrise to sunset, monofilament twine thickness greater than 0.28 mm (#69), commercial fishing for shad from sundown Friday to sundown Sunday except by the use of a scoop net, the use of nets with mesh size less than five inches stretched mesh, fishing in other than the main body of the Connecticut River (no coves) and the use of pound nets or other fixed or staked nets to take shad except in the waters of Long Island Sound.

Regulations

In the inland district, American shad may be taken for commercial purposes only in the main body of the Connecticut River from the I-95 Bridge in Old Saybrook/Old Lyme to the William H. Putnam Memorial Bridge on Route 3 in Glastonbury/Wethersfield.
In Marine Waters, American shad shall not be netted between lines drawn south in Long Island Sound to the New York state line from Menunketesuck Point, Westbrook and from Hatchett Point, Old Lyme except with seines, pounds, and gill nets. Reports of daily fishing activities and catch are required. Each licensed commercial shad fisherman shall submit a report of daily fishing activities no later than June 30 of the year covered by the report.

2. Characterization of directed harvest for all alosines.

American shad are the only alosine species harvested by directed fisheries in Connecticut waters. Commercial or recreational take of migratory populations of alewife and blueback herring is prohibited in state waters. The take of river herring has been prohibited by annual declaration from the CT DEEP Commissioner since 2002.

a. *Landings and method of estimation*.

Commercial shad fishermen are required to submit a complete catch report detailing the catch, effort and landing activities associated with: All landings made in Connecticut regardless of where the landings take place and all fishing in Connecticut waters regardless of where the landings take place. Commercial logbooks detail catch effort. Landings are reported to NMFS on an annual basis. The *preliminary* 2012 landings are 61,623 pounds or 13,168 fish (Table 1). All but 60lbs of these landings were from the Connecticut River Fishery. The 60lbs of reported bycatch does not exceed the 5% trip limit for American shad. Landings will be reported to NMFS when they are finalized. Total fishing effort (160 trips) was summed from individual catch reports (Table 2).

b. *Catch composition*.

i. Age frequency.

A limited number (51) of American shad scale samples representative of the commercial fishery were collected in 2012 (Table 4). CT DEEP staff collected biological samples with drift gill nets with a mesh size similar to the commercial fishery and in a similar fashion to that used by commercial operators to assist in characterizing the fishery. Gill nets were fished during daylight hours to avoid interfering with commercial efforts; research nets were shorter in length and drift times were shorter than those employed by commercial netters. Seven fishing trips were made by CT DEEP staff in 2012.

Shad ages ranged from 4 to 6 year olds among males and from ages 4 to 7 year olds among females. Overall age frequencies were dominated by five and six year old fish. Among males, most of the samples were 5 year old fish and among females, most were 6 year old fish. (Table 4).

ii. Length frequency.

Fork lengths of males ranged from 40.0 to 49.5. The majority (96%) of males fell with 40 and 45 cm. Females ranged from 40.0 to 54.5 cm FL. Female length distribution was more spread out.

iii. Sex ratio.

The sex ratio of the samples collected was 75% females to 25% % males. This is not unexpected given the low sample size and selectivity of gill nets.

iv. *Degree of repeat spawning*.

The repeat spawning rate based on scale samples collected was 9.8%.

c. Estimation of effort.

Nine commercial shad license holders reported landings in 2012. The number of licenses sold is comparable to recent years. The number of shad boats fishing annually continues to remain low as few new participants enter the fishery.

3. Characterization of other losses (poaching, bycatch, etc.).

a. Estimate and method of estimation

Amendment 1 requires that each state annually document that the American shad ocean bycatch does not exceed 5% of the total landings (in pounds) per trip. Based on logbook reports, the bycatch allowance documented in one trip, 60 lbs., was below the 5% limit. No poaching or illegal catch of American shad has been documented. The fishery is somewhat self-regulating in that drift gill nets are pre-emptive in nature and licensed commercial fishermen are not likely to allow unlicensed fishers to displace them from preferred fishing reaches.

b. Estimate of composition (length and/or age)

Using an average weight, the reported bycatch estimate in numbers could range from 12 to 17 adult shad. Length and age of catch is unknown.

B. Recreational Fishery

1. Characterization of fishery (seasons, cap, regulations).

Angling for American shad is the only legal method of take and may take place during the open season from April 1 through June 30 in rivers and streams open to fishing all year; otherwise, the open season runs from the 3rd Saturday in April through June 30. There is a daily possession limit of 6 American and hickory shad in the aggregate, per person, in both the Inland and Marine Districts. In the Pawcatuck River, which forms the border between Connecticut and Rhode Island, the open season for American shad follows Rhode Island regulations. Fishing licenses are required for anyone 16 years of age or older fishing in the Inland and Marine Districts. Licenses are issued on a calendar basis and expire on December 31st.

There have been no changes to Connecticut Statutes or regulations pertaining to shad fishing since March 19, 1999 when the existing 6 fish recreational creel limit was modified to include hickory shad as an aggregate creel limit for the two species. The 2014 compliance report will address management strategies implemented in 2013 through the Connecticut River American shad sustainability plan.

2. Characterization of directed harvest.

a. Landings and method of estimation

The last creel survey conducted in 2010 indicates that few fishermen target American shad in the traditional shad fishing areas from Hartford to the CT/MA state. This decline in the American shad sport fishery has been going on for several years and the trend is not expected to change. Most anglers that traditionally fished for shad have switched their efforts to pursue striped bass, which provides a quality fishery from Hartford up into Massachusetts. The last creel survey conducted in 2010 estimate the sport landings of shad to be just over 600 fish (Table 3). There was no creel survey conducted in 2012.

b. Catch composition.

i. Age Frequency

ii. Length frequency (legal and sub-legal catch)

No information available, assumed to be comparable to age and length frequencies of shad collected from the Holyoke fish lift.

c. Estimation of effort.

No data was collected on the recreational fishery in 2012.

3. Characterization of other losses (poaching, hook/release mortality, etc.)

a. Estimate and method of estimation

b. Estimate of composition (length and/or age)

No other losses are known to take place in Connecticut waters.

C. Other losses (fish passage mortality, discarded males, brood stock capture, research losses, etc.).

For 2012, 51 shad were sacrificed for research purposes in Connecticut waters. No other losses of American shad are known to occur in Connecticut waters from any of the cited reasons. Transplanting of Connecticut River American shad within and out of basin occurs from the Holyoke Fish lift in Massachusetts.

D. **Table 1. Harvest and losses-*Including all above Estimates in Numbers and weight (pounds) of fish and mean weight per fish for each gear type.***

Commercial and research losses are reported in Table 1.

E. Protected species

Atlantic sturgeon bycatch estimates.

Prior to the Federal listing of Endangered, commercial harvest of Atlantic sturgeon from the marine waters of the State was prohibited (effective 06/24/97) with the adoption of the ASMFC required moratorium. Required reporting of Atlantic sturgeon bycatch in the American shad commercial fishery was accomplished through modification to the required Annual American Shad Catch Report Form. A total of 9 sturgeon (species unclassified) were reported as caught and released by shad fishermen in 2012. Both Atlantic sturgeon and shortnose sturgeon are known to be present in the lower Connecticut River during spring months (Savoy and Pacileo 2003). However, given the uncertainty or lack of species determination by commercial fishermen, the total number of sturgeon reported captured and released are reported here.

II. **Required fishery independent monitoring.**

A. Description of requirement as outlined in American Shad and River Herring Addendum 1 to Amendment I and Technical Addendum # 1, Table 2. Annual spawning stock survey and representative sampling for biological data. Calculation of mortality and/or survival estimates where possible. JAI: Juvenile abundance survey (GM).

B. Brief description of work performed.

The adult American shad population estimate, age structure and sex ratio were calculated from samples collected at the Holyoke dam fish lift at Holyoke, MA. Information on the number of fish lifted daily, the number of lift days (days the lift is in operation) and the daily sex ratio at Holyoke was obtained from the Massachusetts Division of Fisheries. The annual sex ratio was calculated by weighting the daily sex ratios by the number of fish lifted that day.

The annual population estimate was derived based on the 2011 passage efficiency of 63%. This was determined thorough a Connecticut River tag and recapture study. Adult American shad were double tagged with PIT and radio tags. Receivers were placed in several locations including the Holyoke Dam. Passage efficiency was calculated as the number of tags detected at the Holyoke dam divided by the number of shad tagged in the lower river.

Age structure was derived from scale samples collected at the Holyoke Fish lift in Holyoke, MA and was used to characterize the population.– Adult shad collected at Holyoke were sexed, measured to fork length (mm) and 15-25 scales removed. All scale samples collected were separated by sex and stratified into 1 cm length groups. Scale samples were processed by cleaning with an ultrasonic cleaner and pressed onto acetate for aging. Age determinations were made as the consensus of two or more readers of projected images (43x) counting annuli and spawning scars according to the criteria of Cating (1953). Repeat spawners were noted by the presence of spawning scar(s) at the periphery of the scale. The age and repeat spawning frequency were extrapolated to the entire population by direct proportion.

Juvenile American shad were collected weekly from July 11^{h} through October 12th at seven fixed stations located from Holyoke, MA to Essex, CT in the Connecticut River. Seine haul locations and techniques have remained similar to those employed in past Connecticut River shad investigations (Marcy 1976; Crecco et al. 1981). Sites were previously chosen based on location, physical conditions and accessibility. One seine haul per station was made during daylight hours with a 15.2 m nylon bag seine (4.6 mm mesh, 2.4 m deep, and 2.4 m bag) and 0.5 m lead ropes. Each haul was completed by using a boat to set the net approximately 30 m upstream and offshore of the site. Using the lead ropes, the seine was then towed in a downstream arc to the shore and beached. With small sample sizes (less than 500 fish), all clupeids (*Alosa sapidissima*, *A. aestivalis*, *A. pseudoharengus*, and *Brevoortia tyrannus*) were stored in ice and returned to the laboratory. With large sample sizes, clupeids were subsampled volumetrically and unneeded fish returned to the water. Water temperature, weather conditions, time and tidal stage (when appropriate) were recorded for each station.

In the laboratory, juvenile clupeids were identified to species by the criteria of Lippson and Moran (1974) and counted. Up to 40 juvenile shad per haul were measured (TL mm). Individual seine collections containing greater than 40 shad were randomly subsampled for length measurements. All other clupeids were only counted. The relative abundance of juvenile American shad was calculated as the geometric mean catch per seine haul from all stations and all dates sampled.

C. Results.

1. Juvenile indices.

a. Index of abundance.

A total of 1,545 juvenile American shad were collected in the Connecticut River during 2012. The geometric mean catch of juvenile American shad from all stations and all dates was 3.03 (Table 6).

b. Variance.

The variance about the geometric mean of juvenile shad collected in the Connecticut River was 2.0.

2. Spawning stock assessment

Shad passage at the Holyoke Dam in 2012 (490,000) is the highest number of shad lifted since 1992. Holyoke Fish lift was in operation April 2nd through July 8thth in 2012.

a. Length frequency.

Length frequency of American shad collected at the Holyoke lift ranged from 33.0 to 47.5 cm for male shad and 36.0 to 50.0 cm FL among female shad. Average size among males was 41.2 cm FL and among females was 45.1 cm FL.

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b. Age frequency.

The 2012 male population of spawning adult shad was produced from the 2005-2009 year classes. Forty two percent of male shad scales examined were from 4 year old fish. Forty three percent of male shad scales examined were from five year old fish. Six and seven year old fish were 12 and 0.2 percent of the population, respectively, while three year old males comprised on1y two percent of the age structure (Table 5).

The majority of female shad sampled in 2012 were from the 2007 year class. Fifty six percent of female scale samples examined were 5 year old fish. Four year old fish contributed twenty two percent to the annual run and twenty one percent were 6 year old fish. The incidence of overall repeat spawning remains low. The percentage of repeat spawners for males is 3.2% and 5.4% among females, with a combined repeat spawn rate of 4.1%. The shad spawning population continues to rely on a few age classes and low rates of repeat spawners (Table 5).

c. Sex.

A total of 911 scale samples obtained from the Massachusetts fisheries staff were aged by CT DEEP. Information collected on the weighted sex ratio at the Holyoke Fish lift was obtained from Massachusetts State Fisheries staff. Massachusetts's staff reported a weighted sex ratio of 61.7% males and 38.3% females for the 2012 run of American shad in the Connecticut River.

d. Degree of repeat spawning.

The repeat spawning rate for the Connecticut River among females was 5.5%, slightly higher than the rate among males of 3.2%. The overall repeat spawning rate for both sexes combined was 4.1%.

3. Annual mortality rate calculation.

In river fishing mortality (F) rates have been estimated for Connecticut River shad by the Connecticut Marine Fisheries Division from 1990 to 2012 (Table 3). The estimate of in-river fishing mortality (FR) for 2012 was 0.027. Fishing mortality rates vary somewhat, but have generally shown a decline and remained well below the overfishing threshold since 1990. The Connecticut River shad population has remained stable based on trends in adult shad population size from 1990 to 2012 (Table 3). The overfishing definition for American shad in the Connecticut River was based on the F30% threshold fishing mortality rate. The F30% level generated for Connecticut River shad from yield-per-recruit modeling is 0.43 and refers to the fishing mortality (F) that generates 30% of the unfished (F = 0) female spawning biomass-per-recruit. The Connecticut River stock is considered to be recruitment overfished if the magnitude of the average total F during the last three years (i.e. 2005-2008) exceeded the F30% threshold. Total F estimates from the combined in river and coastal intercept fisheries have consistently been well below the F30% overfishing threshold. In river commercial landings and fishing effort (gill net days) have also declined since 1992. Recreational landings peaked in 1992 (120,146). Recreational landings have declined since 1997 and have fallen well below 10,000 fish. Beginning in 2013, the Connecticut River Shad fishery will be managed using Connecticut's sustainability plan as required through Amendment 3 to the SRH FMP.

4. Hatchery evaluation (% wild vs. hatchery juveniles).

No shad are produced in hatcheries for placement into Connecticut waters.

River Herring

I. Harvest and losses.

A. Commercial Fishery

1. Characterization of fishery (seasons, cap, gears, regulations):

The river herring closure was renewed through annual declaration for 2012. The state of Connecticut has had a full fishery closure in effect since 2002 for the take of anadromous alewives and blueblack herring from all Connecticut state waters.

2. **Characterization of directed harvest for all alosines**.

American shad are the only alosine species harvested by directed commercial fisheries in Connecticut waters.

a. Landings and method of estimation.
None

b. Catch composition.
None

i. Age frequency.
No data to report

ii. Length frequency.
No data to report

iii. Sex ratio.
No data to report

iv. ***Degree of repeat spawning***.

v. No data to report

c. Estimation of effort.
No data to report

There are no reported landings of river herring in 2012.

3. Characterization of other losses (poaching, bycatch, etc.).
There was zero river herring bycatch reported in 2012

a. Estimate and method of estimation
Not Applicable

b. Estimate of composition (length and/or age)
No data to report

There are no reports of river herring being taken in any other fisheries in Connecticut in 2012.

B. Recreational Fishery

1. Characterization of fishery (seasons, cap, regulations).

Since 2002, the take of anadromous alewives and blueblack herring has been prohibited from all Connecticut state waters.

2. Characterization of directed harvest.

a. Landings and method of estimation
No landings to report

b. **Catch composition.**

i. **Age Frequency**

No Data to report

ii. **Length frequency (legal and sub-legal catch)**

No Data to Report

c. **Estimation of effort**.

No effort to report

3. **Characterization of other losses (poaching, hook/release mortality, etc.)**

No other losses are known to take place in Connecticut waters.

a. **Estimate and method of estimation**

None

b. **Estimate of composition (length and/or age)**

None

C. **Other losses (fish passage mortality, discarded males, brood stock capture, research losses, etc.).**

No other losses are known to occur.

D. **Table 1. Harvest and losses-*Including all above Estimates in Numbers and weight (pounds) of fish and mean weight per fish for each gear type.***

E. **Protected species**

Atlantic sturgeon bycatch estimates.

There is no commercial fishery for river herring; bycatch of protected species is zero.

II. Required fishery independent monitoring.

A. **Description of requirement as outlined in American Shad and River Herring Amendment II.**

Table 2. Annual spawning stock survey and representative sampling for biological data (blueback herring). Calculation of mortality and/or survival estimates. JAI: Juvenile abundance survey (GM).

B. **Brief description of work performed.**

Blueback herring scale collection efforts are coordinated with the USFWS Connecticut River Coordinators office since CT Marine Fisheries Division does not have the resources to conduct blueback herring collection efforts. The CT River coordinators office was fully committed to a shad tagging study in 2012 and could not collect blueback herring samples. River herring sampling was conducted in the Connecticut River by the USFWS in 2013 and will be reported in next year's compliance report.

In 2011, limited blueback herring adult age structure was derived from scale samples collected in Wethersfield Cove by electrofishing Adult blueback herring were sexed, measured to fork length (mm) and 15-25 scales removed. All scale samples collected were separated by sex and stratified into 1 cm length groups. Scale samples were processed by cleaning with an ultrasonic cleaner and pressed onto acetate for aging. Age determinations will be made as the consensus of two or more readers of projected images (43x) counting annuli and spawning scars according to the criteria of Cating (1953) and Marcy (1969). Repeat spawners were noted by the presence of spawning scar(s) at the periphery of the scale.

Juvenile blueback herring were collected weekly from July 11th through October 12th at seven fixed stations located from Holyoke, MA to Essex, CT in the Connecticut River. Seine haul locations and techniques have remained similar to those employed in past Connecticut River shad investigations (Marcy 1976; Crecco et al. 1981). Sites were previously chosen based on location, physical conditions and accessibility. One seine haul per station was made during daylight hours with a 15.2 m nylon bag seine (4.6 mm mesh, 2.4 m deep, and 2.4 m bag) and 0.5 m lead ropes. Each haul was completed by using a boat to set the net approximately 30 m upstream and offshore of the site. Using the lead ropes, the seine was then towed in a downstream arc to the shore and beached. With small sample sizes (less than 500 fish), all clupeids (*Alosa sapidissima*, *A. aestivalis*, *A. pseudoharengus*, and *Brevoortia tyrannus*) were stored in ice and returned to the laboratory. With large sample sizes, clupeids were subsampled volumetrically and unneeded fish returned to the water. Water temperature, weather conditions, time and tidal stage (when appropriate) were recorded for each station.

In the laboratory, juvenile clupeids were identified to species by the criteria of Lippson and Moran (1974) and counted. Up to 40 juveniles by species per haul were measured (TL mm). Individual seine collections containing greater than 40 shad were randomly subsampled for length measurements. All other clupeids were only counted. The relative abundance of juvenile American shad was calculated as the geometric mean catch per seine haul from all stations and all dates sampled.

C. Results.

1. Juvenile indices.

a. Index of abundance.

A total of 6,249 blueback herring were collected in 2012. The geometric mean CPUE for blueback herring was lower than American shad. The ratio of blueback catches to shad has been widely variable through the time series. In more recent times, shad catches exceed blueback catches. Early in the time series, blueback catches far exceeded those of American shad. The 2012 *Alosa spp.* CPUE indices were both well below average and the blueback CPUE is the 3rd lowest geometric mean in the time series. As with American shad, a station in the lower river had the highest total catch for blueback herring, with 92% of the season's catch. A single catch early in the season in the lower river (2,620) was 42% of the season's total catch of 6,249 blueback herring (Table 5).

2. Spawning stock assessment

Unable to assess due to lack of samples

a. Length frequency.

Blueback herring were not sampled in 2012. In 2011, 58 blueback herring were sampled. Fork length of samples ranged from 18-29 cm. For males, length frequency ranged from 18-26.5 cm. Female fork lengths ranged from 21.5-29.0 cm.

b. Age frequency.

Fifty eight scale samples from blueback herring were collected during one electrofishing trip in 2011. Scales have been pressed but ageing has not been completed.

c. Sex.

The 2011 sex ratio of bluebacks collected was 43.1 % females, 53.4% males and 3.4% unknown.

d. Degree of repeat spawning.

Samples have not been aged yet.

3. Annual mortality rate calculation.

Currently no population estimate is available for the Connecticut River.

4. Hatchery evaluation (% wild vs. hatchery juveniles).

There are no river herring hatcheries in Connecticut.

Table 1. Preliminary harvest and losses for American shad in Connecticut, 2012.

Harvest and Losses	Number	Weight (pounds)	Mean weight per fish (pounds)
Commercial			
Gear			
Set Gill Nets			
Drift Gill Nets	13,168	61,623	4.7
Recreational			
Gear			
Hook and Line	unknown	unknown	unknown
Fish Passage Mortality	0	0	0
Discarded Males	unknown	unknown	unknown
Brood Stock Capture	0	0	0
Research Losses	13	60	4.6

Table 2. Reported number of male, female and total harvest (numbers and pounds), number of fishermen and boats used by the shad commercial fishery, 1990-2012.

Year	Total lbs.	# Male	Male Wt (lbs.)	Mn Wt Male	# Female	Female Wt (lbs.)	Mn Wt Female	# of Boats	Total Trips
1990	259,425	8,568			21,142			20	402
1991	149,300	9,174			23,112			21	416
1992	144,300	7,171			26,768			16	410
1993	96,660	5,173			17,790			15	332
1994	104,000	1,812			19,400			16	312
1995	61,576	1,862	5,893	3.16	12,299	55,682	4.53	19	352
1996	66,757	2,298	6,941	3.02	13,660	59,816	4.38	13	264
1997	91,003	2,812	10,275	3.65	18,743	80,728	4.31	11	271
1998	89,342	2,983	9,440	3.16	18,529	79,902	4.31	12	280
1999	44,574	872	3,373	3.87	9,506	41,201	4.33	11	195
2000	107,416	2,342	7,491	3.2	21,228	99,925	4.71	11	210
2001	59,234	1,469	3,980	2.71	13,074	55,254	4.23	13	193
2002	108,099	7,153	22,555	3.15	20,653	85,544	4.14	11	248
2003	111,127	5,176	17,518	3.38	21,244	93,609	4.41	14	249
2004	66,328	2,456	8,000	3.26	13,436	58,328	4.34	14	226
2005	69,333	1,873	6,136	3.28	15,336	67,070	4.37	12	218
2006	38,547	1,864	5,445	2.92	7,372	33,102	4.49	12	185
2007	51,572	1,688	5,701	3.38	9,888	43,497	4.4	13	199
2008	28,419	858	2,637	3.07	6,486	25,782	3.97	10	203
2009	40,680	1,156	4,045	3.5	6,437	32,187	5	13	182
2010	24,641	855	2,994	3.5	4,238	21,192	5	7	202
2011	32,183	953	3,334	3.5	5,772	28,849	5	8	218
2012	61,623	2,810	9,835	3.5	10,358	51,788	5	9	160

Table 3. American shad population estimates (numbers), reported Connecticut River commercial landings (numbers), commercial fishing effort (gillnet days), CT River recreational landings (numbers), and estimated fishing mortality rates for in-river commercial and recreational fisheries (FR) from 1990-2012.

Year	CT Pop	CT Comml	days	CT Rec [1]	FR [2]
1990	816,400	29,710	402	37,831	0.124
1991	1,195,900	32,286	416	85,494	0.140
1992	1,628,100	30,939	410	120,146	0.110
1993	749,200	22,963	332	64,855	0.139
1994	325,600	21,212	312	45,014	0.227
1995	304,500	14,161	352	14,425	0.143
1996	667,000	15,958	264	11,000	0.059
1997	659,000	21,555	271	6,590	0.066
1998	651,000	21,512	280	6,513	0.044
1999	475,000	10,378	195	4,751	0.032
2000	428,000	23,570	210	4,274	0.067
2001	773,000	14,543	193	7,731	0.029
2002	687,000	27,806	248	6,867	0.052
2003	527,000	26,420	249	5,273	0.062
2004	351,000	15,892	226	3,511	0.057
2005	226,000	17,209	223	2,260	0.090
2006	293,000	9,236	185	2,930	0.042
2007	244,000	11,576	199	3,820	0.041
2008	277,000	7,344	203	2,750	0.037
2009	321,000	7,593	182	3,210	0.034
2010	279,000	5,094	202	616	0.002
2011	387,000	6,725	218	4,000	0.028
2012	778,462	13,168	160	8,000	0.027

1/ In years when a creel survey is not conducted, sport landings are estimated as 1% of population.
2/ FR = -log(1 -(inriver landings/ pop size)).

Table 4. American shad age distribution in the lower Connecticut River, 2012. Samples were collected by gill net to characterize the commercial fishery.

2012 Fishery Dependent Shad Age Structure					
	4	**5**	**6**	**7**	**Total**
Bucks	2	8	3		13
%	15.38	61.54	23.08		
Shad (n)	1,513	6,052	2,270		9,835
	4	**5**	**6**	**7**	**Total**
Roes	2	14	19	3	38
%	5.26	36.84	50.01	7.89	
Shad (n)	2,724	19,079	25,899	4,086	51,788
	4	**5**	**6**	**7**	
Combined	4	22	22	3	51
%	7.84	43.14	43.14	5.88	
Shad (n)	4,831	26,584	26,584	3,623	

Table 5. Fishery independent spawning history and age distribution of American shad in the Connecticut River based on Holyoke fish lift samples, 2012.

2012 American Shad Age Structure							
	3	**4**	**5**	**6**	**7**	**Total**	**% Repeat Spawn**
Bucks	13	234	241	67	1	556	3.24
%	2.34	42.09	43.35	12.05	0.18		
Shad (n)	7,137	128,460	132,303	36,781	549	305,229	
		4	**5**	**6**	**7**	**Total**	**% Repeat Spawn**
Roes		77	195	73	2	347	5.48
%		22.19	56.20	21.04	0.58		
Shad (n)		42,061	106,517	39,876	1,092	189,546	
	3	**4**	**5**	**6**	**7**		**% Repeat Spawn**
Combined	13	311	436	140	3		4.10
%	1.44	34.44	48.28	15.50	0.33		
Shad (n)	7,123	170,405	238,895	76,709	1,644	494,776	

Table 6. Geometric mean relative abundance index (CPUE) of juvenile American Shad and blueback herring from the 1978-2012 year classes.

Year	Juv Shad	Juv BBH
1978	5.89	
1979	7.84	24.8
1980	9.21	26.75
1981	6.05	11.49
1982	1.81	6.09
1983	4.99	16.47
1984	3.37	11.57
1985	7.14	18.23
1986	6.29	13.61
1987	9.89	21.58
1988	5.68	17.04
1989	4.85	7.52
1990	10.39	14.41
1991	3.92	11.36
1992	7.21	9.87
1993	9.49	14.43
1994	12.22	13.92
1995	1.34	5.03
1996	6.5	5.91
1997	6.75	9.66
1998	3.65	4.39
1999	5.47	5.57
2000	4.42	4.17
2001	2.73	3.83
2002	5.55	3.95
2003	6.88	5.88
2004	5.62	2.36
2005	10.08	4.10
2006	1.82	3.50
2007	8.15	6.61
2008	5.06	2.20
2009	3.4	1.77
2010	10.23	12.82
2011	3.08	2.93
2012	3.03	2.22

New York's Annual Report
for American shad and River herring in 2012
to the Atlantic States Marine Fisheries Commission

Prepared by:
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Part 1. Fishery Dependent and Independent Surveys for American shad and river herring in the Hudson River

I. Harvest and Losses

AMERICAN SHAD

A. Commercial Fishery

1. Characterization of in-river fishery: New York closed all fisheries for American shad in the Hudson River and ocean waters in 2010.

2. Characterization of directed harvest

a. Landings and method of estimation:
The American shad fishery remains closed; no landings occurred (Table 1).

b. Catch composition
i. Age frequency: No data collected due to fishery closure.
ii. Length frequency: No data collected due to fishery closure.
iii. Sex ratio: No data collected due to fishery closure.

c. Estimation of effort: None.

3. Characterization of other losses (Poaching, bycatch, etc.)

a. Estimate and method of estimation
Ocean fishery bycatch: American shad are caught as bycatch in a variety of fisheries that occur in New York's Marine District: coastal waters from all areas surrounding Long Island including the waters in and / or adjacent to New York harbor. New York's fishery closure for American shad included these waters. Although American shad are not allowed to be landed, the ACCSP SAFIS database indicated 1,485 pounds were landed.

B. Recreational Fishery

1. Characterization of the fishery
The American shad fishery remains closed.

2. Characterization of directed harvest:

a. Landings and Method of Estimation: No data collected due to fishery closure.
b. Catch Composition: No data collected due to fishery closure.

c. Estimation of Effort: No data collected due to fishery closure.

3. Characterization of losses (poaching, hook / release mortality, etc.)

a. Estimate and method of estimation: No data collected due to fishery closure.

C. Other Losses

No other losses were permitted (scientific take) of American shad in the Hudson River in 2012.

D. Table of Harvest and Losses- American shad

See Table 1.

E. Protected species / Atlantic sturgeon bycatch estimates: No data collected due to fishery closure.

RIVER HERRING

A. Commercial Fishery

1. Characterization of in-river fishery: The ASMFC Management Board approved New York's Sustainable Fishery Plan (SFP) for New York river herring in November 2011. In September 2012, New York adopted regulations to reduce fish mortality as outlined in the SFP. The Hudson fishery remains open, however, restrictions were put in place for both recreational and commercial fisheries. A summary of these changes includes:

- Recreational:
  - Season: 15 March to 15 June
  - Possession limit of 10 river herring per day;
  - Gear restrictions: no net use allowed in any tributary or embayment of the Hudson River; maximum size of scap net reduced to 16 square feet with no change for dip nets, seine or cast net.
- Commercial:
  - Season remained at 15 March to 15 June
  - Take limits: none.
  - Gear restrictions:
    - Gill net size remained the same, limited to 183m in length, mesh size limited to between 3.8 to 8.8cm stretch mesh, no gill nets allowed on the Kingston Flats (Rkm 148-156) or between the I90 bridge in Castleton NY through Troy (Rkm 217-245).
    - *New:* Gill net restrictions allowed only tended drift nets north of the Bear Mountain Bridge at Rkm 75
    - No change to dip or cast nets.
    - *New:* Scap (lift) nets size reduced to a maximum of 100 square feet
    - *New:* No net use allowed in any Hudson River tributary or embayment
  - *New:* 36 hour Escapement period made applicable to *all* commercial gears.
  - *New:* Mandatory reports due on a *monthly* basis.

New: New York closed all recreational river herring fisheries in Bronx, Kings, Manhattan, Nassau, Richmond, Suffolk, and Queens Counties, Westchester County streams that empty into the East River or Long Island Sound, the Delaware River and its tributaries, and the Marine & Coastal District. Commercial restrictions include no fishing allowed in waters listed above (under Recreational) except for the Marine & Coastal District. Vessels with a valid Federal Permit for Atlantic herring or Atlantic mackerel will have a maximum trip limit for river herring of five percent, by weight, of all species possessed. Any river herring possessed shall not be bartered, sold, or offered or exposed for sale.

2. Characterization of directed harvest

a. Landings and method of estimation:

In-river landings are compiled annually from mandatory reports required of all commercial permit holders in the Hudson River Estuary. Preliminary river herring landings were approximately 16,692 pounds for the Hudson River (Table 1). Landings data are incomplete as data entry on still ongoing. The data has not been checked for accuracy. Ocean bycatch landings, available through ACCSP (SAFIS) were 273 pounds (Tables 1 and 2). We included a short times series of recent landings to continue to outline the uncertainty of river herring landings in ocean waters as identified in the 2012 stock assessment (ASMFC 2012). Approximately 29,000 pounds of "herring, unclassified" are reported by ACCSP for New York (Table 2). A unknown portion of these landings may be river herring, included with any other fish identified as "Clupeidae".

b. Catch Composition:

Commercial catch of the in-river fishery was monitored by onboard observers. Catch was sampled for length, weight, and sex. Scales were collected for age and repeat spawn determination.

Five hundred and seventy-nine alewives and 212 blueback herring were sampled from the in-river commercial catch. Average length was 270 mm TL for alewife and 261 mm TL for blueback herring (Table 3, Figure 1). Alewives weighed slightly more than blueback herring (mean of 195 g vs 166 g respectively, Table 3, Figure 1). Females of both species were larger than the males.

c. Estimation of Effort

For the Hudson River herring fishery, 155 gill net and 151 scap permits were sold in 2012 (Table 4). As data entry for reports are incomplete, we do not have estimates of use. In previous years, reports indicate an average of 32% of gill net fishers and 45% of scap net fishers actively catch river herring (Table 4).

3. Characterization of losses (poaching, hook / release mortality, etc.): No data are available.

B. Recreational Fishery

1. Characterization of the fishery

Hudson River: Season: none; Daily limit: none. Regulation changes did not take effect until fall 2012.

2. Characterization of directed harvest:

a. Landings and Method of Estimation: A creel survey was not conducted in 2012.
b. Catch Composition: Not available.
c. Estimation of Effort: Not available.

3. Characterization of losses (poaching, hook / release mortality, etc.): No data are available

C. Other Losses: No data are available

D. Table of Harvest and Losses- river herring: See Table 1.

II. Required Fishery Independent Monitoring Programs

A. Description of requirement

New York is required to conduct annual spawning stock surveys for American shad and river herring in the Hudson River Estuary. Biological samples (size and sex composition, scales for age and repeat spawning data) and annual estimates of survival or mortality are required to characterize the spawning population.

B. Description of work performed

New York annually samples mature American shad in the Hudson River Estuary with a 500 foot haul seine. Beaches are within the spawning reach, from Kingston to Coxsackie NY (rkm 150 to 210). Mature river herring are sampled with a smaller 300 foot haul seine from Newburgh to Albany (rkm 89 to rkm 225). The river herring sampling program was relatively small until 2012 when New York secured a grant to greatly increase monitoring of the river herring stock. The current sampling program covers the majority of the freshwater portion of the river. All fish captured are measured, sampled for scales, and released. Otoliths are collected on a subset of fish collected.

New York also samples for young-of-the-year juvenile Alosine abundance. The nursery for young Alosines is the freshwater portion of the river from Newburgh to Albany (rkm 89 to rkm 225). Standard sites are sampled every other week beginning in mid June through late October or early November for total of ten weeks. Gear used is a 3.05 m x 30.5 m beach seine with 0.64 cm mesh. The annual index of relative abundance is a geometric mean of catch per haul. The first quartile (25th percentile) is the management action trigger for all Alosine species.

C. Results

1. Juvenile Abundance Index

The 2012 index for YOY American shad was 1.4, with confidence intervals (CI) of 1.1 to 1.8 (Table 5, Figure 2). Recruitment failure in the Shad and River herring Amendment 3 is defined as a JAI being lower than 75% of all other values in the dataset. The first quartile value is 13.0, based on the years 1983 to 2001 when sampling was consistent and production was good. The Hudson shad index has been below this first quartile since 2002 (Table 5, Figure 2).

The 2012 index for YOY blueback herring was 6.0, CI = 4.3 to 8.3 (Table 6, Figure 3). The blueback herring YOY indices have varied for the entire time series; a slightly declining trend occurs over all years. NY SFP uses the first quartile as the target measure to achieve. The first quartile target is 11.1 for Hudson blueback herring, based on the years 1983 to 2010 (Table 6, Figure 3). The base years encompass a period when sampling was consistent for YOY fish. The 2012 JAI was below this value.

The 2012 JAI for Hudson alewife was 0.4, CI =0.2 to 0.7 (Table 7, Figure 4). This index remained fairly low until the late 1990s. Since 2000, the index has generally increased, although it remains extremely variable. It is not clear what is driving this dramatic change. As for blueback herring, we chose the first quartile as the target measure in NY's SFP. The 2012 index was equal to this value (Figure 4).

American shad

2. Spawning Stock Assessment

a. <u>Length frequency / average weight:</u> NY sampled 341 American shad in 2012. Average length and weight for males were 462 mm, TL and 1012 g (Table 8, Figure 5). Females averaged 529 mm TL and weighed 1533 g. American shad males ranged from 360 to 559 mm TL; length frequency of females ranged from 400 mm TL to 659 mm TL (Table 9). A relative rapid shift to larger sizes of shad occurred in the spawning population in 2003 and 2004. It was not clear what caused this. However, since it happened quickly, the change is suggestive of a change in fishery operation - as in a gill net selectivity pattern. Female fish size decline from 2004 to 2010; a slight increase occurred in 2011and 2012. Size of males followed the same decline from 2004 however, the increase noted in 2010 continued through 2012.

b. Age frequency: The 2012 scale samples are being aged. Age structure was estimated using an age-length key developed from 1980 through 2001 data. Estimated age and mean age has declined since 2004 (Figure 6). Most males were age four; mean age increased slightly in 2010 through 2012. Females were primarily age five (Table 10); mean age increased slightly in 2012. Degree of repeat spawning: Repeat spawning data will be reported when the aging of scale samples is complete (Table 11)

c. Spawning Stock Index: For the period 1985 through 2001, we calculated empirical spawning stock abundance (SSA) and biomass (SSB) indices for the Hudson River shad stock using the relative abundance index (CPUE) of female shad in the fixed gear commercial gill-net fishery, age structure of females in the commercial fishery and the spawning stock, and observed annual mean weight-at-age. However, in 2002, the commercial CPUE data became unusable due to small sample size. To continue the data series, we examined the relationship of the SSA and SSB to other available data sets and found that the SSB showed a strong positive relationship to an Egg abundance index collected in the Hudson River for all years in the time series. Current SSB estimates are generated from this relationship. Detailed methods are described in ASMFC (2007). The biomass index has been very low since 2006; a slight increase occurred in 2011 (Table 12, Figure 7).

d. Sex ratio (%) of the spawning stock was 56:44, males to females(Table 8)

3. Annual mortality rate calculation

Mortality rates are calculated by catch curve for ages and number of repeat spawners (Crecco and Gibson 1988). Total mortality (Z) calculated from catch curve analysis of the estimated age structure was 1.39 for males and 1.16 for females; Z estimates for both sexes remains well above the Z_{30}. (Table 13, Figure 8).

4. Tagging

New York State stopped tagging American shad in 2010 when the fishery closed. However New York still assists in this interstate cooperative program by coordinating tag returns. Other cooperators include the states of New Jersey, Delaware, Virginia (VIMS), and USFWS.

Tag returns

No tag returns have been received since 2008. Please refer to previous annual report for earlier data summaries.

River herring

2. Spawning Stock Assessment

a. Length / weight data: We sampled 1,400 alewives and 365 blueback herring in 2012. Average length and weight for male alewife were 258 mm, TL and 157 g (Table 14). Female alewife averaged 271 mm TL and 181 g. Blueback herring were smaller: males averaged 237 mm TL and 107 g; females averaged 254 mm TL and 129 g. Limited length and weight data have been collected in years prior to 2012. Mean total length declined through the mid 2000s and has since increased for both species and sexes (Figure 9). Weights have slightly increased since the mid 2000s.

Length frequency data for both species are presented in Table 15. In some years, immature fish are caught. It is unknown if these fish are “holdovers” in that they did not leave the previous year or if these young fish migrated back in to the river with the spawning adults.

b. Age frequency: River herring scales are still being aged and will be reported when complete.

c. Sex ratio (%) of the spawning alewives was 74:26 males to females; for blueback herring the ratio was 48:52, males to females.

3. Annual mortality rate calculation: These data will be reported when aging is complete.

Part 2. New York State Fishing Plan for 2012

Hudson River American shad

I. In-river fishery

A. Description of in-river management area

The in-river management area for the Hudson River Stock for American shad is defined as the area from the Verrazano Narrows, NY to the Federal Dam at Troy NY.

B. Restoration target for stock

New York developed both long and short term targets for the Hudson stock following the 2007 ASMFC American shad stock assessment. A more detailed description can be found in Hudson River American Shad - An Ecosystem-Based Plan for Recovery (http://www.dec.ny.gov/animals/6945.html). The quantitative long term target will be the relative abundance of age zero American shad estimated for 1940-1950 from population modeling and calibrated to relative abundance indices obtained by NYSDEC beach seine sampling. Progress toward this goal will be measured as the five year running average of age zero relative abundance from ongoing NYSDEC beach seine monitoring.

The short term goal is to restore American shad abundance to levels observed in the late 1980s. The quantitative targets will be: 1. The mean age zero abundance index from NYSDEC beach seine monitoring from 1985 through 1989, measured as the five year running average of age zero relative abundance; and 2. The spawning stock biomass index from 1985 to 1989, measured as a three year running average.

The Hudson Shad Recovery Plan is currently being revised and will be submitted to ASMFC in response to requirements of Amendment 3 to the Shad and River herring Fishery Management Plan.

C. Restoration target mortality rates for Hudson River stock

The benchmark Z for the Hudson stock was determined to be 0.73 (ASMFC 2007). A target restoration mortality rate is under development.

D. Time-line for restoration for Hudson River stock

We do not know how long it will take to recover the Hudson stock.

E. Management measures to achieve restoration

1. Commercial quota, season, gear restrictions

Due to the lack of any improvement in young of year production, the all commercial fisheries for American shad in the Hudson River and Marine District of the state (waters surrounding Long Island) remain closed.

2. Recreational possession limits, seasons

Due to the lack of any improvement in young of year production, all recreational fisheries for American shad in the Hudson River and Marine District of the state (waters surrounding Long Island) remain closed.

3. Hatchery programs: The NYSDEC plans to base recovery on the remaining wild stock and has no plans to implement stocking in the near future.

4. Other programs: Not applicable.

II. Ocean intercept fisheries

A. Description of the fishery

Due to the lack of any improvement in young of year production, all commercial fisheries for American shad in the Hudson River and Marine District of the state (waters surrounding Long Island) remain closed. Moreover, the state has banned the landing of any bycatch.

B. Phase-out Plan: Not applicable.

C. Mixed stock evaluation

As per Table 3 in Amendment 1 (Mandatory fishery dependent monitoring programs for American shad), New York is not required to participate in an ocean landings stock composition study.

Delaware River, NY – American shad

New York, as a member of the Delaware River Basin Fish and Wildlife Management Cooperative, provides monetary and in-kind personnel support for the fishery independent and dependent programs conducted by the states of Delaware, New Jersey, and Pennsylvania. Data for the Delaware River shad stock is presented in the joint Delaware River Basin report prepared by the Basin states.

NYSDEC staff participated in the development of the Delaware River American shad Sustainable Fishery Plan and preparation for Habitat Plan in response to requirements of Amendment 3 to the Shad and River herring Fishery Management Plan.

Susquehanna River, NY- American shad

American shad are not yet present in New York waters of the Susquehanna River.

River herring

A. Description of in-river management area

In the New York SFP, three management areas for the river herring (alewife and blueback herring) were identified within state waters. They include:

- Hudson River: Verrazano Narrows, NY to the upper Hudson above the Federal Dam at Troy NY, and all tributaries, including the Mohawk River.
- Long Island / New York City area: All streams in the Bronx, Kings, Manhattan, Nassau, Richmond, Suffolk, and Queens Counties, and Westchester County streams that empty into the East River or Long Island Sound.
- Delaware River and its tributaries

New York adopted regulation changes to reduce mortality of river herring in September 2012. A limited fishery is only allowed on the Hudson stock; a moratorium on fishing is in place for all other waters, with the exception of a small (5%) trip limit for vessels that hold federal permits for Atlantic herring and Mackerel. New York will continue with these regulations into the future.

B. Sustainable Fishery target(s) for the Hudson River

The first quartile of both alewife and blueback herring juvenile abundance indices are the management targets in New York's SFP. The JAI for blueback herring fell below the target level for 2012; the alewife index was equal to the target. It is not known if the low indices were influenced by the pervasive lack of SAV in the Hudson in 2012. The lack of SAV is suspected to be related to the approximately 1.7 million tons of sediment that came into the Hudson during Tropical Storms Irene and Lee in late summer 2011. See the fishery independent – juvenile abundance index section above.

Fishery independent and dependent monitoring will continue in 2013.

C. Target mortality rates – No target mortality was determined for the Hudson Stock in the ASMFC river herring stock assessment (ASMFC 2012).

D. Time-line for restoration for Hudson River stock - NA

E. Management measures to achieve restoration - NA

References:

ASMFC (Atlantic States Marine Fisheries Commission). 2012. Stock assessment report No. 12-02. River Herring Benchmark Stock Assessment. Arlington, VA, USA.

ASMFC (Atlantic States Marine Fisheries Commission). 2007. Stock assessment report No. 07-01 (Supplement). American shad stock assessment report for peer review. Washington DC USA.

Crecco, V. and M. Gibson. 1988. Methods of estimating fishing mortality rates on American shad stocks. IN 1988 Supplement to the American shad and river herring Management Plan, Fisheries Management Report No. 12 of the Atlantic States Marine Fisheries Commission, Washington, D.C. USA.

Table 1 Harvest* and losses (number and weight in pounds) of American shad and river herring in New York State, 2012.

Method	N	Total weight (lbs)	Mean weight (lbs)
American shad			
Directed commercial harvest - Hudson River		Fishery closed	
Ocean bycatch*			
Various gear		1,485	unknown
Recreational harvest - Hudson River		Fishery closed	
Non-directed (poaching, Hook & release kill)		Unknown	
Other (research etc., estimated)	0	0	
TOTAL		1,485	unknown
River herring			
Harvest			
Recreational		No data collected in 2012	
Commercial Hudson River**		16,692	0.36
Commercial Ocean*		273	unknown
TOTAL	0	16,965	unknown

* Ocean landings from SAFIS. "A. shad" suspected to be hickory shad as catch occurred in late summer through fall. River herring landings- see Table 2; the "Herring unclassified" category adds to the uncertainty of actual landings of river herring

**Draft estimates, data entry ongoing; QA check not complete

Table 2. Recent (1995 to the present) commercial fishery landings (kg) of river herring in the Hudson River Estuary and "herring" as reported by ACCSP.

	Hudson River ONLY [a]	**New York State**									
	NYSDEC license reports	ACCSP Non-confidential [c]				Non-con total	ACCSP Confidential [c]				Con total
Year	river herring - lbs [b]	Alewife	Blueback herring	River herrings	Herring, unc		Alewife	Blueback herring	River herrings	Herring, unc	
1995	511				50,864	50,864					
1996	566				82,255	82,255					
1997	3,166				69,318	69,318					
1998	6,244		4,867		83,638	88,505					
1999	3,315				74,446	74,446					
2000	16,846				58,377	58,377					
2001	19,597				23,491	23,491					
2002	20,334		390		31,388	31,778					
2003	19,634		20,467		32,821	53,288					
2004	16,424		688		11,721	12,409					
2005	13,500		2,463		259	2,722					
2006	10,001		9,835		6,424	16,259					
2007	13,902	24	11,992		13,839	25,855					
2008	13,146	99	4	13,038		13,141					
2009	11,832	82	224	11,412		11,718					
2010	12,769			15,392		15,392					
2011	10,166				9,762	9,762					
2012	16,692 [d]		273		25,303	25,576					

a Total landings include river herring caught in all gears over the entire season.

b NYSDEC License Reports - Mandatory commercial license reporting system: pounds and/or numbers estimated

c All potential river herring species: blueback herring, alewife, and river herring. "Herring, unclassified" may contain river herring plus any other Clupiedae

d NYSDEC reported landings as of 3/14/2013; river landings NOT included in New York state portion of table

Table 3. Mean length and weight of river herring collected in fishery dependent sampling in the commercial fishery in the Hudson River.

	Total Length				Weight			
Year	N	Mean	SD	SE	N	Mean	SD	SE
Male Alewife								
2001	40	270.5	10.8	1.71	40	193.0	22.7	3.59
2002	7	261.0	10.9	4.12	7	179.4	26.8	10.13
2003	20	266.4	11.6	2.59	20	178.9	27.3	6.10
2004	58	266.7	18.3	2.40	58	189.7	28.8	3.78
2005	10	273.5	11.5	3.64	10	192.0	42.1	13.31
2006	0				0			
2007	7	254.4	4.9	1.85	7	162.9	24.3	9.18
2008	0				0			
2009	59	258.0	8.7	1.13	59	170.0	19.3	2.51
2010	20	253.2	11.0	2.46	7	154.9	14.8	5.59
2011	31	258.8	9.9	1.78	31	169.5	23.2	4.17
2012	231	263.6	11.3	0.74	219	180.1	28.7	1.94
Female Alewife								
2001	41	275.4	9.5	1.48	41	219.1	36.4	5.68
2002	1	286.0	0.0	0.00	1	222.0		0.00
2003	20	282.8	12.7	2.84	20	219.7	38.9	8.70
2004	73	281.5	19.2	2.25	73	218.2	29.6	3.46
2005	10	271.4	13.9	4.40	10	196.0	46.2	14.61
2006	0				0			
2007	2	265.5	3.5	2.47	2	190.0	14.1	9.97
2008	0				0			
2009	62	266.0	9.7	1.23	61	199.9	29.1	3.73
2010	20	255.8	11.0	2.46	8	162.5	11.2	3.96
2011	40	272.7	13.9	2.20	40	212.4	36.2	5.72
2012	345	274.1	12.4	0.67	272	206.0	39.3	2.38
All sexes Alewife								
2001	82	273.0	10.4	1.15	82	206.3	32.8	3.62
2002	8	264.1	13.4	4.74	8	184.8	29.0	10.25
2003	40	274.6	14.6	2.31	40	199.3	39.1	6.18
2004	131	274.9	20.1	1.76	131	205.6	32.4	2.83
2005	20	272.4	12.5	2.80	20	194.0	43.1	9.64
2006	0				0			
2007	13	258.4	12.0	3.33	13	169.2	29.0	8.04
2008	0				0			
2009	125	262.4	10.4	0.93	124	185.4	28.6	2.57
2010	40	254.5	10.9	1.72	15	158.9	13.1	3.38
2011	71	266.7	14.1	1.67	71	193.7	37.7	4.47
2012	579	269.9	13.0	0.54	494	194.5	37.2	1.67

Table 3. Continued.

Year	Total Length N	Mean	SD	SE	Weight N	Mean	SD	SE
Male Blueback Herring								
2001	0				0			
2002	52	260.9	11.9	1.65	52	189.6	28.2	3.91
2003	0				0			
2004	31	258.5	11.3	2.03	31	173.9	23.5	4.22
2005	10	259.6	7.3	2.31	10	187.0	20.0	6.32
2006	10	253.4	11.0	3.48	10	169.5	22.9	7.24
2007	11	251.5	4.8	1.45	11	156.4	12.1	3.65
2008	0				0			
2009	37	257.8	6.5	1.07	36	169.2	12.7	2.12
2010	18	253.9	8.9	2.10	7	152.4	12.2	4.61
2011	3	251.0	20.1	11.60	3	163.3	32.5	18.76
2012	75	253.6	11.3	1.30	75	154.0	21.6	2.49
Female Blueback Herring								
2001	0				0			
2002	60	274	12.4	1.6	60	211.2	30.0	3.87
2003	0				0			
2004	23	268	13.8	2.9	23	190.6	30.1	6.28
2005	10	268	6.5	2.1	10	205.0	11.8	3.73
2006	10	265	6.1	1.9	10	194.5	16.2	5.12
2007	10	268	12.3	3.9	10	193.0	25.8	8.16
2008	0				0			
2009	35	263	7.1	1.2	35	180.8	16.8	2.84
2010	20	262	11.6	2.6	10	179.2	24.4	7.72
2011	5	274.6	10.1	4.52	5	199.4	16.6	7.42
2012	137	265.0	10.6	0.91	103	175.4	19.9	1.96
All Sexes Blueback Herring								
2001	0				0			
2002	112	267.9	13.8	1.3	112	201.2	31.0	2.93
2003	0				0			
2004	54	262.5	13.2	1.8	54	181.0	27.5	3.74
2005	20	263.6	7.9	1.8	20	196.0	18.5	4.14
2006	20	259.0	10.4	2.3	20	182.0	23.2	5.19
2007	21	259.3	12.3	2.7	21	173.8	26.9	5.87
2008	0				0			
2009	72	260.3	7.3	0.9	71	174.9	15.9	1.89
2010	38	258.2	11.1	1.8	17	168.2	24.0	5.82
2011	8	265.8	18.0	6.4	8	185.9	28.4	10.04
2012	212	261.0	12.1	0.8	178	166.4	23.1	1.73

Table 4 Recent records of type of commercial gill licenses sold for the New York portions of the Hudson River Estuary.

		Gill Nets			Scap Nets			Gill net		Scap Net	
Year	N-Fishers	Shad/herring Gill Net	Gill Net	Total GN permits sold	N-Fishers	Permits sold		N-Fishers reporting herring	% Reporting	N-Fishers reporting herring	% Reporting
1995	112	47	75	122	2	2		5	4%	2	100%
1996	134	54	88	142	2	2		4	3%	2	100%
1997	112	45	74	119	35	35		22	20%	24	69%
1998	140	65	119	184	46	46		33	24%	33	72%
1999	145	77	68	145	31	31		40	28%	20	65%
2000	223	108	123	231	443	449		67	30%	124	28%
2001	190	87	83	170	345	348		67	35%	127	37%
2002	232	141	120	261	291	338		87	38%	113	39%
2003	238	144	106	250	237	278		96	40%	115	49%
2004	275	160	127	287	245	291		89	32%	106	43%
2005	255	162	111	273	215	255		68	27%	80	37%
2006	290	179	129	308	229	273		92	32%	87	38%
2007	290	178	130	308	201	244		87	30%	75	37%
2008	277	173	119	292	182	219		78	28%	85	47%
2009	254	159	108	267	168	199		76	30%	78	46%
2010	181	0	185	185	161	190		74	41%	73	45%
2011	177	0	181	181	144	164		62	35%	61	42%
2012	154	0	155	155	128	151		Reports incomplete, to be reported at a later date			

Table 5. NYSDEC young of the year index (mean number per haul, weeks 26-42) for American shad collected in the Hudson River Estuary.

		American shad						
Year	Number of hauls	Number of zero hauls	Number collected	UCI	LCI	Geometric Mean	Arithmetic Mean	SE
1980	20	0	1071	43.5	12.9	23.9	53.6	18.1
1981	21	3	1098	40.6	8.7	19.1	52.3	14.2
1982	23	3	597	22.9	6.2	12.1	26.0	5.2
1983	133	4	5232	25.6	16.0	20.3	41.9	5.0
1984	124	14	2039	9.9	6.1	7.8	16.4	2.0
1985	177	10	10578	32.7	21.5	26.5	59.8	7.0
1986	186	4	14273	55.0	39.0	46.3	77.2	5.5
1987	95	7	3622	26.3	15.5	20.2	38.1	5.9
1988	192	10	14074	35.1	22.5	28.1	74.1	10.3
1989	212	4	19649	56.0	39.9	47.3	92.7	9.1
1990	202	8	16501	49.2	34.5	41.2	81.7	9.6
1991	240	17	15051	29.5	19.5	24.0	62.7	5.5
1992	245	15	18408	42.2	29.3	35.2	75.1	8.0
1993	205	22	5107	14.2	9.5	11.6	24.9	2.2
1994	217	2	9335	29.9	22.0	25.7	43.0	2.9
1995	238	64	3851	6.9	4.6	5.6	16.2	2.2
1996	187	9	14589	50.8	34.7	42.0	78.0	6.5
1997	210	17	6717	16.6	11.3	13.7	32.0	3.7
1998	219	55	1954	4.5	3.0	3.7	8.9	1.1
1999	239	18	15926	25.8	16.9	20.9	66.6	8.7
2000	241	41	7580	15.0	10.0	12.3	31.5	3.4
2001	227	5	15692	44.7	32.2	38.0	69.1	4.9
2002	219	98	2591	3.8	2.2	2.9	11.8	1.7
2003	244	50	4004	8.2	5.5	6.7	16.4	1.7
2004	229	48	3223	6.5	4.3	5.3	14.1	1.6
2005	237	41	4783	10.1	6.7	8.3	20.4	2.1
2006	216	102	831	2.0	1.3	1.6	3.9	0.5
2007	217	54	3113	6.2	4.0	5.0	14.1	1.5
2008	203	90	762	2.1	1.4	1.7	3.8	0.5
2009	232	70	1385	3.0	2.0	2.5	6.0	0.7
2010	237	70	2074	4.1	2.7	3.3	8.8	1.3
2011	203	51	1853	4.6	3.0	3.7	9.1	1.0
2012	236	120	1826	1.8	1.1	1.4	7.7	3.7
1st Quartile, based on years 1983-2001						13.0		

Table 6 NYSDEC young of the year index (mean number per haul, weeks 26-42) for blueback herring collected in the Hudson River Estuary.

		Blueback herring						
Year	Number of hauls	Number of zero hauls	Number collected	UCI	LCI	Geometric Mean	Arithmetic Mean	SE
1980	20	4	1042	29.0	4.7	12.0	52.1	19.7
1981	21	9	4051	22.6	1.8	7.2	192.9	149.2
1982	23	5	2234	40.6	5.9	15.9	97.1	35.8
1983	133	14	19969	50.0	25.2	35.5	150.1	23.3
1984	124	33	10395	16.6	7.5	11.3	83.8	22.5
1985	177	38	42351	29.9	14.7	21.0	237.9	72.1
1986	186	31	21769	23.2	12.6	17.1	117.7	27.6
1987	95	12	15646	53.1	23.2	35.2	164.7	33.3
1988	192	21	51845	59.0	31.8	43.3	270.0	69.1
1989	212	47	29556	23.0	12.2	16.8	139.4	24.4
1990	202	32	87146	63.2	31.0	44.3	431.4	73.4
1991	240	44	77748	33.3	17.6	24.3	324.0	78.6
1992	245	56	51507	18.8	10.3	14.0	210.2	55.5
1993	205	35	35054	40.1	21.3	29.3	171.0	22.8
1994	217	51	81371	39.2	19.2	27.5	375.0	64.1
1995	238	82	18886	8.8	4.8	6.5	79.4	21.1
1996	187	25	24168	28.6	15.9	21.4	129.2	26.4
1997	210	56	27028	21.6	11.2	15.6	128.7	21.5
1998	219	141	2705	2.0	1.0	1.5	12.4	2.8
1999	239	35	69957	46.5	25.6	34.6	292.7	68.5
2000	241	53	15850	14.0	8.3	10.8	65.8	11.9
2001	227	23	81578	59.6	32.2	43.8	359.4	78.8
2002	219	118	8355	3.9	2.0	2.8	38.2	10.0
2003	244	68	28769	23.2	12.6	17.1	117.9	13.6
2004	229	84	18830	10.3	5.4	7.5	82.2	17.7
2005	237	46	41731	35.8	19.4	26.4	177.6	23.7
2006	216	104	4650	3.2	1.8	2.4	21.5	6.3
2007	217	30	40503	45.1	24.4	33.2	186.6	22.5
2008	203	50	35679	23.3	12.4	17.0	175.8	70.2
2009	232	114	5466	3.7	2.0	2.8	23.6	4.4
2010	237	55	35725	21.1	11.3	15.5	150.7	24.2
2011	203	45	26775	22.0	11.4	15.9	131.9	21.4
2012	236	100	23163	8.3	4.3	6.0	98.2	34.8
NYS-SFP: 25th Percentile, based on years 1983-2010						11.14		

Table 7. NYSDEC young of the year index (mean number per haul, weeks 26-42) for Alewife collected in the Hudson River Estuary.

Year	Number of hauls	Alewife						
		Number of zero hauls	Number collected	UCI	LCI	Geometric Mean	Arithmetic Mean	SE
1980	20	17	11	0.6	0.0	0.3	0.6	0.3
1981	21	19	16	0.6	0.0	0.2	0.8	0.5
1982	23	15	39	1.3	0.1	0.6	1.7	0.8
1983	124	100	159	0.6	0.2	0.4	1.3	0.4
1984	124	118	10	0.1	0.0	0.0	0.1	0.0
1985	177	127	463	0.8	0.4	0.6	2.6	0.8
1986	185	159	95	0.3	0.1	0.2	0.5	0.2
1987	95	76	121	0.5	0.2	0.3	1.3	0.6
1988	190	156	232	0.5	0.2	0.3	1.2	0.4
1989	212	184	76	0.2	0.1	0.2	0.4	0.1
1990	202	146	546	0.8	0.4	0.6	2.7	0.8
1991	240	162	2652	1.4	0.7	1.0	11.1	4.2
1992	245	199	186	0.4	0.2	0.3	0.8	0.2
1993	205	155	357	0.6	0.3	0.5	1.7	0.5
1994	217	151	768	1.0	0.5	0.7	3.5	1.1
1995	238	189	440	0.6	0.3	0.5	1.8	0.4
1996	187	149	606	0.6	0.2	0.4	3.2	1.7
1997	210	164	457	0.7	0.3	0.5	2.2	0.6
1998	219	194	96	0.2	0.1	0.2	0.4	0.1
1999	239	109	6151	3.9	2.2	2.9	25.7	6.7
2000	241	182	1186	0.9	0.5	0.7	4.9	1.3
2001	227	120	2801	2.8	1.6	2.1	12.3	2.4
2002	219	146	2110	1.5	0.8	1.1	9.6	3.2
2003	244	166	794	1.0	0.5	0.7	3.3	0.9
2004	229	167	412	0.7	0.4	0.5	1.8	0.5
2005	234	136	2388	1.9	1.0	1.4	10.2	2.6
2006	211	159	950	0.8	0.4	0.6	4.5	2.2
2007	217	80	7135	6.0	3.4	4.6	32.9	6.5
2008	203	115	3226	3.1	1.7	2.3	15.9	4.0
2009	232	185	439	0.6	0.3	0.5	1.9	0.4
2010	237	111	5177	3.9	2.2	2.9	21.8	4.4
2011	203	127	1123	1.3	0.7	1.0	5.5	1.8
2012	236	196	1294	0.5	0.2	0.4	5.5	3.2
NYS-SFP: 25th Percentile, based on years 1983-2010						0.36		

Table 8 Mean total length and weight of American shad collected during spawning stock sampling in the Hudson River Estuary.

	TL			Weight			Sex Ratio	TL			Weight			Sex Ratio	TL			Weight		
Year	N	Mean	SD	N	Mean	SD	(% present)	N	Mean	SD	N	Mean	SD	(% present)	N	Mean	SD	N	Mean	SD
	Males							Females							All fish					
1984	86	513.9	44.8	85	1429.7	398.1	0.57	61	587.0	42.3	61	2361.4	541.0	0.43	150	543.0	57.9	149	1806.0	656.7
1985	203	491.0	49.8	148	1166.4	422.2	0.62	126	574.6	46.0	80	2010.7	627.4	0.38	329	523.0	63.2	228	1462.7	644.6
1986	416	491.7	46.8	393	1299.1	386.7	0.59	287	568.3	44.1	277	2040.1	542.4	0.41	703	523.0	59.2	670	1605.4	585.1
1987	316	501.1	48.1	313	1270.5	399.6	0.50	314	570.2	45.3	308	1907.3	505.0	0.50	632	535.3	58.1	623	1584.8	554.9
1988	228	505.8	38.7	220	1369.8	368.9	0.42	315	572.6	38.8	309	2007.1	524.2	0.58	543	544.5	50.9	529	1742.0	561.7
1989	169	501.3	49.4	169	1243.3	405.7	0.42	213	566.7	40.1	211	1878.7	522.8	0.58	404	537.7	54.4	401	1586.5	560.4
1990	39	481.4	49.9	38	1047.1	387.6	0.44	48	555.4	46.2	49	1656.7	440.8	0.56	88	522.0	60.0	88	1388.3	512.8
1991	119	461.3	36.7	117	894.8	221.5	0.53	101	536.5	35.7	100	1483.1	335.3	0.47	225	495.7	51.8	222	1164.6	402.7
1992	954	459.9	29.5	807	885.2	238.0	0.68	443	525.9	33.3	438	1429.4	370.4	0.32	1401	480.9	43.4	1248	1076.7	390.2
1993	318	459.4	27.2	316	799.0	189.2	0.68	144	514.8	31.0	139	1173.5	261.0	0.32	467	476.7	38.1	460	913.9	273.7
1994	93	461.6	26.7	87	890.1	202.7	0.51	89	514.5	23.3	83	1248.0	240.7	0.49	184	487.6	36.3	172	1064.2	283.4
1995	286	471.5	34.9	280	989.0	249.1	0.38	455	528.7	25.7	447	1478.9	308.3	0.62	757	506.9	40.5	743	1288.4	370.8
1996	295	460.1	37.5	292	890.8	438.5	0.68	131	533.2	43.5	126	1547.1	505.1	0.32	433	482.6	51.8	425	1085.7	547.0
1997	77	454.9	38.8	76	915.2	285.6	0.54	64	522.0	47.2	63	1440.2	438.0	0.46	143	485.5	54.0	141	1151.2	443.5
1998	164	457.1	32.0	160	946.4	223.2	0.52	145	529.8	36.8	143	1532.5	404.2	0.48	313	491.7	50.4	307	1227.5	438.1
1999	183	470.0	34.4	180	912.7	213.6	0.48	193	518.9	35.0	191	1312.6	315.6	0.52	383	494.8	42.4	377	1117.9	336.7
2000	216	475.9	34.6	207	1058.3	260.4	0.49	217	534.5	30.0	213	1502.9	300.8	0.51	439	505.0	43.6	426	1281.0	357.5
2001	574	477.5	35.6	538	969.3	241.8	0.54	486	541.6	35.0	462	1498.6	349.1	0.46	1065	506.9	47.5	1002	1213.2	396.6
2002																				
2003	274	495.4	35.4	271	1201.8	301.2	0.44	342	559.7	38.8	338	1830.4	453.2	0.56	621	531.0	49.1	613	1549.8	501.3
2004	282	502.4	42.5	283	1250.6	335.2	0.34	542	569.2	43.7	539	1920.4	528.6	0.66	832	546.3	53.5	830	1687.2	567.0
2005	224	491.3	48.5	223	1168.4	350.8	0.37	382	564.3	41.9	380	1840.8	479.4	0.63	613	537.2	56.7	609	1590.0	542.6
2006	133	473.9	46.3	131	1125.1	349.9	0.31	294	558.5	50.7	293	1889.0	564.1	0.69	435	531.8	62.7	431	1647.1	615.1
2007	72	470.3	43.9	72	1118.3	351.7	0.36	121	549.3	49.1	121	1794.5	539.7	0.64	200	520.4	60.2	200	1544.1	571.8
2008	110	463.2	48.1	110	982.0	317.1	0.28	258	538.3	52.6	256	1731.5	564.2	0.72	387	515.9	61.2	385	1499.8	605.4
2009	150	443.4	32.1	148	820.5	215.6	0.79	33	522.1	44.7	32	1445.6	389.8	0.21	190	459.8	47.8	187	948.2	362.8
2010	282	458.9	25.4	279	921.7	173.7	0.66	137	505.6	32.5	136	1264.0	308.6	0.34	426	474.7	35.6	422	1035.1	276.7
2011	32	461.2	28.1	32	989.7	210.7	0.35	60	522.5	33.2	59	1430.7	277.4	0.65	92	501.2	42.9	91	1275.6	331.2
2012	191	462.4	40.1	188	1012.5	292.6	0.56	148	528.7	34.6	147	1533.1	359.4	0.44	341	491.4	50.0	337	1241.2	413.1

Table 9 Length frequency of Hudson River American shad collected during the spawning stock survey.

Male

	Total length (mm)																				
Year	300-319	320-339	340-359	360-379	380-399	400-419	420-439	440-459	460-479	480-499	500-519	520-539	540-559	560-579	580-599	600-619	620-639	640-659	660-679	>680	TOTAL
1984						1	4	8	6	8	16	18	17	3	3	1	1				86
1985				2	3	6	17	27	35	30	25	22	18	7	7	4					203
1986				4	9	15	25	32	72	93	65	37	27	19	14	4					416
1987				3	2	8	9	39	52	47	41	53	23	14	19	4	1	1			316
1988				1	1	3	1	19	23	61	43	33	20	14	7	2					228
1989					3	5	13	15	18	18	37	21	16	14	8	1					169
1990				1	1		3	9	8	5	2	2	6	1	1						39
1991					4	11	23	19	26	19	12	2	2	1							119
1992				5	5	36	188	280	223	120	64	21	4	6	2						954
1993					3	17	51	90	85	50	14	7		1							318
1994						3	13	32	25	12	6	1	1								93
1995			1		9	14	30	39	64	64	46	16	2	1							286
1996					6	27	71	64	41	36	23	18	6	2	1						295
1997				1	3	15	8	12	16	16	1	4	1								77
1998					1	11	34	52	35	12	7	10	1	1							164
1999				1	1	4	33	32	41	41	15	8	5	2							183
2000				1		7	28	38	43	39	35	19	6								216
2001				1	6	14	54	100	136	111	85	36	23	7		1					574
2002																					
2003					1		14	30	48	58	51	42	18	11		1					274
2004					2	9	9	21	41	52	42	46	34	19	6	1					282
2005					5	13	21	28	20	27	41	30	21	11	6	1					224
2006					3	14	14	26	24	16	10	10	11	4	1						133
2007					1	3	11	24	10	8	2	6	4	2	1						72
2008				2	5	16	10	22	21	10	10	3	5	5	1						110
2009					7	22	44	46	13	11	3	2	1		1						150
2010					1	11	46	90	84	32	14	1	3								282
2011						2	8	3	12	4	2	1									32
2012				1	9	27	21	24	39	32	24	11	3								191

Table 9 continued.

Females

Year	Total length (mm)																			
	300-319	320-339	340-359	360-379	380-399	400-419	420-439	440-459	460-479	480-499	500-519	520-539	540-559	560-579	580-599	600-619	620-639	640-659	660-679	>680	TOTAL
1984								1			2	6	4	12	12	9	8	6	1		61
1985							1			4	10	17	16	20	20	17	12	4	5		126
1986									1	10	22	44	68	39	33	24	20	17	9		287
1987								3	2	5	17	37	79	66	33	22	19	15	13	3	314
1988								1	1	5	9	41	62	65	66	29	17	10	7	2	315
1989								1		4	11	40	46	43	25	21	15	2	3	2	213
1990									2	5	6	6	5	7	8	4	5				48
1991								1	1	10	20	32	12	9	11	3	1	1			101
1992						1		3	24	76	88	104	88	39	9	5	4	1	1		443
1993						1		2	10	33	43	24	16	11	4						144
1994									6	18	27	27	10		1						89
1995								2	19	36	92	164	86	44	9	3					455
1996								5	9	18	22	19	20	20	9	6	1	1	1		131
1997							1	4	5	14	13	9	5	3	4	4	2				64
1998								1	11	13	29	41	23	9	13	3	1	1			145
1999								2	13	49	48	31	22	14	9	3	2				193
2000								3	4	13	43	55	60	25	12	1		1			217
2001							1	5	11	37	71	94	110	104	33	10	8	2			486
2002																					
2003							1	1	7	14	28	42	72	64	66	25	18	3	1		342
2004							1	2	6	19	46	76	70	86	90	69	52	22	3		542
2005								1	6	17	35	47	76	65	56	36	31	9	3		382
2006							1	5	11	22	34	31	37	44	43	33	17	11	5		294
2007								2	3	13	20	18	15	17	9	13	8	1		2	121
2008					1	1	1	3	18	40	50	29	27	27	19	18	15	7	2		258
2009								1	3	9	8	2	2	3	3	1	1				33
2010							1	6	16	39	40	21	5	4	2	2		1			137
2011								2	1	9	21	12	6	4	3	2					60
2012						1		2	7	19	31	30	26	25	5		1	1			148

Table 10. Age structure and repeat spawn percent of American shad from spawning stock sampling in the Hudson River Estuary.

	Age												Mean	Mean	%	%
Year	3	4	5	6	7	8	9	10	11	12	13	Total	age	Repeat	virgin	repeat
Male																
1983		2	5	5	4	2	2					20	6.25	1.75	0.20	0.80
1984	3	18	23	22	9	7	1	1				84	5.55	1.10	0.45	0.55
1985	13	54	53	24	12	8	2	1				167	5.03	0.78	0.59	0.41
1986	9	77	72	39	15	6	3		1			222	5.05	0.74	0.61	0.39
1987	5	51	59	31	17	6	6	2	2			179	5.38	0.97	0.55	0.45
1988	2	42	97	42	26	7	4	2				222	5.43	0.83	0.58	0.42
1989	2	33	46	36	23	17	5	1				163	5.74	1.19	0.48	0.52
1990		7	16	7	7	1						38	5.45	0.74	0.63	0.37
1991	12	46	33	16	4	1						112	4.62	0.29	0.79	0.21
1992	13	172	232	68	7	1	2					495	4.79	0.27	0.78	0.22
1993	5	92	156	47	17	2						319	4.95	0.44	0.68	0.32
1994	2	32	36	7	3							80	4.71	0.53	0.69	0.31
1995	23	96	82	31	9							241	4.61	0.46	0.68	0.32
1996	23	162	64	15	4	1						269	4.32	0.49	0.62	0.38
1997	4	24	30	10	1			1				70	4.79	0.47	0.69	0.31
1998	7	78	48	12	4							149	4.52	0.69	0.52	0.48
1999	2	64	80	19	2	2						169	4.77	0.87	0.43	0.57
2000	22	79	67	15	1	1						185	4.44	0.63	0.56	0.44
2001	41	209	146	71	24	4						495	4.68	0.86	0.44	0.56
2002	No sampling											0				
2003	5.2	63.4	107.7	62.0	25.8	7.9	1.4	0.4	0.2			274	5.26			
2004	7	39	86	60	35	32	4	2	1			266	5.77	1.60	0.29	0.71
2005	11.2	58.0	69.7	46.9	23.6	9.5	3.6	1.1	0.4			224	5.29			
2006	9.1	48.0	42.8	18.8	9.2	3.8	0.9	0.4	0.0			133	4.91			
2007	4.4	28.5	23.8	8.7	4.1	1.7	0.6	0.2	0.0			72	4.84			
2008	10.3	44.2	33.7	12.5	5.5	2.7	0.8	0.2	0.0			110	4.74			
2009	18.7	78.5	42.3	7.8	1.6	0.6	0.4	0.1	0.0			150	4.33			
2010	16.1	128.1	110.9	22.5	3.5	0.8	0.0	0.1				282	4.55			
2011	2.1	14.1	12.3	2.9	0.5	0.1						32	4.56			
2012	17.2	74.1	67.5	24.7	6.5	0.9	0.0	0.1				191	4.65			
Female																
1983												0				
1984		1	7	15	14	8	5	3	1			54	6.98	1.85	0.31	0.69
1985	1	10	16	27	17	11	5	4	3			94	6.49	1.51	0.34	0.66
1986		17	56	65	26	17	10	2	4			197	6.14	1.07	0.53	0.47
1987		13	61	46	25	20	14	6	1	2	1	186	6.46	0.87	0.55	0.45
1988		16	90	104	56	14	11	6	5	2		302	6.23	1.14	0.42	0.58
1989		8	57	52	45	19	7	6	3			197	6.36	1.20	0.49	0.51
1990		2	16	11	13	5	1	1				49	6.20	0.96	0.55	0.45
1991	1	10	31	34	14	3	1	1				95	5.72	0.51	0.72	0.28
1992		21	169	161	67	8	6	2				434	5.76	0.54	0.62	0.38
1993		9	59	53	18	9						148	5.72	0.60	0.60	0.40
1994			49	19	7	2						77	5.51	0.62	0.60	0.40
1995	3	64	215	132	34	3						451	5.31	0.51	0.63	0.37
1996		30	50	20	8	4	2	1				115	5.27	0.94	0.47	0.53
1997		13	32	13	6	5	6					75	5.68	0.79	0.63	0.37
1998		28	65	24	7	5	1					130	5.22	1.01	0.41	0.59
1999		35	108	28	13		1					185	5.12	0.85	0.41	0.59
2000		46	113	25	5	2	1					192	4.99	0.78	0.47	0.53
2001	7	76	175	122	40	6	3	1				430	5.34	1.11	0.37	0.63
2002	No sampling											0				
2003	0.9	23.7	103.0	108.2	66.5	23.4	11.5	3.4	1.4	0.1		342	6.05			
2004	1	21	97	117	128	63	48	24	3	1	1	502	6.78	2.18	0.23	0.77
2005	0.6	25.6	113.1	111.5	71.9	30.5	19.0	6.4	3.2	0.2		382	6.18			
2006	1.2	29.5	87.3	74.4	52.3	23.9	14.8	6.8	3.6	0.3		294	6.15			
2007	1.3	21.9	47.9	27.1	13.8	4.9	2.0	1.4	0.7			121	5.53			
2008	1.3	38.6	98.9	56.4	31.3	14.6	10.0	3.8	2.0	0.2		257	5.76			
2009	0.2	6.8	14.7	6.5	3.1	1.1	0.5	0.1	0.0			33	5.35			
2010	1.3	34.9	70.5	22.3	5.4	1.5	0.6	0.3	0.1	0.0		137	5.04			
2011	0.3	10.7	29.1	13.6	4.7	1.2	0.3	0.1	0.0			60	5.29			
2012	0.6	22.0	66.9	41.9	13.3	2.1	1.0	0.2	0.1	0.0		148	5.39			

BOLD Ages estimated using an age-length key, aging in progress

Table 11. Number, mean and percent repeat spawn of American shad from spawning stock sampling in the Hudson River Estuary.

	Repeat										Mean	%	
Year	0	1	2	3	4	5	6	7	8	Total	RS	virgin	% repeat
Male repeat spawners													
1983	4	6	3	5	2					20	1.75	0.20	0.80
1984	38	17	16	10	2	1				84	1.10	0.45	0.55
1985	99	33	17	11	4	3				167	0.78	0.59	0.41
1986	135	41	25	10	11					222	0.74	0.61	0.39
1987	98	33	26	8	8	4	2			179	0.97	0.55	0.45
1988	128	40	30	14	8	2	0			222	0.83	0.58	0.42
1989	78	31	18	19	15	2				163	1.19	0.48	0.52
1990	24	4	7	2	1	0				38	0.74	0.63	0.37
1991	89	17	4	1	1					112	0.29	0.79	0.21
1992	387	84	22		2					495	0.27	0.78	0.22
1993	217	72	23	7						319	0.44	0.68	0.32
1994	55	12	10	2	1					80	0.53	0.69	0.31
1995	164	48	25	4						241	0.46	0.68	0.32
1996	168	76	19	5	1					269	0.49	0.62	0.38
1997	48	16	3	2		1				70	0.47	0.69	0.31
1998	78	44	22	5						149	0.69	0.52	0.48
1999	73	53	37	4	2					169	0.87	0.43	0.57
2000	103	52	27	2	1					185	0.63	0.56	0.44
2001	216	172	71	32	4					495	0.86	0.44	0.56
2002	No sampling									0			
2003*													
2004	76	63	53	46	22	5	1			266	1.60	0.29	0.71
2005-2012*													
Female repeat spawners													
1983										0			
1984	17	10	8	6	9	4				54	1.85	0.31	0.69
1985	32	24	15	11	5	7				94	1.51	0.34	0.66
1986	104	42	18	11	14	6	1	1		197	1.07	0.53	0.47
1987	96	36	23	9	5	2	2			173	0.87	0.55	0.45
1988	127	86	45	26	11	5	4			304	1.14	0.42	0.58
1989	97	27	34	25	6	5	3			197	1.20	0.49	0.51
1990	27	6	10	4	1	1				49	0.96	0.55	0.45
1991	68	14	8	3	1	1				95	0.51	0.72	0.28
1992	268	118	35	6	5	2				434	0.54	0.62	0.38
1993	89	35	18	6						148	0.60	0.60	0.40
1994	46	19	8	3	1					77	0.62	0.60	0.40
1995	284	113	47	7						451	0.51	0.63	0.37
1996	54	30	20	7	3	1				115	0.94	0.47	0.53
1997	47	11	6	8	3					75	0.79	0.63	0.37
1998	53	36	31	7	3					130	1.01	0.41	0.59
1999	76	71	30	7		1				185	0.85	0.41	0.59
2000	91	63	29	7	2					192	0.78	0.47	0.53
2001	157	125	103	37	6	2				430	1.11	0.37	0.63
2002	No sampling									0			
2003*													
2004	115	83	86	99	73	35	11	0	2	504	2.18	0.23	0.77
2005-2012*													

Table 12 Relative indices of spawning stock abundance and biomass for American shad of the Hudson River Estuary.

Year	Empirical spawning stock indices	
	Abundance	Biomass
1985	31.82	64.33
1986	55.40	112.88
1987	45.03	89.26
1988	39.30	80.24
1989	36.57	69.21
1990	15.60	25.92
1991	17.83	26.64
1992	14.49	20.95
1993	11.95	14.25
1994	23.23	30.14
1995	12.63	19.13
1996	26.75	41.51
1997	9.12	13.61
1998	13.87	21.49
1999	11.79	19.09
2000	37.71	26.11
2001	29.08	9.58
2002		8.55
2003		16.40
2004		8.34
2005		10.20
2006		3.18
2007		3.59
2008		3.80
2009		2.97
2010		2.56
2011		9.79
2012*		

BOLD: Biomass index estimated since 2002, see text. Abundance input data not useful after 2002.
* Data not yet available.

Table 13 Estimates of total instantaneous mortality (Z), annual survival and fishing mortality assume M=0.3) of American shad collected in the spawning stock survey in the Hudson River Estuary.

	Catch curve-Age					Catch curve-Spawning marks				
						Spawning				
Year	Ages	Z	SE	S	F	Marks	Z	S	SE	F
Spawning Stock - Males										
1984	5-10	0.72	0.12	0.49	0.42	1-5	0.77	0.15	0.46	0.47
1985	4-10	0.70	0.07	0.50	0.40	1-5	0.62	0.05	0.54	0.32
1986	4-9	0.68	0.05	0.51	0.38	1-4	0.49	0.14	0.61	0.19
1987	5-11	0.60	0.05	0.55	0.30	1-6	0.54	0.15	0.58	0.24
1988	5-10	0.79	0.05	0.45	0.49	1-5	0.73	0.11	0.48	0.43
1989	5-10	0.72	0.14	0.48	0.42	1-5	0.57	0.21	0.57	0.27
1990	5-8	0.83	0.26	0.44	0.53	2-5	0.97	0.16	0.38	0.67
1991	4-8	0.98	0.14	0.38	0.68	1-4	0.99	0.25	0.37	0.69
1992	5-9	1.37	0.30	0.25	1.07	1-4	1.24	0.03	0.29	0.94
1993	5-8	1.41	0.18	0.24	1.11	1-3	1.17	0.01	0.31	0.87
1994	5-7	1.24	0.23	0.29	0.94	1-4	0.91	0.18	0.40	0.61
1995	4-7	0.81	0.18	0.45	0.51	1-3	1.24	0.34	0.29	0.94
1996	4-8	1.29	0.05	0.27	0.99	1-4	1.43	0.04	0.24	1.13
1997	5-10	0.65	0.32	0.52	0.35	1-5	0.63	0.20	0.53	0.33
1998	4-7	1.03	0.13	0.36	0.73	1-3	1.09	0.23	0.34	0.79
1999	5-8	1.33	0.31	0.26	1.03	1-4	1.21	0.25	0.30	0.91
2000	4-8	1.29	0.25	0.27	0.99	1-4	1.45	0.27	0.24	1.15
2001	4-8	0.97	0.16	0.38	0.67	1-4	1.21	0.21	0.30	0.91
2002										
2003	5-11	1.13	0.07	0.32	0.83					
2004	5-11	0.80	0.10	0.45	0.50	1-6	0.82	0.17	0.44	0.52
2005	5-11	0.90	0.06	0.41	0.60					
2006	4-11	1.03	0.11	0.36	0.73					
2007	4-11	0.98	0.08	0.38	0.68					
2008	4-11	1.03	0.09	0.36	0.73					
2009	4-11	1.14	0.06	0.32	0.84					
2010	4-10	1.48	0.15	0.23	1.18					
2011	4-8	1.14	0.32	0.32	0.84					
2012	4-10	1.39	0.18	0.25	1.09					
Spawning Stock - Females										
1984	7-11	0.53	0.07	0.59	0.23	1-5	0.17	0.09	0.84	-0.13
1985	6-11	0.46	0.04	0.63	0.16	1-5	0.36	0.09	0.70	0.06
1986	6-11	0.63	0.12	0.53	0.33	1-7	0.63	0.10	0.53	0.33
1987	5-13	0.56	0.06	0.57	0.26	1-6	0.64	0.06	0.53	0.34
1988	6-12	0.63	0.06	0.53	0.33	1-6	0.65	0.04	0.52	0.35
1989	5-11	0.54	0.06	0.58	0.24	2-6	0.65	0.11	0.52	0.35
1990	5-10	0.63	0.13	0.53	0.33	1-5	0.59	0.18	0.56	0.29
1991	6-10	0.97	0.15	0.38	0.67	1-5	0.74	0.10	0.48	0.44
1992	5-10	0.98	0.13	0.38	0.68	1-5	1.01	0.14	0.36	0.71
1993	5-8	0.67	0.13	0.51	0.37	1-3	0.88	0.13	0.41	0.58
1994	5-8	1.06	0.05	0.35	0.76	1-4	0.98	0.04	0.37	0.68
1995	5-8	1.42	0.31	0.24	1.12	1-3	1.39	0.30	0.25	1.09
1996	5-10	0.78	0.03	0.46	0.48	1-5	0.87	0.07	0.42	0.57
1997	5-9	0.43	0.14	0.65	0.13	1-4	0.36	0.16	0.70	0.06
1998	5-9	0.99	0.10	0.37	0.69	1-4	0.89	0.18	0.41	0.59
1999	5-9	1.15	0.07	0.32	0.85	1-5	1.09	0.06	0.34	0.79
2000	5-9	1.20	0.12	0.30	0.90	1-4	1.18	0.09	0.31	0.88
2001	5-10	1.11	0.09	0.33	0.81	1-5	1.11	0.16	0.33	0.81
2002										
2003	6-12	1.13	0.14	0.32	0.83					
2004	7-13	0.91	0.11	0.40	0.61	3-8	0.82	0.07	0.44	0.52
2005	5-12	0.83	0.12	0.44	0.53					
2006	5-12	0.75	0.11	0.47	0.45					
2007	5-11	0.73	0.04	0.48	0.43					
2008	5-12	0.81	0.09	0.44	0.51					
2009	5-11	0.99	0.05	0.37	0.69					
2010	5-12	1.08	0.05	0.34	0.78					
2011	5-11	1.16	0.31	0.31	0.86					
2012	5-12	1.16	0.06	0.31	0.86					

**Estimate, aging still in process

Table 14 Length and weight of river herring collected from spawning stock in the Hudson River.

	Total Length				Weight				Sex Ratio
Year	N	Mean	SD	SE	N	Mean	SD	SE	% present
Male Alewife									
2001	399	262.7	13.2	0.7					76%
2002									
2003	265	262.9	13.7	0.8	166	148.7	38.6	3.0	66%
2004									
2005	96	252.0	10.2	1.0	88	143.2	30.0	3.2	86%
2006	16	238.4	8.3	2.1	12	114.6	24.8	7.2	62%
2007	47	251.6	12.6	1.8	47	140.6	30.7	4.5	90%
2008	202	243.7	12.1	0.9	188	158.0	38.3	2.8	79%
2009	460	255.5	10.8	0.5	221	162.6	27.6	1.9	84%
2010	272	253.0	13.2	0.8	115	155.7	31.6	2.9	76%
2011	105	249.4	11.5	1.1	74	138.6	28.4	3.3	51%
2012	1023	258.4	13.5	0.4	1008	157.4	30.8	1.0	74%
Female Alewife									
2001	123	272.4	12.9	1.2					24%
2002									
2003	139	272.0	18.3	1.5	85	161.4	40.3	4.4	34%
2004									
2005	16	263.0	16.2	4.0	13	123.1	31.5	8.7	14%
2006	10	255.3	12.6	4.0	8	155.6	60.8	21.5	38%
2007	5	257.8	12.2	5.4	5	148.0	22.8	10.2	10%
2008	55	264.5	18.3	2.5	55	208.4	53.2	7.2	21%
2009	85	267.6	12.1	1.3	41	205.9	32.0	5.0	16%
2010	87	271.0	18.4	2.0	73	193.3	45.0	5.3	24%
2011	102	265.5	14.9	1.5	53	173.0	39.0	5.4	49%
2012	360	270.5	15.2	0.8	357	181.0	45.4	2.4	26%
All sexes Alewife									
2001	522	265.0	13.8	0.6					
2002									
2003	414	266.0	16.0	0.8	260	152.9	39.3	2.4	
2004									
2005	120	253.6	11.7	1.1	107	138.9	30.9	3.0	
2006	27	247.3	17.8	3.4	21	140.0	61.1	13.3	
2007	53	252.2	12.4	1.7	53	140.6	30.2	4.1	
2008	262	248.3	16.1	1.0	247	169.7	47.0	3.0	
2009	565	257.5	11.7	0.5	281	169.9	31.6	1.9	
2010	363	257.3	16.5	0.9	191	170.3	41.4	3.0	
2011	208	257.3	15.5	1.1	128	152.9	37.1	3.3	
2012	1400	261.5	14.9	0.4	1382	163.5	36.7	1.0	

Table 14. Continued.

Year	Total Length N	Mean	SD	SE	Weight N	Mean	SD	SE	Sex Ratio % present
Male Blueback Herring									
2001	2	251.0	22.6	16.0					40%
2002									
2003	4	254.0	14.5	7.2	4	130.0	34.6	17.3	57%
2004	6	246.2	11.9	4.9	1	240.0		0.0	60%
2005	21	246.4	10.8	2.3	16	108.8	36.5	9.1	57%
2006	2	252.5	4.9	3.5	2	130.0	14.1	10.0	67%
2007									
2008	13	236.6	7.6	2.1	13	130.8	19.3	5.4	62%
2009	108	243.9	13.7	1.3	54	108.8	35.1	4.8	49%
2010	62	237.8	12.1	1.5	46	115.6	23.7	3.5	55%
2011	85	233.0	11.6	1.3	48	107.8	20.1	2.9	42%
2012	171	237.2	13.9	1.1	170	106.8	23.5	1.8	48%
Female Blueback Herring									
2001	3	267.3	11.7	6.8					60%
2002									
2003	3	268.7	15.6	9.0	2	120.0	0.0	0.0	43%
2004	4	252.0	11.4	5.7					40%
2005	16	245.0	9.3	2.3	13	98.5	18.2	5.0	43%
2006	1	245.0		0.0	1	160.0		0.0	33%
2007									
2008	8	245.8	10.4	3.7	8	148.8	24.7	8.7	38%
2009	112	253.7	9.0	0.9	54	128.6	18.6	2.5	51%
2010	50	250.3	11.5	1.6	44	144.6	25.1	3.8	45%
2011	117	243.8	14.6	1.3	75	121.9	21.9	2.5	58%
2012	188	253.7	12.2	0.9	185	129.2	26.8	2.0	52%
All Sexes Blueback Herring									
2001	5	260.8	16.6	7.4					
2002									
2003	7	260.3	15.7	5.9	6	126.7	27.3	11.1	
2004	10	248.5	11.5	3.6	1	240.0		0.0	
2005	41	246.1	11.0	1.7	31	105.8	29.5	5.3	
2006	3	250.0	5.6	3.2	3	140.0	20.0	11.5	
2007									
2008	21	240.1	9.6	2.1	21	137.6	22.8	5.0	
2009	223	248.8	12.5	0.8	111	118.5	29.6	2.8	
2010	116	243.4	13.2	1.2	93	129.4	27.9	2.9	
2011	205	239.3	14.4	1.0	124	116.2	22.3	2.0	
2012	365	245.9	15.3	0.8	361	118.8	27.6	1.5	

Table 15 Length frequency of river herring caught in spawning stock sampling in the Hudson River.

	Alewife-males												Blueback herring-male											
Bin	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
170-179												2												
180-189																								
190-199																					1			
200-209																					5	1		4
210-219	3						1	1	2			2									2	2	7	16
220-229	6		2			1	2	18	6	4	5	7					1			2	3	9	26	26
230-239	11		9		13	8	2	62	25	36	10	71	1			3	6			7	16	23	31	37
240-249	31		37		18	6	13	60	77	69	40	169			2	1	4	1		3	39	13	8	57
250-259	78		48		41		18	39	186	80	35	262				1	8	1		1	35	13	12	25
260-269	142		69		20	1	10	16	127	50	9	295	1		2	1	2				7	1	1	3
270-279	100		71		3			4	32	26	4	166												3
280-289	23		27		1			2	4	6	2	44												
290-299	4		1				1		1	1		5												
300-309	1		1																					
310-319																								
320-329																								
330-339																								
340-349																								
350-359																								
Total	399	0	265	0	96	16	47	202	460	272	105	1023	2	0	4	6	21	2	0	13	108	62	85	171

	Alewife-females												Blueback herring-females											
170-179			1																					
180-189																								
190-199																								
200-209			1																		1			
210-219																						1	3	
220-229	1							2												1			14	
230-239	1		1		2	1		2	2	3	4	4					5			1	1	7	35	22
240-249	2		6		1	2	1	9	2	8	7	28				2	5	1		2	32	14	20	49
250-259	13		20		4	4	2	8	17	11	19	47	1		1	1	5			3	47	17	24	59
260-269	32		27		3	2	1	11	26	16	32	89	1			1	1			1	28	8	16	39
270-279	37		33		5		1	11	28	22	20	88			1						3	3	3	14
280-289	27		34			1		8	6	14	13	68	1		1								2	3
290-299	7		7		1			2	3	7	6	23												2
300-309	3		8					2	1	4	1	10												
310-319			1							1		2												
320-329										1		1												
330-339																								
340-349																								
350-359																								
Total	123	0	139	0	16	10	5	55	85	87	102	360	3	0	3	4	16	1	0	8	112	50	117	188

Alewife-all fish													Blueback herring-all fish											
Bin	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
170-179			1									2												
180-189																								
190-199																					1			
200-209			1																		6	1		4
210-219	3						1	1	2			2									2	3	10	16
220-229	7		2			1	2	20	6	4	5	8					1			3	4	9	40	26
230-239	12		11		15	9	2	65	27	40	14	76	1			3	13			8	17	31	68	60
240-249	33		44		21	8	14	71	80	77	48	199			2	3	9	2		5	71	29	28	108
250-259	91		69		50	4	21	47	211	91	54	314	1		1	2	13	1		4	84	31	37	86
260-269	174		98		23	3	11	28	162	68	41	389	2		2	2	4			1	35	9	17	43
270-279	137		108		9		1	15	62	49	24	256			1		1				3	3	3	17
280-289	50		62		1	1		11	10	20	15	113	1		1								2	3
290-299	11		8		1		1	2	4	8	6	28												2
300-309	4		9					2	1	4	1	10												
310-319			1			1				1		2												
320-329										1		1												
330-339																								
340-349																								
350-359																								
Total	522	0	414	0	120	27	53	262	565	363	208	1400	5	0	7	10	41	3	0	21	223	116	205	365

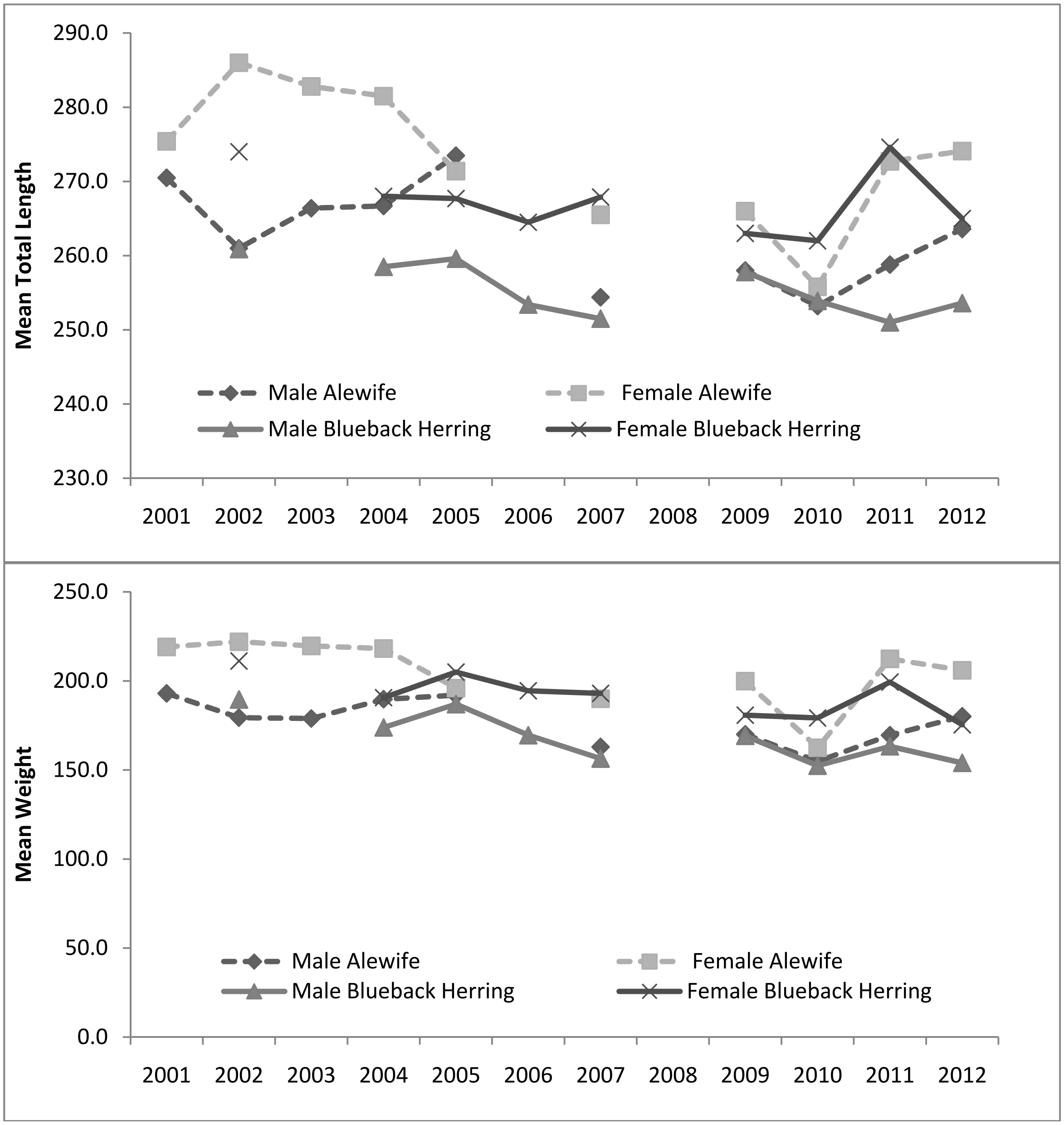

Figure 1. Mean length and weight of river herring collected in fishery dependent sampling in the commercial fishery in the Hudson River.

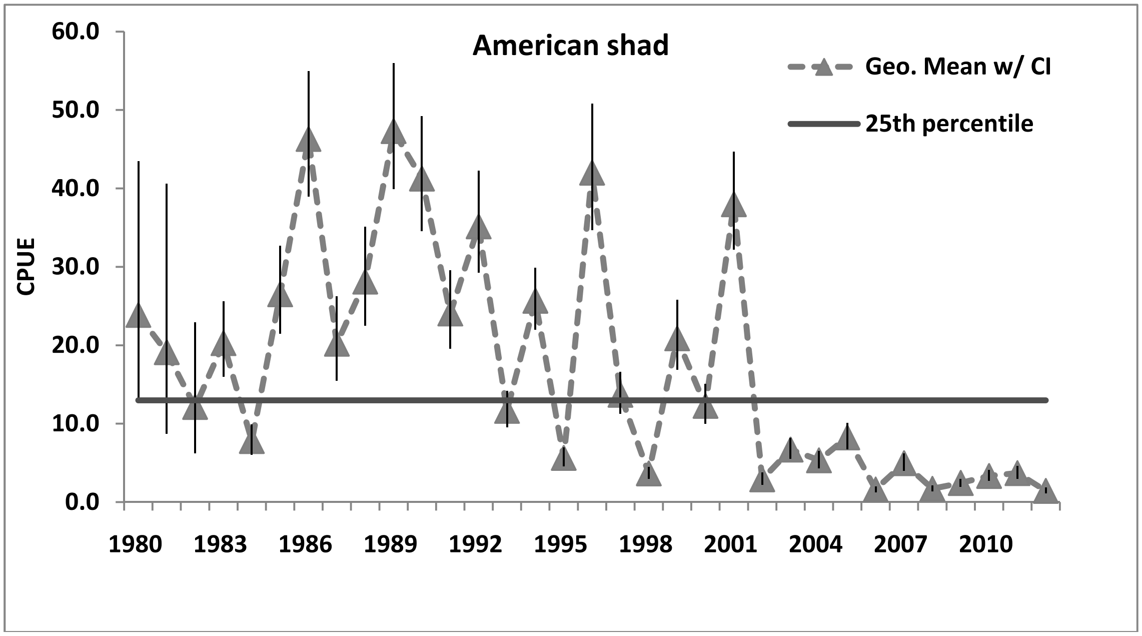

Figure 2 NYSDEC young of the year index (mean number per haul, weeks 26-42) for American shad collected in the Hudson River Estuary.

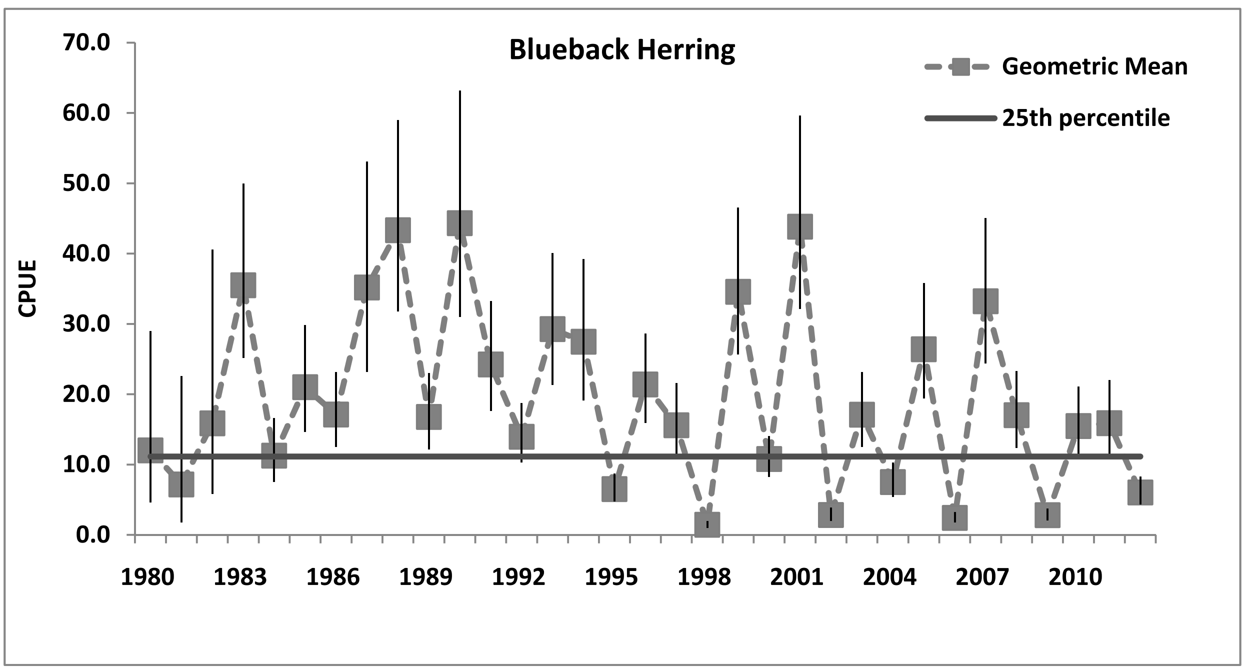

Figure 3 NYSDEC young of the year index (mean number per haul, weeks 26-42) for Blueback herring collected in the Hudson River Estuary.

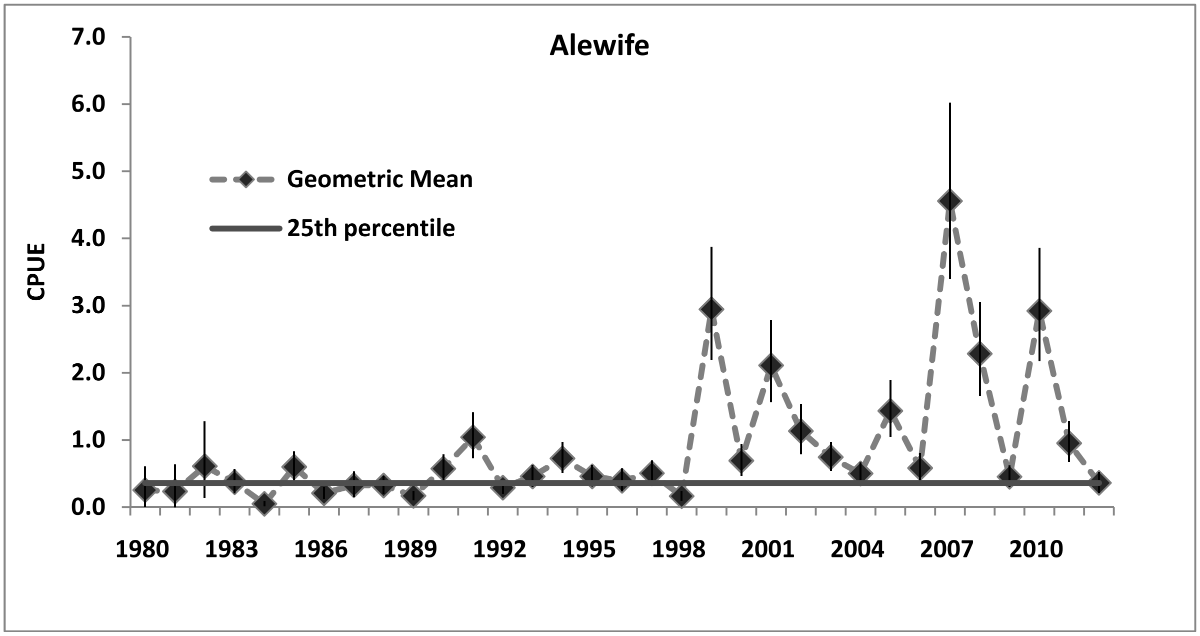

Figure 4 NYSDEC young of the year index (mean number per haul, weeks 26-42) for Alewife collected in the Hudson River Estuary.

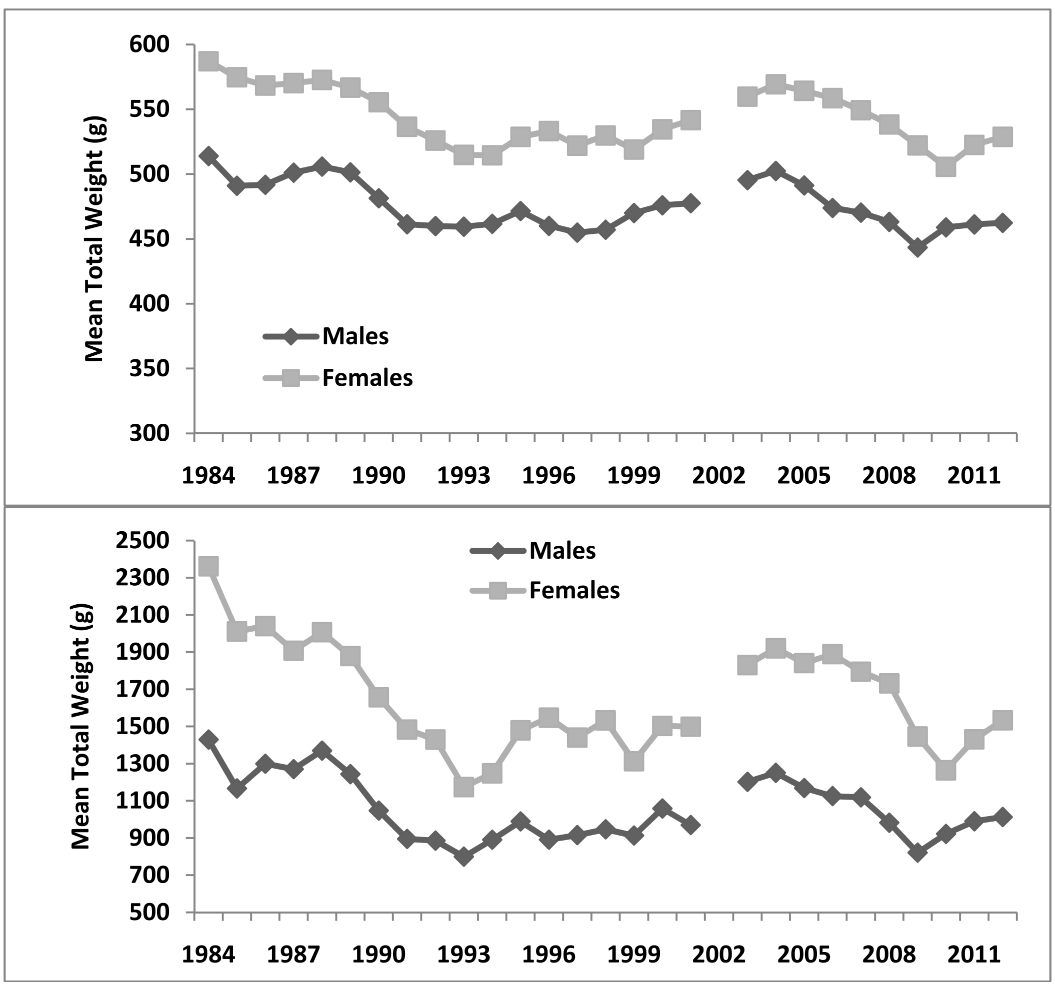

Figure 5 Mean total length and weight of American shad collected during spawning stock sampling in the Hudson River Estuary.

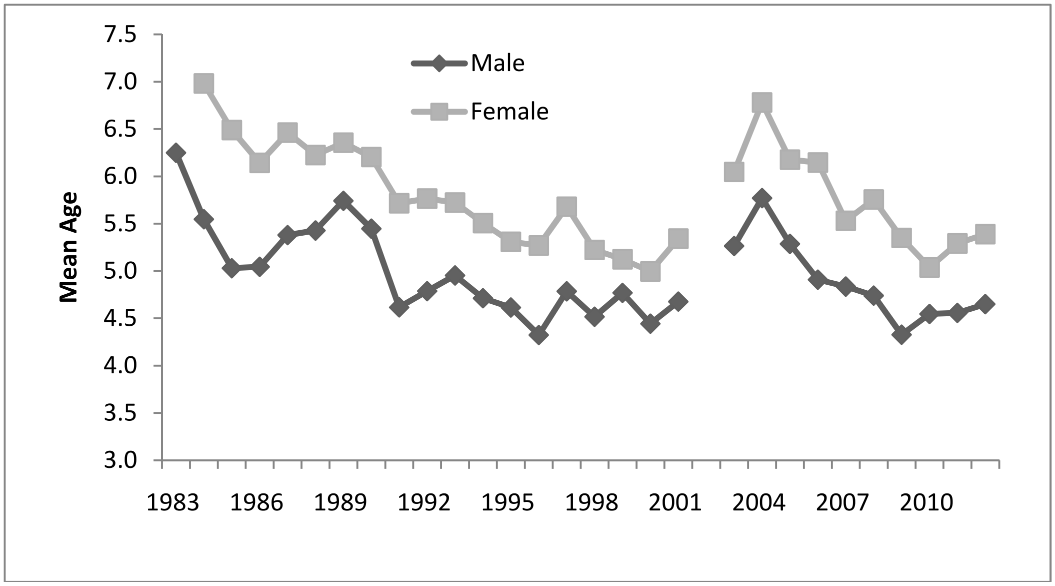

Figure 6 Estimated mean age of American shad from spawning stock sampling in the Hudson River Estuary.

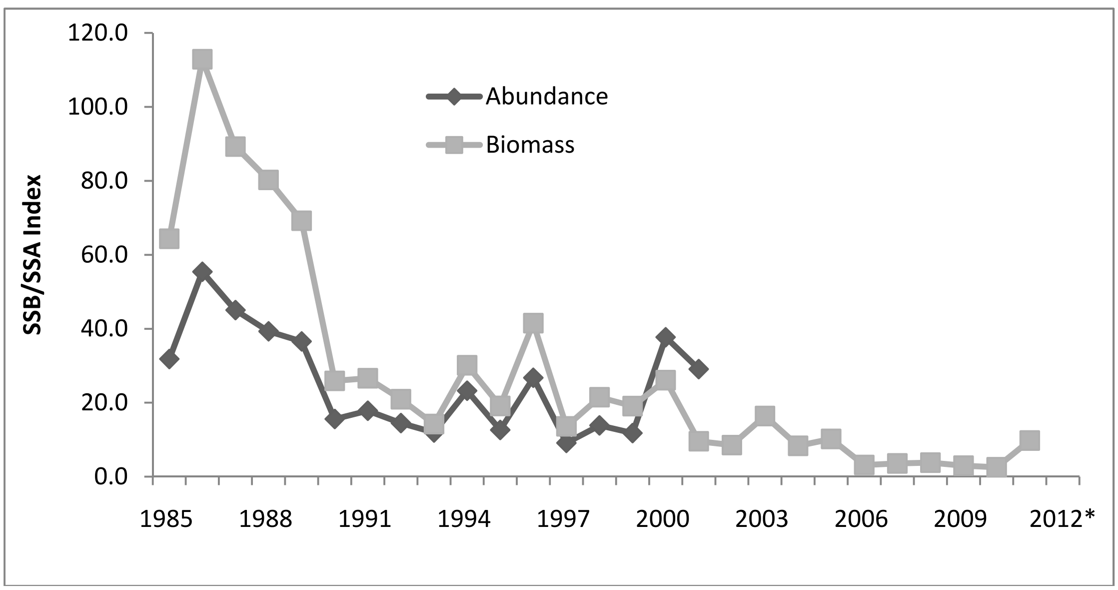

Figure 7 Relative indices of spawning stock abundance and biomass for American shad of the Hudson River Estuary. *Data not yet available.

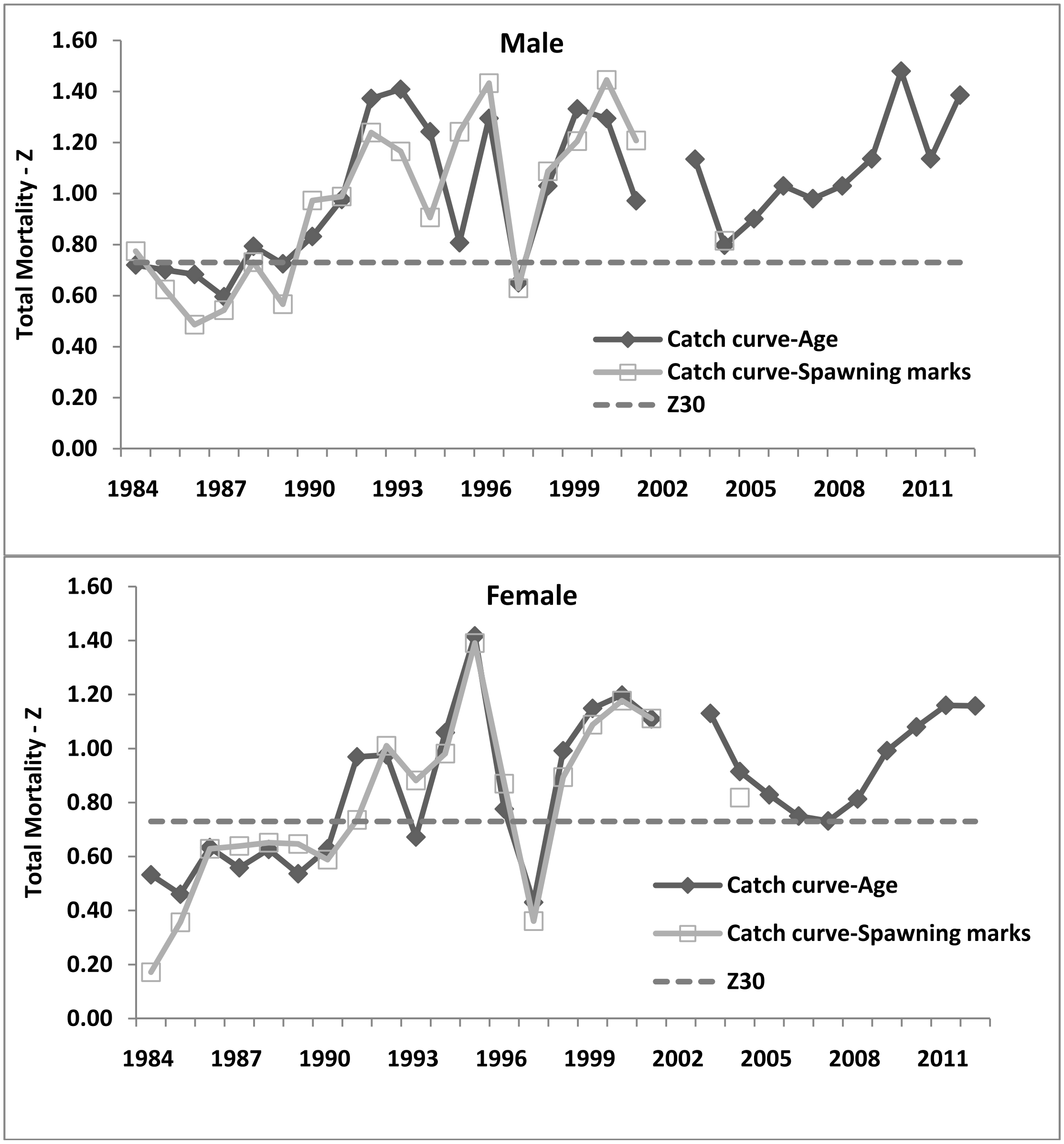

Figure 8 Estimates of total instantaneous mortality (Z) in comparison to the ASMFC 2007 Z30 benchmark of American shad collected in the spawning stock survey in the Hudson River Estuary.

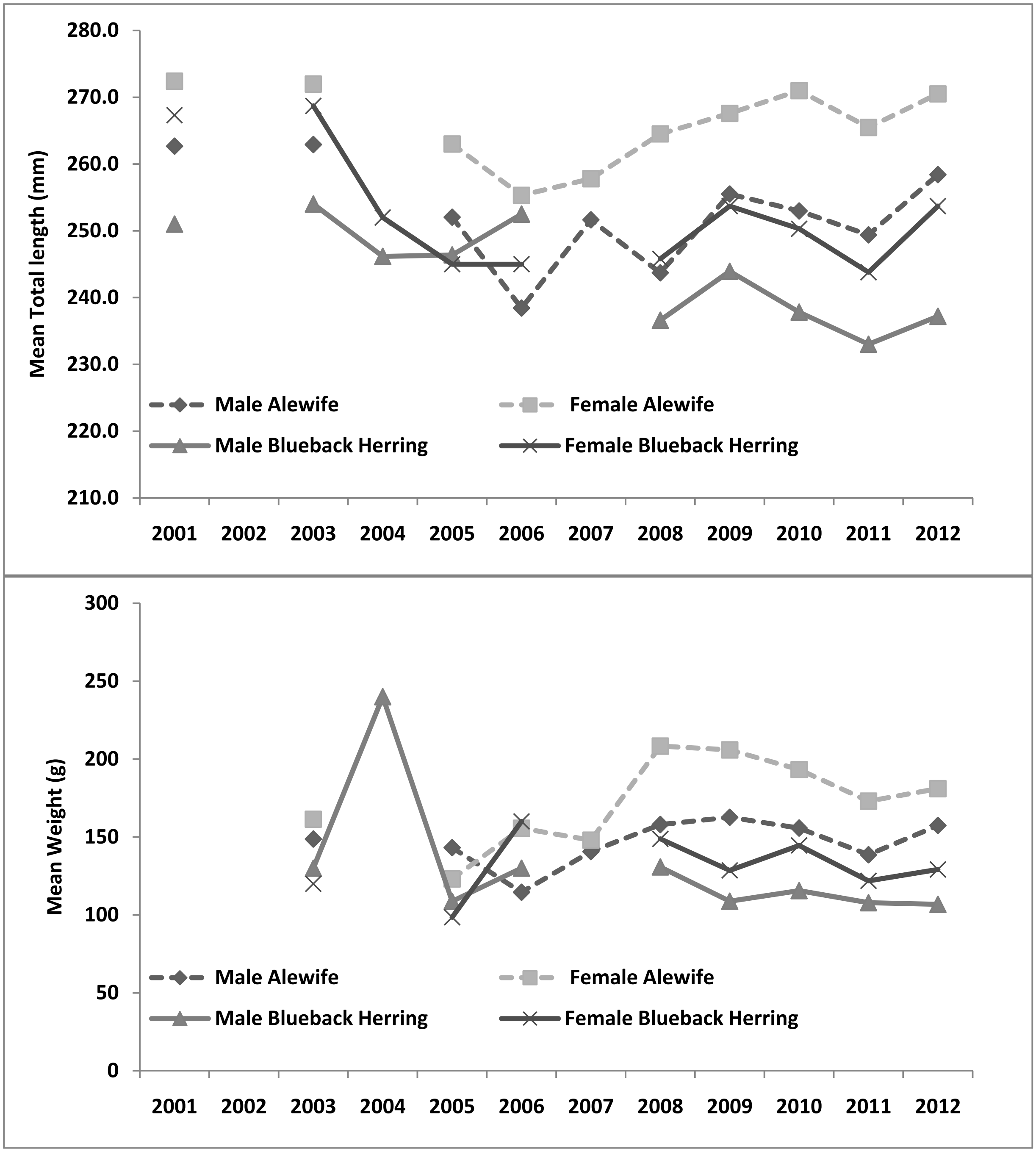

Figure 9. Mean total length of river herring collected from spawning stock in the Hudson River.

STATE OF NEW JERSEY
DEPARTMENT OF
ENVIRONMENTAL PROTECTION

DIVISION OF FISH & WILDLIFE

Annual Coastal Report for
Shad and River Herring: 2012

May 2013

Report By:
Hugh Carberry
&
Heather Corbett

Submitted to the Atlantic States Marine Fisheries Commission as a Requirement of Amendment 1 to the Interstate Fisheries Management Plan for Shad and River Herring

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In accordance with Amendment 1 of the Interstate Fisheries Management Plan for Shad and River Herring (Plan), the State of New Jersey herein submits its annual report on Alosine fisheries conducted within state coastal waters during 2012. This report covers New Jersey's management programs for commercial and recreational fisheries as well as all fishery independent monitoring. Additional fisheries data for 2013 are included where appropriate.

AMERICAN SHAD

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of Fishery

New Jersey's net regulations for American shad can be found in Table 1. Although New Jersey waters are open to gill netting for the majority of the year, the current directed commercial fishery for American shad occurs primarily during March through April of each year depending on environmental conditions. New Jersey initiated limited entry and mandatory reporting prior to the 2000 fishing season. As of April 23, 2013 there were 83 permits issued (45 commercial and 38 incidental). Currently, only 53 of these permits are active, due to attrition, and ***only 1 fisher landed shad outside of Delaware Bay during 2012.*** The shad permit allows the holder to fish in any state waters where the commercial harvest of shad is allowed as long as the permit holder meets all other net requirements for commercial fishing in a particular area. Permits are not gear specific. All permits are currently non-transferable except to immediate family members.

2. Characterization of Catch and Harvest

a. Landings and method of estimation

The National Marine Fisheries Service (NMFS) estimated American shad landings for the State of New Jersey through 1998. In 1999, the NMFS estimates were combined with voluntary logbook data from New Jersey's commercial fishers. Since 2000, the data has been collected via mandatory logbooks through the limited entry program. The estimated coastal harvest for 2012 was 752 pounds of American shad, which was the second lowest of the time series (Table 2). The most recent decline is the combined effect of the ocean closure, abundance of striped bass and the decline of the Delaware River shad stock. Coastal landings accounted for 0.5% of NJ's total landings for 2012 (Figure 1). There are no estimates of underreporting.

b. Catch composition

i. Age and length frequency

There was no biological data collected from the coastal fishery in 2012.

ii. Sex ratio

Data collected from New Jersey's mandatory logbooks in 2012 show that the mesh size in the non-directed American shad gill net fishery ranged from 5 to 6 inch stretch mesh. In the past, the directed coastal fishery was primarily a roe fishery, although regulations instituted by the NMFS in 2000 to protect Harbor Porpoise lowered the mesh size to 5 inches and resulted in an increase in the percent harvest of bucks (Table 3). The closure of the directed ocean fishery in 2005 resulted in a decrease in the harvest of buck shad in order to maximize landings. The percentage of roe harvested in 2012 was higher than 2011 and the percentage of harvested bucks was lower than 2011.

iii. Degree of repeat spawning

No repeat spawning data was collected from any commercial fisheries in New Jersey waters by the State of New Jersey.

c. Estimation of effort

New Jersey conducted a voluntary logbook survey of the shad commercial gill net fishery from 1996 to 1999. Mandatory reporting was instituted in 2000 for all shad fishers.

The Catch Per Unit Effort (CPUE) for the non-directed coastal gill net fishery in 2012 was 0.0001 pounds of shad per square foot of net set (Table 4). There has been virtually no effort since 2005 when the directed fishery in coastal waters was closed (Table 5).

3. Ocean Bycatch Analysis

Since the ocean closure for the harvest of American shad in January 2005, coastal gill net fishers have been allowed to harvest shad providing that the harvest is no more than five percent of the total weight of fish harvested for these mixed stock fisheries. None of these trips resulted in reported levels of American shad harvest over the five percent trip limit.

4. Characterization of Other Losses (poaching, bycatch, etc.)

The state of New Jersey presently has no additional data on poaching or bycatch of American shad from other fisheries. The landings from coastal waters in 2012 can be classified as bycatch harvest since the directed shad fishery has been closed. There is undoubtedly some bycatch discard loss, especially for male shad, but there is no data as to the severity of this bycatch. In addition, any landings taken by fishers without a shad permit are considered poaching. This would include any trawl landings or other landings from gear types not currently permitted. The NMFS landings are unavailable for 2012 however; the landings for 2011 indicate that 87 pounds were landed via trawl.

B. Recreational Fishery

1. Characterization of Fishery

No known fishery exists in coastal NJ waters.

2. Characterization of Directed Harvest

No data

3. Characterization of Other Losses (poaching, hook/release mortality, etc.)

No data

C. Other Losses

There is presently no data available to estimate other losses of American shad.

D. Estimated Losses

There are no 2012 harvest loss estimates since there is no coastal fishery

E. Protected Species

Harvest reporting in the American shad gill net fishery was voluntary prior to new regulations that took effect in January 2000. Although shad fishers are required to report shad landings and effort, bycatch reporting of Atlantic sturgeon remains on a voluntary basis. According to logbooks collected from New Jersey commercial shad fishers there were 11 Atlantic sturgeon caught as bycatch during 2012 in Delaware Bay. All sturgeon were released alive at the time of tending the net. Permit holders are not required to report Atlantic sturgeon interactions however, so this number is an underestimate of the total interactions with commercial shad gill netters throughout the state. The accuracy of reported data is also unquantifiable without onboard observers.

The data was extrapolated to the entire shad fishery for 2012, based on the number caught by cooperating fishers and effort data from all logbooks. Although the number of interactions is still considered an underestimate, the final reported estimate is 24 sturgeon caught.

II. Fishery Independent Monitoring

A. Description of Requirements

There are no monitoring requirements.

B. Description of Work Performed

There was no sampling in New Jersey's coastal waters in 2012.

III. Other Monitoring

A. Ocean Trawl Survey

The New Jersey Ocean Trawl Survey is a multispecies survey that started in August 1988 and samples the near shore waters from the entrance of New York Harbor south, to the entrance of the Delaware Bay five times a year (January, April, June, August and October). There are 15 strata with five strata assigned to three different depth regimes; inshore (3 to 5 fathoms), mid-shore (5 to 10 fathoms), and off-shore (10 to 15 fathoms). Station allocation and location is random and stratified by strata size (Figure 2).

The survey net is a two-seam trawl with forward netting of 4.7 inch stretch mesh and rear netting of 3.1 inches stretch mesh. The codend is 3.0 inches stretch mesh and is lined with a 0.25 inch bar mesh liner. Each trawl is 20 minutes long and at the end of each tow, the total weight of each species is measured in kg and the length of all individuals, or a representative sample by weight for large catches, is measured to the nearest cm. A series of water quality parameters, such as surface and bottom salinity, temperature and dissolved oxygen, are also recorded at the start of each tow. American shad estimates are discussed here while the river herring analysis is handled in a separate section of this report.

The majority of American shad are captured during the January through June trawls so only those months are used for the geometric mean. During the 2012 sampling season, there were 1,018 American shad caught during the January through June surveys. The geometric mean CPUE index was 1.09, which was the highest value since 2008, ranking fourth in the 24-year time series and above the time series average of 0.77 (Table 7, Figure 3). The overall index has varied without trend except there was a definite decrease in abundance from 1989 through 2000 that had rebounded somewhat prior to 2009. The 2012 size range was 70 to 270 mm fork length with a mean of 124 mm (Figure 4). Overall 96% of the shad caught were between 100 to 160 mm.

RIVER HERRING AND HICKORY SHAD

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of Fishery

The only commercial data on river herring and hickory shad are landing data from the NMFS. River herring are taken primarily by gill net or fyke net while hickory shad are landed by gill net or trawl.

2. Characterization of Directed Harvest

a. Landings and method of estimation

Coastal landing estimates for river herring and hickory shad were obtained from SAFIS on May 29, 2013. There were 924 pounds of hickory shad and 45 pounds of river herring landings during 2012.

II. Fishery Independent Monitoring

A. Ocean Trawl Survey

A synopsis of this survey was discussed in the American shad section of this report. The majority of river herring are captured during the January and April trawls so only those months are used for the geometric mean (Table 8, Figure 5). During the 2012 sampling season, there were 2,509 blueback herring and 2,087 alewife caught during the January and April surveys. For blueback herring, the geometric mean was 1.02, which was the lowest of the 24-year time series and well below the time series average of 3.89. The overall index declined from 1993 through 2004 but increased rapidly through 2009, with two of the top three values coming in the past five years. The 2012 size range was 50 to 260 mm fork length with a mean of 185 mm (Figure 6). Overall 83 percent of blueback herring were between 170 to 230 mm.

The alewife index for 2012 was 2.85, which is well below the time series mean (5.15). This value was above 2011 and was 15th in the time series. The index varied with an increasing trend until 1998 before declining rapidly through 2000. The index showed a slight increasing trend through 2009 but has decreased since. The 2012 size range was 70 to 290 mm fork length with a mean of 145 mm. Overall 83 percent of alewife collected were between 80 to 180 mm.

New Jersey began collecting otoliths and other biological data in 2009 to develop age at length keys for both species. The otoliths are currently being processed for age determination and data will be included in future reports when it is completed.

A total of 514 hickory shad have been collected during the survey including 39 in 2012 (Table 9).

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Atlantic States Marine Fisheries Commission, 1999. Fishery Management Report No. 35 of the Atlantic States Marine Fisheries Commission: Amendment 1 to the Interstate Fishery Management Plan for Shad & River Herring, 75pp.

Lukacovic, R. 1998. Mortality of American Shad (*Alosa sapidissima*) caught and released by Anglers below Conowingo Dam. Maryland Department of Natural Resources Fisheries Service. Fisheries Technical Report Series, Number 21.

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ACKNOWLEDGEMENTS

The enthusiasm and hard work of the many individuals and groups involved with the Striped Bass Project is greatly appreciated. These include the following Division employees for their assistance with data processing/analysis, laboratory analysis, and field sampling: Tom Baum, Jen Pyle, Maryellen Gordon, Debbie Vareha, Matt Heyl, Patrick Barker, Shana Fehring, Kirsten Gash, Steve Luell, Cody Meyer, Dan Allen, William Maxwell, Amber Johnson, Becky Ford, Linda Barry, Anthony Mazzarella, Greg Hinks and other participants of the Ocean Trawl Survey who collected striped bass scales in addition to processing the trawl catches.

Jamie Darrow, Ray Ringen and Lloyd Lomelino of the Division's Wildlife Conservation Corps (WCC) volunteered their time to assist with the Delaware River Recruitment Survey.

The cooperation of businesses and the general public are greatly appreciated. The Division thanks Mr. George Swickla, Jimmy Richards and personnel of the various marinas whose boat ramps and facilities were utilized by the Division. These include Smokey's Marina in Reed's Beach, RiverGate Boat Ramp in West Deptford, Hawk Island Marina in Delanco and Buttonwood Marina in Bridgeport.

Table 1. New Jersey's coastal net regulations for the harvest of American shad: 2012

System	Season	Gear Limits	Mandatory Reporting	Other Restrictions
Raritan/ Sandy Hook Bays	Anchored/staked gill nets: Feb 1 to May 15	5" min. stretch mesh; length-2400' Shad only No drift gill nets allowed	YES	Limited entry; gear restrictions in defined areas

Hudson River	Anchored/staked gill nets: Mar 15 to Jun 15	5" min. stretch mesh; length-1200' Shad only No drift gill nets allowed 36 hr. escapement period per week	YES	Limited entry; gear restrictions in defined areas
Ocean	Gill nets: Feb 12-Dec 15	5" min. stretch mesh Feb 12-Feb 29 * 3.25" min. stretch Mar 1-Dec 15 length: 2400' Feb 12-May 15 1200' May 16-Dec 15	YES	Limited entry; gear restrictions in defined areas; bycatch only

*except with special permit

Table 2. New Jersey's American shad coastal harvest, in pounds: 1980-2012

Year	Hudson	Coastal	Cape May	Total Coastal	Year	Hudson	Coastal	Cape May	Total Coastal
1980	172,000	65,600	3,500	241,100	1998	5,687	186,032	32,764	224,483
1981	132,500	61,500	1,600	195,600	1999	1,920	156,540	21,529	179,989
1982	69,000	115,200	31,700	215,900	2000	0	135,676	0	135,676
1983	72,200	131,200	15,400	218,800	2001	0	174,018	0	174,018
1984	76,800	143,200	23,900	243,900	2002	0	227,909	0	227,909
1985	53,400	166,100	200	219,700	2003	0	145,449	0	145,449
1986	160,500	92,200	900	253,600	2004	0	120,267	0	120,267
1987	63,100	75,100	0	138,200	2005	0	2,670	0	2,670
1988	183,800	113,900	38,900	336,600	2006	849	2,366	0	3,215
1989	109,000	225,600	111,100	445,700	2007	0	3,840	0	3,840
1990	121,985	227,596	8,951	358,532	2008	0	1,112	0	1,112
1991	46,523	127,967	106,177	280,667	2009	0	1,354	0	1,354
1992	39,454	125,323	46,251	211,028	2010	25	1,140	0	1,165
1993	22,793	152,161	44,503	219,457	2011	83	30	0	113
1994	35,684	132,694	42,870	211,248	2012	614	138	0	752
1995	1,204	162,853	55,444	219,501					
1996	1,409	149,801	42,677	193,887	1980-2012	41,531	108,600	20,061	170,193
1997	0	157,279	33,652	190,931	2003-2012	157	27,837	0	27,994
					2008-2012	144	755	0	899

NMFS (1980-1999) and commercial logbooks (2000-2012)

Table 3. New Jersey's coastal commercial gill net shad landings, roe vs. buck: 1996–2012

Year	% Roe	% Buck	Year	% Roe	% Buck
1996	84.1	15.9	2004	71.3	28.7
1997	82.8	17.2	2005	98.9	1
1998	81.4	18.6	2006	73.3	26.7
1999	81.9	18.1	2007	96.6	3.6
2000	69	31	2008	91.7	8.3
2001	70.8	29.2	2009	84	16
2002	71.4	28.6	2010	75.5	24.5
2003	61	39	2011	66.7	33.3
			2012	**94.2**	**5.8**
			AVG	75.3	24.7

Table 4. Omitted due to confidentiality rules.

Table 5. CPUE in New Jersey's coastal American shad commercial gill net fishery: 1999-2012

Year	CPUE	Year	CPUE
1999	0.005	2006	0.001
2000	0.007	2007	0.001
2001	0.009	2008	0.001
2002	0.014	2009	0.001
2003	0.013	2010	0.001
2004	0.008	2011	0.0001
2005	0	**2012**	**0.0001**
		mean	0.008

Table 6. New Jersey's estimated American shad losses in NJ coastal waters: 2012

	Number	Mean Weight	Pounds
Commercial	167	4.51[1]	752
Recreational	0	0	0
Release Mortality	0	0	0
Poaching	N/A	N/A	N/A
Total	167		752

(1) Based on mean weight data from Delaware Bay sampling in 2012

Table 7. Ocean Trawl Survey American shad geometric mean per tow: 1989-2012

YEAR	CPUE	YEAR	CPUE
1989	1.35	2001	0.46
1990	0.79	2002	0.59
1991	0.85	2003	0.63
1992	0.80	2004	1.01
1993	0.93	2005	0.64
1994	0.91	2006	0.49
1995	1.24	2007	0.49
1996	0.62	2008	1.39
1997	0.43	2009	0.49
1998	0.90	2010	0.31

1999	0.93	2011	0.88
2000	0.27	**2012**	**1.09**
		MEAN	**0.77**

Table 8. Ocean Trawl Survey river herring geometric mean per tow: 1989-2012

Year	Blueback	Alewife	Year	Blueback	Alewife
1989	5.1	3.01	2001	4.64	1.79
1990	3.68	2.57	2002	2.15	2.39
1991	3.33	5.01	2003	2.21	4.69
1992	4.6	2.85	2004	1.81	4.67
1993	6.57	7.03	2005	3.24	3.92
1994	4.72	2.82	2006	4.48	2.44
1995	5.51	5.01	2007	3.33	4.63
1996	4.71	8.23	2008	8.77	5.71
1997	3.85	3.97	2009	6.21	4.89
1998	2.99	30.08	2010	1.08	0.34
1999	4.01	11.85	2011	1.23	1.04
2000	4.23	1.76	**2012**	**1.02**	**2.85**
			MEAN	**3.89**	**5.15**

Table 9. Ocean Trawl Survey hickory shad number per year: 1989-2012

Year	Number	Year	Number
1989	0	2001	0
1990	2	2002	46
1991	1	2003	1
1992	1	2004	65
1993	3	2005	9
1994	6	2006	60
1995	26	2007	52
1996	12	2008	74
1997	0	2009	6
1998	6	2010	72
1999	0	2011	33
2000	0	**2012**	**39**
		TOTAL	514

Figure 1. New Jersey's coastal American shad commercial harvest, in pounds: 1980-2012

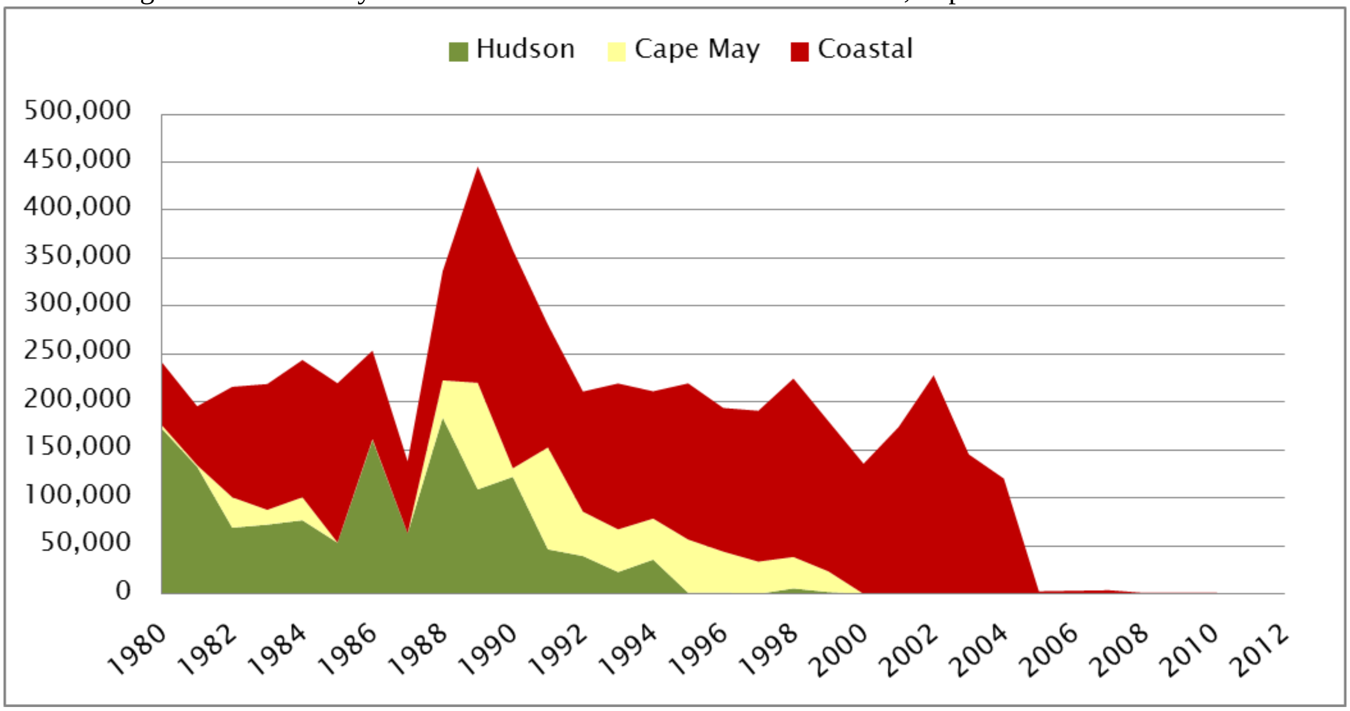
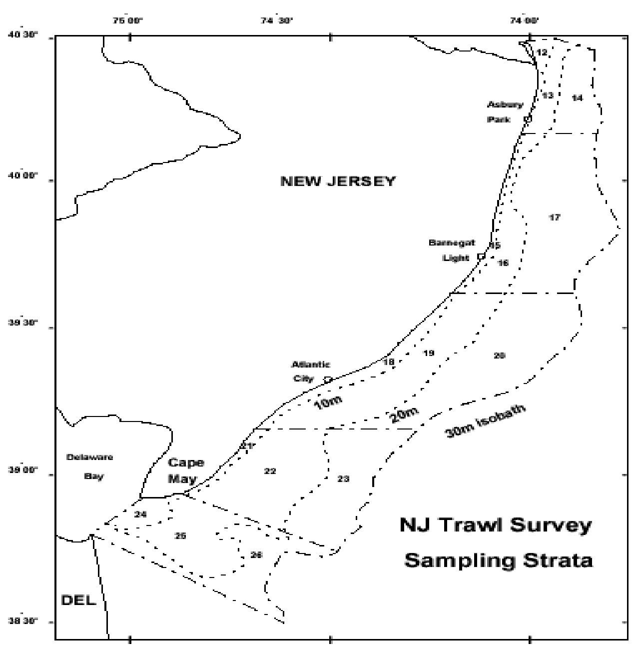


Figure 2. New Jersey Ocean Trawl Survey area: 2012



*Strata correspond to those of the National Marine Fisheries Service's spring and fall groundfish surveys.

Figure 3. Ocean Trawl Survey American shad geometric mean per tow: 1989-2012

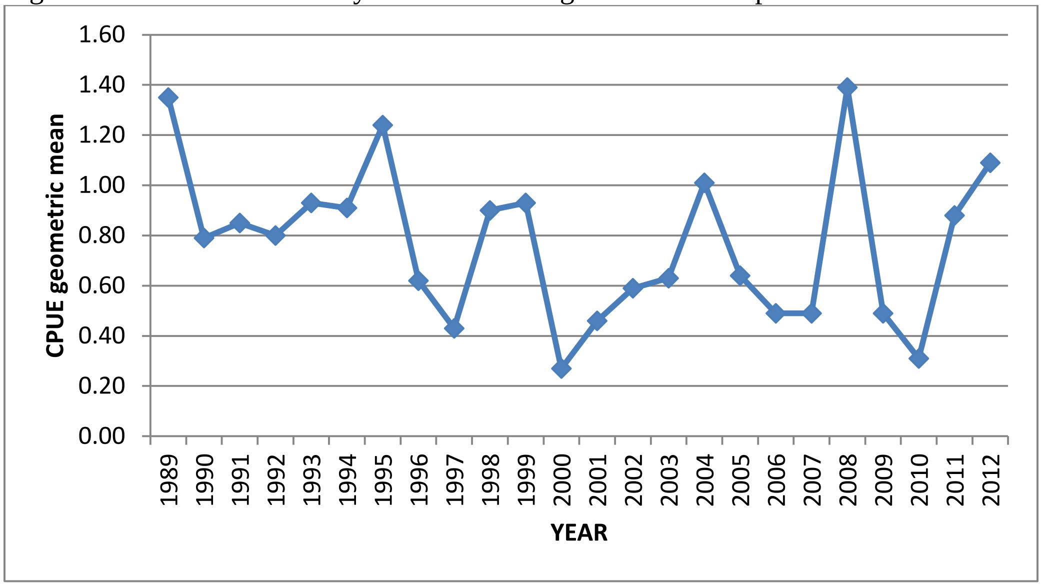


Figure 4. Ocean Trawl Survey American shad length frequency (fl, mm): 2012

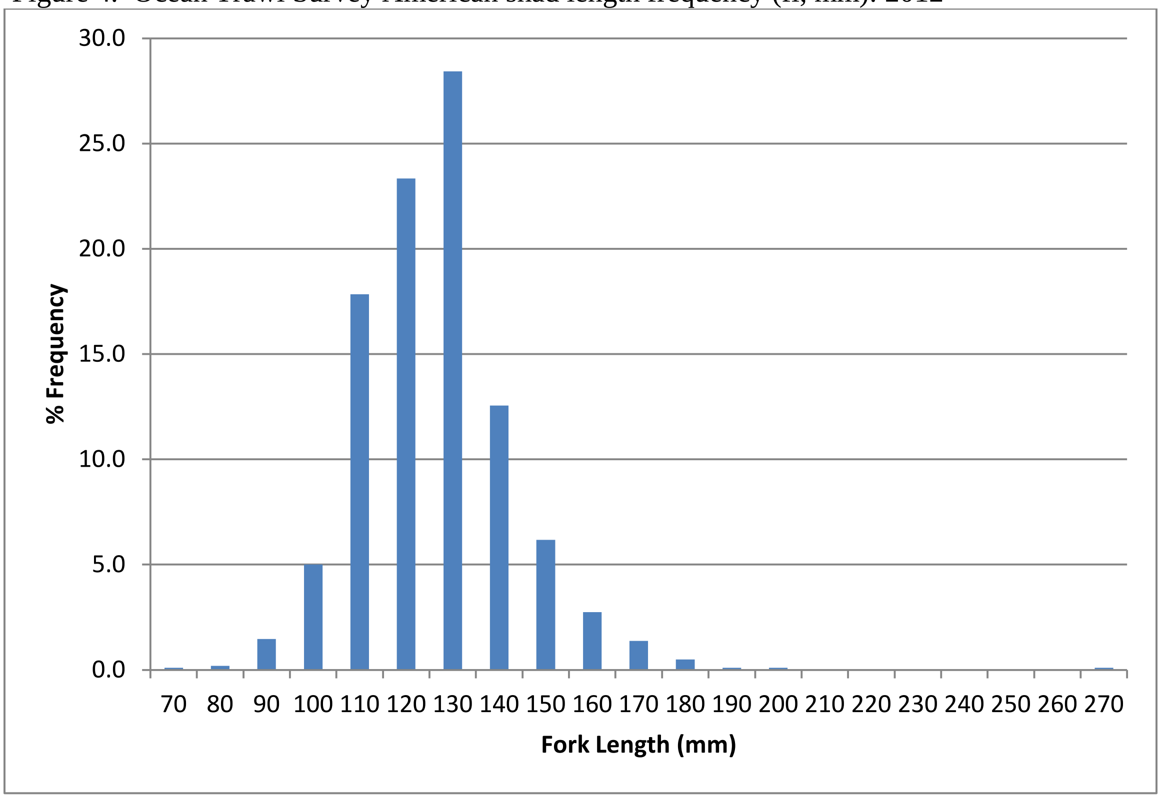


Figure 5. Ocean Trawl Survey river herring geometric mean per tow: 1989-2012

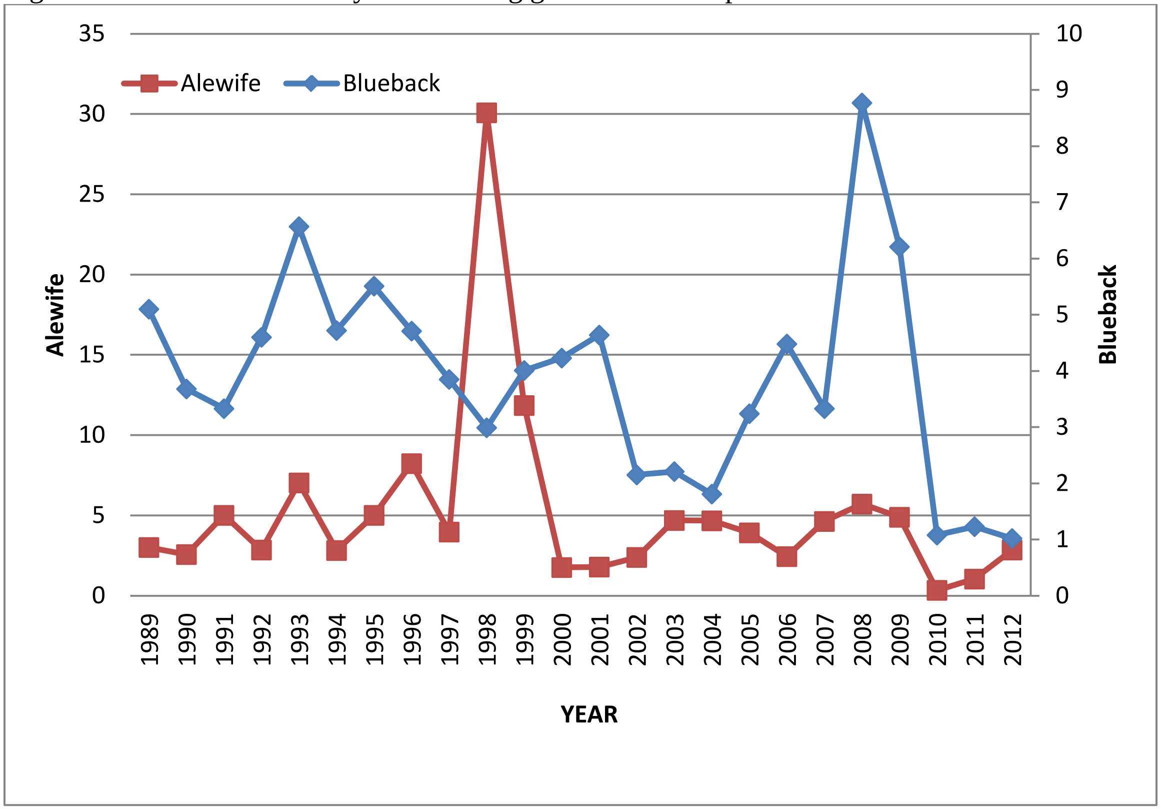
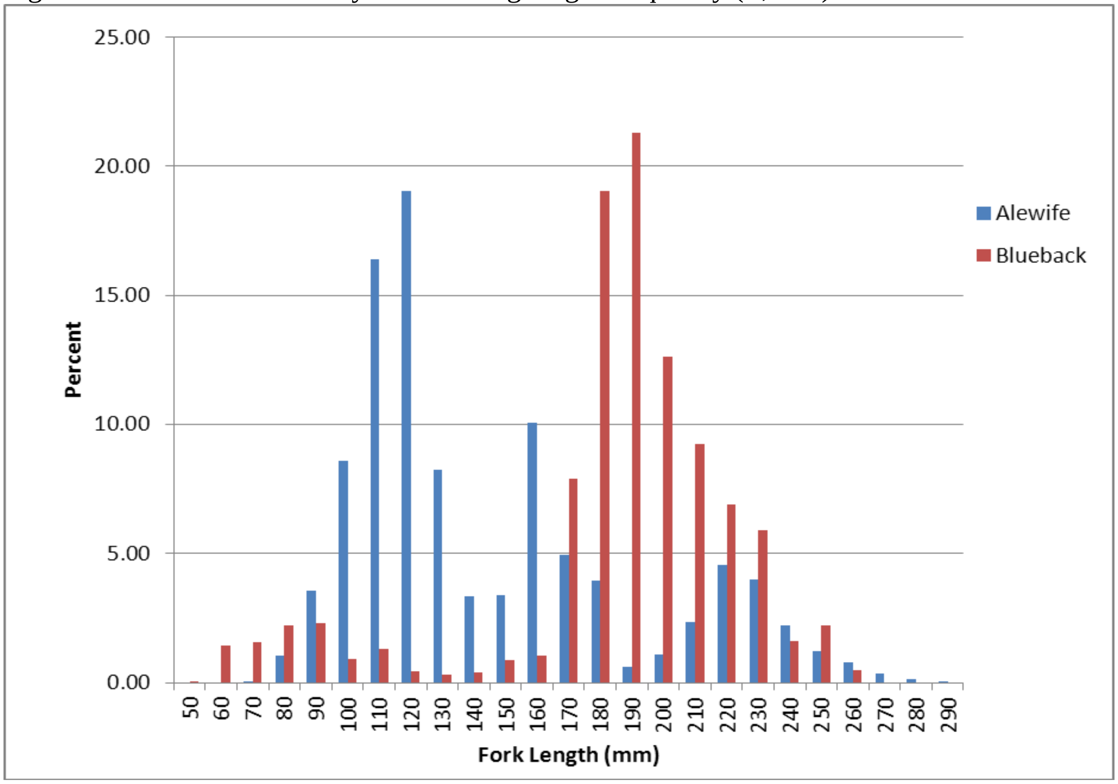


Figure 6. Ocean Trawl Survey river herring length frequency (fl, mm): 2012



STATE OF NEW JERSEY
DEPARTMENT OF
ENVIRONMENTAL PROTECTION

DIVISION OF FISH & WILDLIFE

Annual Delaware Estuary Report for Shad and River Herring: 2012

May 2013

Report By:
Hugh Carberry
&
Heather Corbett

Submitted to the Atlantic States Marine Fisheries Commission as a Requirement of Amendment 1 to the Interstate Fisheries Management Plan for Shad and River Herring

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In accordance with Amendment 1 of the Interstate Fisheries Management Plan for Shad and River Herring (Plan), the State of New Jersey herein submits its annual report on Alosine fisheries conducted within the Delaware Estuary during 2012. This report covers New Jersey's management programs for commercial and recreational fisheries as well as all fishery independent monitoring. Additional fisheries data for 2013 are included where appropriate.

AMERICAN SHAD

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of Fishery

New Jersey's net regulations for American shad can be found in Table 1. Although New Jersey waters are open to gill netting for the majority of the year, the current directed commercial fishery for American shad occurs primarily during March through April of each year depending on environmental conditions. New Jersey initiated limited entry and mandatory reporting prior to the 2000 fishing season. As of April 23, 2012 there were 83 permits issued (45 commercial and 38 incidental). Currently, only 53 of these permits are active, due to attrition, and only ***1 fisher*** landed shad outside of Delaware Bay during 2012. The shad permit allows the holder to fish in any state waters where the commercial harvest of shad is allowed as long as the permit holder meets all other net requirements for commercial fishing in a particular area. Permits are not gear specific. All permits are currently non-transferable except to immediate family members.

2. Characterization of Catch and Harvest

a. Landings and method of estimation

The National Marine Fisheries Service (NMFS) estimated American shad landings for the State of New Jersey through 1998. In 1999, the NMFS estimates were combined with voluntary logbook data from New Jersey's commercial fishers. Since 2000, the data has been collected via mandatory logbooks through the limited entry program. The estimated harvest for 2012 was 27,368 pounds (Table 2). Landings have continued a decreasing trend since the modern peak in 1990, although landings were fairly steady from 1997 to 2004. The most recent decline is the combined effect of the abundance of striped bass and the decline of the Delaware River shad stock. The majority (72.8 %) of NJ landings in 2012 (Figure 1) were taken in the upper Delaware Bay and River.

There are no estimates of underreporting, however it is assumed that harvest in the upper reaches of Delaware Bay, prior to 2000, was actually higher than the NMFS data suggests. This is due to a lack of sampling by the NMFS in this area. The evidence for underreporting can be found in New Jersey's mandatory logbook data since 2000, which shows that the five highest landings years occurred during this time period, with a peak of more than 90,000 pounds in 2004.

b. Catch composition

i. Age and length frequency

Length and weight data were collected from American shad tagged in Delaware Bay which can be compared to previous length frequency data for Delaware Bay in Figure 2.

ii. Sex ratio

Data collected from New Jersey's mandatory logbooks in 2012 show that the mesh size in the directed American shad gill net fishery ranged from 5 to 6 inch stretch mesh. The percentage of females harvested in Delaware Bay has consistently outnumbered the percentage of harvested males (Table 3). In 2012, harvested females (85.6 %) increased from 2011 and was above the time series average (78.7 %). The percentage of harvested males (14.4 %) decreased from 2011 and was slightly above the average (21.4 %).

iii. Degree of repeat spawning

No repeat spawning data was collected from any commercial fisheries in New Jersey waters by the State of New Jersey.

c. Estimation of effort

New Jersey conducted a voluntary logbook survey of the shad commercial gill net fishery from 1996 to 1999. Mandatory reporting was instituted in 2000 for all shad fishers. American shad harvest data was collected from 11 fishers who supplied landing data for the 2012 spring fishery. A total of 82 trips resulted in 27,368 pounds of gill net harvest (Table 4).

The Catch Per Unit Effort (CPUE) for the Delaware Bay gill net fishery in 2012 was 0.019 pounds of shad per square foot of net set. Although the trends for the upper and lower Delaware Bay have fluctuated throughout the time series, the overall CPUE for Delaware Bay remained consistent until 2008 (Table 5). The 2012 CPUE increased from last year and was above the time series average (0.018). Landings have dropped off considerably since 2008.

There is also a CPUE calculated for the Lewis haul seine fishery in Lambertville, NJ. Records for this fishery date back to 1890 with effort data documented since 1925. The fishery employs seine nets of different length depending on the water flow and depth. Although this may be problematic, the length of the time series still gives a good indication of spawning run strength in the Delaware River.

The Lewis haul seine fishery CPUE averaged 4.64 shad per haul from 1935 to 1947 but declined to an average of only 0.67 shad per haul through 1960 (Table 6, Figure 3). The CPUE started to increase steadily in the early 1970s to its peak in 1992 (50.96) before declining drastically to average only 4.28 since 1999. The 2012 index (2.32) drastically decreased since 2010 and was well below the time series mean of 9.67.

3. Characterization of Other Losses (poaching, bycatch, etc.)

The state of New Jersey presently has no additional data on poaching or bycatch of American shad from other fisheries within the Delaware Basin. There is undoubtedly some bycatch discard loss, especially for male shad, but there is no data as to the severity of this bycatch.

B. Recreational Fishery

1. Characterization of Fishery

The majority of fishing effort for American shad in the Delaware River occurs along a 160 mile stretch from Trenton, NJ to Hancock, NY. This fishery takes place mainly from late March to early June of each year.

2. Characterization of Directed Harvest

The last survey of the recreational fishery was an access point survey in conjunction with an aerial effort survey conducted by Versar, Inc. during 2002. The study area included all tidal and non-tidal waters from the Delaware Memorial Bridge to Downsville, NY. Results of this study were included in previous reports.

3. Characterization of Other Losses (poaching, hook/release mortality, etc.)

a. Estimate and method of estimation

No data were available on poaching or hook and release mortality from the recreational fishery during 2011. There have been at least two studies that developed estimates of hook and release mortality in the Susquehanna River (Lukacovic 1998) and the Hudson River (USFWS/NYDEC 2000 and NYDEC personal communication). These studies produced estimates of release mortality of less than two percent and are used for estimating Delaware River hook and release mortality when data is available.

C. Other Losses

There is presently no data available to estimate other losses of American shad.

D. Estimated Losses

Table 7 shows New Jersey's estimated harvest loss estimates for the Delaware Estuary respectively for 2012.

E. Protected Species

Harvest reporting in the American shad gill net fishery was voluntary prior to new regulations that took effect in January 2000. Although shad fishers are required to report shad landings and effort, bycatch reporting of Atlantic sturgeon remains on a voluntary basis. According to logbooks collected from New Jersey commercial shad fishers there were 11 Atlantic sturgeon caught as bycatch during 2012 in Delaware Bay. All sturgeon were released alive at the time of tending the net. Permit holders are not required to report Atlantic sturgeon interactions however, so this number is an underestimate of the total interactions with commercial shad gill netters throughout the state. The accuracy of reported data is also unquantifiable without onboard observers.

The data was extrapolated to the entire shad fishery for 2012, based on the number caught by cooperating fishers and effort data from all logbooks. Although the number of interactions is still considered an underestimate, the final reported estimate is 24 sturgeon caught.

II. Fishery Independent Monitoring

A. Description of Requirements

According to Amendment 1 of the Plan, Delaware River Basin States are required to perform annual sampling of juvenile abundance and the spawning stock of American shad in the Delaware River and provide estimates of survival or mortality on the Delaware Stock.

B. Description of Work Performed

New Jersey has conducted juvenile abundance monitoring for American shad in the Delaware River since 1980. In previous years, production was estimated through two separate beach seine surveys. Both indices have correlated well since 1994 leading to a proposal by the state of New Jersey to the ASMFC Technical Committee in January 2008 to discontinue the upper river survey as a cost cutting measure. The Technical Committee agreed with the proposal and the upper river juvenile survey was eliminated. In 2012, the non-tidal seining in the upper Delaware River at four historic sites was reinstated by the Delaware River Fish and Wildlife Management Cooperative (Co-op) to allow for a greater degree of confidence in determining long-term monitoring sites and potentially identifying factors influencing young-of-the year recruitment. Data for this sampling may be included in the annual report for Pennsylvania.

In the lower Delaware River, data is collected during the annual striped bass recruitment survey from Trenton to Artificial Island during August through October. This index was recalculated to eliminate many of the zero catches in waters of higher salinity where American shad are less likely to be encountered. The sampling range for the reported geometric mean is from Trenton to the Delaware Memorial Bridge.

C. Results

1. Juvenile Indices

The 2012 juvenile abundance index (JAI) in the lower Delaware River was 4.39, which was a significant decrease from 2011. This value ranked 18th in the time series and was below the long-term, five-year, and ten-year averages of 4.90, 4.49, and 6.34 respectively. (Table 8, Figure 4). The JAI had become highly variable in recent years with two very good year classes (2005 and 2007) and two very poor year classes (2006 and 2008).

a. Length frequency

A subsample of juvenile American shad lengths (fork length) was collected and length frequency was calculated from the beach seine survey (Table 9).

b. Variance

No estimates of variance have been calculated on any of the indices of abundance.

2. Spawning Stock Assessment

Data for the Delaware River may be included in the annual report for the State of Pennsylvania.

III. Other Monitoring

A. Cooperative Tagging Program

New Jersey initiated American shad tagging in Delaware Bay as part of the ASMFC Interstate Cooperative Tagging Program in 1995. Staff utilized drifting gill nets during March through April of 2012 to capture and tag American shad. A total of 4,274 American shad were marked from 1995 to 2013. Eighteen American shad were tagged in 2012. Tagging efforts during spring of 2013 were less encouraging with 17 fish tagged. A more comprehensive program targeting only American shad is necessary to perform the project correctly. Additional recapture data through 2008 can be found in previous annual reports.

RIVER HERRING AND HICKORY SHAD

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of Fishery

The only commercial data on river herring and hickory shad are landing data from the NMFS and mandatory logbooks from New Jersey's small mesh gill net fishery. River herring are taken primarily by gill net or fyke net while hickory shad are landed by gill net or trawl.

2. Characterization of Directed Harvest

a. Landings and method of estimation

Landing estimates for river herring and hickory shad were obtained from the NMFS for 1995 to 1999. River herring estimates for 2000 to 2012 were obtained from mandatory logbooks of the small mesh gill net fishery. During 2012, New Jersey's commercial fishers reported a harvest of 39 pounds of river herring while landings of hickory shad were unavailable (Table 10). There are no estimates of underreporting, however it is assumed that the current data for river herring is grossly underreported since the majority of landings are categorized as bait. Some hickory shad are probably harvested by American shad commercial fishers during the spring fishery but no data is available.

II. Fishery Independent Monitoring

A. Delaware River Juvenile Indices

A juvenile abundance index for blueback herring and alewife is derived from New Jersey's Striped Bass Recruitment Survey in the Delaware River, calculated using a geometric mean (Table 11, Figure 5). This survey has been conducted annually during the summer and fall since 1980. The sampling range for the reported geometric mean for both species is from Trenton to the Delaware Memorial Bridge

The production of juvenile blueback herring for 2012 (0.42) ranked 31^{st} in the 33-year time series and remained below average (9.89). The index shows a serious decline in the overall health of the blueback herring stock within the river and tributaries. Alewife recruitment for 2012 (0.01) was also below the time series average (0.36) and ranked 27^{th} in the time series. These low numbers remain a cause of concern. Production of alewife in the Delaware River continues to be varied with some of the best years of time series mixed in with some of the worst years of the time series. There have been a few young-of-year hickory shad caught in recent years (Table 12). One hickory shad was taken during the 2012 survey period

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Ray Ringen of the Division's Wildlife Conservation Corps (WCC) volunteered their time to assist with the Delaware River Recruitment Survey.

The cooperation of businesses and the general public are greatly appreciated. The Division thanks Mr. George Swickla, Jimmy Richards and personnel of the various marinas whose boat ramps and facilities were utilized by the Division. These include Smokey's Marina in Reed's Beach, River Gate Boat Ramp in West Deptford, and Hawk Island Marina in Delanco and Buttonwood Marina in Bridgeport.

Table 1. New Jersey's net regulations for the harvest of American shad: 2012

System	Season	Gear Limits	Mandatory Reporting	Other Restrictions
Delaware Bay & River	Gill nets: Feb 1-Dec 15 ----------------------------------- Haul Seine: Nov 1-Apr 30	Stretch mesh min.: 2.75" Feb 1-Feb 29 *3.25" Mar 1-Dec 15 Length:2400' Feb 12-May 15 1200' May 16-Dec 15 ----------------------------------- 2.75" min. stretch mesh, max length 420'	YES	Limited entry; gear restrictions in defined areas

*except with special permit

Table 2. New Jersey's American shad harvest, in pounds: 1980-2012

Year	LowDelBay	UpDelBay/River	**Total**	Year	LowDelBay	UpDelBay/River	**Total**
1980	50,600	0	50,600	1999	83,036	5,670	88,706
1981	67,600	0	67,600	2000	78,132	43,299	121,431
1982	132,900	1,100	134,000	2001	27,040	69,098	96,138
1983	49,300	4,300	53,600	2002	15,671	32,746	48,417
1984	41,900	7,400	49,300	2003	6,322	84,198	90,520
1985	48,900	23,100	72,000	2004	5,385	92,073	97,458
1986	63,900	17,700	81,600	2005	41,441	46,543	87,984
1987	109,400	20,200	129,600	2006	9,307	56,847	66,154
1988	80,700	17,300	98,000	2007	9,010	53,818	62,828
1989	62,500	16,800	79,300	2008	5,157	23,877	29,034
1990	212,749	40,364	253,113	2009	3,381	9,264	12,645
1991	150,209	23,092	173,301	2010	4,499	7,721	12,220
1992	114,035	41,765	155,800	2011	5,199	6,855	12,054
1993	123,428	19,552	142,980	**2012**	**7,445**	**19,923**	**27,368**
1994	41,305	9,066	50,371				
1995	61,621	11,811	73,432	1980-2012	53,890	24,724	78,614
1996	17,563	1,100	18,663	2003-2012	9,715	40,112	49,827
1997	34,549	9,250	43,799	2008-2012	5,136	13,528	18,664
1998	14,180	75	14,255	NMFS (1980-1999) and commercial logbooks (2000-2012)			

Table 3. New Jersey's commercial gill net shad landings, roe vs. buck: 1996–2012

Delaware Bay

Year	% Roe	% Buck	Year	% Roe	% Buck
1996	-	-	2005	73.9	26.1
1997	-	-	2006	79.5	20.5
1998	-	-	2007	80.6	19.4
1999	82.6	17.4	2008	77.5	22.5
2000	86	14	2009	80.4	19.6
2001	83.8	16.2	2010	67.2	32.8
2002	69.4	30.6	2011	76.4	23.6
2003	80.3	19.7	**2012**	**85.6**	**14.4**
2004	77.9	22.1	AVG	78.7	21.4

Table 4. New Jersey's gill net effort data for the American shad commercial fishery: 2012

	Upper Bay	Lower Bay[1]	Combined
No. of Fishermen	8	3	11
No. of Man-days	44	38	82
Square Feet of Net	1,338,500	117,600	1,456,100
Pounds Harvested	21,406	5,962	27,368
Lbs/Sq Ft	0.016	0.051	0.019

Table 5. CPUE in New Jersey's American shad commercial gill net fishery: 1999-2012

Delaware Bay			
Year	Upper	Lower	Combined
1999	0.007	0.017	0.016
2000	0.014	0.027	0.020
2001	0.022	0.015	0.019
2002	0.013	0.022	0.015
2003	0.022	0.010	0.020
2004	0.025	0.012	0.023
2005	0.015	0.029	0.019
2006	0.025	0.017	0.023
2007	0.022	0.022	0.022
2008	0.014	0.014	0.014
2009	0.010	0.016	0.011
2010	0.011	0.023	0.014
2011	0.008	0.025	0.013
2012	**0.016**	**0.051**	**0.019**
Mean	0.016	0.021	0.018

Table 6. CPUE in the Lewis haul seine, Delaware River: 1925-2012

Year	# hauls	# shad caught	CPUE (hauls)	Year	# hauls	# shad caught	CPUE (hauls)
1925	458	742	1.62	1969	29	90	3.10
1926	208	661	3.18	1970	25	122	4.88
1927	436	1,061	2.43	1971	54	664	12.30
1928	543	2,174	4.00	1972	64	348	5.44
1929	616	2,706	4.39	1973	69	496	7.19
1930	362	470	1.30	1974	49	417	8.51
1931	501	887	1.77	1975	117	1,738	14.85
1932	450	1,442	3.20	1976	123	1,470	11.95
1933	420	2,325	5.54	1977	110	1,120	10.18
1934	520	1,796	3.45	1978	121	1,226	10.13
1935	328	4,417	13.47	1979	107	2,003	18.72
1936	392	951	2.43	1980	148	1,920	12.97
1937	448	4,161	9.29	1981	118	6,392	54.17
1938	693	3,240	4.68	1982	127	3,789	29.83
1939	506	4,439	8.77	1983	100	1,444	14.44
1940	170	611	3.59	1984	152	2,383	15.68
1941	162	129	0.80	1985	69	2,022	29.30
1942	193	1,096	5.68	1986	99	3,036	30.67
1943	215	3,025	14.07	1987	111	1,830	16.49
1944	44	226	5.02	1988	78	2,778	35.62
1945	144	295	2.05	1989	89	4,646	52.20
1946	118	254	2.15	1990	92	2,332	25.35
1947	358	1,358	3.79	1991	76	2,312	30.42
1948	59	43	0.73	1992	94	4,790	50.96
1949	32	3	0.09	1993	33	347	10.52
1950	51	9	0.18	1994	49	387	7.90
1951	38	25	0.66	1995	66	1,257	19.05
1952	43	27	0.63	1996	57	209	3.67
1953	31	0	0.00	1997	46	550	11.96
1954	26	9	0.35	1998	49	647	13.20
1955	43	36	0.84	1999	43	198	4.60
1956	32	0	0.00	2000	45	183	4.07
1957	12	10	0.83	2001	32	219	6.84
1958	18	54	3.00	2002	52	200	3.85
1959	24	27	1.13	2003	56	293	5.23
1960	19	6	0.32	2004	54	220	4.07
1961	26	90	3.46	2005	36	104	2.89
1962	18	250	13.89	2006	44	73	1.66
1963	70	3,983	56.90	2007	21	71	3.38
1964	90	1,646	18.29	2008	37	83	2.24
1965	48	319	6.65	2009	43	108	2.51
1966	44	77	1.75	2010	35	431	12.31
1967	65	243	3.74	2011	26	50	2.01
1968	27	33	1.22	**2012**	**36**	**142**	**2.32**
						MEAN	9.67

Table 7. New Jersey's estimated American shad losses in Delaware Estuary: 2012

	Number	Mean Weight	Pounds
Commercial (gill net)	6,842	4.00[1]	27,368
Commercial (seine)	142	3.65[2]	518
Recreational	N/A	N/A	N/A
C/R Mortality	N/A	N/A	N/A
Poaching	N/A	N/A	N/A
Total	6,984	-	27,886

1) Based on mean weight data from Delaware Bay sampling in 2012
2) Based on 2008 Delaware River haul seine data

Table 8. Juvenile American shad CPUE (geometric) for the lower Delaware River: 1980-2012

Year	Shad GM	Rank	Year	Shad GM	Rank
1980	0.00	31	1997	3.02	20
1981	0.00	31	1998	7.23	8
1982	0.00	31	1999	7.07	10
1983	0.49	28	2000	9.69	4
1984	0.25	29	2001	5.45	16
1985	0.08	30	2002	0.89	24
1986	0.67	25	2003	9.90	3
1987	1.68	22	2004	5.81	12
1988	0.56	26	2005	9.38	6
1989	9.54	5	2006	0.53	27
1990	5.74	13	2007	15.30	2
1991	2.49	21	2008	1.05	23
1992	7.02	11	2009	4.21	19
1993	5.66	14	2010	4.61	17
1994	7.14	9	2011	8.18	7
1995	5.51	15	2012	4.39	18
1996	18.21	1	1980-2012	4.90	
			2003-2012	6.34	
			2008-2012	4.49	

Table 9. Mean length (fl, mm) of juvenile American shad in the Delaware River: 2012

	Aug1	Aug2	Sept1	Sept2	Oct1	Oct2
LOWER DELAWARE (Regions 1 & 2)	64.8	67.7	69.3	69.9	70.8	72.5

Table 10. New Jersey commercial river herring and hickory shad landings (pounds):1995-2012

YEAR	RIVER	HICKORY

1995	795	26
1996	4,449	0
1997	4,515	140
1998	7,371	2,743
1999	1,377	1,326
2000	2,246	0
2001	2,881	0
2002	1,303	0
2003	3,439	327
2004	4,583	127
2005	3,247	0
2006	2,945	125
2007	223	808
2008	1,890	0
2009	489	N/A
2010	1,322	N/A
2011	1,855	N/A
2012	39	N/A

Table 11. Delaware River juvenile river herring indices, geometric mean: 1980-2012

YEAR	ALEWIFE	RANK	BLUEBACK	RANK
1980	0.00	29	30.3	2
1981	0.00	29	0.26	32
1982	0.10	22	3.19	24
1983	0.28	11	46.15	1
1984	0.00	29	16.99	8

1985	0.06	23	7.17	17
1986	0.52	5	18.13	6
1987	0.23	16	10.72	10
1988	3.17	1	9.03	13
1989	0.26	12	17.9	7
1990	0.26	12	4.63	20
1991	0.26	12	9.84	11
1992	0.47	7	6.91	18
1993	0.35	9	19.78	5
1994	0.19	17	2.38	26
1995	0.11	21	1.84	27
1996	1.96	2	24.97	4
1997	0.15	19	2.58	25
1998	0.03	26	4.36	21
1999	0.41	8	5.34	19
2000	0.14	20	12.33	9
2001	0.83	4	26.33	3
2002	0.00	29	0.62	30
2003	0.30	10	7.5	16
2004	0.24	15	8.15	14
2005	0.95	3	9.79	12
2006	0.00	29	0.15	33
2007	0.52	5	4.29	22
2008	0.01	27	1.37	28
2009	0.06	23	3.55	23
2010	0.05	25	1.37	28
2011	0.19	17	7.97	15
2012	0.01	27	0.42	31
1980-2012	0.37		9.89	
2003-2012	0.23		4.46	
2008-2012	0.06		2.94	

Table 12. Delaware River hickory shad caught, in number: 1980-2012

Year	Hickory shad	Year	Hickory shad
1980	0	1996	0
1981	0	1997	0

1982	0	1998	0
1983	0	1999	0
1984	0	2000	3
1985	0	2001	4
1986	0	2002	0
1987	0	2003	3
1988	2	2004	8
1989	0	2005	4
1990	0	2006	0
1991	0	2007	6
1992	0	2008	1
1993	0	2009	0
1994	0	2010	1
1995	0	2011	5
		2012	1
		TOTAL	38

Figure 1. New Jersey's American shad commercial harvest, in pounds: 1980-2012

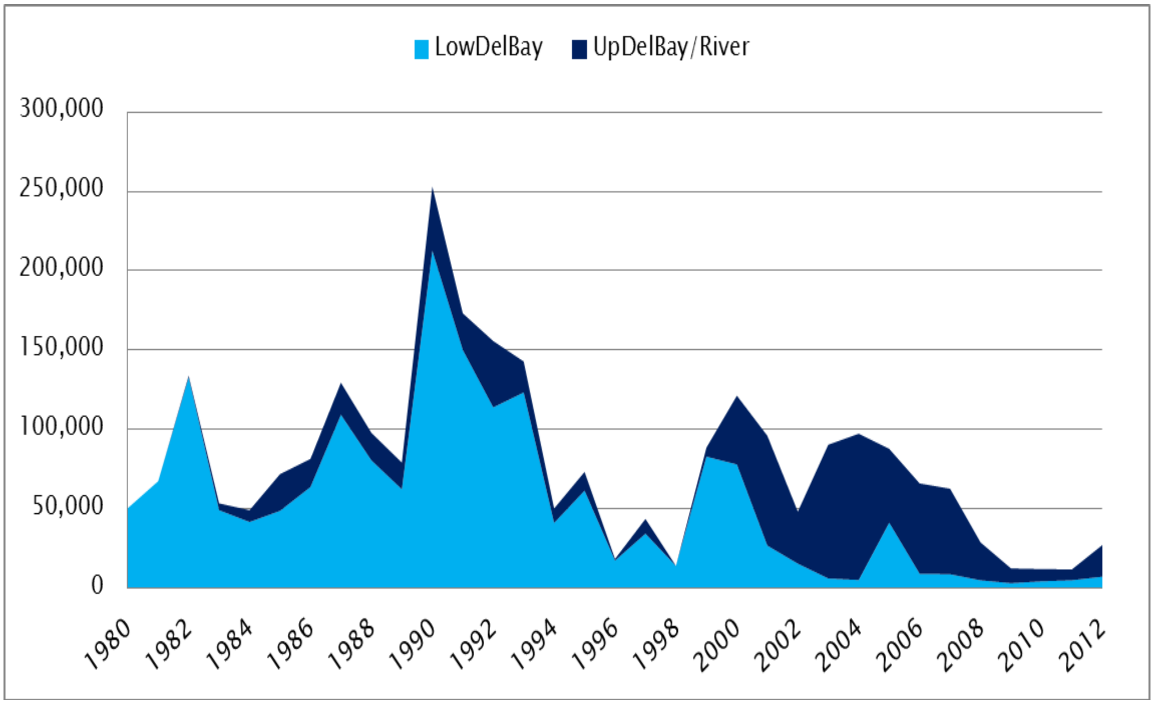


Figure 2. Delaware Bay American shad gill net length frequencies (sexes combined): 1997-2012

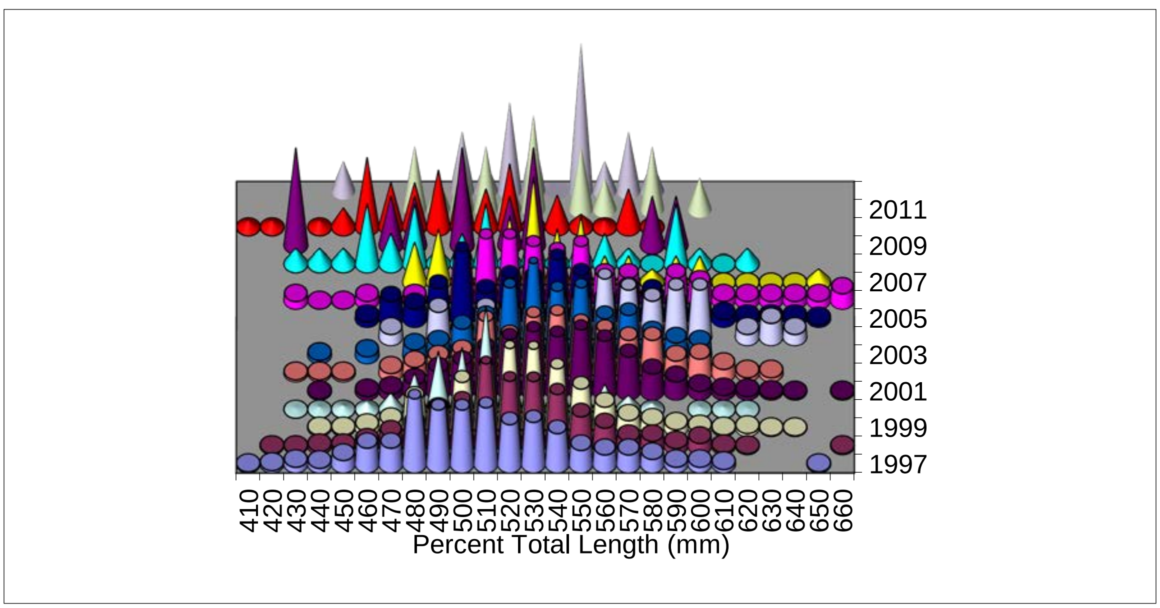


Figure 3. CPUE in the Lewis haul seine, Delaware River: 1925-2012

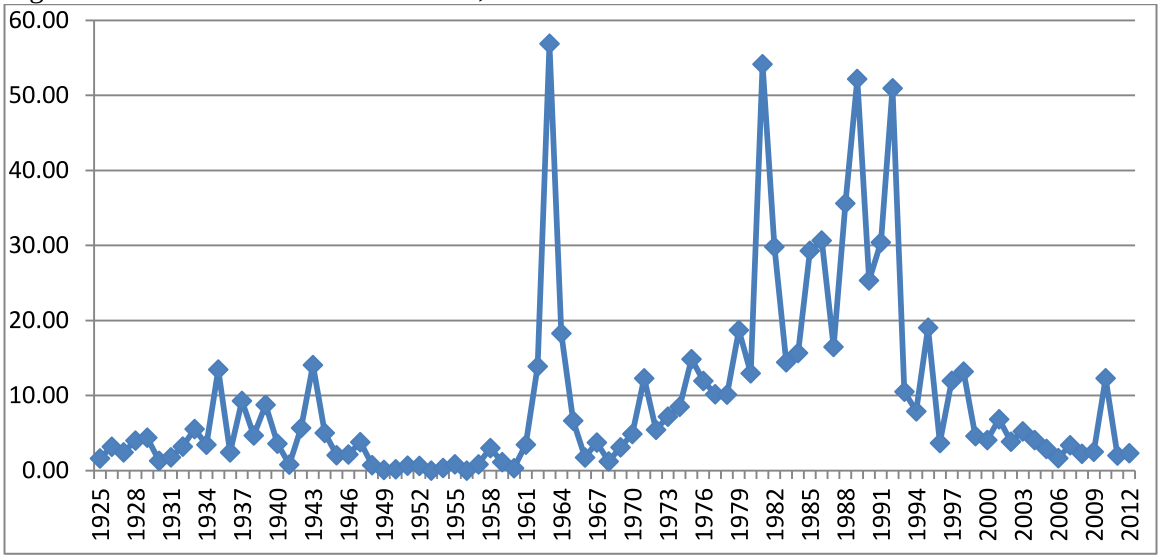


Figure 4. Juvenile American shad CPUE (geometric) for the lower Delaware River: 1980-2012

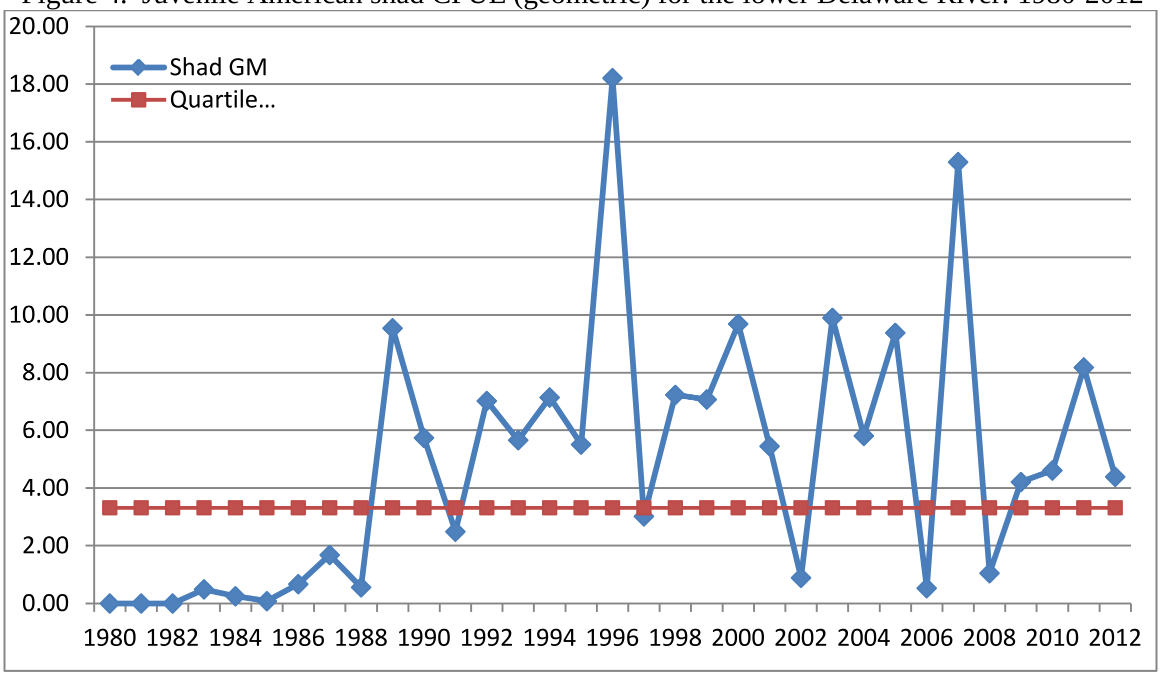
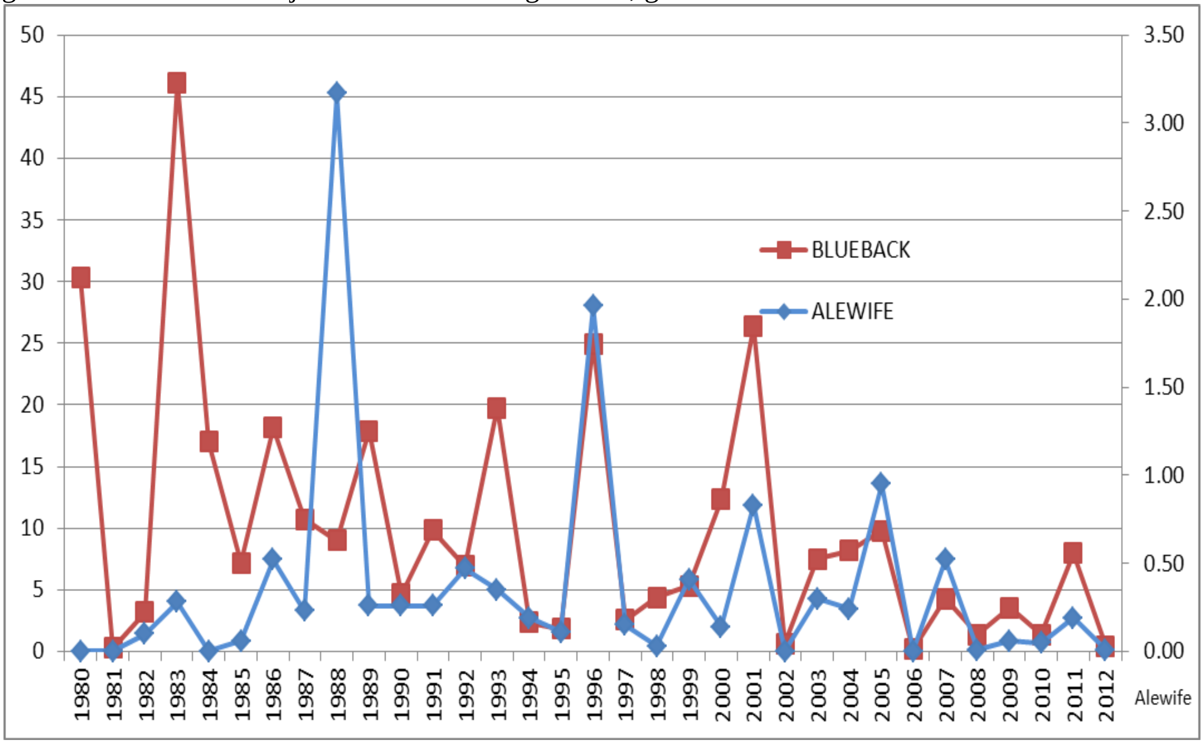


Figure 5. Delaware River juvenile river herring indices, geometric mean: 1980-2012



Pennsylvania

Susquehanna River

American Shad, Hickory shad and River Herring Annual Report (2012)

Submitted to:
Atlantic States Marine Fisheries Commission
to fulfill the requirements of Amendment 1 to the
Interstate Fishery Management Plan for Shad and River Herring

June 30, 2013

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AMERICAN SHAD

Introduction

I. Harvest and Losses

A. Commercial Fishery

Pennsylvania does not permit commercial harvest of American shad *(Alosa sapidissima*).

B. Recreational Fishery

1. Characterization of Fishery

Pennsylvania has no allowable recreational fishery harvest of American shad in the Susquehanna River basin. A year-round closed season is in effect, although limited catch-and-release fishing does occur in years when sufficient numbers of fish pass upstream into PA waters.

2. Characterization of Directed Harvest of American shad

A year-round closed season is in effect.

3. Characterization of Other Losses (poaching, hook/release mortality, etc.)

Losses due to poaching or hook and release mortality were not characterized in 2012. Incidental American shad catch and release fishing and any associated mortality has not been monitored.

C. Other Losses

During 2012, 132 mortalities were noted from the fish lifts or holding tanks (Table 2). A total of 875 adult American shad were used for broodstock in restoration activities. Some 136 shad were sacrificed for research activities. The mean weight of a sample of American shad sacrificed for these activities was used to compute the mean weight. Total weight was estimated by multiplying the mean weight by the number sacrificed.

D.

Table 1. American shad mortality and removals from the Conowingo Dam East and West Fish Lifts.

YEAR	LIFTS & HOLDING	TRUCKING	BROOD STOCK	RESEARCH/ EDUCATION	TOTAL
1997	N/A	58	1,139	557	1,754
1998	N/A	75	1,095	130	1,300
1999	2,478	105	2,553	583	5,719
2000	517	N/A	290	389	1,196
2001	N/A	N/A	2,392	216	2,608
2002	N/A	N/A	2,655	187	2,842
2003	12	N/A	1,837	196	2,045
2004	216	N/A	1,055	0	1,271
2005	116	463	1,012	77	1,668
2006	267	52	1,516	80	1,915
2007	105	N/A	1,504	46	1,655
2008	5	197	1,010	52	1,264
2009	275	15	752	129	1,171
2010	433	0	1,100	129	1,662
2011	132	0	875	138	1,145
2012	289	0	481	745	1,515

Table 2. American shad losses at upstream Dams, Susquehanna River, 2012

2012	LIFTS & HOLDING	RESEARCH/ EDUCATION
Holtwood	0	0
Safe Harbor	0	0
York Haven	0	0
Bio-monitoring	0	0

Table 3. Harvest Losses (number and weight in pounds) of American shad in the Susquehanna River: 2012

Mortality Source	Number	Mean wt.	Pounds
Commercial	0	…	0
Recreational	0	…	0
Catch & Release	Unknown (expected to be nominal)	…	…
Poaching	Unknown (expected to be nominal)	…	…
Research/Broodstock	1,226	2.051 lbs	2,514
Upstream passage at dam sites	?	2.051 lbs	?
Trucked out of system	?		?
Downstream passage at dam sites	Unknown	…	…
Lifts and holding	289	2.051 lbs	593
Total	1,515	2.051 lbs	3,107

Downstream Turbine Passage Mortality:

Susquehanna River turbine passage survival studies for adult American shad have been performed only at Safe Harbor Dam. One-hour survival of adult American passing through turbines at Safe Harbor Dam was estimated at 88.3 percent% survival (90% CI = 84.2% - 91.7%). Twenty-four to forty-eight hour survival was 86.2% percent.

One-hour survival of juvenile American shad passing through a Kaplan turbine, operated at 55- to 56%- wicket gate opening, at Conowingo Dam was 94.9% (RMC Environmental Services, Inc. 1993). Forty-eight hour survival was 92.9 percent%.

One-hour survival of juvenile American shad passing through Francis turbines at Holtwood Dam was 89 percent% (Mathur and Heisey 1993). Twenty-four hour survival was 78% percent.

One-hour survival of juvenile American shad passing through turbines at Safe Harbor Dam was 98%%, 97.8% and 98.9% for Kaplan, mixed flow (unvented) and mixed flow (vented) turbines, respectively (Heisey et al. 1992). Forty-eight hour survival was 98%, 100%, and 67% (adjusted for controls) for Kaplan, mixed flow (un-vented) and mixed flow (vented) turbines, respectively.

One-hour survival of juvenile American shad passing through turbines at York Haven Dam was 92.7% and 77.1% for a vertical shaft Kaplan (Unit 3) and a dual vertical shaft Francis turbine, respectively (Normandeau Associates, 2002). Adjusted forty-eight hour survival exceeded the one-hour survival and was not utilized.

Operational strategies for maximizing turbine survival of out-migrating juvenile American shad are in place at all four Susquehanna River hydroelectric projects. At Conowingo, the downstream juvenile plan calls for preferential use of low mortality Kaplan or mixed flow turbines during the hours of 1700 to- 2300 during October and November (RMC Environmental Services, Inc.

1994). When river flows exceed 40,000 cubic feet per second, higher mortality Francis turbines may be operated. This plan ensures that turbine passage survival is greater than > 94 percent% at Conowingo Dam .Dam.

The downstream juvenile protocol at Holtwood requires selective evening use of single-runner Francis units closest to the eastern end of the powerhouse where fish historically gather and, spilling at the trash sluice to draw fish from outside the skimmer wall or along the face of the dam.

The juvenile downstream passage protocol at Safe Harbor requires that the project selectively utilize one or more of the large new units (9-12) at full capacity during evening hours in October and November.

The juvenile downstream passage protocol at York Haven Dam provides for monitoring the forebay to determine when out-migrating juveniles arrive at the project and starting "Downstream Operation" when juveniles arrive. Downstream Operation begins each evening at sunset and continues until about 23:30 hours. Downstream Operation includes: turning on temporary lighting at the trash sluiceway and opening the sluiceway, preferentially operating only Units 1-6 when river flow is insufficient for operation of any of the remaining units, operating Units 7-20 only when river flow exceeds the hydraulic capacity of available Units 1-6, and ceasing Downstream Operation at the end of the run, based on monitoring and sampling in the forebay to determine when the juvenile shad emigration has ended for the season.

E. Protected species Atlantic sturgeon bycatch estimates

No sturgeon have been reported using the fish passage structures on the Susquehanna River.

II. Fishery Independent Monitoring

A. Description of Requirements in Amendment III

• Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock
• Calculation of mortality and/or survival estimates where possible
• JAI: Juvenile abundance survey (GM)
• Hatchery Evaluation
(Cooperative effort between Pennsylvania and Maryland)

B. Brief Description of Work Performed

1. Annual American Shad Passage Counts

American shad were counted as they passed all four of the lower Susquehanna River hydroelectric dams: Conowingo, Holtwood, Safe Harbor and York Haven.

2. Spawning Stock Survey for Biological Data

The American shad spawning stock for the Susquehanna River upstream of Conowingo Dam was systematically sampled from catches in the West Fish Lift at Conowingo Dam. Every 50th or 100th American shad was sacrificed for otolith, scale and other biological measurements. In 2012, these catches were supplemented by additional adult shad used for hatchery broodstock, also collected from the Conowingo West Fish Lift.

3. American Shad Juvenile Indices

Juvenile indices from haul seining utilized two sites in 2012. CPUE is reported as the geometric mean catch of approximately 84 hauls (six hauls per day, one day per week) between mid-July and mid-October.

4. Hatchery Evaluation

Both adults, captured at the Conowingo Dam West Fish Lift, and juveniles, captured in the haul seining were evaluated for OTC tags.

C. Results

American shad passage on the Susquehanna River increased from 1972 to 2001, primarily due to hatchery augmentation, and has declined since 2001 (Figures 1 and 2). Based on the frequency of otolith tagging, both hatchery and wild components followed this trend (Figure 2). Hatchery fish dominated the catch in the early years of the restoration effort but recent catches have been about 25-40% hatchery. Passage (expressed as a percentage of shad that passed the next lowest dam) at Holtwood, Safe Harbor and York Haven Dams has averaged 31%, 72% and 10%, respectively. Cumulative passage of shad from Conowingo Dam to above York Haven Dam, where the majority of the historical spawning habitat was, averaged 2%. At this rate, 80 million shad would have to pass Conowingo to reach the goal of 2 million shad above York Haven. Restoration partners are working to improve shad passage in conjunction with FERC re-licensing.

Abundance of YOY American shad has generally declined on the Susquehanna River since 2000 when trap and transplant of adults was suspended (Figure 3). This decline is, in part, a result of fewer adults reaching the spawning grounds due to poor fish passage effectiveness, particularly at Holtwood and York Haven Dams. In 2001, more than 16 thousand adults passed York Haven Dam, accounting for the relatively high abundance of YOY in that year.

In addition, production of hatchery larvae has declined since 2003 due the loss of the Hudson River as an egg source, disease issues in the hatchery (in some years), and high river flow (in some years), which reduced survival of hatchery fry (Table 15).

It is clear that successful shad restoration will not be possible on the Susquehanna River unless fish passage can be significantly improved.

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Figure 1. American shad passage at Susquehanna River Dams

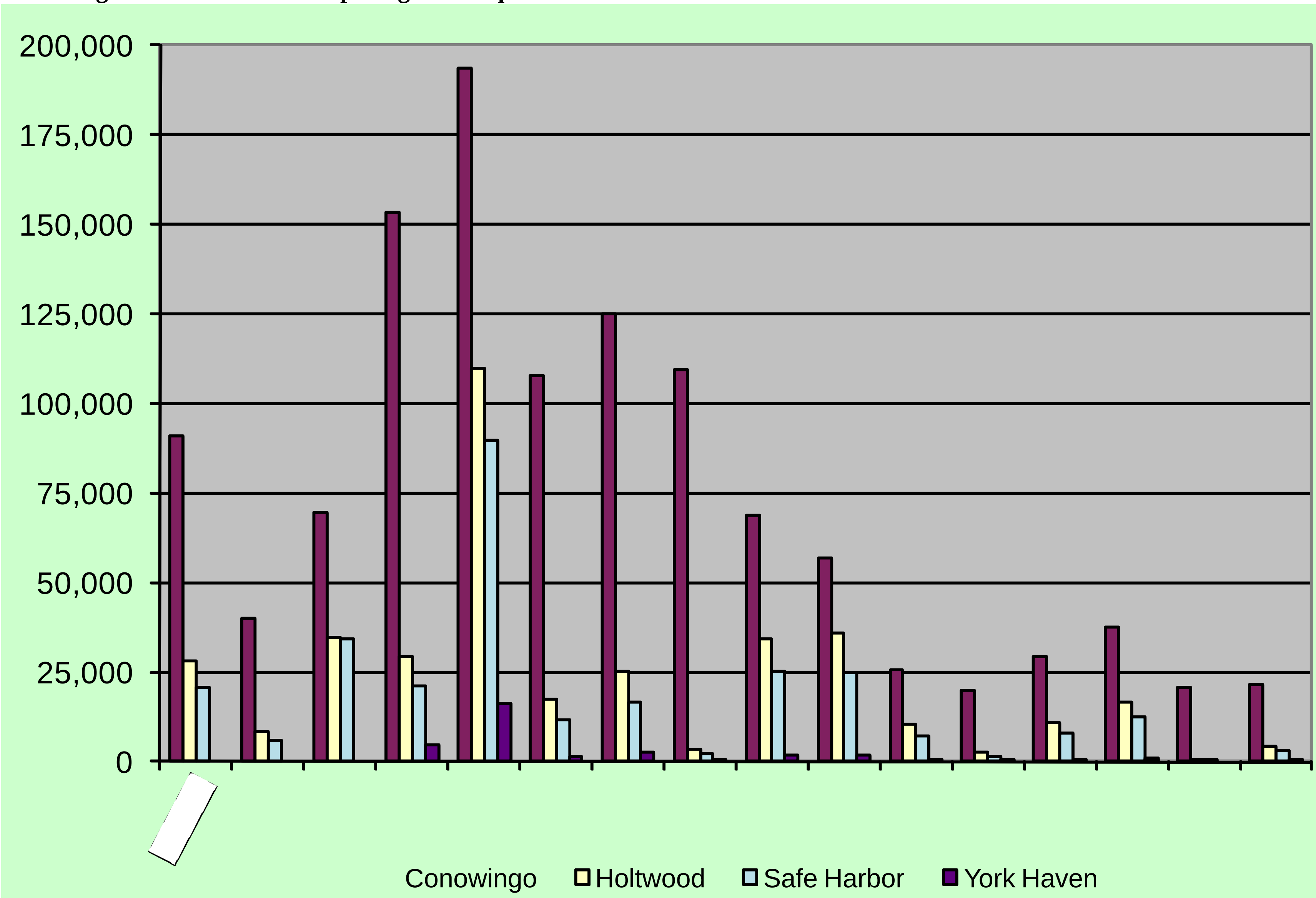

Figure 2. Number of American shad captured by origin, at the Conowingo Dam fish lifts, Susquehanna River.

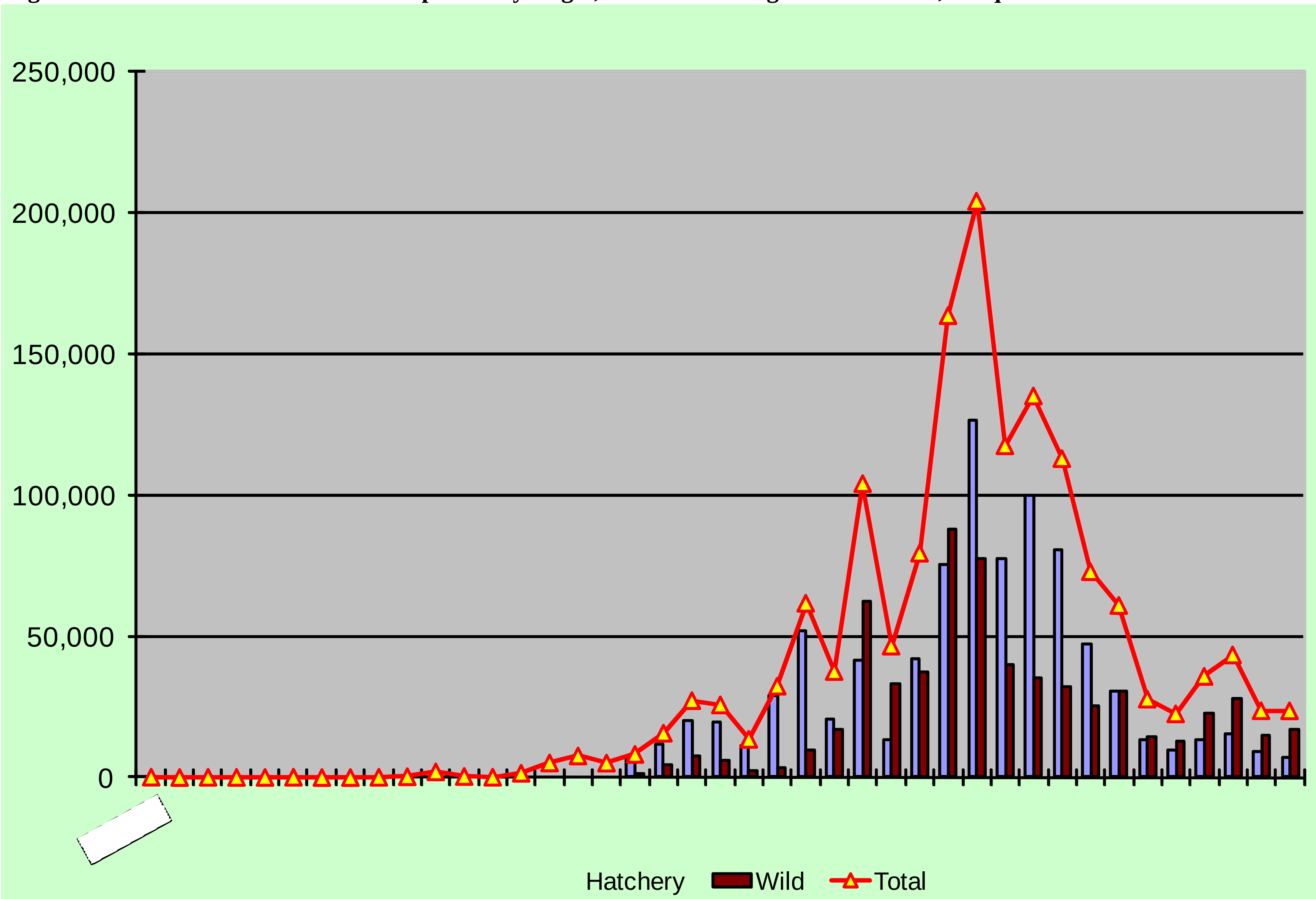

Figure 3. Abundance of YOY American shad collected by lift net at Holtwood Dam and haul seine at Columbia, Susquehanna River. Lift net data is area-under-the-curve and haul seine is GM CPUE.

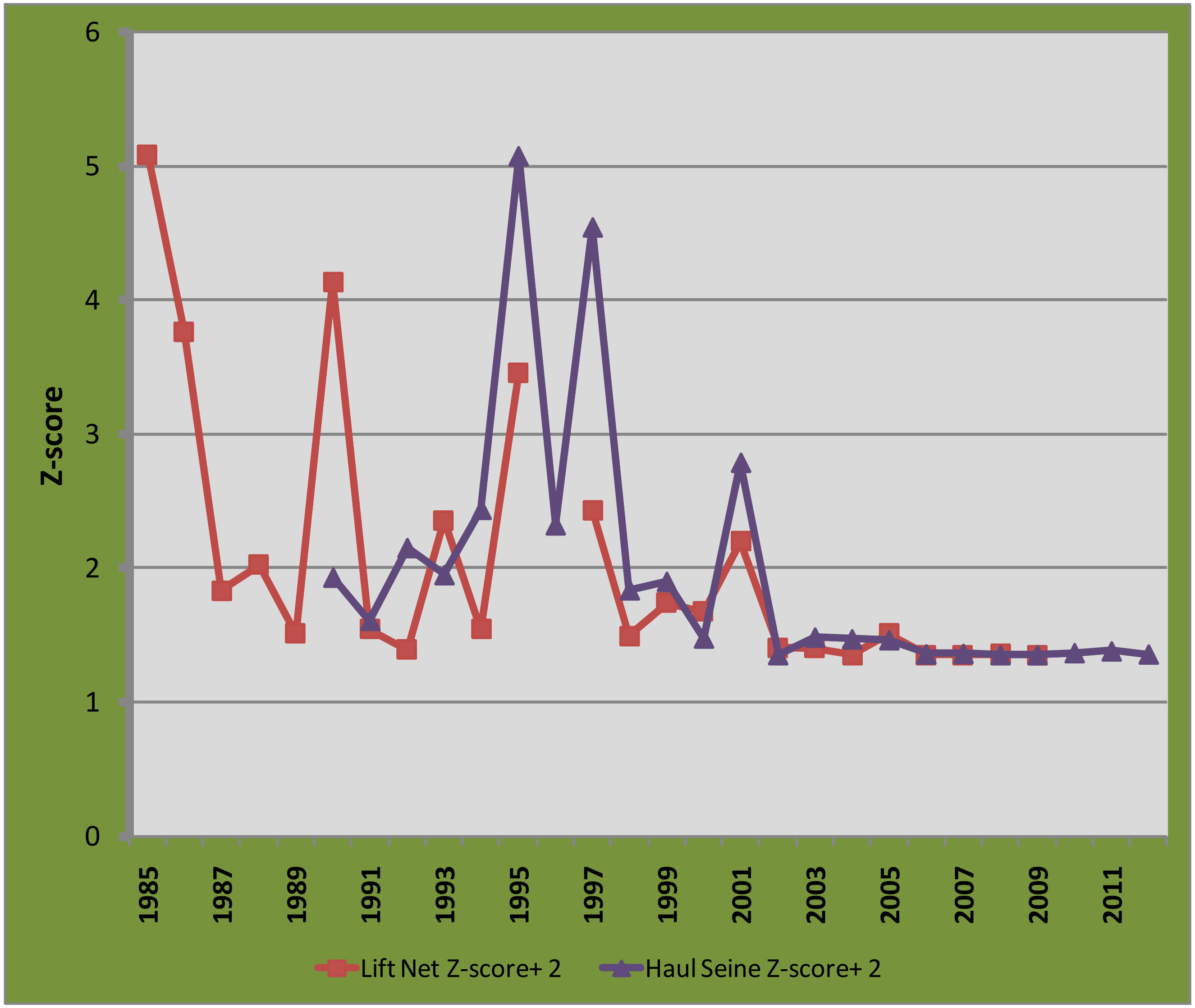

Table 4. Number of American shad counted at Susquehanna River fish passage facilities.

	Susquehanna River					
	Conowingo Dam					
	East Lift, RM 10	West Lift, RM 10	Total	Holtwood Dam, RM 25	Safe Harbor Dam, RM 32	York Haven Dam, RM 56
1997	90,971	12,974	103,945	28,063	20,828	No passage
1998	39,904	6,577	46,481	8,235	6,054	No passage
1999	69,712	8,451	78,163	34,702	34,210	No passage
2000	153,546	9,785	163,331	29,421	21,079	4,687
2001	193,574	10,940	204,514	109,976	89,816	16,200
2002	108,001	9,347	117,348	17,522	11,705	1,555
2003	125,135	10	134,937	25,254	16,646	2,534
2004	109,360	3,426	112,786	3,428	2,109	219
2005	68,926	3,896	72,822	34,189	25,425	1,772
2006	56,899	3,970	60,689	35,968	24,929	1,913
2007	25,464	2,301	27,765	10,338	7,215	192
2008	19,914	2,627	22,541	2,795	1,252	21
2009	29,272	6,534	35,806	10,896	7,994	402
2010	37,757	5,605	43,362	16,472	12,706	907
2011	20,571	3,074	23,645	21	8	0
2012	22,143	1,486	23,629	4,238	3,089	224

Table 5. Hatchery contribution for adult American shad collected from the Susquehanna River.

	Conowingo Dam West fish lift		
	N	Number marked	% marked
1997	250	100	40.0%
1998	130	38	29.2%
1999	188	100	53.2%
2000	193	89	46.1%
2001	208	129	62.0%
2002	182	120	65.9%
2003	197	146	74.1%
2004	158	114	72.2%
2005	274	178	65.0%
2006	177	88	49.7%
2007	155	74	47.7%
2008	176	76	43.2%
2009	173	66	38.2%
2010	176	62	35.2%
2011	133	50	37.6%
2012	129	37	28.7%

Table 6. Sex ratio of American shad collected in the Susquehanna River.

	Susquehanna		
	Males	**Females**	**M:F ratio**
1993	90	45	1: 0.5
1994		no sex data	
1995	333	237	1: 0.7
1996	215	153	1: 0.7
1997	172	82	1: 0.5
1998	68	72	1: 1.1
1999	104	89	1: 0.9
2000	136	59	1: 0.4
2001	85	114	1: 1.3
2002	75	112	1: 1.5
2003	85	101	1: 1.2
2004	74	88	1: 1.2
2005	127	148	1: 1.2
2006	74	106	1: 1.4
2007	54	104	1: 1.9
2008	88	91	1: 1.0
2009	107	67	1: 0.6
2010	105	93	1: 0.9
2011	71	67	1: 0.9
2012	57	72	1: 1.3

Table 7. Length Frequency of adult American shad collected in the fish lifts at Conowingo Dam.

Males	TL - mm																		
	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	Total
1993			2	3	17	17	18	27	6										90
1994	no data																		
1995*				1	1	18	31	80	107	71	18	4	2						333
1996*					2	11	45	56	44	32	13	9	2			1			215
1997*						12	48	47	34	24	6	1							172
1998*						1	6	13	26	19	2	1							68
1999*					1	8	13	40	22	15	4	1							104
2000*							7	32	55	27	12	3							136
2001						1	4	5	20	34	20	1							85
2002						2	11	5	9	14	24	8	2						75
2003							8	12	27	24	12			2					85
2004	1				2	5	2	14	15	19	12	3	1						74
2005					2	2	18	26	33	31	11	4							127
2006						6	9	21	21	12	4	1							74
2007							11	20	11	7	5								54
2008					1	15	17	23	19	12	1								88
2009						10	35	39	17	3	3								107
2010						4	8	24	48	19	2								105
2011					1	1	3	12	27	20	7								71
2012					1	6	16	15	9	4	5	1							57
	1	0	2	4	28	119	310	511	550	387	161	37	7	2	0	1	0	0	

Females																			
	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	Total
1993						3	9	7	7	14	4	1							45
1994	no data																		
1995*					1	1		2	6	64	91	47	14	8	2	1			237
1996*						2	2	1	11	28	36	49	17	7					153
1997*							2	3	4	28	20	12	10	3					82
1998*									4	11	27	24	6						72
1999*						1		3	12	20	26	14	8	4		1			89
2000*									3	14	12	21	5	4					59
2001									3	16	36	39	18	2					114
2002									1	4	14	32	42	15	4				112
2003									5	11	14	19	21	23	7	1		1	101
2004								1	4	10	24	26	12	11					88
2005							2	1	6	19	44	34	29	11	2				148
2006								5	10	28	33	21	9						106
2007						1			6	25	36	23	9	4					104
2008							1	2	14	25	28	13	7	1					91
2009								3	12	25	20	6	1						67
2010								1	12	31	42	4	1	1				1	93
2011									4	13	29	19	2						67
2012								3	7	11	28	19	4						72
	0	0	0	0	1	8	16	32	131	397	564	423	215	94	15	3	0	2	

Table 7. (continued)

Sexes combined																			
	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	Total
1993	0	0	2	3	17	20	27	34	13	14	4	1	0	0	0	0	0	0	135
1994	no data																		
1995*	0	0	0	1	2	19	31	82	113	135	109	51	16	8	2	1	0	0	570
1996*	0	0	0	0	2	13	47	57	55	60	49	58	19	7	0	1	0	0	368
1997*	0	0	0	0	0	12	50	50	38	52	26	13	10	3	0	0	0	0	254
1998*	0	0	0	0	0	1	6	13	30	30	29	25	6	0	0	0	0	0	140
1999*	0	0	0	0	1	9	13	43	34	35	30	15	8	4	0	1	0	0	193
2000*	0	0	0	0	0	0	7	32	58	41	24	24	5	4	0	0	0	0	195
2001	0	0	0	0	0	1	4	5	23	50	56	40	18	2	0	0	0	0	199
2002	0	0	0	0	0	2	11	5	10	18	38	40	44	15	4	0	0	0	187
2003	0	0	0	0	0	0	8	12	32	35	26	19	21	25	7	1	0	1	186
2004	1	0	0	0	2	5	2	15	19	29	36	29	13	11	0	0	0	0	161
2005	0	0	0	0	2	2	20	27	39	50	55	38	29	11	2	0	0	0	275
2006	0	0	0	0	0	6	9	26	31	40	37	22	9	0	0	0	0	0	180
2007	0	0	0	0	0	1	11	20	17	32	41	23	9	4	0	0	0	0	158
2008	0	0	0	0	1	15	18	25	33	37	29	13	7	1	0	0	0	0	179
2009	0	0	0	0	0	10	35	42	29	28	23	6	1	0	0	0	0	0	174
2010	0	0	0	0	0	4	8	25	60	50	44	4	1	1	0	0	0	1	198
2011	0	0	0	0	1	1	3	12	31	33	36	19	2	0	0	0	0	0	138
2012	0	0	0	0	1	6	16	18	16	15	33	20	4	0	0	0	0	0	129
	1	0	2	4	29	127	326	543	681	784	725	460	222	96	15	4	0	2	

*TL estimated from FL according to: TL= FL * 1.117 + 6.674

Table 8. Mean total length and weight for adult American shad collected in the fish lifts at Conowingo Dam.

	Males						Females						Combined					
	N	Mean Total Length (mm)	SD	N	Mean Weight (g)	SD	N	Mean Total Length (mm)	SD	N	Mean Weight (g)	SD	N	Mean Total Length (mm)	SD	N	Mean Weight (g)	SD
1993	x	404	36				45	457	37				135	422	44			
1995*	333	456	33	333	889	205	237	513	32	237	1371	284	624	479	43	624	1090	342
1996*	215	452	41	208	808	227	156	507	79	150	1413	292	371	475	66	358	1062	394
1997*	172	441	32	172	797	187	82	509	38	82	1441	349	254	463	47	254	1005	392
1998*	68	461	26	68	783	149	62	519	27	62	1295	261	130	489	39	130	1027	331
1999*	104	445	32	104	739	145	89	478	40	89	1201	251	193	474	47	193	966	318
2000*	136	465	26	136	862	169	59	493	32	59	1346	292	195	483	39	195	1026	327
2001	85	479	28	86	912	180	114	524	25	114	1372	215	199	505	34	200	1174	304
2002	75	481	44	75	1041	303	112	550	27	112	1618	347	187	523	49	187	1387	434
2003	95	474	36	95	1032	293	102	547	44	101	1735	443	197	512	54	196	1394	516
2004	74	463	48	75	947	255	88	528	34	88	1474	315	163	498	52	164	1232	390
2005	127	458	35	127	907	228	148	526	35	148	1508	333	277	495	49	277	1229	416
2006	74	450	33	74	860	197	106	507	31	106	1311	307	180	483	42	180	1125	347
2007	54	451	31	54	859	205	106	514	31	106	1424	289	160	493	43	160	1233	376
2008	88	436	32	88	759	194	91	503	32	90	1242	311	179	470	46	178	1003	354
2009	107	432	25	107	754	153	67	492	25	67	1199	235	174	456	39	174	925	287
2010	105	454	24	103	900	179	93	500	29	92	1318	271	199	475	35	196	1095	308
2011	71	465	29	71	863	196	67	512	23	67	1269	206	138	488	35	138	1060	286
2012	57	440	39	56	757	209	74	511	32	74	1319	245	134	479	50	133	1075	363

*TL estimated from FL according to: TL= FL * 1.117 + 6.674

Table 9. Age frequency of adult American shad collected in the fish lifts at Conowingo Dam.

Males													
Otolith Age													Mean
	2	3	4	5	6	7	8	9	10	11	??	Total	Age
1995	0	11	75	82	14	2	0	0	0	0	7	**191**	**4.6**
1996	4	79	70	47	1	2	0	0	0	0	10	**213**	**3.8**
1997	0	61	82	17	5	0	0	0	0	0	2	**167**	**3.8**
1998	0	4	36	27	0	0	0	0	0	0	0	**67**	**4.3**
1999	0	19	62	16	2	0	1	0	0	0	1	**101**	**4.1**
2000	0	19	85	25	5	0	0	0	0	0	0	**134**	**4.1**
2001	0	4	29	42	7	0	0	0	0	0	0	**82**	**4.6**
2002	0	16	15	31	9	2	0	1	0	0	1	**75**	**4.6**
2003	0	4	49	17	17	2	1	0	0	0	2	**92**	**4.6**
2004	0	13	12	33	8	5	1	0	0	0	0	**72**	**4.8**
2005	0	7	62	28	22	3	1	0	0	0	1	**124**	**4.6**
2006	1	5	32	27	7	0	0	0	0	0	0	**72**	**4.5**
2007	0	1	25	16	9	0	0	0	0	0	0	**51**	**4.6**
2008	0	17	35	23	10	1	0	0	0	0	0	**86**	**4.3**
2009	0	0	74	26	6	0	0	0	0	0	0	**106**	**4.4**
2010	0	6	21	50	1	0	0	0	0	0	4	**82**	**4.6**
2011	0	1	15	38	17	0	0	0	0	0	0	**71**	**5.0**
2012	0	17	12	21	4	3	0	0	0	0	0	**57**	**4.4**
Total	**5**	**284**	**791**	**566**	**144**	**20**	**4**	**1**	**0**	**0**	**28**	**1843**	**4.4**

Females													
	Otolith Age												Mean
	2	3	4	5	6	7	8	9	10	11	??	Total	Age
1995	0	0	14	86	28	7	0	0	0	0	5	**140**	**5.2**
1996	0	3	44	74	16	5	0	0	0	0	12	**154**	**4.8**
1997	1	2	28	27	21	2	0	0	0	0	1	**82**	**4.9**
1998	0	0	12	34	14	1	0	0	0	0	0	**61**	**5.1**
1999	0	0	24	46	13	2	0	0	0	0	4	**89**	**4.9**
2000	0	1	13	27	14	2	0	0	0	0	0	**57**	**5.1**
2001	0	0	18	56	34	4	0	0	0	0	0	**112**	**5.2**
2002	0	0	13	43	42	9	3	0	0	0	2	**112**	**5.5**
2003	0	1	12	30	44	13	1	0	0	0	0	**101**	**5.6**
2004	0	0	5	43	16	18	2	0	0	0	0	**84**	**5.6**
2005	0	2	18	33	71	16	4	1	0	1	2	**148**	**5.7**
2006	0	0	14	66	14	8	1	1	0	0	0	**104**	**5.2**
2007	0	0	10	29	57	2	2	0	0	0	0	**100**	**5.6**
2008	0	0	10	31	40	8	1	0	0	0	0	**90**	**5.5**
2009	0	0	15	34	11	4	0	0	0	0	0	**64**	**5.1**
2010	0	0	7	57	10	1	1	0	0	0	4	**80**	**5.1**
2011	0	0	0	20	42	3	0	0	0	0	2	**67**	**5.7**
2012	0	0	5	21	35	15	0	0	0	0	0	**76**	**5.8**
Total	**1**	**9**	**262**	**757**	**522**	**120**	**15**	**2**	**0**	**1**	**32**	**1721**	**5.3**

Table 9. (continued)

Sexes Conbined													
	Otolith Age												Mean
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**??**	**Total**	**Age**
1995	0	11	89	168	42	9	0	0	0	0	12	**331**	**4.8**
1996	4	82	114	121	17	7	0	0	0	0	22	**367**	**4.2**
1997	1	63	110	44	26	2	0	0	0	0	3	**249**	**4.2**
1998	0	4	48	61	14	1	0	0	0	0	0	**128**	**4.7**
1999	0	19	86	62	15	2	1	0	0	0	5	**190**	**4.4**
2000	0	20	98	52	19	2	0	0	0	0	0	**191**	**4.4**
2001	0	4	47	98	41	4	0	0	0	0	0	**194**	**5.0**
2002	0	16	28	74	51	11	3	1	0	0	3	**187**	**5.1**
2003	0	5	61	47	61	15	2	0	0	0	2	**193**	**5.1**
2004	0	13	17	76	24	23	3	0	0	0	0	**156**	**5.2**
2005	0	9	80	61	93	19	5	1	0	1	3	**272**	**5.2**
2006	1	5	46	93	21	8	1	1	0	0	0	**176**	**4.9**
2007	0	1	35	45	66	2	2	0	0	0	0	**151**	**5.3**
2008	0	17	45	54	50	9	1	0	0	0	0	**176**	**5.0**
2009	0	0	89	60	17	4	0	0	0	0	0	**170**	**4.6**
2010	0	6	28	107	11	1	1	0	0	0	8	**162**	**4.8**
2011	0	1	15	58	59	3	0	0	0	0	2	**138**	**5.4**
2012	0	17	17	42	39	18	0	0	0	0	0	**133**	**5.2**
Total	**6**	**293**	**1053**	**1323**	**666**	**140**	**19**	**3**	**0**	**1**	**60**	**3564**	**4.8**

Table 10. Total length at age of adult American shad collected in the fish lifts at Conowingo Dam.

Otolith age										
Male	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1995*		410	445	466	477	529				
1996*	392	424	463	484	526	492				
1997*		416	447	488	481					
1998*		431	454	473						
1999*		420	443	472	482		509			
2000*		454	460	488	515					
2001		478	465	486	494	480				
2002		419	471	502	527	509		536		
2003		429	458	488	512	510	512			
2004		366	387	430	444	477	410			
2005		411	441	474	496	492	510			
2006	442	394	442	460	483					
2007		432	439	451	484					
2008		397	433	457	469	451				
2009			426	445	471					
2010		408	446	464	463					
2011		385	447	466	485					
2012		404	430	462	476	481				
Female	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1995*			492	511	515	566				
1996*			504	526	473	533				
1997*	426	442	486	515	538	560				
1998*			491	521	539	495				
1999*			499	508	521	540				
2000*			500	526	541	549				
2001			506	521	538	537				
2002			528	547	554	580	579			
2003		450	489	540	560	579	570			
2004			445	461	486	495	498			
2005		405	488	521	531	549	571	620		575
2006			494	501	522	535	537	573		
2007			498	509	521	528	443			
2008			471	490	514	525	601			
2009			478	493	505	524				
2010			485	497	509	590	682			
2011				504	515	524				
2012			457	508	515	522				

Table 11. Mean weight at age of adult American shad collected in the fish lifts at Conowingo Dam.

Otolith age										
Male	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1995		610	840	936	1022	1293				
1996	546	662	869	967	1220	970				
1997		667	834	1022	1018					
1998		614	750	861						
1999		642	717	855	885		1130			
2000		838	828	983	1195					
2001		949	831	956	1009	795				
2002		669	986	1126	1413	1280		1380		
2003		740	919	1090	1336	1335	1180			
2004		590	834	1025	1094	1402	1020			
2005		608	797	982	1160	1237	1270			
2006	630	557	811	921	1047					
2007		780	777	885	1072					
2008		529	725	896	947	940				
2009			724	816	930					
2010		653	833	964	905					
2011		400	773	872	947					
2012		595	681	863	883	1020				
Female	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1995			1162	1343	1418	1826				
1996			1344	1440	1513	1321				
1997	1400	950	1233	1524	1647	1695				
1998			1012	1311	1474	1210				
1999			1154	1234	1382	1500				
2000			1227	1425	1495	1885				
2001			1247	1340	1496	1460				
2002			1383	1619	1657	1841	1675			
2003		1000	1216	1726	1817	1989	2080			
2004			1250	1345	1572	1739	1715			
2005		673	1242	1437	1555	1740	1613	2470		1900
2006			1253	1248	1468	1589	1605	2050		
2007			1212	1380	1494	1517	1195			
2008			996	1125	1367	1310	1770			
2009			1088	1198	1311	1473				
2010			1143	1307	1306	2000	2820			
2011				1169	1307	1487				
2012			976	1254	1357	1437				

Table 12. Otolith age and repeat spawning for American shad collected in the Conowingo Dam West Fish Lift.

	2000						2001				2002				2003			
Male	**REPEATS IN SAMPLE**						**REPEATS**				**REPEATS**				**REPEATS**			
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**Tot.**	**0**	**1**	**2**	**Tot.**	**0**	**1**	**2**	**Tot.**
2																		
3	18					18	3			3	16			16	4			4
4	77	3				80	30			30	9	5		14	44	3		47
5	17	4	4			25	38	1		39	12	13	4	29	17			17
6	2	3				5	7			7	4	3	2	9	17			17
7							1			1			2	2	2			2
8																1		1
9													1	1				
10																		
11																		
TOTAL	**114**	**10**	**4**	**0**	**0**	**128**	**79**	**1**	**0**	**80**	**41**	**21**	**9**	**71**	**84**	**4**	**0**	**88**

	2000						2001				2002				2003			
Female	**REPEATS IN SAMPLE**						**REPEATS**				**REPEATS**				**REPEATS**			
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**Tot.**	**0**	**1**	**2**	**Tot.**	**0**	**1**	**2**	**Tot.**
2																		
3	1					1									1			1
4	13					13	16			16	11	2		13	12			12
5	19	4	3		1	27	51			51	19	19	4	42	24	3	3	30
6	11		3			14	30			30	21	15	5	41	40	2	2	44
7	1			1		2	4			4	5	4		9	9	2	2	13
8											1	2		3	1			1
9																		
10																		
11																		
TOTAL	**45**	**4**	**6**	**1**	**1**	**57**	**101**	**0**	**0**	**101**	**57**	**42**	**9**	**108**	**87**	**7**	**7**	**101**

	2000						2001				2002				2003			
Sexes combined	**REPEATS IN SAMPLE**						**REPEATS**				**REPEATS**				**REPEATS**			
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**Tot.**	**0**	**1**	**2**	**Tot.**	**0**	**1**	**2**	**Tot.**
2																		
3	19					19	3			3	16			16	5			5
4	90	3				93	46			46	20	7		27	56	3		59
5	36	8	7		1	52	89	1		90	31	32	8	71	41	3	3	47
6	13	3	3			19	37			37	25	18	7	50	57	2	2	61
7	1			1		2	5			5	5	4	2	11	11	2	2	15
8											1	2		3	1	1		2
9													1	1				
10																		
11																		
TOTAL	**159**	**14**	**10**	**1**	**1**	**185**	**180**	**1**	**0**	**181**	**98**	**63**	**18**	**179**	**171**	**11**	**7**	**189**

Table 12. (continued)

	2004						2005						2006					
Male	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2													1					1
3	13					13	7					7	5					5
4	13					13	44	18	2			64	30	2				32
5	27	7				34	21	4	2			27	20	6	1			27
6	7	1				8	6	9	5	2		22	6		1			7
7	3	1	1			5	1	1		1		3						0
8	1					1		1				1						0
9																		
10																		
11																		
TOTAL	**64**	**9**	**1**			**74**	**79**	**33**	**9**	**3**		**124**	**62**	**8**	**2**	**0**		**72**

	2004						2005						2006					
Female	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2																		
3							2					2						0
4	5					5	11	7				18	14					14
5	37	5	1			43	19	7	7			33	50	12	3	1		66
6	14	2	1			17	37	21	5	7		70	10	4				14
7	12	4		3		19	4	4	3	3	2	16	5	2	1			8
8			1		1	2	1	2	1			4		1				1
9									1			1					1	1
10																		
11									1			1						0
TOTAL	**68**	**11**	**3**	**3**	**1**	**82**	**74**	**41**	**18**	**10**	**2**	**145**	**79**	**19**	**4**	**1**	**1**	**104**

	2004						2005						2006					
Sexes combined	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2													1					1
3	13					13	9					9	5					5
4	18					18	55	25	2			82	44	2				46
5	64	12	1			77	40	11	9			60	70	18	4	1		93
6	21	3	1			25	43	30	10	9		92	16	4	1			21
7	15	5	1	3		24	5	5	3	4	2	19	5	2	1			8
8	1		1		1	3	1	3	1			5		1				1
9									1			1					1	1
10																		
11									1			1						
TOTAL	**132**	**20**	**4**	**3**	**1**	**160**	**153**	**74**	**27**	**13**	**2**	**269**	**141**	**27**	**6**	**1**	**1**	**176**

Table 12. (continued)

	2007						2008						2009					
Male	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2						0						0						0
3	1					1	17					17						0
4	17	7	1			25	29	6				35	73	3				76
5	13	2	1			16	13	7	3	1		24	22	3				25
6	2	4	2	1		9	4	5	1			10	2	2	1			5
7						0						0						0
8						0						0						0
9																		
10																		
11																		
TOTAL	**33**	**13**	**4**	**1**		**51**	**63**	**18**	**4**	**1**		**86**	**97**	**8**	**1**	**0**		**106**

	2007						2008						2009					
Female	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2																		
3						0						0						0
4	10					10	9	1				10	15	3				18
5	16	7	5	1		29	22	6	3			31	24	6				30
6	33	8	12	4		57	22	9	5	4	1	41	10	2				12
7	2		1			3	2	2	1	2	1	8	2	1	1			4
8	2					2				1		1						0
9						0						0						0
10																		
11						0						0						0
TOTAL	**63**	**15**	**18**	**5**	**0**	**101**	**55**	**18**	**9**	**7**	**2**	**91**	**51**	**12**	**1**	**0**	**0**	**64**

	2007						2008						2009					
Sexes combined	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2	0					0	0					0						0
3	1					1	17					17						0
4	27	7	1			35	38	7				45	88	6				94
5	29	9	6	1		45	35	13	6	1		55	46	9				55
6	35	12	14	5		66	26	14	6	4	1	51	12	4	1			17
7	2		1			3	2	2	1	2	1	8	2	1	1			4
8	2					2				1		1						0
9																		
10																		
11																		
TOTAL	**96**	**28**	**22**	**6**	**0**	**152**	**118**	**36**	**13**	**8**	**2**	**177**	**148**	**20**	**2**	**0**	**0**	**170**

Table 12. (continued)

	2010						2011						2012					
Male	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2						0						0						0
3	6					6	1					1	17					17
4	25	4				29	15					15	12					12
5	49	5				54	29	7				36	21	5				26
6	1	1				2	14	2		1		17	4	2				6
7						0						0	3	1				4
8						0						0						0
9																		
10																		
11																		
TOTAL	**81**	**10**	**0**	**0**		**91**	**59**	**9**	**0**	**1**		**69**	**57**	**8**	**0**	**0**		**65**

	2010						2011						2012					
Female	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2																		
3						0						0						0
4	8		1			9						0	5					5
5	58	6				64	19					19	21	2				23
6	8	3	1			12	37	5				42	35	3				38
7			1			1	3					3	15	2				17
8	1					1						0						0
9						0						0						0
10																		
11						0						0						0
TOTAL	**75**	**9**	**3**	**0**	**0**	**87**	**59**	**5**	**0**	**0**	**0**	**64**	**76**	**7**	**0**	**0**	**0**	**83**

	2010						2011						2012					
Sexes combine	**REPEATS**						**REPEATS**						**REPEATS**					
Otolith Age	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**	**0**	**1**	**2**	**3**	**4**	**Tot.**
2						0						0						
3	6					6	1					1	17					17
4	33	4	1			38	15					15	17					17
5	107	11				118	48	7				55	42	7				49
6	9	4	1			14	51	7		1		59	39	5				44
7			1			1	3					3	18	3				21
8	1					1						0						
9																		
10																		
11																		
TOTAL	**156**	**19**	**3**	**0**	**0**	**178**	**118**	**14**	**0**	**1**	**0**	**133**	**133**	**15**	**0**	**0**	**0**	**148**

Table 13. Comparison of total mortality estimates (Z) using three methods, Susquehanna River. Hatchery method uses iterative back-calculation of the number of shad required to produce the known recruitment of virgin fish from the known number of fish stocked, assuming annual survival is constant. Catch curve analysis (slope of descending limb) based on otolith age. Repeat spawning method uses catch-curve for repeat spawners only.

		Catch-curve		Repeat spawning
Cohort	**Hatchery***	**(otolith age)**	***Virgin age***	**Otos/ scales****
1986	1.02	1.51		
1987	0.96	1.02		
1988	0.91	1.25		
1989	1.04	2.04		
1990	0.86	1.75		
1991	0.93	1.38		
1992	0.91	1.77		
1993	0.98	1.32		
1994	0.82	1.18	*6*	
1994			*7*	1.46
1995	0.76	2.07	*5*	1.59
1995			*6*	2.77
1995			*7*	1.52
1996	0.65	1.58	*4*	1.18
1996			*5*	2.13
1996			*6*	1.57
1996			*7*	1.68
1997	0.66	2.50	*3*	0.58
1997			*4*	1.23
1997			*5*	1.68
1997			*6*	2.51
1998	0.88	1.59	*4*	0.86
1998			*5*	1.79
1998			*6*	2.39
1998			*7*	1.37
1999	0.87	1.66	*3*	0.55
1999			*4*	1.35
1999			*5*	2.44
1999			*6*	2.83

Table 13. (continued)

		Catch-curve		Repeat spawning
Cohort	**Hatchery***	**(otolith age)**	***Virgin age***	**Otos/ scales****
2000	0.88	1.15	*4*	1.81
2000			*5*	1.53
2001	0.90	2.28	*3*	1.06
2001			*4*	1.31
2001			*5*	2.62
2001			*6*	3.22
2002	0.77	1.08	*2*	0.36
2002			*3*	0.42
2002			*4*	1.49
2002			*5*	1.61
2002			*6*	2.75
2003	1.31	0.27	*2*	0.36
2003			*3*	0.40
2003			*4*	1.58
2003			*5*	1.45
2004	1.07	1.44	*4*	1.49
2004			*5*	2.30
2005	0.82	1.14	*3*	0.85
2005			*4*	1.93
2005			*5*	3.04
2005			*6*	2.94
2006		0.35	*4*	1.87
2006			*5*	2.37
2007			*4*	0.87
Mean	**0.90**	**1.44**		**1.66**
*Z at lift efficiency = 40%				
** Used otoliths for age and scales for repeats				

Table 14. Number of juvenile American shad released into the Susquehanna River above barriers to adult migration.

	Susquehanna		
Year	Eggs Planted (millions)	Fry (thousands)	Fingerlings (thousands)
1971	8.4	-	-
1972	7.1	-	-
1973	58.6	-	-
1974	50.0	-	-
1975	33.2	-	-
1976	54+	518	266
1977	11+	969	35
1978	-	2,124	6
1979	-	629	34
1980	-	3,526	5
1981	-	2,030	24
1982	-	5,019	41
1983	-	4,048	98
1984	-	11,996	31
1985	-	6,228	115
1986	-	9,899	73
1987	-	5,180	81
1988	-	6,451	74
1989	-	13,465	65
1990	-	5,619	90
1991	-	7,218	54
1992	-	3,039	22
1993	-	6,542	79
1994	-	6,420	140
1995	-	10,001	-
1996	-	7,466	-
1997	-	8,019	25
1998	-	11,757	2.2
1999	-	13,501	-
2000	-	9,461	-
2001	-	6,524	6.5
2002	-	2,589	-
2003	-	12,742	-
2004	-	4,730	-
2005	-	3,571	-
2006	-	4,346	-
2007	-	1,380	-
2008	-	2,490	-
2009	-	2,701	-
2010	-	4,743	2.5
2011	-	3,053	9.1
2012	-	3,437	1.5
Totals	**157**	**213,430**	**1,380**

Table 15. Geometric mean catch per haul of juvenile American shad by haul seine in the Susquehanna River at Columbia, Pennsylvania.

YEAR	N	Geometric Mean	Variance
1997	90	3.36	1.01
1998	94	0.50	0.35
1999	90	0.67	0.51
2000	90	0.14	0.08
2001	90	1.52	0.67
2002	84	0.00	0.00
2003	48	0.20	0.08
2004	66	0.17	0.09
2005	90	0.16	0.13
2006	66	0.01	0.007
2007	66	0.02	0.014
2008	90	0.00	0.00
2009	84	0.00	0.00
2010	84	0.03	0.017
2011	50	0.06	0.03
2012	90	0.01	0.01

Table 16. Geometric mean catch per haul, and area under the curve for juvenile American shad collected by lift net in the Susquehanna River, Holtwood Dam forebay.

	N	Geometric Mean	Variance	Area under the curve
1997	300	0.61	0.66	412
1998	300	0.22	0.14	53
1999	300	0.50	0.33	147
2000	300	0.18	0.20	122
2001	299	0.43	0.54	322
2002	220	0.09	0.07	20
2003	300	0.07	0.05	18
2004	240	0.00	0.00	0
2005	300	0.10	0.26	60
2006	230	0.00	0.02	2
2007	300	0.00	0.00	0.0
2008	300	0.002	0.002	0.2
2009	300	0.00	0.00	0.0
2010	No	collections		
2011	No	collections		
2012	No	collections		

Table 17. American shad marked with Oxytetracycline and stocked in the Susquehanna River Basin, 2012.

Number	Size	Immersion mark (days)	Stocking Location	Egg Source	Immersion mark
172,320	Fry	3,18	W. Br. Susq. R.	Potomac	427ppm OTC
271,120	Fry	3,6,9,12,15	Bald Eagle Creek	Potomac	427ppm OTC
425,034	Fry	3,6,9	Raystown Branch Juniata R.	Susquehanna	427ppm OTC
2,419,189	Fry	3	Raystown Branch Jun. R. or Juniata R.	Potomac	427ppm OTC
149,672	Fry	3,6,9,15	N. Br. Susq. R.(PA)	Potomac	427ppm OTC
3,437,335	Fry	Total Susquehanna River Basin			
-					
1,500	Fingerling	various	Juniata R.	various	427ppm OTC

Table 18. Hatchery evaluation (wild vs. hatchery contribution) for juvenile American shad recovered upstream of Conowingo Dam.

	FRY STOCKED	N	% WILD	% HATCHERY
1997	8,019,000	1096	11	89
1998	11,757,000	321	5	95
1999	13,501,000	791	5	95
2000	9,460,728	452	3	97
2001	5,510,184	418	43	57
2002	2,588,797	86	22	78
2003	10,685,252	101	7	93
2004	4,729,967	25	0	100
2005	3,570,675	230	58	41
2006	4,345,561	70	10	90
2007	1,380,463	24	25	75
2008	2,490,081	47	2	98
2009	2,700,956	7	0	100
2010	4,743,360	18	70	30
2011	3,052,870	7	0	100
2012	3,438,835	64	16	83

HICKORY SHAD AND RIVER HERRING

There are no commercial fisheries for river herring in Pennsylvania. Hickory shad are considered threatened in Pennsylvania and harvest is not permitted.

I. Harvest and Losses

A. Commercial Fishery

Pennsylvania does not permit commercial harvest of hickory shad (*Alosa mediocris*), or river herring (alewife *Alosa pseudoharengus* and blueback herring *Alosa aestivalis*) from any state water.

B. Recreational Fishery

1. Characterization of Fishery

Recreational harvest of river herring was prohibited in 2012.

2. Characterization of Other Losses (poaching, hook/release mortality, etc.)

Losses associated with poaching and hook and release mortality for alosines during 2012 are unknown. Mortality rates of recreationally caught and released hickory shad, and river herring are unknown.

C. Other Losses

Table 1. Harvest losses (number and weight in pounds) of hickory shad at Conowingo Dam, Susquehanna River, 2012.

Mortality Source	Number	Mean wt	Pounds
Commercial	0	…	…
Recreational	0	…	…
Catch & Release	Unknown (expected to be nominal)	…	…
Poaching	Unknown (expected to be nominal)	…	…
Research/Broodstock	0	…	…
Upstream passage at dam sites	0	…	…
Downstream passage at dam sites	Unknown	…	…
Total	…	…	…

Table 2. Harvest losses (number and weight in pounds) of blueback herring at Conowingo Dam, Susquehanna River, 2012.

Mortality Source	Number	Mean wt	Pounds
Commercial	0	…	…
Recreational	0	…	…
Catch & Release	Unknown (expected to be nominal)	…	…
Poaching	Unknown (expected to be nominal)	…	…
Research/Broodstock	0	…	…
Upstream passage at dam sites	Unknown (expected to be nominal)	…	…
Downstream passage at dam sites	Unknown	…	…
Total	…	…	…

Table 3. Harvest losses (number and weight in pounds) of alewife at Conowingo Dam, Susquehanna River, 2012.

Mortality Source	Number	Mean wt	Pounds
Commercial	0	…	…
Recreational	0	…	…
Catch & Release	Unknown (expected to be nominal)	…	…
Poaching	Unknown (expected to be nominal)	…	…
Research/Broodstock	0	…	…
Upstream passage at dam sites	Unknown (expected to be nominal)	…	…
Downstream passage at dam sites	Unknown	…	…
Total	…	…	…

E. Protected species Atlantic sturgeon bycatch estimates

No take of Atlantic sturgeon was known to occur by fishers in the Susquehanna River in Pennsylvania in 2012.

III. Fishery Independent Monitoring

D. Description of Requirements under Amendment II for the Susquehanna River

- Annual spawning stock survey and representative sampling for biological data
- Calculation of mortality and/or survival estimates
- JAI: Juvenile abundance index (GM)

In addition to the required monitoring, Pennsylvania has monitored upstream passage on the Susquehanna River.

E. Brief Description of Work Performed

1. River herring Juvenile Indices

Juvenile indices from haul seining were expanded from a single site to two sites in 2011 due to the loss of the Holtwood lift net site. CPUE is reported as the geometric mean catch of approximately 84 hauls (six hauls per day, one day per week) between mid-July and mid-October. Seining sites on the lower Susquehanna River included Columbia (RM 43) and City Island (RM 71). Seine size was 400 X 6 feet with 3/8 inch mesh.

Holtwood lift netting was discontinued in 2010 due to construction at the site associated with re-development. Prior to 2010, CPUE was reported as the geometric mean catch of approximately 300 lifts (10 lifts per day, every third day) from September to December. The lift net was 8 X 8 feet and pulled vertically through the water column in Holtwood Hydroelectric Dam forebay (RM 24). Although data is presented only for 1997-2009, similar collections occurred annually from 1985 to 1996.

2. Annual River herring Spawning Stock Survey for Biological Data

Fish passage facility counts were provided for each of the four lower river dams. Counts were made by trained biological observers at windows provided to evaluate fish passage facility effectiveness. Counts were made during all operating periods and video tape recordings were made of the windows to confirm fish counts.

No river herring have been sampled for biological data due to the low numbers of river herring passed in recent years (Tables 6, 7, and 8).

F. Results

Blueback herring passage at Conowingo Dam on the Susquehanna River decreased from more than 200,000 in 1997 and 2001 to less than 500 in 2007 and less than 5 in 2005, 2006, and 2008 to 2012 (Table 7). Alewife passage followed the same trend but numbers were much smaller (Table 8). No biological samples have been collected due to the low numbers of river herring passed in recent years.

In the Susquehanna River, abundance of YOY river herring is assessed by haul seine and lift net. No juvenile blueback herring or Alewife were collected in the haul seine from 2002 to 2012. (Tables 10 to14). The lift net at Holtwood did captured 13 alewives, however these are thought to be strays from several inland reservoirs which have self-sustaining, non-migratory populations of Alewives (Table 14). No blueback herring were captured in the lift net (Table 13).

Literature cited

ASMFC Stock Assessment Subcommittee. 2008. Atlantic States Marine Fisheries Commission, Arlington, VA.

Table 4. Hickory shad larvae stocked in the upper portion of Conowingo Reservoir.

	Muddy Cr. (Conowingo Reservoir)
2003	1,000,000
2004	3,366,573
2005	5,355,381
2006	2,593,163
2007	3,323,741
Total	**15,538,858**

Table 5. Hickory shad larvae stocked in Pennsylvania waters of Octoraro Creek.

	Octoraro Cr.
2008	3,545,292
2009	1,823,481
2010	0
2011	500,000
2012	0
Total	**5,868,773**

Table 6. Passage of hickory shad at Susquehanna River dams.

Year	**Conowingo (rm 10.0)**	**Holtwood (rm 24.6)**	**Safe Harbor (rm 32.2)**	**York Haven (rm 56.1)**
1997	0	1	0	N/A
1998	0	0	0	N/A
1999	0	0	0	N/A
2000	0	0	0	0
2001	0	0	0	0
2002	6	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	4	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	20	0	0	0
2012	0	0	0	0
Total	**30**	**1**	**0**	**0**

Table 7. Passage of blueback herring at Susquehanna River dams.

Year	Conowingo (rm 10.0)	Holtwood (rm 24.6)	Safe Harbor (rm 32.2)	York Haven (rm 56.1)
1997	242,815	1,042	534	no fishway
1998	700	62	20	no fishway
1999	130,625	73	30	no fishway
2000	14,963	27	21	0
2001	284,921	1,300	378	4
2002	2,037	13	0	0
2003	530	3	0	0
2004	101	0	0	0
2005	4	0	0	0
2006	0	0	0	0
2007	460	0	0	0
2008	1	0	0	0
2009	0	0	0	0
2010	4	0	0	0
2011	17	0	0	0
2012	25	0	0	0
Total	**677,203**	**2,520**	**983**	**4**

Table 8. Passage of alewife at Susquehanna River dams.

Year	Conowingo (rm 10.0)	Holtwood (rm 24.6)	Safe Harbor (rm 32.2)	York Haven (rm 56.1)
1997	63	0	1	no fishway
1998	6	0	0	no fishway
1999	14	1	1	no fishway
2000	2	0	685	2
2001	7,458	431	345	0
2002	74	0	1	1
2003	21	2	0	0
2004	89	0	1	0
2005	0	0	0	0
2006	0	0	0	0
2007	429	0	0	0
2008	1	0	0	0
2009	0	1	0	0
2010	1	0	0	2
2011	2	0	5	0
2012	27	0	0	0
Total	**8,187**	**435**	**1,039**	**5**

Note: Landlocked populations of alewives are present in Susquehanna River Basin impoundments and some of those recorded at the fishways may not be anadromous in origin.

Table 9. Geometric mean catch per haul of juvenile hickory shad by haul seine in the Susquehanna River at Columbia, Pennsylvania.

Year	No. Hauls	No. Fish	Mean Combined Daily CPUE	GM Combined Daily CPUE
2002	84	0	0	0
2003	48	0	0	0
2004	66	0	0	0
2005	90	0	0	0
2006	66	0	0	0
2007	66	0	0	0
2008	90	0	0	0
2009	84	0	0	0
2010	84	0	0	0
2011	50	0	0	0
2012	90	0	0	0

Table 10. Geometric mean catch per haul of juvenile blueback herring by haul seine in the Susquehanna River at Columbia, Pennsylvania.

Year	No. Hauls	No. Fish	Mean Combined Daily CPUE	GM Combined Daily CPUE
2002	84	0	0	0
2003	48	0	0	0
2004	66	0	0	0
2005	90	0	0	0
2006	66	0	0	0
2007	66	0	0	0
2008	90	0	0	0
2009	84	0	0	0
2010	84	0	0	0
2011	50	0	0	0
2012	90	0	0	0

Table 11. Geometric mean catch per haul of juvenile alewife by haul seine in the Susquehanna River at Columbia, Pennsylvania.

Year	No. Hauls	No. Fish	Mean Combined Daily CPUE	GM Combined Daily CPUE
2002	84	0	0	0
2003	48	0	0	0
2004	66	0	0	0
2005	90	0	0	0
2006	66	0	0	0
2007	66	0	0	0
2008	90	0	0	0
2009	84	0	0	0
2010	84	0	0	0
2011	50	0	0	0
2012	90	0	0	0

Table 12. Geometric mean catch per haul of juvenile hickory shad by lift net in the Susquehanna River, Holtwood Dam forebay.

Year	No. Lifts	No. Fish	Mean Combined Daily CPUE	GM Combined Daily CPUE
2002	220	0	0.000	0.000
2003	300	0	0.000	0.000
2004	240	0	0.000	0.000
2005	300	0	0.000	0.000
2006	230	0	0.000	0.000
2007	300	0	0.000	0.000
2008	300	0	0.000	0.000
2009	300	0	0.000	0.000
2010	No		collections	
2011	No		collections	
2012	No		collections	

Table 13. Geometric mean catch per haul of juvenile blueback herring by lift net in the Susquehanna River, Holtwood Dam forebay.

Year	No. Lifts	No. Fish	Mean Combined Daily CPUE	GM Combined Daily CPUE
2002	220	0	0.000	0.000
2003	300	0	0.000	0.000
2004	240	0	0.000	0.000
2005	300	0	0.000	0.000
2006	230	0	0.000	0.000
2007	300	0	0.000	0.000
2008	300	0	0.000	0.000
2009	300	0	0.000	0.000
2010	No		collections	
2011	No		collections	
2012	No		collections	

Table 14. Geometric mean catch per haul of juvenile alewife by lift net in the Susquehanna River, Holtwood Dam forebay. Note: Landlocked populations of alewives are present in Susquehanna River Basin impoundments and some of those collected may not be anadromous in origin.

Year	No. Lifts	No. Fish	Mean Combined Daily CPUE	GM Combined Daily CPUE
2002	220	8	0.036	0.033
2003	300	0	0.000	0.000
2004	240	1	0.004	0.004
2005	300	4	0.013	0.011
2006	230	0	0.000	0.000
2007	300	0	0.000	0.000
2008	300	0	0.000	0.000
2009	300	0	0.000	0.000
2010	No		collections	
2011	No		collections	
2012	No		collections	

Maryland's 2012 Compliance Report:
American Shad (*Alosa sapidissima*)
Hickory Shad (*Alosa mediocris*)
Alewife Herring (*Alosa pseudoharengus)*
Blueback Herring (*Alosa aestivalis)*

Submitted to
Atlantic States Marine Fisheries Commission

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American Shad

Introduction

Restoration of American shad in the upper Chesapeake Bay began in the 1970s with the building of fish lifts and the stocking of juvenile American shad. The upper Chesapeake Bay became the focus of American shad monitoring by the Maryland Department of Natural Resources (MDNR) when Maryland's American shad fishery in the Chesapeake Bay closed in 1980. Monitoring efforts included collecting adult characterization data, calculating tag-based population estimates in the upper Chesapeake Bay (1980-2001), and calculating surplus production model population estimates in the Conowingo Dam tailrace (i.e., the area below Conowingo Dam; 1984-present).

American shad are currently managed under Amendment 3 to the Atlantic States Marine Fisheries Commission's (ASMFC) Fishery Management Plan, which became effective in January 2010. Under Amendment 3, states or jurisdictions without an approved sustainability management plan in place by 1 January 2013 closed their American shad fisheries; states or jurisdictions are allowed to keep catch and release recreational fishing. Maryland's commercial and recreational fisheries for American shad are closed and will remain closed, as is detailed in Maryland's Recovery Plan for American shad (accepted by ASMFC in May 2012).

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of Fishery

The American shad commercial fishery closed in1980, and the ocean intercept fishery closed in 2005.

2. Characterization of Directed Harvest for all alosines

No commercial data have been collected from the ocean intercept fishery since it closed in 2005.

a. Landings

American shad are not commercially landed. Commercial landings from 1983-2004 are included for reference (Table 1).

b. Harvest Composition

American shad are not commercially landed.

c. Estimation of Effort

American shad are not commercially landed.

3. Characterization of Other Losses

American shad are captured as bycatch primarily in the spring pound and fyke net commercial fishery targeting perch and catfish species. This fishery occurs in the upper Chesapeake Bay and various Maryland tributaries in the spring. Commercial fishermen are permitted a 2 fish per day bycatch of dead American shad for personal use (no sale is permitted).

a. Estimate and method of estimation

Bycatch monitoring does not occur in Maryland because there is no mechanism for fishermen to report American shad as bycatch under the current reporting system; funding and staffing constraints are also factors.

b. Estimate of composition (length and/or age)

There are no data available to estimate composition.

B. Recreational Fishery

1. Characterization of the Fishery

Maryland has permitted a catch and release sport fishery since the closure of the recreational American shad fishery in 1980. American shad anglers are interviewed during the spawning run through a roving creel survey below the Conowingo Dam on the Susquehanna River. Fifty-eight interviews were conducted over five days during the creel survey at the Conowingo Dam Tailrace. The CPAH in 2012 was the third lowest since the start of the survey in 2001 (Table 2), and CPAH has decreased over the time series (2001-2012; $r^2 = 0.46$, $P = 0.02$; significance determined at $\alpha = 0.05$ for all statistics).

The spring recreational shad fisheries in Maryland are also characterized through a logbook survey in which anglers report daily effort and catches. Although American shad CPAH calculated from shad logbook data decreased significantly over the time series (1999-2012; $r^2 = 0.35$, $P = 0.03$), CPAH increased in 2011 and 2012 (Table 3).

2. Characterization of Directed Harvest

Directed recreational harvest of American shad has not been permitted in state waters since 1980.

a. Landings and method of estimation

Not applicable

b. Estimation of effort or annual CPUE from a subsample

Not applicable

3. Characterization of Other Losses

Total recreational release mortality remains unknown, but the impact of the recreational fishery appears negligible on the recovery of the upper Chesapeake Bay stock.

a. **Estimate and method of estimation**
A catch and release study was conducted at the Conowingo Dam in 1997 (Lukacovic 1998), and mortality of American shad in the study was 0.97% (n = 309). The total catch of American shad from a creel survey in the lower Susquehanna River (by Normandeau, Inc., in 2010) was 14,831 fish. Using these studies, total recreational release mortality can be estimated as 144 American shad per year.

C. Other Losses

1. Research Losses

There are two lifts operating at Conowingo Dam, the lowest dam on the Susquehanna River. The East Fish Lift (EFL) empties fish directly into a raceway, which directs fish past a viewing window and into the pool above the dam. In 2012, 22,571 adult American shad were observed passing this viewing window (see Turbine Mortality below). The West Fish Lift (WFL) captures fish for research purposes using a manual process. In 2012, 1,486 American shad were captured at the WFL. Of these fish, 136 were sacrificed for otolith analysis, 481 were used for other research, and 5 mortalities were due to daily operations (Table 4).

2. Turbine Mortality

The mortality of adult American shad emigrating back through Holtwood Dam is estimated at 100% (R. St. Pierre, pers. comm.). However, turbine mortality is estimated at 25% for fish emigrating back through the Conowingo Dam. The total loss of American shad resulting from turbine mortality at or above Conowingo Dam was 8,714 fish in 2012. This estimate is based on the turbine mortality calculated for Conowingo Dam (4,476 fish) plus all American shad passed at Holtwood Dam (4,238 fish).

3. Hatchery Propagation

No American shad were removed from waters under the jurisdiction of Maryland for MDNR American shad propagation in 2012.

D. Estimated adult American shad losses in Maryland waters.

Year	Total Commercial Landings in Maryland's Portion of Chesapeake Bay	Conowingo Dam East Fish Lift Mortality[1]	Conowingo Dam West Fish Lift Mortality[2]	Estimated Commercial Chesapeake Bay Bycatch Mortality[3]	Recreational Bycatch Mortality	Ocean Commercial Landings[4]	Minimum Total Losses	Conowingo Dam Tailrace Abundance Estimate
1997	0	43,790	2,274	4,200	Unknown	24,859	75,123	159,878
1998	0	16,152	1,300	4,200	Unknown	18,526	39,908	161,430
1999	0	43,455	3,136	4,200	Unknown	13,623	64,414	193,920
2000	0	60,452	3,102	4,200	Unknown	4,834	72,588	207,028
2001	0	130,876	2,607	4,200	Unknown	2,347	140,030	205,924
2002	0	40,142	2,837	4,200	Unknown	1,882	49,061	134,373
2003	0	50,224	2,160	4,200	Unknown	621	57,205	129,196
2004	0	29,911	1,218	4,200	Unknown	220	35,549	111,931
2005	0	42,873	1,412	4,200	Unknown	0	48,485	109,654
2006	0	41,201	1,696	4,200	Unknown	0	95,582	94,790
2007	0	14,120	1,737	4,200	Unknown	0	20,057	77,166
2008	0	7,075	1,477	4,200	Unknown	0	12,752	80,208
2009	0	15,490	1,566	4,200	Unknown	0	21,256	90,989
2010	0	21,793	1,219	4,200	Unknown	0	27,212	98,743
2011	0	5,159	1,038	4,200	Unknown	0	10,397	103,500
2012	0	8,714	681	4,200	Unknown	0	13,595	111,550

1 Estimated to be 100% of fish passing above Holtwood Dam and 25% turbine mortality of fish passing back through Conowingo Dam.
2 West Fish Lift Mortality includes day to day operation mortalities
3 Extrapolated from American shad observed mortalities from pound nets in the upper Chesapeake Bay.
4 Reported numbers were calculated by multiplying total pounds by an estimated four pounds per fish.

E. Protected Species

The Atlantic sturgeon bycatch for Maryland's American shad ocean intercept fishery has been zero since this fishery was closed in 2005.

II. Required Fishery Independent Monitoring

A. Description of Requirements

Under Amendment 3, Maryland is required to have the following sampling programs in the upper Chesapeake Bay/Susquehanna River, Nanticoke River and Potomac River:

1. Annual spawning stock survey to include passage counts (upper Chesapeake Bay/Susquehanna River), CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock.
2. Calculation of mortality and/or survival estimates where possible
3. JAI: Juvenile abundance survey (GM)
4. Hatchery Evaluation (upper Chesapeake Bay/Susquehanna River and Potomac River)

B. Description of Work Performed

1. Juvenile Abundance Survey

American shad juvenile indices were derived from the Maryland DNR Estuarine Juvenile Finfish Seine Survey (EJFS) conducted at fixed stations within the upper Chesapeake Bay and the Nanticoke and Potomac Rivers, as well as the Choptank and Patuxent rivers.

2. Annual Spawning Stock Surveys

Data from various surveys in Maryland waters provided information on length, age, sex composition, spawning history and abundance of American shad. In the Susquehanna River, American shad were sampled by the Conowingo hook and line survey in the Conowingo Dam tailrace between 4 April and 30 May 2012. Normandeau Associates, Inc. was responsible for counting American shad that passed the Conowingo Dam at the EFL and collecting American shad samples at the WFL. Only fishery dependent data are available from the Nanticoke River. Three commercial pound nets and one commercial fyke net were surveyed for American shad between 22 February and 30 April 2012. In the Potomac River, American shad were captured in gill nets targeting striped bass between 26 March and 7 May 2012. All nets were sampled one to two days per week during the survey period.

For all surveys, captured American shad were measured (fork and total length, mm), scales were removed below the insertion of the dorsal fin, and sex was determined (by expression of gonadal products). Scales were cleaned, mounted between two glass slides and read for age and spawning marks. American shad sampled by the Conowingo hook and line survey were tagged (if in good condition).

Catch-per-unit-effort (CPUE) from the Conowingo hook and line survey was calculated as the number of adult fish captured per boat hour. We computed a combined lift CPUE as the total number of adult fish lifted per hour of lifting at the EFL and WFL. The geometric mean (GM) of adult American shad CPUE for both the tailrace area and the lifts was then calculated as the average LN (CPUE + 1) for each fishing/lifting day, transformed back to the original scale. In addition, a biomass surplus production model was used to estimate abundance of American shad in the Conowingo tailrace. In the Nanticoke River, the GM CPUE of American shad was calculated as the average LN (CPUE + 1) for each net day by gear type, transformed back to the original scale. In the Potomac River, CPUE was calculated as the number of fish caught per 1,000 square yards of experimental drift gill net per hour fished.

3. **Mortality and/or Survival Estimates**

Catch curve analysis was used to estimate total instantaneous mortality (Z) of adult American shad sampled by the Conowingo hook and line survey and in the Nanticoke and Potomac rivers. The number of repeat spawning marks was used in this estimation instead of age because ageing techniques for American shad scales are tenuous (McBride et al. 2005). Z was estimated by the $\log_e$-transformed spawning group frequency plotted against the corresponding number of times spawned, assuming that consecutive spawning occurred. Therefore, the Z calculated for these fish represents mortality associated with repeat spawning.

4. **Hatchery Evaluation**

Maryland DNR hatchery personnel collected adult American shad from the Potomac River for strip spawning. After water hardening, eggs were transported to Manning Hatchery for culture and grow-out. OTC was applied to all larvae prior to stocking target tributaries or grow-out ponds. More than 30 million larval or juvenile American shad were stocked from 2001-2013 in the Patuxent, Choptank, Nanticoke, and Patapsco rivers. A small portion of the eggs removed from the Potomac River via broodstock were returned as marked reared larval hatchery fish, but Maryland does not conduct a hatchery assessment for American shad in the Potomac River.

Maryland does not stock or evaluate stocked American shad in the Susquehanna River. However, the percentage of hatchery fish present in juvenile American shad populations are assessed using seine gear by MDNR personnel in the Patuxent and Choptank rivers. Restocking in the

Patuxent River ended in 2009 to permit maximum stocking effort and impact in the Choptank River. Additionally, the Pennsylvania Fish and Boat Commission (PFBC) and DE DFW determine the proportion of hatchery reared juveniles that return as adults to the WFL and Nanticoke River (both in Maryland), respectively.

C. Results

1. Juvenile Indices

a. Index of Abundance

Juvenile data have been collected since 1959 in the Upper Chesapeake Bay and Potomac and Nanticoke rivers; data have also been collected since 1983 in the Patuxent River (Table 5). Juvenile American shad indices for the Upper Chesapeake Bay and the Potomac River have increased linearly since 1980 ($r^2 = 0.13$, $P = 0.04$ and $r^2 = 0.32$, $P < 0.001$, respectively; auxiliary sites not included). However, juvenile American shad indices have shown no trend in the Nanticoke River since 1980 ($r^2 < 0.07$, $P = 0.14$) and no trend in the Patuxent River since 1983 ($r^2 = 0.05$ $P = 0.22$).

b. Variance

See Table 5.

2. Spawning Stock Assessment

a. Length-Frequency

Length-frequency histograms include data from both male and female American shad because the sample sizes by sex were not large enough to meaningfully draw conclusions (Figure 1). Mean (± SD) fork length for American shad from the Conowingo hook and line survey (2012) was 381 ± 31 mm for males and 448 ± 31 mm for females. Mean fork length for American shad captured from the WFL at Conowingo Dam for otolith extraction was 388 ± 39 mm for males and 450 ± 25 mm for females. In the Nanticoke River, mean fork length for American shad was 381 ± 35 mm for males and 418 ± 67 mm for females. In the Potomac River, mean fork length for American shad was 373 ± 27 mm for males and 450 ± 27 mm for females. For all systems, the average male was smaller than the average female.

b. Age-Frequency

Age-frequency histograms include data from both male and female American shad because the sample sizes were not large enough to meaningfully draw conclusions by sex. American shad were present in age groups 3-8 in the Conowingo tailrace, 3-7 in the Nanticoke River, 4-8 in the Potomac River, and 3-7 in the WFL (Figures 2).

c. Sex

The male-female ratio of adult American shad was 1:0.72 for fish captured in the Conowingo tailrace, 1:0.5 for fish captured in the Nanticoke River, and 1:1.22 for fish captured in the Potomac River.

d. Degree of Repeat Spawning

In the Conowingo Dam tailrace, 34% of males and 73% of females were repeat spawners. The arcsine-transformed proportion of these repeat spawners (sexes combined) has significantly increased over the time series (1984-2012; $r^2 = 0.45$, $P < 0.001$). In the Nanticoke River, 40% of males and 56% of females were repeat spawners in the Nanticoke River. The arcsine-transformed proportion of repeat spawning American shad (sexes combined) has significantly increased over the time series (1988-2012; $r^2 = 0.35$, $P = 0.002$). In the Potomac River, 34% of males were repeat spawners, which is higher than the 8.3% of repeat spawners observed in 2011; 60% of females were repeat spawners in 2012. The arcsine-transformed proportion of Potomac River repeat spawning American shad (sexes combined) showed no significant trend over the time series (2002-2012; $r^2 = 0.054$, $P = 0.49$).

e. Abundance

Estimates of hook and line GM CPUE in the Conowingo Dam tailrace vary without trend over the time series (1984-2012; $r^2 = 0.11$, $P = 0.07$); abundance is variable from 2005-2011 and remains below the high indices observed from 1999 to 2002 (Figure 3). The Conowingo Dam combined lift GM CPUE significantly increased over the time series (1980-2012; $r^2 = 0.33$, $P < 0.001$), although the 2012 GM CPUE was lower than the indices from 2009-2011 (Figure 4). The best surplus production model estimates were derived when estimates of losses due to ocean bycatch and upstream and downstream passage were included. The Conowingo tailrace adult American shad annual population estimates increased through 2001, declined through 2007 and have since increased slightly each year through 2012. In 2012, the estimated population of American shad was 111,550 fish (Figure 5).

The 2012 Nanticoke River pound net GM CPUE was the highest value since the start of the survey in 1988. The GM CPUE significantly increased over the time series (1988-2012; $r^2 = 0.24$, $P = 0.02$, Figure 6). No fyke nets were fished in 2012.

The Potomac River CPUE increased significantly over the time series (1996-2012; $r^2 = 0.23$, $P = 0.053$), although CPUE in each of the past four years has been lower than the CPUE in 2007 and 2008 (Figure 7).

3. Annual Mortality Rates

The Conowingo Dam tailrace total instantaneous mortality estimate from catch curve analysis resulted in Z = 0.61. The Nanticoke River mortality estimate was Z = 0.82. The Potomac River mortality estimate was Z = 0.50.

4. **Hatchery evaluation**
Of the 129 adult American shad otoliths collected from the WFL at Conowingo Dam in 2011, 71% were classified as non-hatchery fish (M. Hendricks, PFBC, pers. comm.). Forty-nine of the 52 scales sent to DE DFW for OTC analysis from the Maryland portion of the Nanticoke River were readable, and results indicated that 55% were non-hatchery fish (M. Stangl, pers. comm.). In the Choptank River, 92% of juvenile American shad were hatchery fish (Table 6).

Hickory Shad

Introduction

Hickory shad were historically encountered by commercial and recreational fishermen targeting American shad and river herring during spawning runs in the Chesapeake Bay and its tributaries. Stocks drastically declined due to the loss of habitat, overfishing, blockages, and pollution, and a statewide moratorium on hickory shad harvest in Maryland waters was implemented in 1981. Current fishery independent and dependent sampling is concentrated during adult spawning runs in the spring.

I. Harvest and Losses

A. Commercial Fishery

1. **Characterization of Fishery**
Maryland's hickory shad commercial fishery has been closed since 1981.

2. **Characterization of directed harvest of all alosines**
No data have been collected from this fishery since it closed in 1981.

4. **Characterization of other losses**
There are no data available to estimate other losses.

B. Recreational Fishery

1. **Characterization of the Fishery**
There is a significant catch and release recreational fishery for hickory

shad in the lower Susquehanna River and in Deer and Octoraro creeks. A voluntary logbook survey provides daily location, catch and hours spent fishing for hickory shad in the Susquehanna River for each participating angler.

2. Characterization of Directed Harvest

Recreational harvest of hickory shad has not been permitted from Maryland waters since 1981.

3. Characterization of Other Losses

Based on limited estimated catch and release mortality rates, recreational fishing mortality appears to be minimal (Lukacovic and Pieper 1998).

C. Other Losses

Turbine mortality is not a significant source of hickory shad mortality. Only 32 fish were lifted at the Conowingo Dam EFL from 1991 to 2012, and 20 of these fish passed in 2011. No hickory shad were observed in the EFL or WFL in 2012.

D. Harvest and Losses

None

E. Protected Species

None

II. Required Fishery Independent Monitoring

A. Description of Requirements

Amendment 1 recommends the monitoring of juvenile hickory shad in the Chesapeake Bay tributaries.

B. Description of Work Performed

Juvenile hickory shad are not collected in significant numbers ($n < 10$) by the EJFS survey or the MDNR juvenile survey (seine and trawl) on the Chester River (likely because of habitat preference for deeper water and/or gear avoidance). Therefore, indices were not calculated for juvenile hickory shad.

Adult hickory shad spawning stock data were obtained from MDNR's Susquehanna Restoration and Enhancement Program with electrofishing gear near the mouth of Deer Creek, a Susquehanna River tributary. MDNR staff removed scales, determined sex, and measured fork and total length (mm) of captured hickory shad. Scales were later cleaned and read for age and spawning history. Catch curve analysis was used to estimate Z of adult hickory shad from Deer Creek. We were able to examine length, age, sex composition, repeat spawning, and mortality of hickory shad from this survey.

C. Results

1. Juvenile Indices

a. Index of abundance

Calculation of an index of abundance was not possible due to the low number of juvenile hickory shad collected by the EJFS and MDNR juvenile survey gear.

b. Variance

No index of abundance was calculated.

2. Spawning Stock Assessment

a. Length-Frequency

In 2012, 1,014 hickory shad were collected from Deer Creek. Hickory shad mean fork length was 312 ± 28 mm for males and 344 ± 31 mm for females.

b. Age-Frequency

In 2012, 200 hickory shad collected from Deer Creek were aged. Males were present in age groups 3-6 and females were found in age groups 3-7. The most abundant year-classes by sex were the 2008 year-class (age 4) for both males (43%) and females (34%). Hickory shad sampled from 2004 to 2012 ranged from 2 to 9 years of age, with ages 3 through 8 present every year, except for 2012.

c. Sex

The 2012 male: female sex ratio for Deer Creek adult hickory shad was 2.06:1.

d. Degree of Repeat Spawning

In Deer Creek, the percentage of hickory shad repeat spawners in 2012 was 59% for males and 73% for females. The arcsine-transformed proportion of these repeat spawners (sexes combined) indicated no significant trend over the time series (2004-2012; $r^2 = 0.028$, $P = 0.67$), although the total percent of repeat spawners in 2012 (64%) was the lowest of the time series.

3. Annual Mortality Rates

The Deer Creek total instantaneous mortality estimate from catch curve analysis resulted in $Z = 0.68$. In general, Z can be attributed to natural mortality because only catch and release fishing for hickory shad is permitted in Maryland.

4. Hatchery evaluation

None

Alewife and Blueback Herring

Introduction

Alewife and blueback herring, collectively known as river herring, were once caught by the millions in the Chesapeake Bay and its tributaries. Stocks drastically declined due to the loss of habitat, overfishing, stream blockages and pollution. Both species of river herring are at historic lows based on commercial landings.

River herring are currently managed under Amendment 2 to the Atlantic States Marine Fisheries Commission Fishery Management Plan. Amendment 2 became effective in May of 2009. Amendment 2 requires the closure of all commercial and recreational fisheries by 1 January 2012, with exceptions for sustainable fisheries. Due to the decline in and persistently low levels of river herring in Maryland, a moratorium on the possession of river herring went into effect on 26 December 2011. It is no longer legal to possess river herring within Maryland unless the possessor has a bill of sale indicating that the river herring were legally caught in waters not under Maryland jurisdiction.

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of Fishery

The river herring commercial fishery closed on 26 December 2011. Prior to this date, this fishery was both directed (using cast, gill and dip nets) and non-directed (using pound and fyke nets). MDNR monitored Maryland's commercial river herring fisheries in the Nanticoke River.

2. Characterization of Directed Harvest

a. Landings and Method of Estimation

As of 30 May 2012, 290 pounds of river herring were reported landed, despite the closure of the fishery (there was no differentiation between species in the commercial river herring fishery). Total commercial landings for river herring in Maryland waters were at multi-decadal lows before the closure of the fishery (Figure 8).

b. Catch Composition

i. Length-Frequency

In the Nanticoke River (2012), mean fork length for alewife herring was 224 ± 14 mm for males and 244 ± 17 mm for females (Figure 9). The mean fork length for blueback herring was 219 ± 13 mm for males and 230 ± 15 mm for females (Figure 10).

ii. **Age-Frequency**

In the Nanticoke River (2012), male alewife herring were present in age groups 3-6 and females were found in age groups 3-7 (Figure 11). The most abundant year-classes by sex were the 2008 year-class (age 4) for males (37%) and the 2007 year-class (age 5) for females (34%). Male blueback herring were present in age groups 2-6 and females were found in age groups 3-7 (Figure 12). The 2008 year-class (age 4) was most abundant for males (44%) and the 2007 year-class (age 5) for females (46%).

iii. **Sex**

The 2012 male-female ratio for alewife and blueback herring in the Nanticoke River was 1:1.7 and 1:0.78, respectively.

iv. **Degree of Repeat Spawning**

For the Nanticoke River, 41% of alewife herring and 24% of blueback herring were repeat spawners (sexes combined). There was no trend in the arcsine-transformed proportion of alewife herring repeat spawners over the time series (1989-2012; $r^2 < 0.007$ $P = 0.70$); however, blueback herring exhibited a decreasing trend over the same time series (1989-2012; $r^2 = 0.61$, $P < 0.001$).

c. **Estimation of Effort**

Fyke nets were not fished in the Nanticoke River in 2012 and no data are available for this year. Our protocol has been to only calculate alewife and blueback herring CPUE from fyke net data because pound nets were not consistently set in ideal habitat for river herring. As of 2011, the GM CPUE for Nanticoke River alewife herring captured in fyke nets varied without trend over the time series (1990-2011; $r^2 = 0.14$, $P = 0.09$; Figure 13); in contrast, the GM CPUE for blueback herring decreased over the time series (1989-2011; $r^2 = 0.64$, $P < 0.001$; Figure 13).

3. Characterization of other losses

None

B. Recreational Fishery

1. Characterization of the Fishery

A recreational catch and release fishery for river herring is permitted. In 2012, river herring were recreationally fished in select Chesapeake Bay tributaries by hook and line. However, mortality due to these catches is considered insignificant compared to the millions of pounds historically landed in Maryland.

2. **Characterization of Directed Harvest**

Directed recreational harvest of river herring is not permitted in Maryland.

a. **Landings and Method of Estimation**

Directed recreational harvest of river herring is not permitted in Maryland.

b. **Catch Composition**

i. **Age-frequency**

No data are available.

ii. **Length-frequency**

No data are available.

c. **Estimation of effort**

Directed recreational harvest of river herring is not permitted in Maryland.

3. **Characterization of Other Losses**

None

C. Other losses

Turbine mortality rates for river herring at the Conowingo Dam are unknown, but are likely not a significant source of mortality. Only 25 blueback herring and 27 alewife herring passed the viewing window at the Conowingo Dam EFL in 2012, and seven alewife herring were encountered in the WFL.

D. Harvest and Losses

The only quantifiable loss of river herring in Maryland in 2012 is the 290 pounds of river herring were reported landed, despite the closure of the fishery.

II. Required Fishery Independent Monitoring

A. Description of Requirements

Under Amendment 2, Maryland is required to have the following sampling program in the upper Chesapeake Bay:

1. Annual spawning stock survey and representative sampling for biological data
2. Calculation of mortality and/or survival estimates
3. JAI: Juvenile abundance survey (GM)

B. Description of Work Performed

Juvenile river herring indices were derived from the EJFS surveys at fixed stations within the upper Chesapeake Bay and the Nanticoke River.

Limitations in staffing prohibited previous spawning stock assessments of river herring in the upper Chesapeake Bay. A river herring gill net survey is currently being developed by MDNR in the upper Chesapeake Bay.

C. Results

1. Juvenile Indices

a. Index of Abundance

Data provided by the EJFS indicated that the GM CPUE for juvenile alewife and blueback herring decreased in 2012 in both the Nanticoke River and the Upper Bay (Figures 14, 15).

b. Variance

See Table 7.

2. Spawning Stock Assessment

A river herring gill net survey is currently being developed in the upper Chesapeake Bay by MDNR.

a. Length-Frequency

No data are available at this time.

b. Age-Frequency

No data are available at this time.

c. Sex

No data are available at this time.

d. Degree of Repeat Spawning

No data are available at this time.

3. Annual Mortality Rates

A river herring gill net survey is currently being developed in the upper Chesapeake Bay by MDNR.

4. Hatchery evaluation

No hatchery evaluation is required.

Literature Cited

Lukacovic, R. 1998. Mortality of American shad caught and released by anglers below Conowingo Dam. Maryland Department of Natural Resources, Fisheries Service. Fisheries Technical Report Series, Number 21.

Lukacovic, R. and L Pieper. 1998. Short-term mortality of hickory shad (*Alosa mediocris*) caught and released by fishermen in Deer Creek, Maryland. Maryland Department of Natural Resources, Fisheries Service. Fisheries Technical Report Series, Number 19.

McBride, R.S., M.L. Hendricks and J.E. Olney. 2005. Testing the validity of Cating's (1953) method for age verification of American shad using scales. Fisheries 30:10-18.

Table 1. American shad commercial landings and fishing effort in Maryland's ocean waters, 1983-2004.

Year	Total Pounds Landed	Number of Watermen	Number of Days Fished	Total Yards Fished	Pounds Landed per 1,000 Yards (CPUE)
1983	20,043	6	151	10,800	1,855.8
1984	19,088	8	257	9,825	1,942.8
1985	150,030	6	420	26,173	5,732.2
1986	126,223	8	512	34,400	3,669.3
1987	119,304	6	443	33,067	3,608.0
1988	264,642	14	767	74,900	3,533.3
1989	487,812	15	539	56,150	8,687.7
1990	283,649	12	545	78,840	3,597.8
1991	233,968	17	894	107,950	2,167.4
1992	198,784	12	579	85,200	2,333.1
1993	77,883	7	242	42,634	1,826.8
1994	33,646	9	290	34,600	9,72.4
1995	49,927	9	269	68,300	7,31.0
1996	94,980	11	306	53,933	1,761.1
1997	99,435	17	479	65,300	1,522.7
1998	74,105	10	285	36,400	2,035.9
1999	54,491	13	241	44,795	1,216.5
2000	19,337	11	117	21,150	914.3
2001	9,386	5	34	14,350	654.1
2002	7,529	2	21	15,000	501.9
2003	2,485	4	19	5,500	451.8
2004	879	3	53	9,942	11.3
Commercial fishery for American shad was closed prior to the 2005 season					

Table 2. Catch (numbers), effort (hours fished) and catch-per-angler-hour (CPAH) from the recreational creel survey in the Susquehanna River below Conowingo Dam, 2001-2012. Due to sampling limitations, no data were available for 2011.

Year	Number of Interviews	Hours Fished for American Shad	American Shad Catch	American Shad CPAH
2001	90	202.9	991	4.88
2002	52	85.3	291	3.41
2003	65	148.2	818	5.52
2004	97	193.3	233	1.21
2005	29	128.8	63	0.49
2006	78	227.3	305	1.34
2007	30	107.5	128	1.19
2008	16	32.5	24	0.74
2009	40	85.0	120	1.41
2010	36	64.0	114	1.78
2011				
2012	58	189.0	146	0.77

Table 3. Catch (numbers), effort (hours fished) and catch-per-angler-hour (CPAH) from spring logbooks for American shad, 1999-2012.

Year	Number of Returned Logbooks	Hours Fished for American Shad	American Shad Catch	American Shad CPAH
1999	7	160.5	463	2.88
2000	10	404.0	3,137	7.76
2001	8	272.5	1,647	6.04
2002	8	331.5	1,799	5.43
2003	9	530.0	1,222	2.31
2004	15	291.0	1035	3.56
2005	12	258.5	533	2.06
2006	16	639.0	747	1.17
2007	10	242.0	873	3.61
2008	14	559.5	1,269	2.27
2009	15	378.0	967	2.56
2010	16	429.5	857	2.00
2011	9	174.0	413	2.37
2012	5	180.5	491	2.77

Table 4. Summary of the number of losses from the West Fish Lift at the Conowingo Dam (1998-2012). Numbers were converted to pounds (using a standard weight per fish of 4 pounds) and included in parentheses.

Year	Number captured in the WFL	Number sacrificed for otoliths	Number transported to upstream locations	Transport mortality	Number supplied to MDNR for propagation	Number supplied for other research
1998	6,577 (23,020)	130 (455)	5,277 (18,470)	75 (263)	588 (2,058)	507 (1,775)
1999	9658 (33,803)	193 (676)	5,508 (19,278)	232 (812)	1,471 (5,149)	2,254 (7,889)
2000	9,785 (34,248)	195 (683)	1,351 (4,729)	29 (102)	1,726 (6,041)	1,626 (5,691)
2001	10,940 (38,290)	215 (753)	0	0	823 (2,881)	1,569 (5,492)
2002	9,347 (37,388)	182 (728)	0	0	343 (1,372)	2,350 (9,400)
2003	9,802 (39,208)	196 (784)	0	0	460 (1,840)	1,504 (6,016)
2004	3,426 (13,704)	158 (632)	0	0	0	1,055 (4,220)
2005	3896 (13,636)	277 (970)	0	0	0	1,857 (6,500)
2006	3,970 (15,880)	180 (720)	0	0	0	1,516 (6,064)
2007	4,272 (17,088)	80 (320)	0	0	0	1,503 (6,012)
2008	2,627 (10,508)	164 (656)	0	0	197 (788)	1,393 (5,572)
2009	6,534 (26,136)	173 (692)	0	0	0	1,393 (5,572)
2010	5,605 (22,420)	113 (452)	0	0	25 (100)	1,074 (4,296)
2011	3,074 (12,296)	61 (244)	0	0	0	974 (3,896)
2012	1,486 (5,944)	136 (544)	0	0	0	481 (1,924)

Table 5. Geometric mean CPUE (with upper and lower 95% confidence intervals) of juvenile American shad from Maryland waters.

	Upper Bay			Potomac			Nanticoke			Patuxent		
Year	GM	Lower 95%	Upper 95%	GM	Lower 95%	Upper 95%	GM	Lower 95%	Upper 95%	GM	Lower 95%	Upper 95%
1959	6.49	1.51	21.33	0.00	0.00	0.00	0.20	-0.16	0.72			
1960	12.80	8.10	19.94	0.41	0.04	0.92	1.14	0.15	2.99			
1961	4.37	1.95	8.77	0.04	-0.04	0.14	0.19	-0.05	0.49			
1962	2.27	1.21	3.84	1.45	0.57	2.83	0.56	0.00	1.42			
1963	0.45	0.18	0.79	0.88	0.27	1.78	0.09	-0.08	0.29			
1964	0.20	0.02	0.42	0.59	0.14	1.22	0.09	-0.03	0.22			
1965	0.14	0.00	0.30	1.44	0.57	2.81	0.04	-0.04	0.14			
1966	2.38	1.25	4.08	1.07	0.49	1.88	0.03	-0.03	0.09			
1967	0.34	0.11	0.61	0.78	0.32	1.38	0.83	0.35	1.48			
1968	1.03	0.51	1.71	0.25	0.05	0.50	0.58	0.06	1.34			
1969	0.90	0.46	1.46	0.00	0.00	0.00	0.16	-0.01	0.37			
1970	0.39	0.15	0.69	1.74	0.73	3.33	0.03	-0.03	0.09			
1971	0.37	0.12	0.68	0.80	0.36	1.39	0.21	-0.01	0.47			
1972	0.15	0.03	0.28	2.14	1.02	3.89	0.05	-0.04	0.15			
1973	0.02	-0.02	0.05	0.31	0.11	0.55	0.10	-0.03	0.24			
1974	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.01	0.41			
1975	0.09	-0.08	0.28	0.94	0.48	1.56	0.19	0.00	0.41			
1976	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
1977	0.00	0.00	0.00	0.02	-0.02	0.05	0.00	0.00	0.00			
1978	0.00	0.00	0.00	0.98	0.40	1.82	0.00	0.00	0.00			
1979	0.00	0.00	0.00	0.03	-0.01	0.08	0.03	-0.03	0.09			
1980	0.00	0.00	0.00	0.24	0.08	0.42	0.15	-0.03	0.37			
1981	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
1982	0.00	0.00	0.00	0.02	-0.02	0.05	0.00	0.00	0.00			
1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.12	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.07	-0.01	0.16	0.03	-0.03	0.09	0.00	0.00	0.00
1986	0.02	-0.02	0.05	0.03	-0.01	0.08	0.00	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.11	-0.04	0.27	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.02	-0.02	0.05	0.09	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.38	0.08	0.76	0.00	0.00	0.00	0.00	0.00	0.00
1990	0.02	-0.02	0.05	0.00	0.00	0.00	0.05	-0.04	0.15	0.00	0.00	0.00
1991	0.00	0.00	0.00	0.17	0.03	0.35	0.00	0.00	0.00	0.00	0.00	0.00
1992	0.00	0.00	0.00	0.05	-0.01	0.11	0.03	-0.03	0.09	0.00	0.00	0.00
1993	0.09	0.00	0.18	0.15	-0.01	0.34	0.00	0.00	0.00	0.00	0.00	0.00
1994	0.03	-0.01	0.08	0.36	0.13	0.65	0.00	0.00	0.00	0.00	0.00	0.00
1995	0.13	0.02	0.25	0.59	0.21	1.07	0.03	-0.03	0.09	1.01	0.17	2.45
1996	0.84	0.50	1.26	1.20	0.51	2.21	0.00	0.00	0.00	1.07	0.21	2.53
1997	0.00	0.00	0.00	0.81	0.35	1.43	0.00	0.00	0.00	0.08	-0.07	0.26
1998	1.39	0.80	2.17	2.00	0.90	3.75	0.03	-0.03	0.09	0.29	0.05	0.58
1999	0.13	0.00	0.27	0.31	0.09	0.57	0.00	0.00	0.00	0.12	-0.01	0.27
2000	2.98	1.69	4.88	2.89	1.38	5.34	0.00	0.00	0.00	1.00	0.30	2.08
2001	0.07	-0.01	0.17	4.75	2.01	9.96	0.00	0.00	0.00	1.14	0.18	2.89
2002	0.35	0.09	0.68	4.16	1.90	8.19	0.03	-0.03	0.09	0.09	-0.08	0.30
2003	1.10	0.60	1.75	2.73	1.32	4.99	0.08	-0.03	0.20	0.75	0.05	1.93
2004	1.43	0.75	2.38	13.30	6.13	27.68	0.08	-0.03	0.20	0.08	-0.03	0.20
2005	1.14	0.59	1.89	4.66	2.03	9.56	0.00	0.00	0.00	0.55	0.02	1.34
2006	0.10	-0.02	0.24	2.04	0.90	3.87	0.13	-0.01	0.29	0.04	-0.04	0.12
2007	7.63	4.23	13.23	5.07	2.30	10.15	0.03	-0.03	0.09	0.34	-0.03	0.87
2008	0.03	-0.01	0.08	2.42	1.11	4.55	0.00	0.00	0.00	0.56	-0.05	1.57
2009	0.03	-0.01	0.08	3.63	1.59	7.26	0.08	0.03	0.20	0.08	-0.03	0.20
2010	0.61	0.23	1.12	1.05	0.41	1.97	0.14	0.01	0.29	0.00	0.00	0.00
2011	1.22	0.66	1.97	1.99	1.22	3.02	0.05	-0.04	0.15	0.00	0.00	0.00
2012	0.08	-0.03	0.20	2.87	1.26	5.63	0.00	0.00	0.00	0.00	0.00	0.00

Table 6. Percent hatchery origin of juvenile American shad collected from Maryland systems.

Year	River System		
	Patuxent	Choptank	Nanticoke
2000	92	100	NA
2001	86	83	NA
2002	86	83	59
2003	83	84	44
2004	91	93	62
2005	83	91	53
2006	97	92	93
2007	94	84	84
2008	96	83	92
2009	99	93	92
2010	NA	94	NA
2011	NA	96	NA
2012	NA	92	NA

Table 7. Geometric mean CPUE (with upper and lower 95% confidence intervals) of juvenile alewife and blueback herring from Maryland waters.

	Alewife Upper Bay			Alewife Nanticoke			Blueback Upper Bay			Blueback Nanticoke		
Year	GM	Lower 95%	Upper 95%	GM	Lower 95%	Upper 95%	GM	Lower 95%	Upper 95%	GM	Lower 95%	Upper 95%
1959	1.13	0.11	3.09	0.00	0.00	0.00	8.63	2.90	22.77	1.67	-0.29	9.00
1960	0.07	-0.06	0.23	1.88	-0.05	7.79	12.87	2.68	51.26	0.41	-0.28	1.79
1961	1.52	0.28	3.95	0.76	0.01	2.05	9.22	3.53	22.06	3.52	-0.14	22.72
1962	5.18	2.38	10.29	0.33	0.06	0.67	8.09	3.09	19.18	1.45	0.29	3.65
1963	2.26	1.01	4.27	0.63	-0.03	1.73	5.09	1.79	12.27	0.61	-0.18	2.17
1964	0.29	0.05	0.57	0.77	0.07	1.94	4.39	1.58	10.24	0.79	0.02	2.14
1965	0.92	0.33	1.76	0.25	-0.03	0.62	1.36	0.36	3.10	3.79	1.10	9.94
1966	8.10	4.09	15.28	0.27	0.04	0.56	7.65	3.62	15.17	3.67	1.07	9.54
1967	1.49	0.79	2.48	0.91	0.30	1.82	9.82	4.56	20.06	4.61	1.49	11.63
1968	0.16	0.04	0.30	1.61	0.60	3.26	4.27	1.79	8.94	1.54	0.33	3.84
1969	3.66	2.07	6.08	0.35	0.03	0.77	35.36	16.81	73.25	2.85	0.57	8.40
1970	21.04	11.48	37.93	0.68	0.16	1.42	8.91	3.71	19.85	0.87	0.34	1.62
1971	3.15	1.76	5.22	0.22	0.00	0.49	2.49	1.10	4.82	0.78	0.15	1.75
1972	0.71	0.32	1.21	0.80	0.17	1.77	1.37	0.63	2.44	1.68	0.56	3.58
1973	0.74	0.30	1.34	0.20	-0.02	0.46	2.07	0.92	3.93	0.69	0.05	1.73
1974	0.28	0.03	0.59	0.47	-0.04	1.27	0.00	0.00	0.00	1.23	0.25	2.98
1975	3.49	1.87	6.01	0.27	0.06	0.51	0.22	0.05	0.42	0.62	0.11	1.36
1976	0.87	0.41	1.47	0.09	-0.01	0.20	0.17	0.03	0.33	0.09	-0.04	0.23
1977	2.02	1.00	3.56	0.06	-0.02	0.15	0.13	-0.01	0.28	0.14	0.01	0.29
1978	1.96	1.21	2.96	0.11	-0.01	0.24	3.03	1.39	5.77	0.63	0.00	1.66
1979	0.88	0.43	1.47	0.19	0.00	0.40	0.49	0.22	0.83	1.59	0.37	3.87
1980	0.76	0.30	1.38	0.36	0.02	0.82	0.08	0.00	0.16	0.60	0.06	1.42
1981	1.57	0.85	2.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1982	0.21	0.07	0.36	0.14	0.01	0.29	0.04	-0.02	0.11	0.62	0.10	1.38
1983	0.02	-0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	1.38	0.20	3.75
1984	0.30	0.05	0.61	0.10	-0.03	0.24	0.20	0.01	0.44	1.23	0.26	2.93
1985	0.16	0.04	0.28	0.47	0.09	0.98	0.00	0.00	0.00	0.44	0.05	0.96
1986	0.86	0.33	1.60	0.00	0.00	0.00	0.47	0.09	0.98	0.20	0.00	0.43
1987	0.09	-0.04	0.24	0.14	-0.02	0.32	0.00	0.00	0.00	0.27	-0.01	0.64
1988	0.03	-0.01	0.08	0.12	0.01	0.25	0.07	-0.04	0.20	0.61	0.16	1.24
1989	0.18	0.01	0.38	0.03	-0.03	0.09	0.31	0.00	0.72	2.17	0.23	7.13
1990	0.51	0.13	1.00	0.14	-0.03	0.34	0.92	0.25	1.95	1.76	0.23	5.20
1991	0.09	0.00	0.18	0.23	-0.05	0.61	0.50	0.19	0.89	0.30	0.05	0.61
1992	0.02	-0.02	0.05	0.00	0.00	0.00	0.09	0.00	0.18	0.06	-0.02	0.15
1993	1.38	0.60	2.53	0.75	0.12	1.76	7.82	3.12	17.89	5.35	1.67	14.07
1994	1.60	0.55	3.38	0.28	0.02	0.60	5.22	2.46	10.17	2.00	0.50	5.01
1995	0.20	0.04	0.38	0.19	-0.03	0.47	1.28	0.43	2.65	0.96	0.40	1.76
1996	4.02	2.00	7.38	1.76	0.83	3.17	26.23	13.93	48.69	2.82	0.77	7.24
1997	0.24	0.03	0.48	0.00	0.00	0.00	0.62	0.22	1.16	0.75	0.14	1.69
1998	0.49	0.14	0.95	0.12	-0.02	0.28	6.01	2.57	12.80	0.98	0.28	2.06
1999	0.52	0.22	0.89	0.52	0.19	0.94	0.64	0.26	1.15	0.26	-0.05	0.67
2000	2.28	1.14	4.05	0.21	0.00	0.46	4.19	1.74	8.83	0.55	0.03	1.31
2001	3.49	1.50	7.05	0.15	-0.08	0.44	1.97	0.58	4.59	1.13	-0.04	3.74
2002	0.14	-0.05	0.35	0.28	0.06	0.54	0.38	-0.01	0.91	0.25	-0.20	0.95
2003	3.19	1.86	5.14	0.78	0.29	1.46	8.97	3.23	22.53	0.38	-0.07	1.04
2004	2.82	1.48	4.89	0.48	0.13	0.94	5.33	2.41	10.74	0.23	-0.02	0.54
2005	1.70	0.88	2.89	0.14	-0.02	0.32	0.17	0.03	0.33	0.18	-0.10	0.56
2006	0.46	0.21	0.76	0.11	-0.01	0.24	0.58	0.17	1.14	0.46	0.01	1.11
2007	1.50	0.69	2.71	0.40	0.05	0.86	3.58	0.80	6.50	0.56	0.09	1.24
2008	0.00	0.00	0.00	0.03	-0.03	0.09	0.10	-0.01	0.23	0.21	-0.05	0.53
2009	0.30	0.03	0.64	0.28	-0.09	0.81	1.35	0.51	2.64	0.20	0.00	0.45
2010	1.41	0.70	2.43	0.80	0.23	1.64	1.37	0.54	2.67	0.23	-0.08	0.64
2011	0.42	0.19	0.68	0.24	0.05	0.46	5.16	2.66	9.35	0.98	0.04	2.77
2012	0.17	-0.02	0.39	0.13	-0.02	0.31	0.13	-0.01	0.28	0.14	0.01	0.29

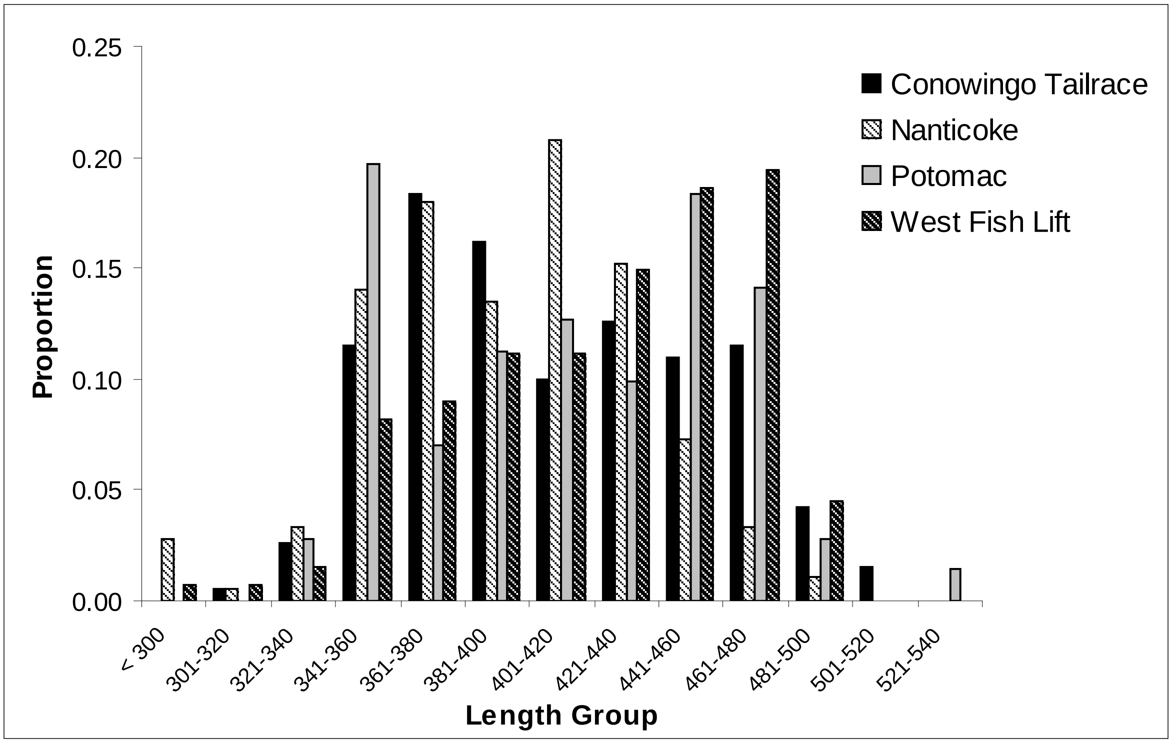

Figure 1. Length-frequency of American shad (sexes combined) captured in the Conowingo Dam tailrace, Nanticoke River, Potomac River, and the West Fish Lift, 2012.

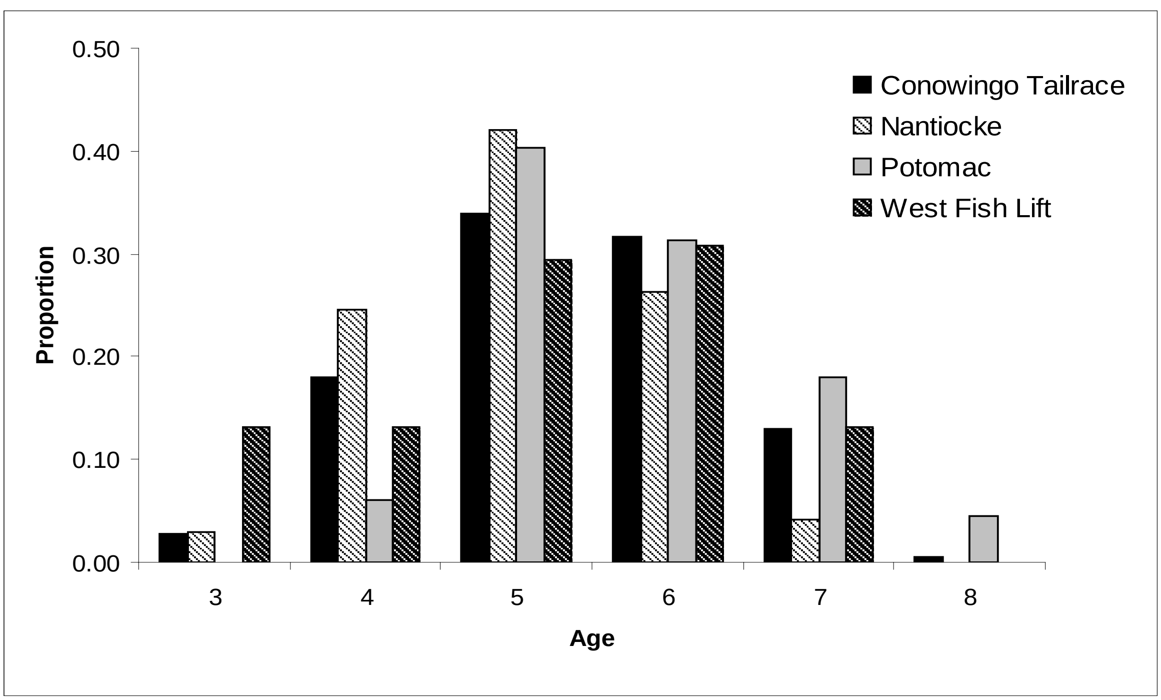

Figure 2. Age-frequency of American shad (sexes combined) captured in the Conowingo Dam tailrace, Nanticoke River, Potomac River, and the West Fish Lift, 2012.

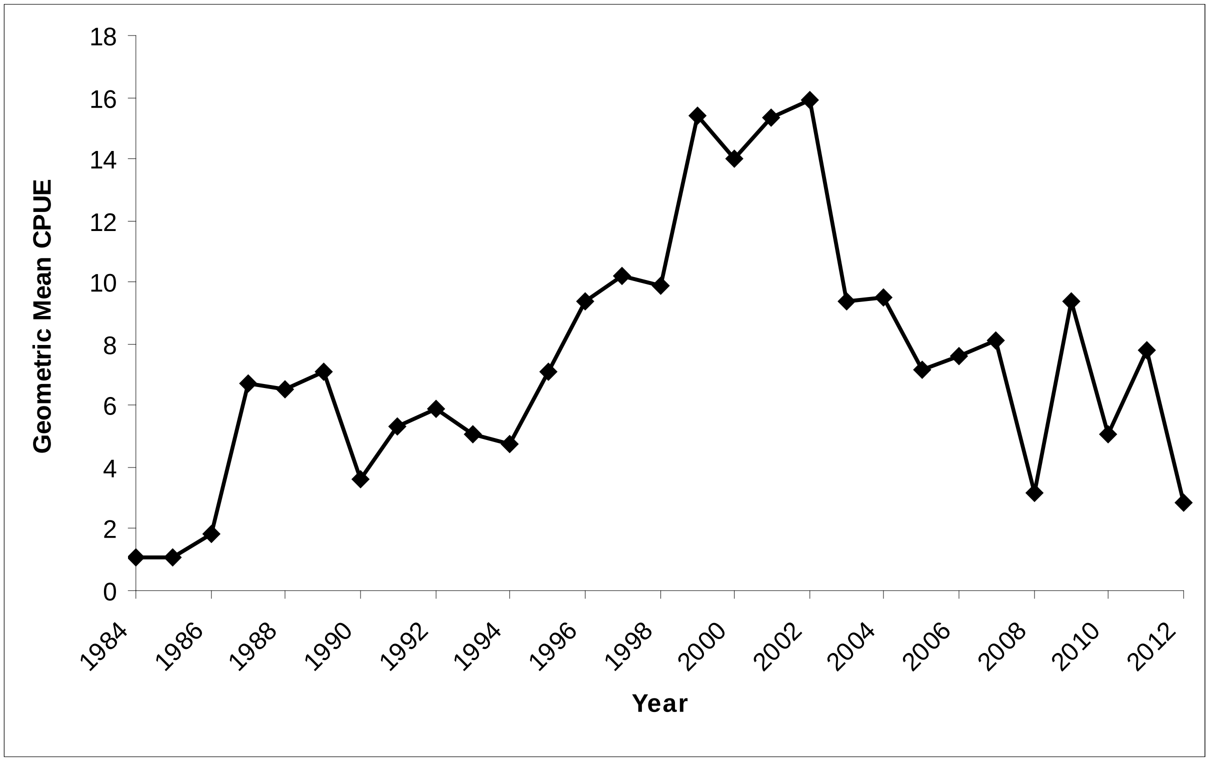

Figure 3. American shad geometric mean CPUE (fish per boat hour) from the Conowingo Dam tailrace hook and line sampling, 1984-2012.

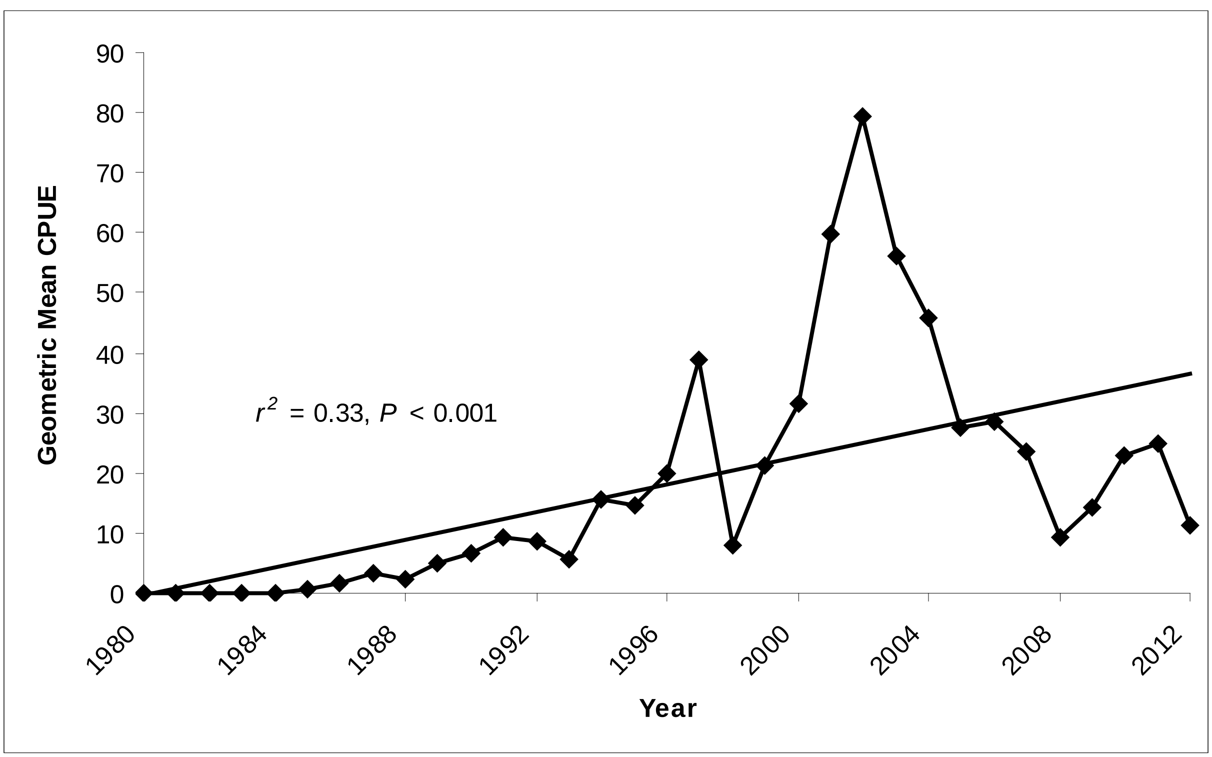

Figure 4. American shad geometric mean CPUE (fish per lift hour) from the East and West Fish Lifts at the Conowingo Dam, 1980-2012.

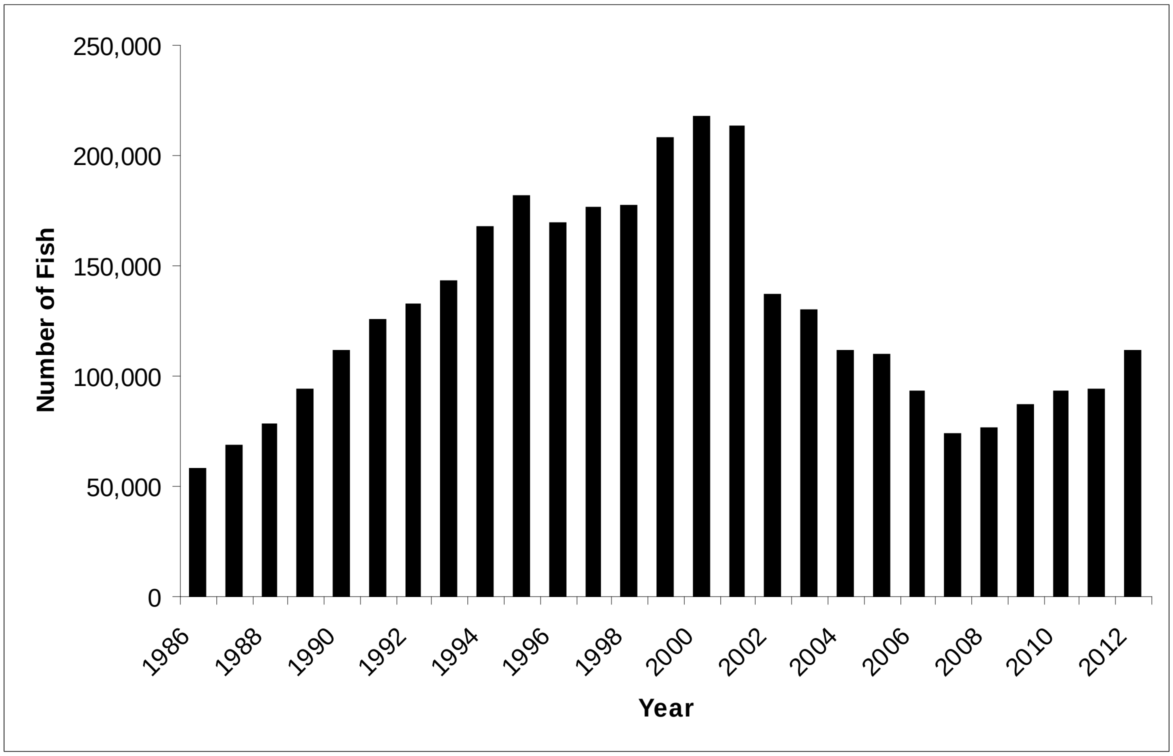

Figure 5. Conowingo Dam tailrace adult American shad abundance estimates from the biomass surplus production model, 1986-2012.

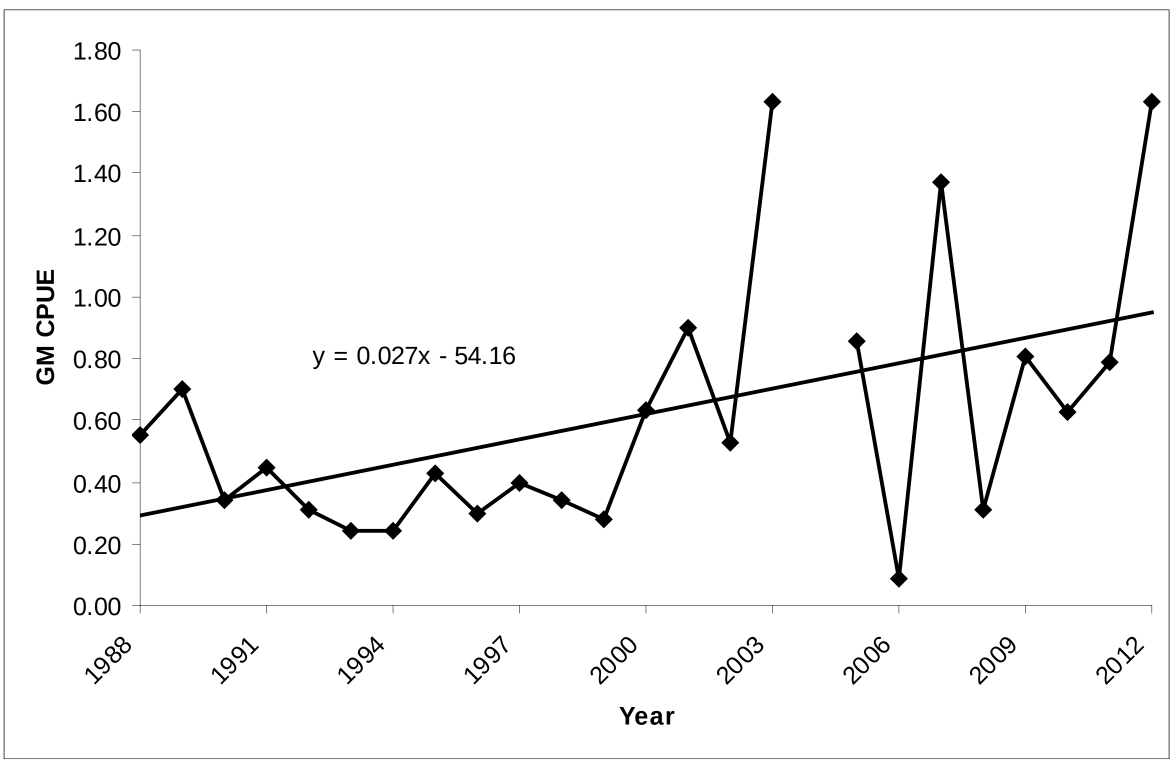

Figure 6. American shad geometric mean CPUE (fish per net day) from the Mill Creek pound nets in the Nanticoke River, 1988-2012. No pound nets were fished in 2004.

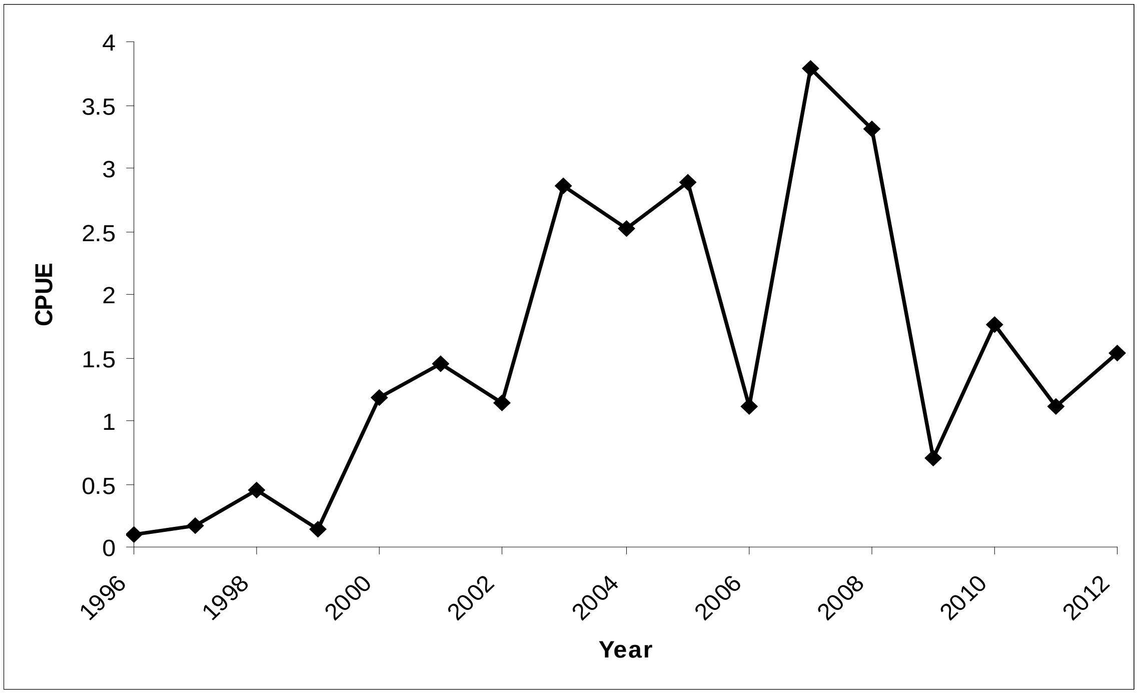

Figure 7. American shad geometric mean CPUE (fish per 1,000 square yards of experimental drift gill net per hour fished) from the Potomac River, 1996-2012.

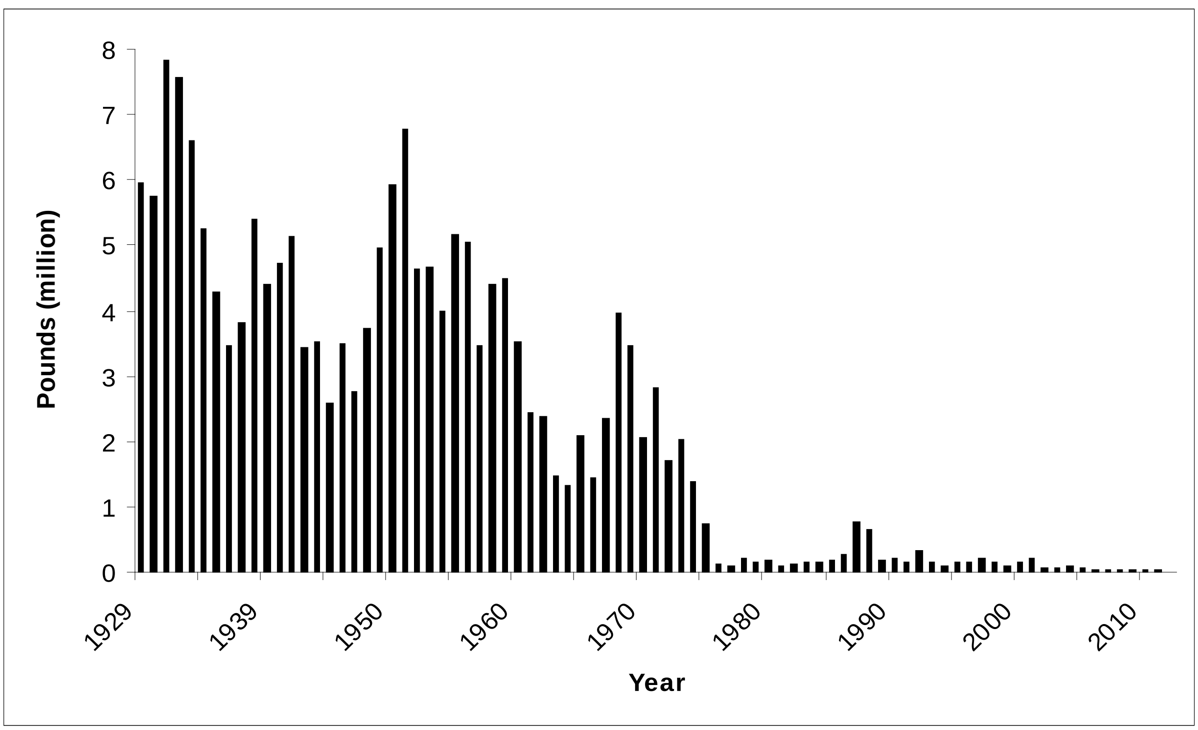

Figure 8. Reported commercial river herring landings in Maryland, 1929-2012.

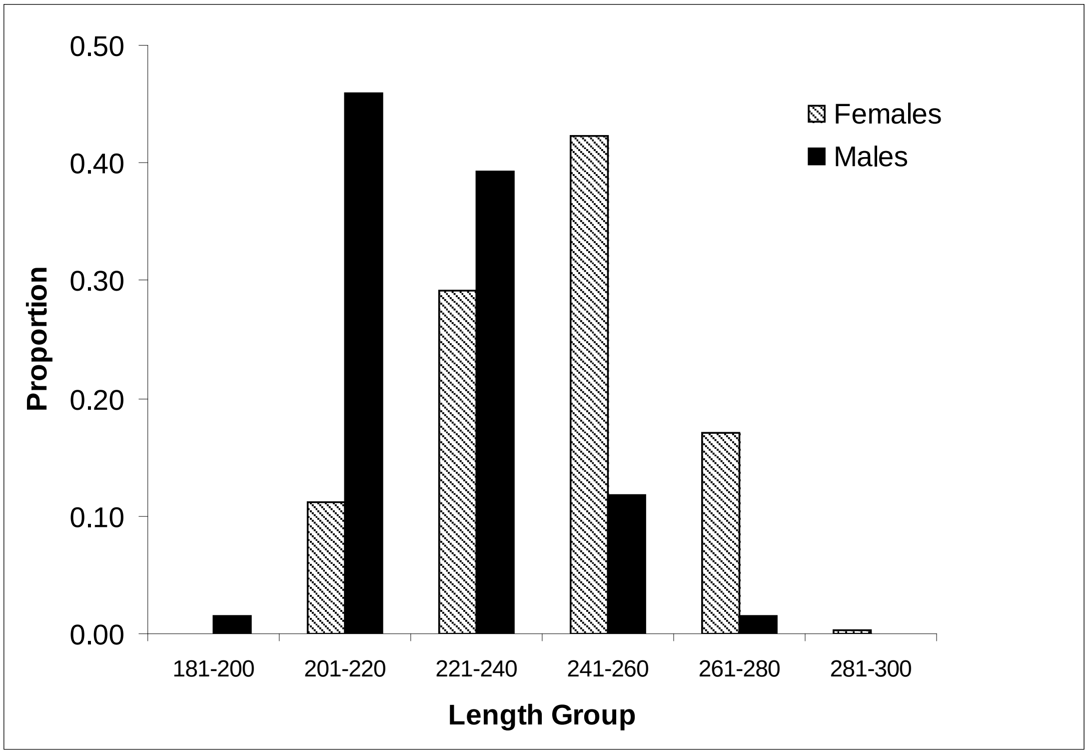

Figure 9. Length-frequency of male and female alewife herring captured by the Nanticoke River pound and fyke net survey, 2012.

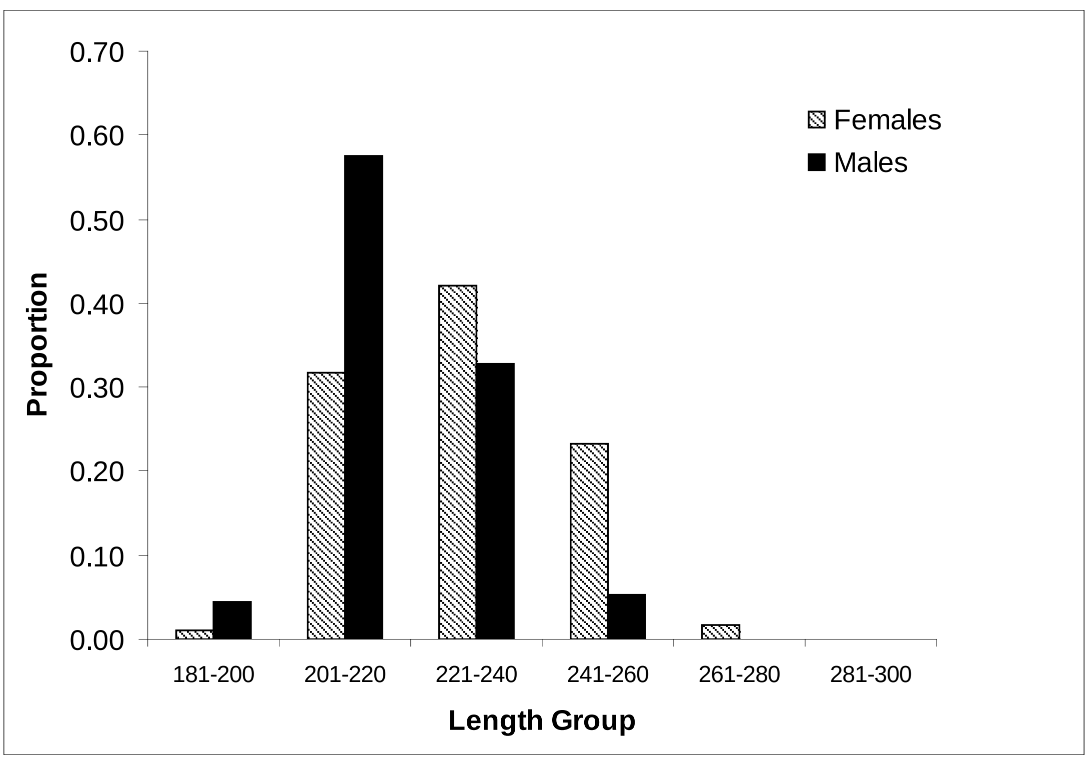

Figure 10. Length-frequency of male and female blueback herring captured by the Nanticoke River pound and fyke net survey, 2012.

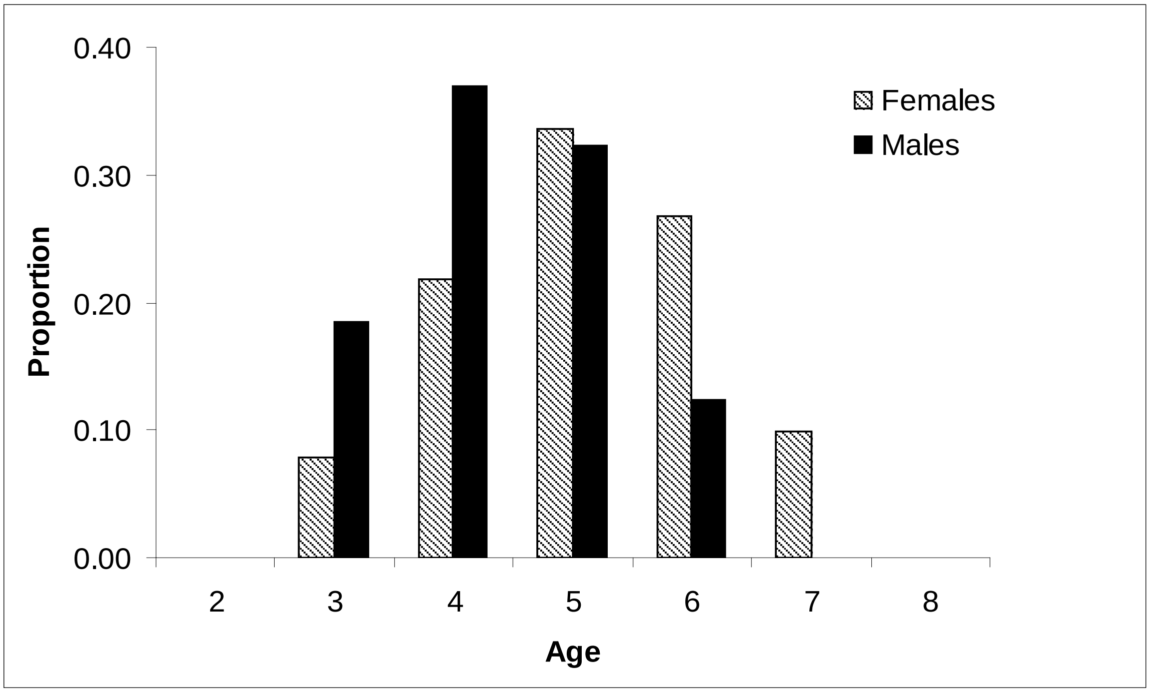

Figure 11. Age-frequency of male and female alewife herring captured by the Nanticoke River pound and fyke net survey, 2012.

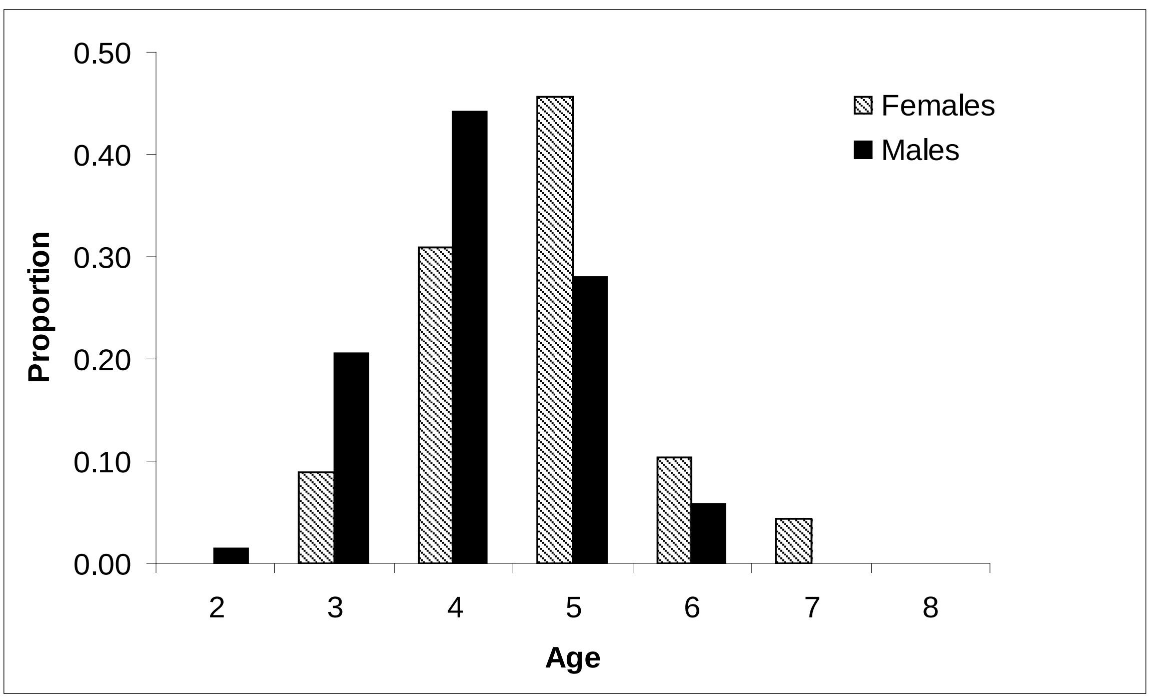

Figure 12. Age-frequency of male and female blueback herring captured by the Nanticoke River pound and fyke net survey, 2012.

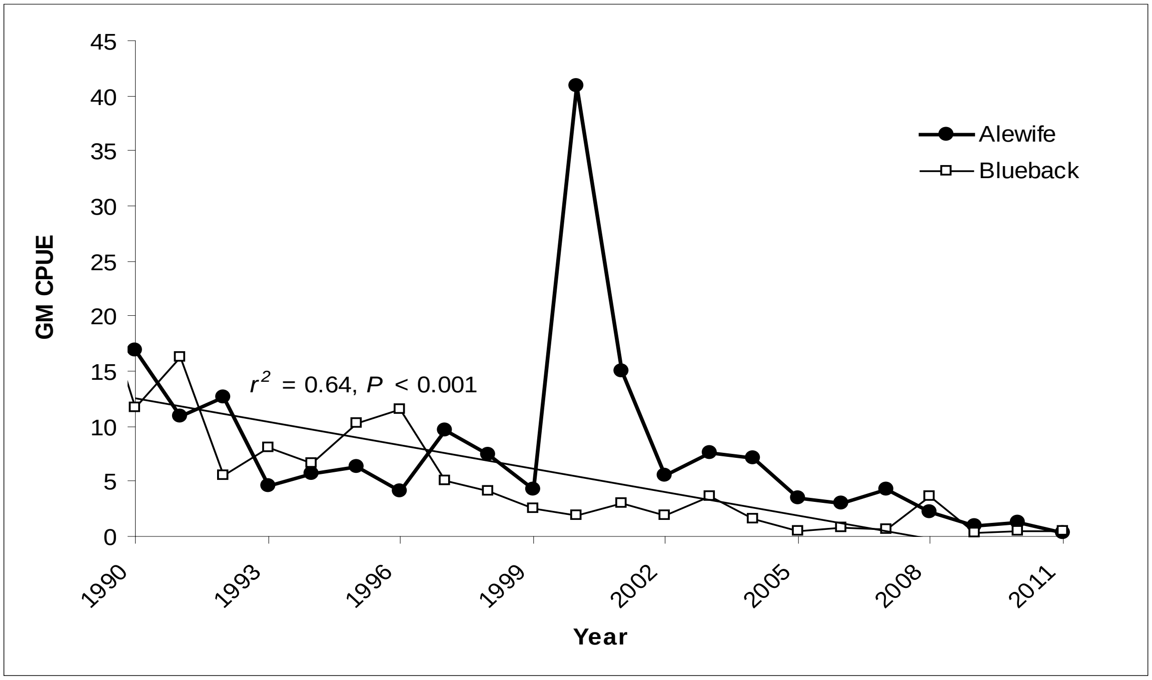

Figure 13. Geometric mean CPUE (catch per net day) of adult alewife and blueback herring from Nanticoke River fyke nets, 1989-2011. No fyke nets were fished in 2012.

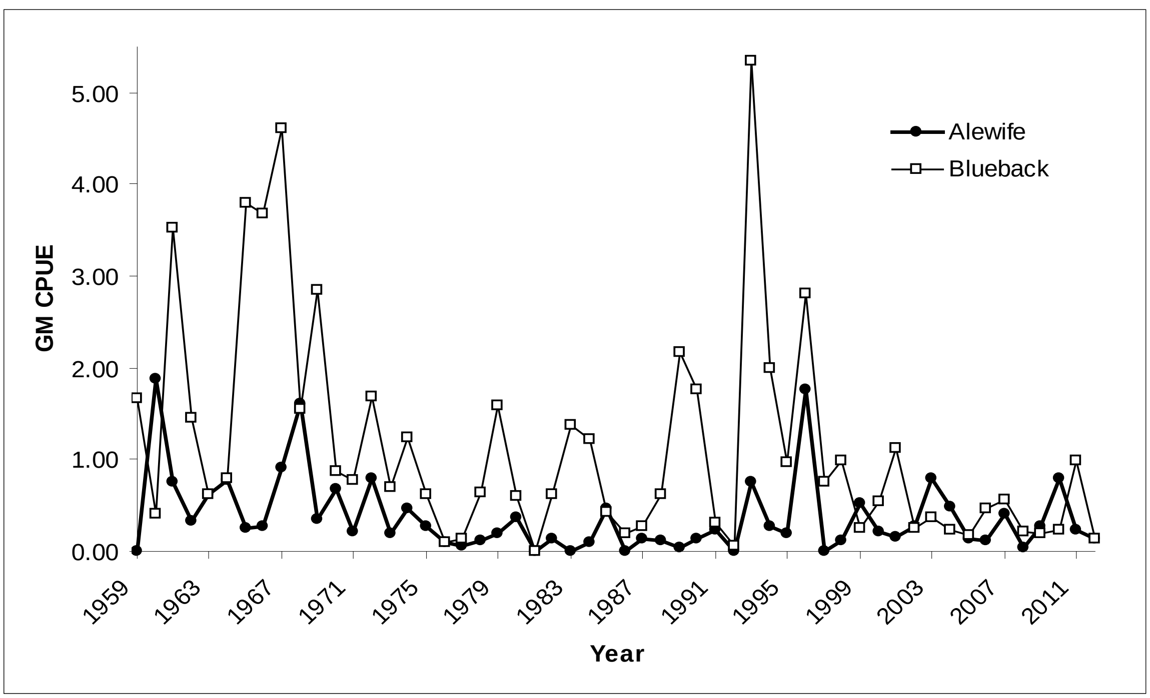

Figure 14. Nanticoke River juvenile alewife and blueback herring geometric mean CPUE (catch per haul), 1959-2012.

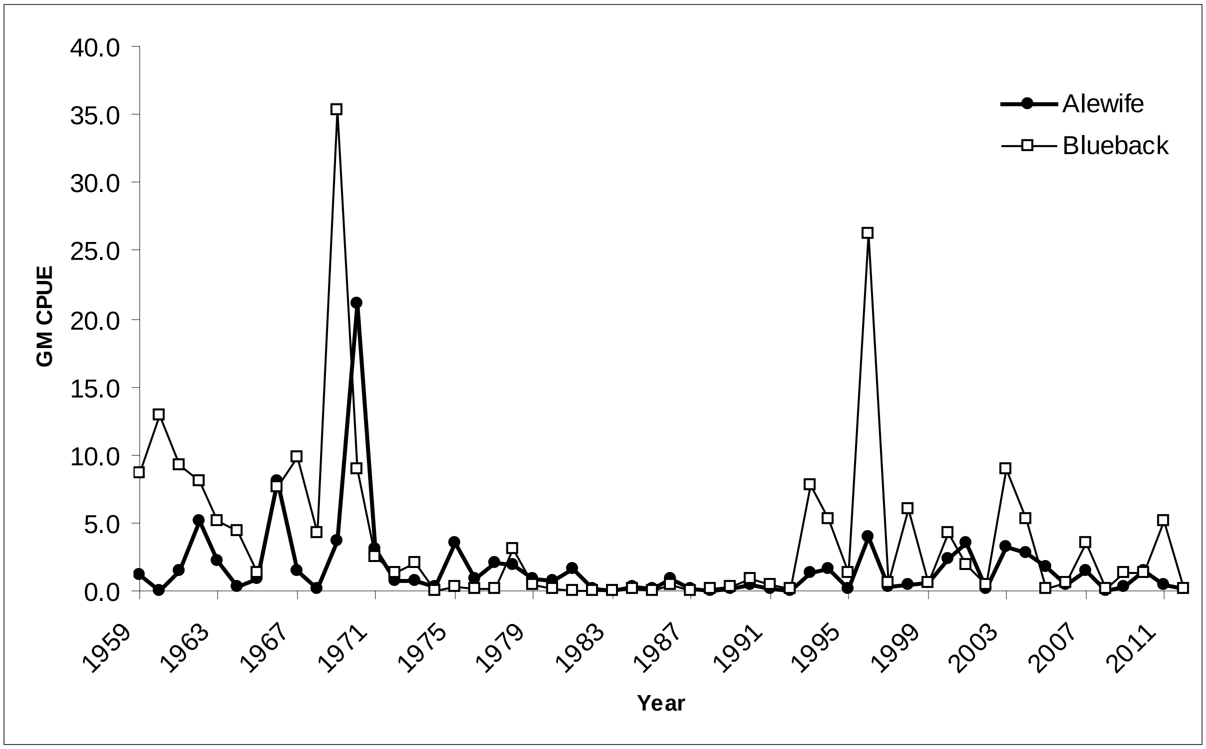

Figure 15. Upper Chesapeake Bay juvenile alewife and blueback herring geometric mean CPUE (catch per haul), 1959-2012.

A Summary of Virginia's American Shad Fisheries in 2012 and Results of Monitoring and Restoration Programs

Annual Compliance Report to the Atlantic States Marine Fisheries Commission

1 July 2013

by

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INTRODUCTION

This report describes the fishery-independent and fishery-dependent monitoring programs for American shad performed in Virginia during 2012. The fishery-dependent monitoring results describe the ASMFC-approved limited bycatch allowance of American shad in 2012. The Virginia Institute of Marine Science bycatch monitoring data are included in this report. Other than this very limited bycatch fishery, there has been a moratorium on the harvest of American shad from the Chesapeake Bay since 1994. Effective January 1, 2005, it became unlawful for any person aboard any vessel or on land in Virginia to possess any American shad harvested from the Coastal Area. This document follows the reporting format specified in Table 5 of Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (ASMFC 2010). Data are reported from a cooperative restoration program for American shad among the Virginia Marine Resources Commission (VMRC), the Virginia Department of Game and Inland Fisheries (VDGIF), and the U.S. Fish and Wildlife Service (USFWS). Summaries of fishery-independent monitoring programs are provided by the Department of Fisheries Science of Virginia Institute of Marine Science (VIMS), while the VMRC reports the results from the bycatch fishery.

Regulations of harvest and the monitoring of American shad populations in Virginia using methods outlined in this report continued in 2013, with the exception of the permitted bycatch fishery. In 2013 this fishery will continue as in 2012, but is limited entry (capped at 30 permittees) with a maximum of 500 American shad allowed.

I. Harvests and losses

A. Commercial Fishery

Since January 1, 1994, a moratorium on the harvest and possession of American shad from the Chesapeake Bay or its tidal tributaries has been in effect for commercial fishermen. Effective January 1, 2005, it became unlawful for any person aboard any vessel or on land in Virginia to possess any American shad harvested from the Coastal Area.

1. Characterization of fishery (season, cap, gears, regulations)

   Not Applicable.

2. Characterization of directed harvest

   Not Applicable.

3. Characterization of permitted bycatch harvest for American shad.

   All management measures and restrictions that pertained to the limited bycatch fishery for American shad can be found in VMRC Regulation 4VAC20-530-10 et seq. (http://www.mrc.state.va.us/regulations/fr530.shtm; Appendix 1). In 2012, a permit system remained in effect whereby permitted, registered commercial fishermen were allowed to retain up to 10 American shad per vessel harvested only as bycatch from anchored gill nets and staked gill nets in areas above the first bridge in the James, York, and Rappahannock rivers but below the spawning reaches. The permit-based bycatch system has been in place since February 2006.

   For this bycatch allowance of American shad, it was unlawful for any person to possess aboard a vessel or land any American shad, unless that person possessed at least an equal number of fish of only the following food-grade species: spot, Atlantic croaker, bluefish, catfish, striped bass, or white perch.

a. Estimate and method of estimation.
b. A total of 21 bycatch permits were issued in 2012. Commercial fishermen possessing an American shad bycatch permit are required to report numbers harvested to the VMRC Interactive Voice Response System (IVRS) in addition to reporting total pounds harvested to the mandatory reporting database. A total of 861.0 pounds of American shad was reported to the mandatory reporting database as harvested, and a total number of 230 American shad was reported to the IVRS (Table 1). Eight permit holders reported retaining at least one American shad. There were 219 shad reported kept from the York River, four from the James River; and seven fish was reported kept on the Rappahannock River (Table 2). Table 3 reports harvest of species, including bycatch of American shad, by anchor and staked gill nets. This table summarizes activity reported to the VMRC's mandatory harvest reporting database and is not restricted to fishermen with American shad bycatch permits. The total number of trips during the months of February through April, when American shad were harvested, was 66 in 2012. The James River had 2 trips, the Rappahannock River had 3, and the York River had 61. Table 4 provides catch-per-trip estimates for the river of the bycatch areas.
c. Trip and effort data have been summarized for all species harvested by anchored (sink) and staked gill nets during the months of February through April, by water body, since 2003. This has been done to see if the establishment of a bycatch allowance in 2006 has possibly resulted in increasing the amount of overall gill nets trips in any of the rivers. There has been no trend regarding effort in the York River; there were a total of 611 trips in 2012. The 2012 total number of trips for the York River is above both the 2003-2005 average of 529 trips and the 2006-2012 average of 575 trips. The number of spring gill net trips in the James River has been stable, there were 318 trips in 2012. The average number of trips for 2003-2005 for the James River was 308, the average for 2006-2011 was 354 trips. The total number of spring gill net trips in the Rappahannock River has been trending upward, the 711 trips in 2012 is the second highest total for any of the three river systems for the 2003-2011 time period. However the average number of trips in the Rappahannock since the permit was created (2006-2012) is 614 trips, which is lower than the 2003-2005 average of 580 trips.

d. Estimate of composition (length and/or age)

A subsample of American shad (n=87) from the permitted bycatch was collected by VIMS from four cooperating gill netters and processed for length, weight, sex, maturity stage, age, and the presence of hatchery (OTC) marks. All fish that were obtained for biological analysis were captured in the James and York rivers; cooperating fishers on the Rappahannock River were not available in 2012.

In the James, the bycatch subsample contained 4 males and 48 females harvested in anchored and staked gill nets. The subsample ranged in size and age from 367-473 mm FL and 4-8 years, respectively. Virgin and repeat spawners (52.5% and 47.5% respectively) were both present in the subsample. Otoliths of 48 American shad

(92.3% of the total that were collected from the river) from the sample were scanned for hatchery marks and 16 specimens (33.3%) with OTC marks were detected.

In the York, the bycatch subsample contained 2 males and 33 females harvested in anchored and staked gill nets. The subsample ranged in size and age from 381-484 mm FL and 4-7 years, respectively. Virgin and repeat spawners (48.1% and 51.9% respectively) were both present in the subsample. Otoliths of 27 American shad (77.1% of the total that were collected from the river) from the sample were scanned for hatchery marks and 1 specimen (3.7%) with OTC marks were detected.

B. Recreational fishery

1. Characterization of fishery (season, cap, gears, regulations)

   Since January 1, 1994, a moratorium on the harvest and possession of American shad from the Chesapeake Bay or its tidal tributaries has been in effect for recreational fishermen.

2. Characterization of directed harvest

   Not applicable.

3. Characterization of other losses (poaching, hook-and-release mortality, etc.)

   No available data.

C. Other Losses

1. Scientific collection of pound net bycatch harvest of American shad.

   VIMS scientists examined pound net samples from three fishers operating at locations in the upper and lower portions of Chesapeake Bay, including the western and eastern shores (Figure 1). Pound net fishers had special permits to take American shad for scientific monitoring, but their catches were not permitted to be sold or retained as bycatch by the VMRC. Daily log books were also obtained from two of these cooperating fishers.

   Samples of up to 129 American shad were collected from each pound net fisher at intervals of approximately every two weeks. Fish in these samples were taken randomly from the total catch on a given day or represented the entire catch from a single fishing day. Some samples were taken more frequently when individual operations were catching American shad.

   A total of 353 American shad were processed for length, weight, sex, maturity stage, and age. Biological information is recorded for each date of harvest in Tables 5-7. Year class composition from each pound net location is reported in Table 8.

2. Losses to capture of brood stock on the Pamunkey River and other activities related to hatchery evaluation.

   The VDGIF conducted American shad egg taking efforts in the spring of 2012. This marked the twentieth season for such operations on the Pamunkey River and the twenty-second season overall since American shad restoration efforts began in 1992. Eggs collected from this river were used to stock the James River for restoration purposes. For the fifth consecutive year, the egg collection operation on the Pamunkey (river kilometer 91; PRK91) was contracted to a private consulting firm; this firm conducted drift gill netting efforts on 21 nights during the period March 16 – April 20. A total of 514 female and 324 male brood fish were collected and used for egg production. Strip-spawning yielded a total of 12,172,498 eggs; all were sent to the Harrison Lake National Fish Hatchery (HLNFH). Hatchery raised fish were marked with oxytetracycline (OTC). HLNFH stocked a total of 5,352,847 OTC tagged shad fry in the upper mainstem of the James River at Scottsville (JRK 300).

VDGIF staff also collected adult American shad from above and below the fall line of the James and Rappahannock Rivers near Richmond and Fredericksburg, Virginia (respectively), using boat mounted electrofishing gear. Sagittal otoliths (sagittae) were removed and viewed via a dissecting microscope under an ultraviolet light to check for the presence of hatchery (OTC) marks. Eighteen adult American shad were collected from the Rappahannock River and 126 were collected in the James River.

VDGIF has continued its James River restocking program in the spring of 2013. Adult American shad males and females were once again taken for egg collections. Egg collection work was contracted out to a private consulting firm. Harrison Lake National Fish Hatchery was used as a rearing facility.

3. Harvest of American shad by tribal governments

The Mattaponi and Pamunkey tribal governments harvest American shad from the York River system but do not report landings to the VMRC, following the treaty of 1677.

D. Protected species/Atlantic sturgeon bycatch estimates

Atlantic sturgeon is taken as bycatch in the staked gill nets used by VIMS to monitor abundance of adult American shad in the James, York, and Rappahannock rivers. In 2012, a total of 4 Atlantic sturgeon were caught as bycatch, all in the James River.

II. Required fishery-independent monitoring

A. Description of Requirement

Virginia is required to conduct fishery-independent monitoring of the James, York, and Rappahannock rivers including: an annual spawning stock survey and representative sampling for biological data; calculation of mortality and/or survival estimates; annual juvenile abundance index reported as a geometric mean; and hatchery evaluation.

B. Description of Work Performed

For the spawning stock survey, commercial fishermen were contracted to set staked gill nets for weekly sampling of adult American shad during the monitoring period (approximately February–May). Scientists accompanied commercial fishermen to fish each net and returned the catch to the laboratory. Fork length, total length, body weight, and sex were recorded for each specimen. Scales and otoliths were removed for processing. Otoliths were scanned for hatchery marks using epifluorescent microscopy.

Catch data from each river are summarized in terms of a standardized catch index (the area under the curve of daily catch rate versus time of year). The catch index, the duration of the run in days, the maximum daily catch rate in each year, and the mean catch rate in each year were compared to summaries of historical logbook data to provide a measure of the relative size of the current shad runs.

An index of abundance of juvenile American shad is obtained through the annual VIMS striped bass seine survey in the James, York, and Rappahannock rivers. Catches from different years are standardized by calculating a juvenile abundance index (JAI) and the geometric mean catch per haul, which allows for a relative comparison of catches among years and between rivers. In 2011, weekly fyke net sampling for juvenile American shad in the Mattaponi River was initiated by VIMS to provide an alternative measure of recruitment for American shad; this was also conducted in 2012 from May 16 to August 21. Summertime electrofishing and push net surveys by VDGIF for juvenile American shad were conducted on the James and Rappahannock Rivers in 2012.

C. Results

1. Juvenile Indices

Tables 9 and 10 report index values of juvenile abundance of American shad based on seine surveys (1979-2012) on the James and Chickahominy rivers, the Rappahannock River, the main stem of the York River, the Pamunkey River and the Mattaponi River. The geometric mean catch (followed by standard deviation and number of seine hauls in parentheses) of juvenile American shad captured in daylight seine hauls in 2012 was: James River, inclusive of Chickahominy River, 0.01 (0.092, 57); Chickahominy River, 0 (0, 10); Rappahannock River, 0.19(0.422, 35); York River, inclusive of Pamunkey and Mattaponi Rivers, 0.02 (0.101, 93); Mattaponi River, 0.01 (0.099, 48); and Pamunkey River, 0.02 (0.111, 39).

The seine survey data on the James River (Table9) in recent years (2006-2012) shows measureable recruitment. On the Rappahannock River, the highest JAI value in the time series was recorded in 2010 and 2011. Within the York River system, except for 2003, the juvenile index values based on the seine survey are consistently higher on the Mattaponi River than they are on the Pamunkey River and the York River (Table 10).

In the fyke net sampling, a total of one American shad was caught (70 mm FL) with a daily age estimate of 81 days. In comparison, 441 juvenile American shad were collected using the same methods in 2011.

VDGIF biologists collected 50 juvenile American shad in push net surveys on the tidal portions of the Rappahannock River below Fredericksburg, VA. VDGIF biologists are also conducting push net surveys in the tidal portion of the James River near Richmond and in Bosher's Pool. Fifty juvenile American shad were collected from the James River.

2. Spawning Stock Assessment

a. Catch rates

A total of 906 maturing American shad (91 males; 815 females) were captured in 2012. The total weight of the sample was 3016.6 lbs (male, 241.0 lbs; female, 2775.6 lbs). Catches were lowest on the York River (217 total fish, 32 males and 185 females). Total catches of American shad were similar on the James (291 total fish, 29 males and 262 females) and Rappahannock (398 total fish, 30 males and 368 females) rivers. A total of 9 post spawning American shad were caught in 2012; which were not included in catch rate analysis.

The duration of the spawning run is defined as the number of days between the first and last observation of a catch rate that equals or exceeds 0.01 female kg/m. The 2012 spawning run duration was estimated to be 51 days on the James River (26 February – 16 May), 66 days on the York River (5 February – 10 April), and 62 days on the Rappahannock River (29 February – 30 April).

Seasonal catch indices in 2012 were: York River, 3.17; Rappahannock River, 7.28; James River, 6.06.

On the York River, the seasonal catch index in 2012 was 3.17. This is lower than the value seen in 2011 (4.58) (Figure 2). York River catch indices have been trending downward in recent years and are close to all-time lows (Figure 3).

On the James River, the 2012 index (6.06) decreased from 2011 (9.00), which was the highest of the current sampling since 2003 (9.34) (Figure4). Our overall assessment for the James River is that the stock remains at historically low levels and is dependent on hatchery inputs (in 2012, hatchery prevalence of our James River sample was 34.1%). Due to budget constraints stocking efforts of American shad on the James River have been reduced in recent years. The current reduction in stocking effort is projected to continue.

On the Rappahannock River, the 2012 index (7.28) increased from 2011 (6.51); this is the highest value recorded since the monitoring began in 1998 (Figure 5). The current geometric mean (3.49) is higher than the mean of the historical data (1.45). It should be noted that since the catch index for the Rappahannock River is low in the historical data relative to the York and James rivers, there is uncertainty about what an appropriate target level should be for this stock.

b. Age Composition and Length Frequency

Mean total length at age of males and females from all rivers ranged from 428.8-497.0 mm TL and 473.0–527.8 mm TL, respectively. Mean weight at age of males and females from all rivers ranged from 0.9–1.6 kg and 1.3–1.8 kg, respectively.

Using scale-based ageing methods, we estimated that the 2007 and 2006 year classes (ages 5 and 6) of female American shad were the most abundant on all rivers; on the Rappahannock the 2008 year class (age 4) was also abundant. On the James River, five age-classes of females were represented (2004-2008, ages 4-8), with the sample dominated by age-5 fish (49.0% of the total that was aged). On the York River, four age-classes of females were represented (2005-2008, ages 4-7). The sample was equally dominated by age-5 (50.3.0%). On the Rappahannock River, six age-classes of females were taken (2004-2009, ages 3-8), with the sample dominated by age-5 fish (50.5%). Mean age of females in 2012 was 5.2 y (James River), 5.0 y (York River), and 5.2 y (Rappahannock River). These values are similar on all rivers to those observed in 2011.

c. Sex Ratio

As in previous years of monitoring, numbers and catch rates of males were lower than catch rates of females throughout the period. Sex ratios (males:females) were: York River, 1:5.78; James River, 1:9.03 and Rappahannock River, 1:12.27. It is important to note that the monitoring gear mimics an historical fishery that was selective for mature female fish. Catches of males do not likely reflect true abundance.

d. Degree of Repeat Spawning

On the York River, fish (sexes combined) ranged in age from 4–8 years with 0 (virgin) to 4 spawning marks. On the Rappahannock River, fish (sexes combined) ranged in age from 3-8 years with 0-4 spawning marks. On the James River, fish (sexes combined) ranged in age from 4-8 years with 0-3 spawning marks. The following percentages of fish in each river had at least one prior spawn: York River, 45.6% (98 virgins in a sample of 180); James River, 44.6% (123 virgins in a sample of 222) and Rappahannock River 39.6% (204 virgins in a sample of 338 fish).

3. Annual Mortality Rate

Total instantaneous mortality (Z) was estimated using simple linear regression analysis of the natural log of age-specific catch on the descending limb of the catch curve. Total instantaneous mortality rates of females were: York River, 0.49 (r^2=0.54); James River, 0.74 (r^2=0.64) and Rappahannock River, 0.63 (r^2=0.66). It is assumed that year classes above age-3 are equally catchable by the gear. On the Rappahannock River this assumption may falsely decrease Z due to the larger mesh size being used. Instantaneous mortality rates of males were not calculated because all year classes present are not equally catchable by the sampling gear.

4. Hatchery Evaluation

<u>James River</u> - Otoliths of 82 American shad on the James River were

processed for hatchery marks (28.2% of the total caught); the proportion with hatchery marks was 34.1% (28 of 82 fish). The strength of the James River catch index continues to rely on the prevalence of hatchery fish

York and Rappahannock Rivers - Otoliths of 53 American shad (24.4% of the total that were caught) from the York River were processed for hatchery marks. Two specimens (1.9%) with OTC marks were detected. There were no strays present in the sample. In 2012, 117 American shad (29.4% of the total that were caught) from the Rappahannock river were scanned for the prevalence of hatchery marks. Eight fish (6.8%) with hatchery marks from the Rappahannock River were found. Stocking of American shad in the Rappahannock River began in 2003.

References

Atlantic States Marine Fisheries Commission (ASMFC). 2010. Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). 158 pp.

Table 1. Summary of American shad commercial, research, and restoration losses in Virginia, 2012. Abbreviations are: Avg (average); Ches. (Chesapeake Bay); DGN (drift gill net); EF (electrofishing); FN (fyke net); JA (James River); MAT (Mattaponi River); ND (no data); PN (pound net); PUSH (pushnet); RA (Rappahannock River); SGN (staked gill net).

Commercial Landings					
	Number	**Pounds**	**Avg weight**	**Gear**	**Sex**
	230	861.0	3.74	AGN & SGN	M & F
VIMS Monitoring					
	Number	**Pounds**	**Avg weight**	**Gear**	**Sex**
Juvenile	1	ND	ND	FN, MAT	
Adult	91	241.0	2.6	SGN, all rivers	M
Adult	824	2799.0	3.4	SGN, all rivers	F
Adult	213	342.2	1.6	PN, all rivers, Ches	M
Adult	140	358.4	2.6	PN, all rivers, Ches	F
Total adult	1268	3740.6		All	All
VDGIF/VMRC/USFWS Restoration Projects					
	Number	**Pounds**	**Avg weight**	**Gear**	**Sex**
Juvenile	100	ND	ND	PUSH/EF, RA & JA	M & F
Adult, brood	324	ND	ND	DGN, Pamunkey	M
Adult, brood	514	ND	ND	DGN, Pamunkey	F
Adult, brood	126	ND	ND	EF, JA	M
Adult	18	ND	ND	EF, RA	M & F
Total adult	982	ND		All	All
Pamunkey Tribal Government					
	Number	**Pounds**	**Avg weight**	**Gear**	**Sex**
Adult	ND	ND	ND	DGN	M & F
Mattaponi Tribal Government					
	Number	**Pounds**	**Avg weight**	**Gear**	**Sex**
Adult	ND	ND	ND	DGN	M & F
Grand Minimum Total Adults	2480	4601.6		All	All

Table 2. Number of fisherman with bycatch permits, overall and active, and fishing activity reported to the IVRS, by river system in Virginia, 2006-2012. Permits are considered active if one American shad or more is reported during a fishing season.

Water Body	Year	# Permit Holders	# Active Permits	Total Trips	# Shad Caught	# Shad Kept	% of Bycatch for Year
James River	2012	7	2	2	7	4	2
	2011	9	3	25	42	42	32
	2010	9	0	7	0	0	0
	2009	8	1	6	2	0	0
	2008	6	2	3	3	3	2
	2007	16	7	58	119	52	19
	2006	32	5	27	24	23	9
York River	2012	12	5	61	219	219	95
	2011	11	4	51	88	87	67
	2010	9	5	43	229	208	84
	2009	11	6	97	302	288	100
	2008	10	6	85	89	89	60
	2007	15	8	104	199	199	73
	2006	31	5	198	233	228	90
Rappahannock River	2012	2	1	3	7	7	3
	2011	3	1	1	1	1	1
	2010	7	2	10	40	40	16
	2009	1	0	0	0	0	0
	2008	3	1	8	81	57	38
	2007	5	2	23	22	20	7
	2006	14	2	8	3	3	2

Table 3. Harvest (pounds) by species and bycatch area during January through April 2012. All harvest is from anchored and staked gill nets (not exclusive to American shad bycatch permit holders). Bait includes fish reported as bait and menhaden.

Bycatch Area	Am Shad	Atlantic Croaker	Bait	Blue fish	Catfish	Gizzard Shad	Hickory Shad	Striped Bass	White Perch
James River (Central)	14	2,973	.	5	4,392	.	466	36,238	3,112
James River (General)	.	.	.	.	4,948	.	.	24,041	.
James River (Upper)	15	.	12	.	8,218	365	75	10,610	7
Rappahannock River (Central)	.	876	12,270	658	5,154	15,818	228	54,946	13,282
Rappahannock River (General)	.	132	11,375	9	526	.	.	2,334	2
Rappahannock River (Lower)	9	2,279	16,366	158	4	.	3	16,310	102
Rappahannock River (Upper)	.	184	7,163	.	479	150	197	26,412	1,524
York River (Central)	86	5,436	159,578	124	140	1,680	.	7,872	48
York River (General)	260	2,404	159,055	99	60	20	.	32,389	417
York River (Upper)	477	1,668	8,950	.	3,220	525	30	7,574	5,528
Total	861	15,953	374,768	1,053	27,141	18,558	999	218,726	24,021

Table 4. Catch-per-trip estimates for American shad, by bycatch area, 2012.

Water Body	Number of Shad	Trips	Catch per trip
James River	7	2	3.5
York River	219	61	3.6
Rappahannock River	7	3	2.3
All	233	66	3.5

Table 5. Biological data of American shad (n=91) collected from a pound net located at the mouth of the Great Wicomico River. Abbreviations: TW, total weight; Avg, Average; P. Spent, Partially Spent.

Date	Maturity Stage	# Females	TW (kg)	Avg Weight Per fish (g)	# Males	TW (kg)	Avg Weight Per fish (g)
3/13/2012	Maturing	5	8.92	1783.62			
	Hydrated						
	P. Spent						
	Spent						
	Unstaged				12	10.74	1117.32
3/26/2012	Maturing	12	15.51	1292.75			
	Hydrated						
	P. Spent						
	Spent						
	Unstaged				24	18.08	753.14
4/16/2012	Maturing	3	4.04	1347.0			
	Hydrated						
	P. Spent						
	Spent						
	Unstaged				11	8.80	800.00
5/2/2012	Maturing	8	9.83	1228.14			
	Hydrated						
	P. Spent						
	Spent						
	Unstaged				16	11.06	690.94
Total		28	38.30	1367.86	63	48.68	772.70

Table 6. Biological data of American shad (n=152) collected from a pound net located at the mouth of the Rappahannock River. Abbreviations: TW, total weight; Avg, Average; P. Spent, Partially Spent.

Date	Maturity Stage	# Females	TW (kg)	Avg Weight Per fish (g)	# Males	TW (kg)	Avg Weight Per fish (g)
4/26/2012	Maturing	3	3.73	1243.53			
	Hydrated						
	P. Spent						
	Spent	1	1.14	1138.60			
	Unstaged				7	5.30	756.86
5/7/2012	Maturing	18	22.73	1262.57			
	Hydrated						
	P. Spent	9	7.71	856.46			
	Spent	18	15.37	854.11			
	Unstaged				84	54.09	643.98
5/22/2012	Maturing	4	5.00	1249.35			
	Hydrated						
	P. Spent						
	Spent						
	Unstaged				8	5.39	673.74
Total		53	55.68	1050.57	99	64.78	654.34

Table 7. Biological data of American shad (n=110) collected from a pound net located in the vicinity of Cape Charles, VA. Abbreviations: TW, total weight; Avg, Average; P. Spent, Partially Spent.

Date	Maturity Stage	# Females	TW (kg)	Avg Weight Per fish (g)	# Males	TW (kg)	Avg Weight Per fish (g)
3/21/2012	Maturing	6	8.03	1339.12			
	Hydrated						
	P. Spent						
	Spent						
	Unstaged				23	19.60	852.18
4/10/2012	Maturing	23	33.92	1474.97			
	Hydrated						
	P. Spent	3	2.49	831.07			
	Spent						
	Unstaged				14	13.05	932.47
5/9/2012	Maturing						
	Hydrated						
	P. Spent	13	11.10	853.92			
	Spent	14	13.04	931.65			
	Unstaged				14	9.10	650.00
Total		59	68.58	1162.37	51	41.75	818.63

Table 8. Year class composition of fish taken in pound nets in 2012, indicated as percent of aged catch from three pound net locations in Chesapeake Bay.

	Year Class	Great Wicomico	Cape Charles	Rappahannock
Males	2009	18.0	17.4	9.2
	2008	50.0	30.0	48.7
	2007	32.0	43.0	31.6
	2006	0.0	9.0	7.9
	2005	0.0	0.0	2.6
	2004	0.0	0.0	0.0
Females	2009	0.0	0.0	2.3
	2008	25.0	15.8	25.0
	2007	65.0	44.7	50.0
	2006	5.0	28.9	13.6
	2005	5.0	8.0	6.8
	2004	0.0	2.6	2.3

Table 9. Indexes of abundance of juvenile American shad collected in beach seine surveys (1980-2012) on the James, Chickahominy and Rappahannock rivers. The index is the geometric mean catch per haul. Means are reported for five year increments for years 1980 – 1999. Abbreviations are: SD, standard deviation; N, number of seine hauls.

Year	James	SD	N	Chickahominy	SD	N	Rappahannock	SD	N
1980 - 84	0.08	0.357	18	0		5	0.32	2.774	4
1985 - 89	0.01	0.224	34	0		8	0.16	0.492	16
1990 - 94	0.01	0.162	62	0		10	0.08	0.345	32
1995 - 99	0.01	0.105	65	0		10	0.17	0.457	33
2000	0		70	0		10	0.08	0.245	34
2001	0		70	0		10	0.34	0.434	35
2002	0		69	0		10	0		35
2003	0.10	0.303	70	0		10	0.59	0.659	28
2004	0.05	0.195	67	0		10	0.81	0.940	35
2005	0		66	0		10	0.27	0.656	33
2006	0.21	0.441	64	0.23	0.335	10	0.11	0.302	34
2007	0.04	0.255	65	0		10	0.40	0.504	34
2008	0.01	0.087	64	0		10	0.02	0.117	35
2009	0.02	0.121	65	0.07	0.219	10	0.13	0.360	34
2010	0.02	0.121	65	0		10	1.19	1.166	33
2011	0.15	0.391	59	0		10	1.15	1.052	27
2012	0.01	0.092	57	0		10	0.19	0.422	35

Table 10. Indexes of abundance of juvenile American shad collected in beach seine surveys (1980-2012) on the Mattaponi, Pamunkey, and York rivers. The index is the geometric mean catch per haul. Means are reported for five year increments for years 1980 – 1999. Abbreviations are: SD, standard deviation; N, number of seine hauls.

Year	Mattaponi	SD	N	Pamunkey	SD	N	York	SD	N
1980 - 84	7.21	1.005	17	0.42	0.599	12	2.41	1.152	30
1985 - 89	1.94	0.786	32	0.20	1.031	23	0.91	0.699	59
1990 - 94	0.59	0.772	46	0.04	0.223	36	0.28	0.620	87
1995 - 99	3.96	0.975	49	0.53	0.683	39	1.66	0.921	92
2000	5.77	1.305	39	0.08	0.256	31	1.83	1.331	74
2001	0.58	0.697	49	0.15	0.357	40	0.35	0.577	94
2002	0.23	0.496	48	0.02	0.110	40	0.12	0.374	93
2003	8.57	1.317	50	13.11	1.057	39	9.04	1.295	94
2004	7.52	1.393	47	0.10	0.287	38	2.21	1.448	90
2005	1.66	1.353	50	0.05	0.203	40	0.70	1.092	95
2006	0.93	0.916	48	0.09	0.351	37	0.47	0.760	90
2007	0.30	0.509	47	0		36	0.15	0.393	88
2008	0.11	0.303	50	0		40	0.06	0.225	95
2009	0.02	0.160	47	0		40	0.01	0.115	92
2010	0.97	1.029	50	0.06	0.189	38	0.47	0.823	93
2011	1.16	1.387	48	0.27	0.554	35	0.67	1.114	88
2012	0.01	0.099	48	0.02	0.111	39	0.02	0.101	93

Figure 1. Location of pound net operations (*) with special American shad bycatch permit

Figure 2. Recent (1998-2012) and historic values of the catch index of female American shad on the York River.

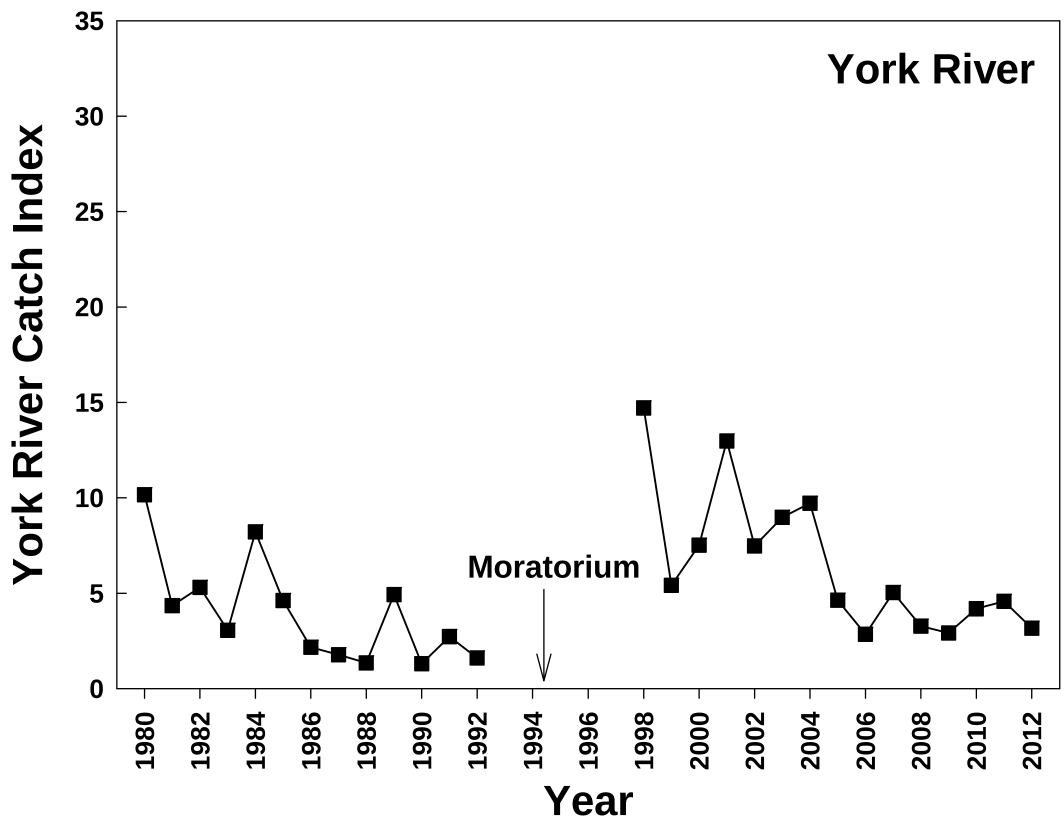


Figure 3. Catch indexes of historical logbook data from the 1950s (M. Greene), 1980s (R. Kellum), and current monitoring. The 1950s data have been adjusted by multiplying index values by 2.16 based on gear comparison trials. Horizontal lines are the geometric means of each data set (solid, 1950s; short dashes, current; long dashes, 1980s)

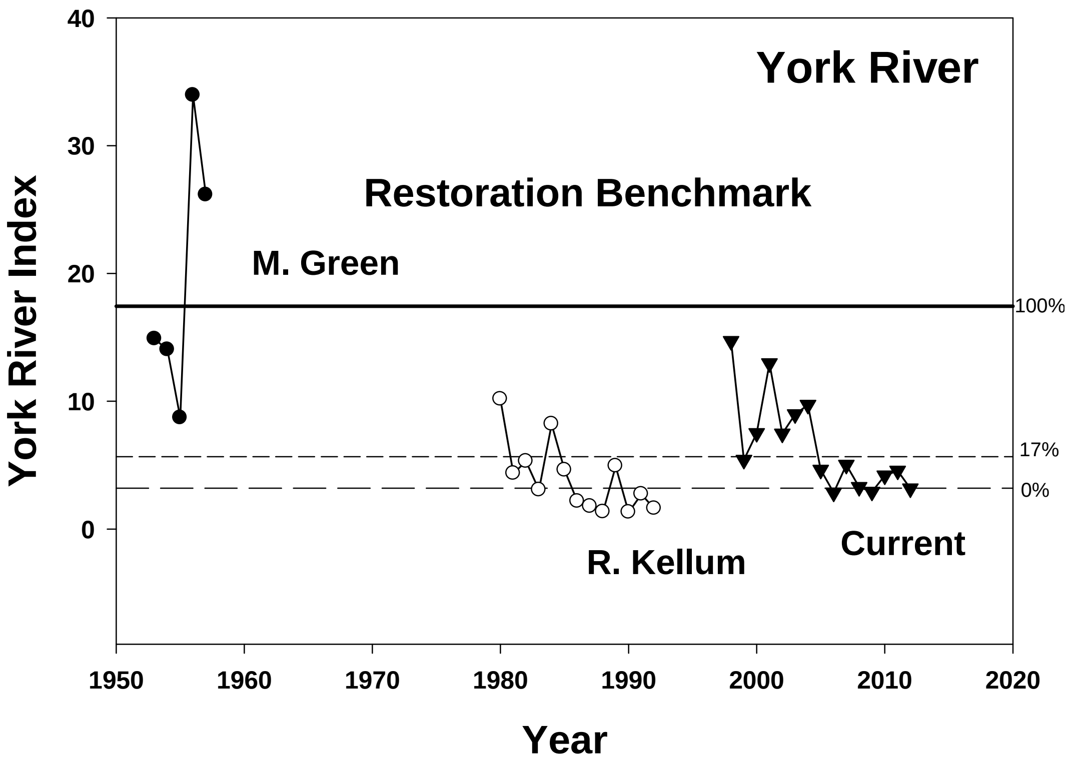


Figure 4. Recent (1998-2012) and historic values of the catch index of female American shad on the James River.

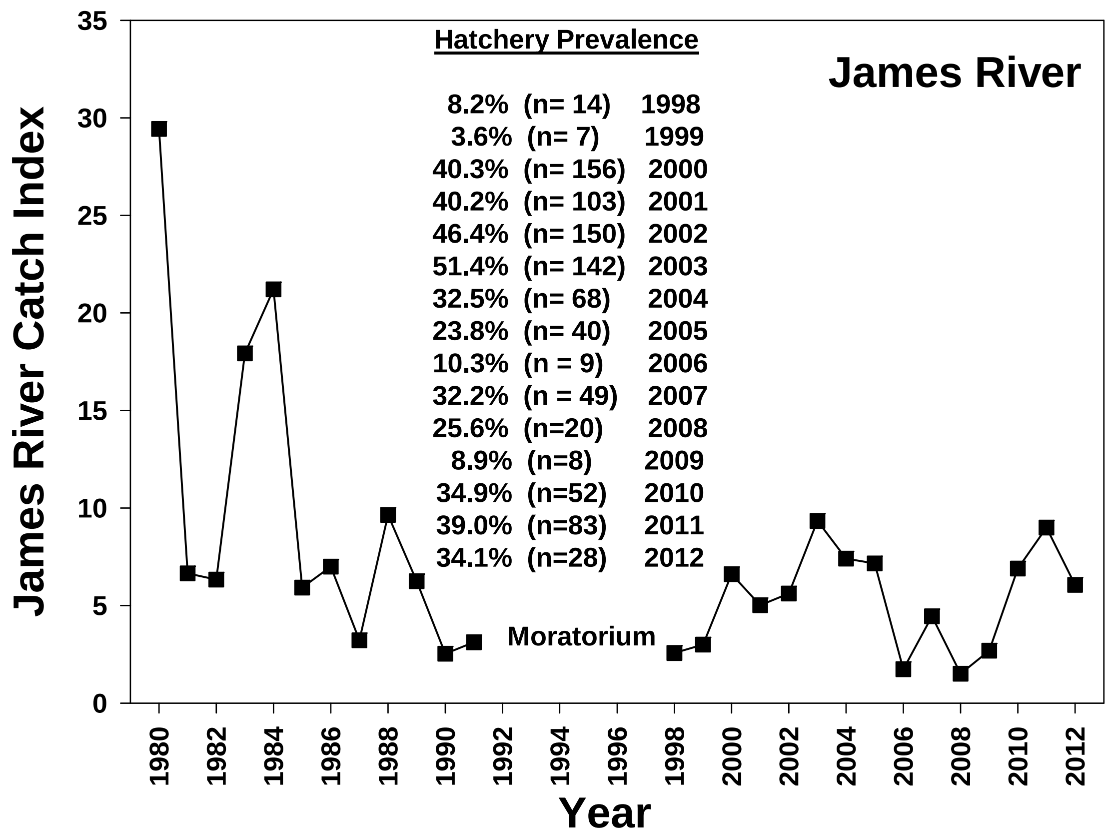
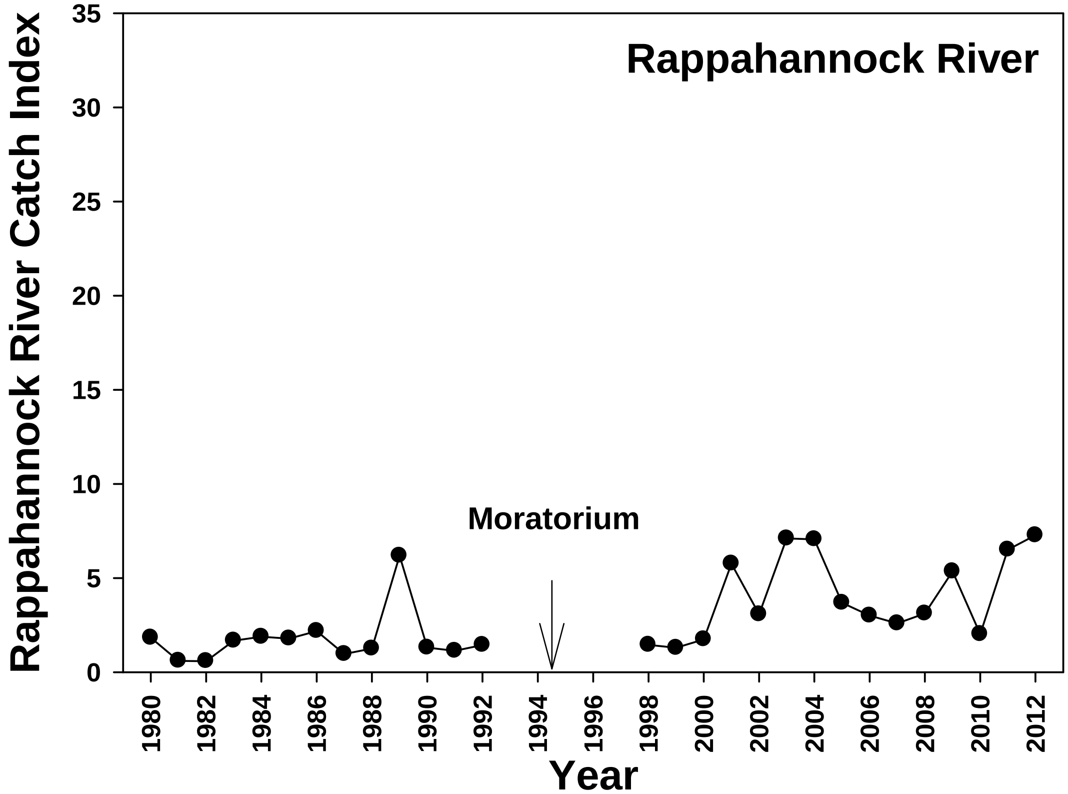


Figure 5. Recent (1998-2012) and historic values of the catch index of female American shad on the Rappahannock River.



Appendix 1

VIRGINIA MARINE RESOURCES COMMISSION
"PERTAINING TO AMERICAN SHAD"
CHAPTER 4VAC20-530-10 ET SEQ.

PREAMBLE

This chapter establishes a moratorium on the harvest of American shad and provides for a limited bycatch of American shad during the 2012 fishing season. This chapter is promulgated pursuant to the authority contained in § 28.2-201 of the Code of Virginia. This chapter amends and re-adopts, as amended, previous Chapter 4VAC20-530-10 et seq. which was adopted on February 22, 2011 and made effective on March 1, 2011. The effective date of this chapter, as amended, is February 1, 2012.

4VAC20-530-10. Purpose.

The purposes of this chapter are to rebuild the Virginia stocks of American Shad and to comply with the requirements for ocean intercept commercial fisheries as specified by the Interstate Fishery Management Plan for Shad and River Herring.

4VAC20-530-20. Definition.

The following words and terms when used in this chapter shall have the following meanings unless the context clearly indicates otherwise.

"Bycatch area" means those tidal waters of (i) the James River, from the James River Bridge upstream to a line connecting Dancing Point and New Sunken Meadow Creek; (ii) the York River, from the George P. Coleman Bridge upstream to the Rt. 33 Eltham and Lord Delaware bridges at West Point; and (iii) the Rappahannock River, from the Norris Bridge upstream to the Rt. 360 Downing Bridge at Tappahannock.

"Chesapeake Bay" means all Virginia tidal waters west of the Colregs Demarcation Line that connect the Cape Henry Lighthouse in Virginia Beach to the Cape Charles Lighthouse on Smith Island.

"Coastal area" means all Virginia tidal waters east of the Colregs Demarcation Line that connect the Cape Henry Lighthouse in Virginia Beach to the Cape Charles Lighthouse on Smith Island.

4VAC20-530-23 to 4VAC20-530-29. [Repealed]

4VAC20-530-30. Moratorium.

A. It shall be unlawful for any person to catch and retain possession of American shad from the Chesapeake Bay, except as described in 4VAC20-530-31.

B. It shall be unlawful for any person to possess aboard a vessel or land in Virginia any American shad harvested from the coastal area.

C. It shall be unlawful for any person to possess any American shad taken from the coastal area or the Chesapeake Bay, except as described in 4VAC20-530-31.

4VAC20-530-31. Bycatch fishery.

A. Any registered commercial fisherman meeting the conditions described in this subsection shall be eligible to participate in the American shad bycatch fishery in 2012:

1. The registered commercial fisherman shall apply for a VMRC American Shad Bycatch Permit and possess that permit while fishing, landing, or selling his catch of American shad.

2. The registered commercial fisherman shall complete the VMRC American Shad Bycatch Survey form to describe his pending fishing activity.

B. It shall be unlawful for any person to possess aboard a vessel more than 10 American shad. When more than one registered and permitted fisherman is fishing on the same vessel, it shall be unlawful to possess more than 10 American shad aboard that vessel.

C. It shall be unlawful for any person to possess aboard a vessel or land any American shad unless that person possesses at least an equal number of fish of only the following food-grade species: spot, croaker, bluefish, catfish, striped bass or white perch.

D. Possession of American shad by any person permitted in accordance with this section shall be lawful only when those American shad were harvested from the bycatch area. Possession of any American shad harvested in Virginia waters that are outside of the bycatch area shall constitute a violation of this regulation.

E. American shad harvested only as bycatch by anchored gill nets and staked gill nets may be possessed or retained for sale in accordance with the provisions of this regulation. It shall be unlawful for any person to harvest, land, or possess any American shad taken by any recreational gear or by any commercial gear, except anchored gill net or staked gill net.

F. Every fisherman permitted for the American shad bycatch fishery shall contact the commission's interactive voice response system once weekly to report the following for the preceding weekly period: name, registration number, number of fishing trips taken, water body fished, number of nets set, number of American shad caught and number retained.

4VAC20-530-32. [Repealed]

4VAC20-530-35. [Repealed]

4VAC20-530-40. Penalty.

As set forth in §28.2-903 of the Code of Virginia, any person violating any provision of this chapter shall be guilty of a Class 3 misdemeanor, and a second or subsequent violation of any provision of this chapter committed by the same person within 12 months of a prior violation is a Class 1 misdemeanor.

* * * * * * * * * * *

This is to certify that the foregoing is a true and accurate copy of the chapter passed by the Marine Resources Commission, pursuant to authority vested in the Commission by § 28.2-201 of the Code of Virginia, duly advertised according to statute, and recorded in the Commission's minute book, at meeting held in Newport News, Virginia on January 24, 2012.

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION

By:______________________________

Steven G. Bowman
Commissioner

Subscribed and sworn to before me this 27th day of January, 2012.

____

A. Notary Public

Delaware, Lehigh and Schuylkill Rivers

American Shad, Hickory shad and River Herring Annual Report for 2012

Submitted to:
Atlantic States Marine Fisheries Commission
to fulfill the requirements of the
Interstate Fishery Management Plan for Shad and River Herring

June 27, 2013

Prepared by:

The Delaware River Basin Fish & Wildlife Management Cooperative

Delaware Division of Fish and Wildlife • New Jersey Division of Fish and Wildlife

Pennsylvania Fish and Boat Commission • New York Division of Fish, Wildlife & Marine Resources

U.S. Fish and Wildlife Service • National Marine Fisheries Service

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Introduction

In accordance with the Interstate Fisheries Management Plan for Shad and River Herring (Plan), the Delaware River Basin Fish and Wildlife Management Cooperative (Coop) is jointly submitting on behest of the states of Delaware, New Jersey, New York, and the Commonwealth of Pennsylvania their annual report on Alosine fisheries conducted within the Delaware River & Estuary during 2012 (Figure 1). This report covers all boundary states management programs for commercial and recreational fisheries as well as all fishery independent monitoring, for American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*).

Request for *de minimis*

N/A

Previous Year's Fishery and Management Program

Commercial landings in the Delaware Estuary and Bay as reported to New Jersey in their directed fishery (27,368 pounds) increased over landings reported for 2009-2011, but remained below the ten year average (71,261 pounds) reported in the 2000's (2000 – 2009). Landings of American shad as bycatch in their striped bass fishery reported to Delaware declined in 2012 (2,618 pounds) to the lowest level since 1985. While no estimation of angler use and harvest is available for the 2012 season, recreational anglers' anecdotal reports and website blogs indicated an excellent fishing season for American shad.

Monitoring of YOY relative abundance was accomplished in the Delaware River and Bay. Estimates of YOY and age +1 relative abundances (geometric means) for American shad captured in Delaware's bottom trawl survey were 0.08 and 0.11, respectively. The trend in the trawl YOY relative abundance declined. Estimation of YOY relative abundance in New Jersey's upper tidal beach seine for 2012 was 4.39 (geometric mean), which was the 18th highest value of the time series (1980-2012), representing a decline from the previous year (i.e., 2011). The Coop reinitiated the JAI beach seine survey at the four historic sites in the non-tidal reaches of the Delaware River, Trenton, NJ – Milford Beach, PA. Estimated YOY relative abundance was 118.91 (geometric mean), which was the 9th highest value of the time series (1980 – 2007; 2012).

Adult American shad abundance in the Delaware River estimated in 2012 continued an increasing trend since 2009, based on gill net CPUE (14.7 shad/foot-hr) at Smithfield Beach (RM 218). The Smithfield Beach CPUE value was the5th highest value of the time series (1990 – 2012). Electrofishing CPUE (47.7 shad/hr) accomplished at Raubsville (RM 176) also increased over previous years.

The Coop has completed an American Shad Sustainable Fishing Plan (SFP) as outlined in Amendment 3. This plan was reviewed and accepted by Atlantic States Marine Fisheries Commission in January, 2012. Review of the identified indices and respective benchmarks were all suggestive that the 2012 values were well within acceptable levels: no management actions are necessary for corrective actions.

Commercial catches of river herring were 39 pounds in New Jersey. The river herring fishery was closed in the State of Delaware jurisdictional waters. No estimates of angler use and harvest of recreational river herring or hickory shad catches were available for 2012. Landings of hickory shad are thought to be nominal in the Delaware Bay, with no landings reported to Delaware or New Jersey. Harvest of hickory shad are prohibited in the non-tidal reaches of the Delaware River above Trenton, NJ and in the Lehigh and Schuylkill rivers.

Monitoring of juvenile abundance of river herring was accomplished in the Delaware River and upper Bay. No YOY or Age 1 blueback herring were caught in Delaware's 2012 trawl survey. The abundance (geometric mean) of for YOY alewife (0.0) during the same trawl survey declined to no catch; whereas, Age 1 alewife abundances (2012: 0.04) vary without any trend. Production of juvenile blueback herring and alewife recruitment (geometric means) in New Jersey's beach seining for 2012 ranked 31^{th} (0.42) and 27^{th} (0.0.01), respectively with both indices declining. No sampling for YOY or adult river herring or hickory shad in the non-tidal reaches of the Delaware, Lehigh or Schuylkill rivers were accomplished in 2012.

The Coop is continuing developing a habitat plan as outlined in Amendment 3.

Planned Management Programs for the Current Calendar Year

Within the Delaware River, beginning Jan 1, 2013, both the State of New Jersey and Commonwealth of Pennsylvania enacted a 3 shad limit, Open year-round, no minimum size, in the tidal waters below the Commodore Berry Bridge. This change was to standardize recreational regulations in tidal and non-tidal reaches of the Delaware River. Recreational creel regulations for American shad in the Lehigh and Schuylkill rivers were changed to catch and release only by January 1, 2013.

The river herring fisheries (commercial and recreational) in Delaware, New Jersey, and Pennsylvania were closed January/February 2012 for the Delaware Basin, inclusive of the Lehigh and Schuylkill rivers. The State of New York changed their regulations to create a moratorium for the New York waters of the Delaware River in September 2012.

There are no anticipated changes in monitoring programs for American shad, river herring, or hickory shad by any members of the Coop. The Coop will seek to continue the non-tidal American shad JAI monitoring dependent on staffing commitments for the 2013 season.

AMERICAN SHAD

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of Fishery

<u>Delaware</u>

The Delaware commercial American shad fishery in the Delaware River & Bay occurred during the spring spawning migration from late February through May. The American shad fishery in Delaware is a multi-species fishery. Almost all shad landed in 2012 were in conjunction with the concurrent striped bass commercial season that began February 15 and extended through May 31 in the estuary. All landings were by gill net, both anchored (fixed) and drifted. Anchor nets were used primarily in Delaware Bay; drift nets were used exclusively in the Delaware River by regulation. There were no specific regulations that have been adopted to reduce or restrict commercial landings of American shad in the Delaware River & Bay. However, regulations that limit commercial fishing effort had a direct impact on catch of American shad. Regulations governing the striped bass fishery had the greatest impact on the total catch of American shad due to the presence of both species in the river and bay during the spring. These restrictions included a limited entry license system, limitations on the amount and type of gear which was allowed to be fished, and gill net season and area restrictions. Specifically, these restrictions included no fixed gill nets in the Delaware River north of Liston Point from January 1 through May 31, and not more than 200’ of fixed, anchored, or staked gill net from May 10 through September in the rest of the Delaware Estuary.

Delaware has a limited entry license system for the commercial gill net fishery under their food fishing equipment permitting regulations. There is a cap of 111 gill net permits, and no new permits will be issued. Fishermen may chose not to renew their permit annually, so the total number actually obtaining a permit will change annually. Many fishermen however, did not land any American shad and many did not fish at all since they were allowed to transfer their individual striped bass quota to other licensed fishermen. Only 20 fishers reported landings for shad in 2012. Furthermore, permits may be passed onto direct descendants or issued to a resident who has completed a commercial fishing apprenticeship program.

New Jersey

New Jersey’s net regulations for American shad can be found in Table 1. Although New Jersey waters are open to gill netting for the majority of the year, the current directed commercial fishery for American shad occurs primarily during March through April of each year depending on environmental conditions. New Jersey initiated limited entry and mandatory reporting prior to the 2000 fishing season. As of April 23, 2012 there were 83 permits issued (45 commercial and 38 incidental). Currently, only 53 of these permits are active, due to attrition, and only 2 fishers landed shad outside of Delaware Bay during 2012. The shad permit allows the holder to fish in any state waters where the commercial harvest of shad is allowed as long as the permit holder meets all other net requirements for commercial fishing in a particular area. Permits are not gear specific. All permits are currently non-transferable except to immediate family members.

New York and Pennsylvania

Neither the State of New York nor Commonwealth of Pennsylvania permits commercial harvest of American shad in their jurisdictional waters of the Delaware River Basin.

2. **Characterization of Catch and Harvest**
    a. **Landings and Method of Estimation**

Delaware

Beginning in 1985, the State of Delaware required mandatory reporting of commercial landings under the provisions enacted by the Delaware General Assembly in 1984. Every fisherman holding a commercial food-fishing license was required to submit a monthly report specifying where he fished, the type and amount of fishing gear deployed, and the pounds landed of each species taken for each day fished. Commercial landings of American shad in Delaware occur as bycatch from the concurrent striped bass fishery. Because striped bass fishers have been targeting larger bass over the last decade, the mesh size of gill nets has increased up to 7 inch stretch mesh. The large majority of shad will swim through that mesh size, so bycatch of shad has declined drastically. The estimated harvest for 2012 was 2,618 pounds (Del. River: 842 pounds; Del. Bay: 1,776 pounds) of American shad (Table 2). The majority of the landings were from the Delaware Bay (Figure 2a). During 2012 no directed commercial landings were reported. While total shad bycatch landings decreased from 2011 to 2012; bycatch landings in the upper bay/river were slightly up from the previous years (2005 – 2011).

New Jersey

The National Marine Fisheries Service (NMFS) estimated American shad landings for the State of New Jersey through 1998. In 1999, the NMFS estimates were combined with voluntary logbook data from New Jersey's commercial fishers. Since 2000, the data has been collected via mandatory logbooks through the limited entry program. The estimated harvest for 2012 was 27,368 pounds (Table 2; Figure 2b). Landings have continued a decreasing trend since the modern peak in 1990, although landings were fairly steady from 1997 to 2004. The most recent decline is the combined effect of the abundance of striped bass and the decline of the Delaware River shad stock. The majority (72.8 %) of NJ landings in 2012 were taken in the upper Delaware Bay and River (Figure 2b).

There are no estimates of underreporting, however it is assumed that harvest in the upper reaches of Delaware Bay, prior to 2000, was actually higher than the NMFS data suggests. This is due to a lack of sampling by the NMFS in this area. The evidence for underreporting can be found in New Jersey's mandatory logbook data since 2000, which shows that the five highest landings years occurred during this time period, with a peak of more than 90,000 pounds in 2004.

b. Catch Composition

i. Age and Length Frequency distribution

Biological data collected by the State of Delaware were gathered from commercial fishers' catches landed in New Jersey and a fish house in the Delaware River and upper Delaware Bay. Using comparable gear and methodology, the State of New Jersey collected biological data from American shad tagged in the Delaware Bay as representative of the commercial landings. For 2012, length frequencies varied from 355 – 635 mm total length (Figure 3). From samples taken by the State of Delaware: mean lengths were 488 mm, 546 mm and 541 mm for males, females and combined sexes, respectively; mean weights were 2.7 lbs, 4.3 lbs and 4.2 lbs for males, females and combined sexes, respectively. Scale samples have been collected from these landings, but have not yet been processed for age estimation. Historical age, length and weight distributions are reported in prior compliance reports.

ii. Sex Ratio

Data collected from New Jersey's mandatory logbooks in 2012 show that the mesh size in the directed American shad gill net fishery ranged from 5 to 6 inch stretch mesh. The percentage of females harvested in Delaware Bay has consistently outnumbered the percentage of harvested males (Table 3). In 2012, harvested females (85.6%) increased from 2011 and were above the time series average (78.7%). The percentage of harvested males in 2012 (14.4%) decreased from 2011 and was below the time series average (21.4%). Given the collections of fish samples by the State of Delaware from fishers landing in New Jersey, that data set is encompassed in New Jersey's mandatory logbooks. A total of 432 individual American shad (females: n = 385; males: n = 42) were collected by the State of Delaware for a ratio of 1 male : 0.11 female. Twenty-nine of those shad collected by the state of Delaware were from a single fish house in Delaware, all females.

iii. Degree of Repeat Spawning

<u>Delaware</u>

Estimation of repeat spawning is pending the laboratory processing of collected scale samples from commercial fishers.

<u>New Jersey</u>

No repeat spawning data was collected from any commercial fisheries in New Jersey waters by the State of New Jersey.

c. Estimation of effort

Delaware

Fishing effort was calculated from the mandatory monthly landings data. Effort measurements include the number of fishermen, man-days, and net-yards. The number of fishermen was the number of fishermen that reported any landings of American shad throughout the season. This would even include those that did not target shad but may have incidentally taken some during the season. A man-day of effort was considered any day that a fisherman landed and reported any shad landings. For example, if no shad were landed the effort accrued would appear as "no effort." Net-meters were the meters of net fished on that day that the landings occurred. Delaware does not require complete net dimensions (only length) from which square meters of net used could be calculated.

The estimates of effort for the commercial fishery during 2012 are listed in Table 4. American shad harvest data was collected from 18 fishers from a total of 125 trips, resulting in 2,618 pounds being harvested. Catch-per-unit-of-effort was highest for anchored gill nets in the Delaware Bay and lowest for drift gill nets in the Delaware River.

New Jersey

New Jersey conducted a voluntary logbook survey of the shad commercial gill net fishery from 1996 to 1999. Mandatory reporting was instituted in 2000 for all shad fishers. American shad harvest data was collected from 11 fishers who supplied landing data for the 2012 spring fishery. A total of 82 trips resulted in 27,368 pounds of gill net harvest (Table 5).

The Catch Per Unit Effort (CPUE) for the Delaware Bay gill net fishery in 2012 was 0.019 pounds of shad per square foot of net set. Although the trends for the upper and lower Delaware Bay have fluctuated throughout the time series, the overall CPUE for Delaware Bay remained consistent until 2008 (Table 6; Figure 4). The 2012 CPUE increased from last year and was above the time series average (0.018). Landings have dropped off considerably since 2008.

There is also a CPUE calculated for the Lewis haul seine fishery in Lambertville, NJ. Records for this fishery date back to 1890 with effort data documented since 1925. The fishery employs seine nets of different length depending on the water flow and depth. Although this may be problematic, the length of the time series still gives a good indication of spawning run strength in the Delaware River.

The Lewis haul seine fishery CPUE averaged 4.64 shad per haul from 1935 to 1947 but declined to an average of only 0.67 shad per haul through 1960 (Table 7, Figure 5). The CPUE started to increase steadily in the early 1970s to its peak in 1992 (50.96) before declining drastically to average only 4.28 since 1999. The 2012 index (2.32) decreased since 2010 remaining below the time series (1925 – 2012) mean of 9.67.

3. Characterization of Other Losses (poaching, bycatch, etc.)

Delaware

Presently the State of Delaware does not have any information pertaining to losses resulting from poaching or bycatch of American shad. Given that there were no seasons or trip limits on the commercial gill net fishery in the Delaware River & Bay, poaching was not an issue.

New Jersey

The state of New Jersey presently has no additional data on poaching or bycatch of American shad from other fisheries within the Delaware Basin. There is undoubtedly some bycatch discard loss, especially for male shad, but there is no data as to the severity.

B. Recreational Fishery

1. Characterization of Fishery

Delaware River

The majority of fishing effort for American shad in the Delaware River occurs along a 160 mile stretch from Trenton, NJ to Hancock, NY. This fishery takes place mainly from late March to early June of each year. Recreational take of American shad from the Delaware River was limited to three fish per day per angler, no closed season or minimum size limits applied in 2012, above the Commodore Barry Bridge (RM 81.9). The river reaches below the C. Barry Bridge are under a 6 fish limit per day per angler between NJ and PA waters. The State of New York creel/size limits and seasons for their jurisdictional waters in the upper Delaware River reflect Pennsylvania/New Jersey non-tidal regulations for 2012. Within the State of Delaware, there was essentially no recreational fishery that targets American shad in tributaries to the Delaware River or Delaware Bay within Delaware's jurisdiction. A few anecdotal reports were verbally received from anglers occasionally taking American shad in the Brandywine River near Wilmington. Delaware imposes a 10 fish aggregate limit combined American shad and hickory shad possession per angler, no closed season or minimum size within their jurisdictional waters. Sale of sport caught alosines in Pennsylvania is prohibited.

Lehigh River

The Lehigh River enters the Delaware River at river mile 184. Recreational harvest of American shad from the Lehigh River is limited to one fish per day per angler; no closed season or minimum size limits apply, for 2012. The PFBC imposed a catch and release only fishery (no harvest) for the 2013 season. The Lehigh River is considered under restoration status for a self-sustaining migration of American shad. Ascent of American shad into the Lehigh River has been impeded for at least 170 years. Since 1994, fish passage has been accommodated through fishways at three Lehigh River dams up to river mile 24. No angler use and harvest information is available for the Lehigh River; however, it is believed nominal effort for anglers is expended targeting American shad.

Schuylkill River

The Schuylkill River enters the Delaware River at river mile 92.5. Recreational harvest of American shad from the Schuylkill River is limited to one fish per day per angler (upstream of Interstate 95 Bridge); no closed season or minimum size limits apply. The PFBC imposed a catch and release only fishery (no harvest) for the 2013 season. Ascent of American shad into the Schuylkill River has been impeded by numerous dams supporting the extensive lock/cannel systems the downriver most being the Fairmount Dam (RM 8.5). Since 2003, fish passage has been accommodated through various designed fishways at four locations up to river mile 36.6. No angler use and harvest information is available within this river; however, angler expenditures for targeting American shad in the Schuylkill River are at best nominal.

2. Characterization of Directed Harvest of American shad

<u>Delaware River</u>

The last survey of the recreational fishery was an access point survey in conjunction with an aerial effort survey conducted by Versar, Inc. during 2002 (Volstad et al. 2003). The study area included all tidal and non-tidal waters from the Delaware Memorial Bridge to Downsville, NY. Results of this study were included in previous reports. No angler use or harvest information is available for 2012.

<u>Lehigh & Schuylkill rivers</u>

The numbers of American shad harvested from the Lehigh and Schuylkill rivers are unknown. With the very low creel limit, harvest was expected to be low. Landings data, catch composition data, age frequency data, length frequency data, and angler effort was not required to be monitored and was not measured in 2012.

3. Characterization of Other Losses (poaching, hook/release mortality, etc.)

No data was available on poaching or hook and release mortality. Losses associated with poaching and hook and release mortality for Delaware, Lehigh, and Schuylkill rivers and Delaware Estuary alosines during 2012 are unknown.

C. Other Losses

<u>Delaware River</u>

During 2012 a total of 1,060 adult American shad were sacrificed for research and restoration activities (Table 8). A random sample of American shad sacrificed for these activities was used to compute the mean weight. Total weight was estimated by multiplying the mean weight by the number sacrificed. Also there were 67 adult American shad sacrificed by the U.S. Fish & Wildlife Service and New York for otolith extraction from the Upper Delaware River adult monitoring survey.

Within the Delaware River & Bay impingement and entrainment from various water intakes, principally located in the upper estuary, are sources of fish losses to the basin. Typically, assessments of impingement and entrainment losses are not annually estimated. Losses associated with these intakes have been discusses in previous compliance reports. No impingement and entrainment reports are available for 2012.

<u>Lehigh River</u>

During 2012, a total of 62 adult American shad were sacrificed for research purposes, equating to 207 pounds (Table 9).

<u>Schuylkill River</u>

During 2012, a total of 25 adult American shad were sacrificed for research purposes, equating to 79 pounds (Table 9).

D. Estimated Losses

Tables 8 - 9 shows the estimated harvest loss estimates for the Delaware River & Estuary, Lehigh River and Schuylkill River for 2012.

E. Protected species Atlantic sturgeon bycatch estimates

Due to the listing of the Atlantic sturgeon as an endangered species by the National Marine Fisheries Service in April 2012, the Delaware Division of Fish and Wildlife suspended its voluntary sturgeon logsheet reporting program and the voluntary sturgeon tagging program. Any bycatch of Atlantic sturgeon is unknown at this time.

Harvest reporting in the American shad gill net fishery was voluntary prior to new regulations that took effect in January 2000 required by the State of New Jersey. Although shad fishers are required to report shad landings and effort, bycatch reporting of Atlantic sturgeon remains on a voluntary basis. According to logbooks collected from New Jersey commercial shad fishers there were 11 Atlantic sturgeon caught as bycatch during 2012 in Delaware Bay. All sturgeon were released alive at the time of tending the net. Permit holders are not required to report Atlantic sturgeon interactions however, so this number is an underestimate of the total interactions with commercial shad gill netters throughout the state. The accuracy of reported data is also unquantifiable without onboard observers

The data was extrapolated to the entire shad fishery for 2012, based on the number caught by cooperating fishers and effort data from all logbooks. Although the number of interactions is still considered an underestimate, the final reported estimate is 24 sturgeon caught.

In the Delaware River above head of tide and the Lehigh and Schuylkill rivers, no sturgeon have been reported caught. Reporting of recreational catch is on a voluntary basis. No sturgeon has been observed using the fish passage structures on the Lehigh and Schuylkill rivers.

II. Fishery Independent Monitoring

A. Description of Requirements

- Annual spawning stock survey and representative sampling for biological data
- Calculation of mortality and/or survival estimates
- Hatchery evaluation
- JAI: Juvenile abundance index (GM)

In addition to the required monitoring, the Pennsylvania Fish and Boat Commission have monitored upstream fish passage on the Lehigh River; and the Philadelphia Water Department has monitored upstream fish passage on the Schuylkill River.

B. Description of Work Performed

<u>Delaware River & upper Bay</u>

Delaware has conducted a juvenile fish trawl survey since 1978. The survey was originally designed to monitor blue crab abundance in the Delaware Bay but was expanded to include juvenile fish beginning in 1980. In 1989, six stations were added in the lower Delaware River upstream of the Chesapeake and Delaware Canal to better monitor juvenile striped bass and other anadromous fish year class strength. Stations in the river and upper bay were sampled monthly from April through October using a 16-ft otter trawl towed for 10 minutes or a 30-ft trawl towed for 20 minutes from March through December. Fish densities were calculated by dividing the number of individuals for a species by the distance towed

(No./nautical mile) at each station sampled. The annual index is calculated as a geometric mean of all hauls for the calendar year.

New Jersey has conducted juvenile abundance monitoring for American shad in the Delaware River since 1980. In previous years, production was estimated through two separate beach seine surveys. Both indices have correlated well since 1994 leading to a proposal by the State of New Jersey to the ASMFC Technical Committee in January 2008 to discontinue the upper river survey as a cost cutting measure. The Technical Committee agreed with the proposal and the upper river juvenile survey was eliminated.

In the lower Delaware River, data is collected during the annual striped bass recruitment survey from Trenton to Artificial Island during August through October. This index was recalculated to eliminate many of the zero catches in waters of higher salinity where American shad are less likely to be encountered. The sampling range for the reported geometric mean is from Trenton to the Delaware Memorial Bridge.

Delaware River

Using gillnet gear and electrofishing gear the Pennsylvania Fish and Boat Commission sampled adult American shad to measure biological attributes (1996-2012). Gill net collections also provided broodfish for egg collection efforts. Unfortunately, this large sample is not representative of the population due to gill net selectivity. Electrofishing collections at Raubsville, PA were resumed in 2010 in an effort to develop an index of abundance of adult shad and an unbiased sample for biological attributes. Annual gill net and electrofishing sampling occurred at regular intervals during the course of the American shad run which typically extended from April to June. Attributes measured include length, weight, age, gender, repeat spawns, and hatchery marks.

In 2012, the non-tidal beach seining in the upper Delaware River at four historic sites (i.e. Trenton, RM 131.6, Phillipsburg, RM 184.2, Water Gap, RM, 210.0, and Milford Beach, RM 246.4) and one additional site located at Lackawaxen, PA (RM 277.0) just below the confluence of the Lackawaxen River were reinstated by the Coop. Sampling followed protocols developed by the State of New Jersey for their historical surveys (1980 – 2007). Briefly, a total of four hauls, beginning at sunset, are accomplished per site once a month in August, September, and October using a bagless 300 ft x 12 ft x ¼ in. mesh seine. Catch-per-unit-effort is defined as the total shad/haul and expressed as a geometric mean. This effort allows for a greater degree of confidence in determining long-term monitoring sites and potentially identifying factors influencing young-of-the year recruitment. This project is a collaborative effort among all Coop members.

Lehigh River

Using electrofishing gear, Pennsylvania has sampled upstream migrating adults during 1996-2012. Length, age, repeat spawns, and hatchery marks were determined. Time-lapsed video monitoring of upstream migrating adults for passage estimates has taken place during 1994-2012 at Easton fishway (RM 0.0). In 2012, fishway monitoring at the Chain Dam was terminated, with efforts continued for the Easton Fishway.

Schuylkill River

Using electrofishing gear, the Philadelphia Water Department has sampled upstream migrating adults 2002 - 2012, in the tidal river reach below the Fairmount Dam (RM 8.5). Annual estimates of relative abundance were calculated with 25 shad harvested each year for length, age, sex, repeat spawning, and hatchery evaluations. Time-lapsed video monitoring of upstream migrating adults for passage estimates has taken place 2004-2012 at only the lowest most fish passage at Fairmount Dam.

C. Results

1. Spawning Stock Assessment

Adult American shad abundance in the Delaware River appeared to increase in 2012, based on anecdotal reports from anglers and gill net CPUE at Smithfield Beach. Smithfield Beach CPUE (14.70 shad/foot-hr) in 2012 was the highest recorded for the time series, 1997 - 2012 (Figure 6, Table 10). Adult shad electrofishing collections at Raubsville also reflected that trend, with the 2012 value (CPUE: 47.7 shad/hr) being the highest in the time series.

Shad passage at Easton Dam (n = 2,096) was ranked the 5th highest for the entire time series, 1997 – 2012; but electrofishing CPUE (55.9 shad/hr) in the Lehigh River below Chain Dam was more reflective of a typical year, ranking 8th in the time series (Figures 6 - 7, Tables 10 - 11). Restoration of the Lehigh and Schuylkill rivers by stocking hatchery marked and reared shad fry has continued since 1983 (Table 12). Hatchery contribution for Lehigh River adult shad was 42.6%, the lowest recorded in the time series (Table 13).

Shad passage (n = 2,227) at Fairmount Dam and electrofishing CPUE (315.7 shad/hr) in the Schuylkill River in the tidal reach were lower in 2012 than the previous two survey years (Figures 6 - 7, Table 10 - 11). Shad passage, however was the third highest recorded (2004 – 2012). Electrofishing CPUE ranked 5th highest but was below the 11-year mean (2002 – 2012: 371.8 shad/hr). Hatchery contribution to the Schuylkill River adult shad run was 84% (Tables 12 - 13). The consistently high percentage of hatchery reared shad in collections is suggestive that a self-sustaining wild shad run into the Schuylkill River has not yet been realized.

Tables 14-30 provide summaries of length and age distributions, repeat spawning, and sex ratios for shad collected in the Delaware, Lehigh, and Schuylkill rivers.

2. Juvenile Indices

Estimates of YOY and Age +1 relative abundances (geometric means) for American shad captured in Delaware's bottom trawl survey were 0.08 and 0.11, respectively (Table 31, Figure 8). The trend in YOY relative abundance declined from the high observed in 2011 (0.44). The Age 1 trend remained relatively consistent at low levels, but did demonstrate an increase from 2011. The low catches of age 1 shad most likely represent gear avoidance of the bottom trawl by older and presumably stronger swimming shad schooling in mid-water depths.

The 2012 juvenile abundance index (JAI) obtained by beach seine in the upper tidal Delaware River was 4.39 representing a sharp decrease from 2011 (CPUE: 8.18). This value ranked 18th in the time series and was below the long-term, five-year, and ten-year averages of 4.90, 4.49, and 6.34 respectively. (Table 32, Figure 9a). The JAI had become highly variable in recent years with two very good year classes (2005 and 2007) and two very poor year classes (2006 and 2008).

Beginning in 2012, the Coop reinitiated the historical non-tidal beach seine survey for monitoring American shad YOY production. The 2012 juvenile abundance index obtained at the four historic non-tidal sites was 118.91 (Table 32; Figure 9b). This value ranked 9th in the time-series (1980 – 2007; 2012) and was above the long-term mean (1980-2007; 2012: 84.36).

a. Length frequency

A subsample of juvenile American shad lengths (fork length) was collected and length frequency was calculated from the New Jersey beach seine survey and non-tidal Coop seining (Table 33).

b. Variance

No estimates of variance have been calculated on any of the indices of abundance.

III. Other Monitoring

A. Cooperative Tagging Program

New Jersey initiated American shad tagging in Delaware Bay as part of the ASMFC Interstate Cooperative Tagging Program in 1995. Staff utilized drifting gill nets during March through April of 2012 to capture and tag American shad. A total of 4,274 American shad were marked from 1995 to 2013. Eighteen American shad were tagged in 2012. Tagging efforts during spring of 2013 were less encouraging with 17 fish tagged. A more comprehensive program targeting only American shad is necessary to perform the project correctly. Additional recapture data through 2008 can be found in previous annual reports.

B. Upper Delaware River Adult Monitoring

Since 2009, the U. S. Fish and Wildlife Service, National Park Service, New York Department of Environmental Conservation, and Pennsylvania Fish and Boat Commission have been collaborating for determining adult spawning stock abundance in the Upper Delaware Scenic and Recreational River. Multiple-pass day-time flat-bottom boat electrofishing was conducted once during mid-May in three target pools, Sparrowbush (RM 258.4), Narrowsburg (RM 289.9) and Buckingham (RM 325.1) for capture of spawning adult American shad. Relative abundance is estimated as a relative CPUE (total number of shad caught per hour). Scale and otolith samples were obtained from which age, frequency of repeat spawning, and hatchery origin were determined. Total length and gender were also recorded.

For 2012, a total of 67 shad were collected: Sparrowbush (n = 5), Narrowsburg (n = 37), and Buckingham (n = 25) pools for estimates of relative abundance of 4.86, 28.44, and 14.10 shad/hr, respectively (Table 34). These estimates are within the range of values seen since the study began in 2009 (Figure 10). Length frequencies are illustrated in Table 35. None of the examined otoliths demonstrated hatchery daily tagging patterns, suggesting all captured shad were of wild origin. In 2012, shad returning to the three upper Delaware pools ranged from age 5 to age 9. The majority of fish were age 5 (n = 35) followed by age 7 (n = 13), age 6 (n = 10), age 8 (n=1), and finally age 9 individuals (n = 1), as interpreted from otolith microstructure (Table 36). In the previous year age 6 fish were most abundant of all year classes captured, but for 2012 there were more 5-yr olds than other ages. The strong 2005 year-class representation seen since the study began in 2009 was also reflected in 2012 by the number of 7-yr-old fish (n = 13). In 2012, only one of the captured shad was identified as a repeat spawner whereas in the previous year about 30% were identified as repeat spawners. Estimates of repeat spawning were not determined for 2010 and 2009 collections.

IV. American Shad Sustainable Fishing Plan

A. Description of Plan

Within the Delaware River basin, the Delaware River Basin Fish and Wildlife Management Cooperative is responsible for the management of American shad. Members include States of Delaware, New Jersey, and New York, the Commonwealth of Pennsylvania, the National Marine Fisheries Service, and the United States Fish and Wildlife Service. The National Park Service and the Delaware River Basin

Commission are non-voting members. In February 2012, the ASMFC has accepted the proposed Coop American Shad Sustainability Fishing Plan (SFP). The SFP identifies four core monitoring programs for which sustainability of the shad population is measured. These include two measures of juvenile production (JAI) - one in tidal reaches and one in the non-tidal reaches, with the non-tidal survey being dependent on funding; a fisheries independent adult relative abundance index, and a measure of the ratio between commercial harvest to the relative adult abundance. It is anticipated that this sustainability plan will permit growth of the Delaware American shad stock while allowing for human use of the resource. The Coop views this plan having a five-year term beginning with its acceptance by the ASMFC. This occurred during the 2012 Spring ASMFC Board meeting.

B. Benchmarks

Tidal JAI

A benchmark was developed based on data from 1987-2010 and is defined as an annual geometric mean JAI value of 2.83 (i.e., the 25^{th} percentile where 75% of values are higher). Three consecutive years with a JAI lower than the benchmark will trigger management action. The 2012 tidal JAI was estimated at 4.39, which is above the benchmark (Figure 9a).

Non-tidal JAI

The Coop is seeking funding for supporting the re-initiation of this index. Field collections for this index were discontinued in 2008. A short-term grant from the National Park Service will provide for a three-year program beginning in 2015. In the interim Coop members are collaboratively re-initiated this survey at the four historic sites (i.e., Trenton, Phillipsburg, Water Gap, and Milford Beach) and an additional site just below the confluence of the Lackawaxen River. Sampling was accomplished at these five sites in 2012. The SFP defines a benchmark based on the historical data from 1987 - 2007 and is defined as an annual geometric mean JAI value of 49.43 (i.e., the 25^{th} percentile where 75% of values are higher). Three consecutive years with a JAI lower than the benchmark will trigger management action. The 2012 tidal JAI was estimated at 118.91, which is above the benchmark (Figure 9b).

Smithfield Beach CPUE

A benchmark was developed based on data from 1990-2011 and is defined as an annual mean of 34.79 (i.e., the 25^{th} percentile where 75% of values are higher). Three consecutive years with values lower than the benchmark will trigger management action. In 2012, the Smithfield Beach CPUE was estimated at 73.54 shad/net-hr*10,000, which is well above the benchmark (Figure 11).

Ratio Commercial Harvest to Smithfield Beach

A benchmark was developed based on data from 1990-2010 and is defined as a value of 27.79 (i.e., the 85^{th} percentile where 15% of values are higher). Three consecutive years with values higher than the benchmark will trigger management action. The 2012, the ratio was estimated at 3.31, which is below the benchmark (Figure 12).

C. Management Action

No management action is needed.

RIVER HERRING AND HICKORY SHAD

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of the Fishery

Delaware

The regulation for no possession of herring went into effect February 11, 2012. This effectively eliminated a river herring fishery, commercial or recreational, in the State of Delaware jurisdictional waters.

New Jersey

The only commercial data on river herring and hickory shad are landing data from the NMFS and mandatory logbooks from New Jersey's small mesh gill net fishery. River herring are taken primarily by gill net or fyke net while hickory shad are landed by gill net or trawl.

New York and Pennsylvania

There are no commercial fisheries for river herring or hickory shad within New York's and Pennsylvania's jurisdictional waters in the Delaware River basin. Hickory shad are considered threatened in Pennsylvania and harvest is not permitted.

2. Characterization of Catch and Harvest

a. Landings and method of estimation

Delaware

No river herring landings were reported in Delaware during 2012. Historical landings are discussed in previous compliance reports.

New Jersey

Landing estimates for river herring and hickory shad were obtained from the NMFS for 1995 to 1999. River herring estimates for 2000 to 2012 were obtained from mandatory logbooks of the small mesh gill net fishery. During 2012, New Jersey's commercial fishers reported a harvest of 39 pounds of river herring while landings of hickory shad were unavailable (Table 37). There are no estimates of underreporting; however it is assumed that the current data for river herring is grossly underreported since the majority of landings are categorized as bait. Some hickory shad are probably harvested by American shad commercial fishers during the spring fishery but no data is available.

b. Catch Composition

Adult river herring or hickory shad in Delaware and New Jersey have not been sampled for any biological characteristics such as size, sex, and age structure or species composition.

c. Estimation of Effort

Delaware

No river herring effort was reported in Delaware during 2012.

New Jersey

Fishing effort was not estimated for landings in the State of New Jersey.

3. Characterization of Other Losses in the Commercial Fishery

a. Estimate and Method of Estimation

None

b. Estimate of Composition (length and/or age)

N/A

B. Recreational Fishery

1. Characterization of the Fishery

The river herring fishery was closed year-round in Delaware (11 Feb. 2012), Pennsylvania (1 Jan 2012) and New Jersey (1 Jan 2012) jurisdictional waters. The State of New York imposed a moratorium on river herring shad in September 2012.

Recreational limits for hickory shad vary amongst the states jurisdictional waters. New Jersey tidal recreational daily creel is limited to a 6 shad combination of hickory shad and American shad; otherwise fishing for hickory shad in non-tidal waters is closed. In Pennsylvania, recreational harvest of hickory shad was prohibited since 1999. In Delaware's jurisdictional waters, hickory shad recreational limit is in combination with American shad: 10 fish aggregate possession limit, no season, no minimum size. Hickory shad are managed under statewide regulations for New York (Aug 1 to November 20 season, 5 possession limit, no minimum size); however, given they do not occur in the PA/NY waters of the Delaware River, recreational harvest of hickory shad in New York jurisdictional waters is anticipated to be nominal.

2. Characterization of Directed Harvest

a. Landings and Method of Estimation

The numbers of river herring harvested from the Delaware, Lehigh, and Schuylkill rivers are unknown. With the closure of the river herring fishery it is anticipated any harvest is nominal.

3. Characterization of Other Losses in the Recreational Fishery (poaching, hook/release mortality, etc.)

Losses associated with poaching and hook and release mortality for alosines during 2012 are unknown. Mortality rates of recreationally caught and released hickory shad, and river herring are unknown.

C. Other Losses

Significant mortality of river herring and hickory shad in the Delaware Estuary from other sources beyond commercial and recreational fisheries has historically occurred from impingement and entrainment of various industrial water intakes. No estimates of impingement and entrainment losses were completed during 2012.

D. Estimated losses

No data was available to estimated losses of river herring and hickory shad in the Delaware River basin during 2012.

E. Protected species

Since the river herring fishery is closed, there was no incidental capture of any protected species such as Atlantic sturgeon.

II. Fishery Independent Monitoring

A. Description of Requirements

- Annual spawning stock survey and representative sampling for biological data
- Calculation of mortality and/or survival estimates
- JAI: Juvenile abundance index (GM)

B. Description of Work Performed

The states of Delaware and New Jersey, monitor river herring and hickory shad juvenile year class strength. Monitoring is accomplished by the same programs as described for American shad; Delaware's fish trawl survey and New Jersey's beach seine survey.

No sampling for YOY or adult river herring or hickory shad in the non-tidal reaches of the Delaware River or the Lehigh River was accomplished in 2012. River herring relative abundance has been quantified by the Philadelphia Water Department during their springtime boat electrofishing surveys in the tidal reach of the Schuylkill River, below Fairmount Dam (RM 8.5). The Philadelphia Water Department also documents successful river herring passage (total number) through the Fairmount Dam fishway, during their spring spawning migration.

C. Results

Relative annual abundances for river herring YOY and Age 1 were calculated as geometric means from trawl catches (Table 38; Figures 13 - 16). The annual abundance (mean catch per tow) from 16-foot otter trawl sampling for YOY alewife has been trending upward since 2008 in the Delaware River and Bay. This trend was reversed in 2012 when abundance was estimated at 0.0 value (Figure 13). A small number of Age 1 alewife was caught in 2012 (Figure 14). No YOY and Age 1 blueback herring were caught in 2012 (Figures 15- 16).

Juvenile abundance indices from river herring were calculated as geometric means from New Jersey's beach seine surveys (Table 39; Figure 17). Production of juvenile blueback herring for 2012 (0.42) ranked 31st in the 33-year time series remaining well below the long-term average (9.37). The index shows a serious decline in the overall health of the blueback herring stock within the river and tributaries. Alewife recruitment for 2012 (0.01) was also below the time series average (0.37) and ranked 27th in the time series. These low numbers remain a cause of concern. Production of alewife in the Delaware River continues to be varied with some of the best years of time series mixed in with some of the worst years of the time series. One hickory shad was taken during the 2012 survey period (Table 40).

The relative abundance (CPUE: river herring/hr) of river herring in Philadelphia Water Department's electrofishing catches in the tidal reach of the Schuylkill River just below Fairmount Dam (RM 8.5) varied since the inception of the program in 2002 (Table 41; Figure 18). An apparent peak in abundance occurred in 2006 (314.6 river herring/hr), declined below 40 herring/hr in 2008-2010. River herring catch rates have since increased since 2011, with the 2012 CPUE (407.0 river herring/hr) ranking 1st in the 11 year time-series. Successful passage of river herring through the Fairmount Dam fishway is nominal. Since monitoring commenced in 2004, a total of 73 river herring have been documented with fewer than 21 river herring passing in any given year (Table 41; Figure 18). The poor passage of river herring compared to the relative high abundance of river herring immediately below the fishway entrance suggests that restoration of these fishes to the Schuylkill River problematic. One interesting obstacle in passing river herring is the strong presence of flathead catfish in the fishway chambers, predating on river herring as they enter the fishway.

A total of 4 alewife (66 – 82 mm FL) and 0 blueback herring were captured at the Trenton site during the Coop's beach seine survey for American shad. These alewife were all captured at the Trenton site.

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Volstad, J. H., W. Richkus, J. Miller, A. Lupine, J. Dew. 2003. The Delaware River Creel Survey 2002. Prepared for the Pennsylvania Fish and Boat Commission. Versar, Inc. Columbia, MD. USA.

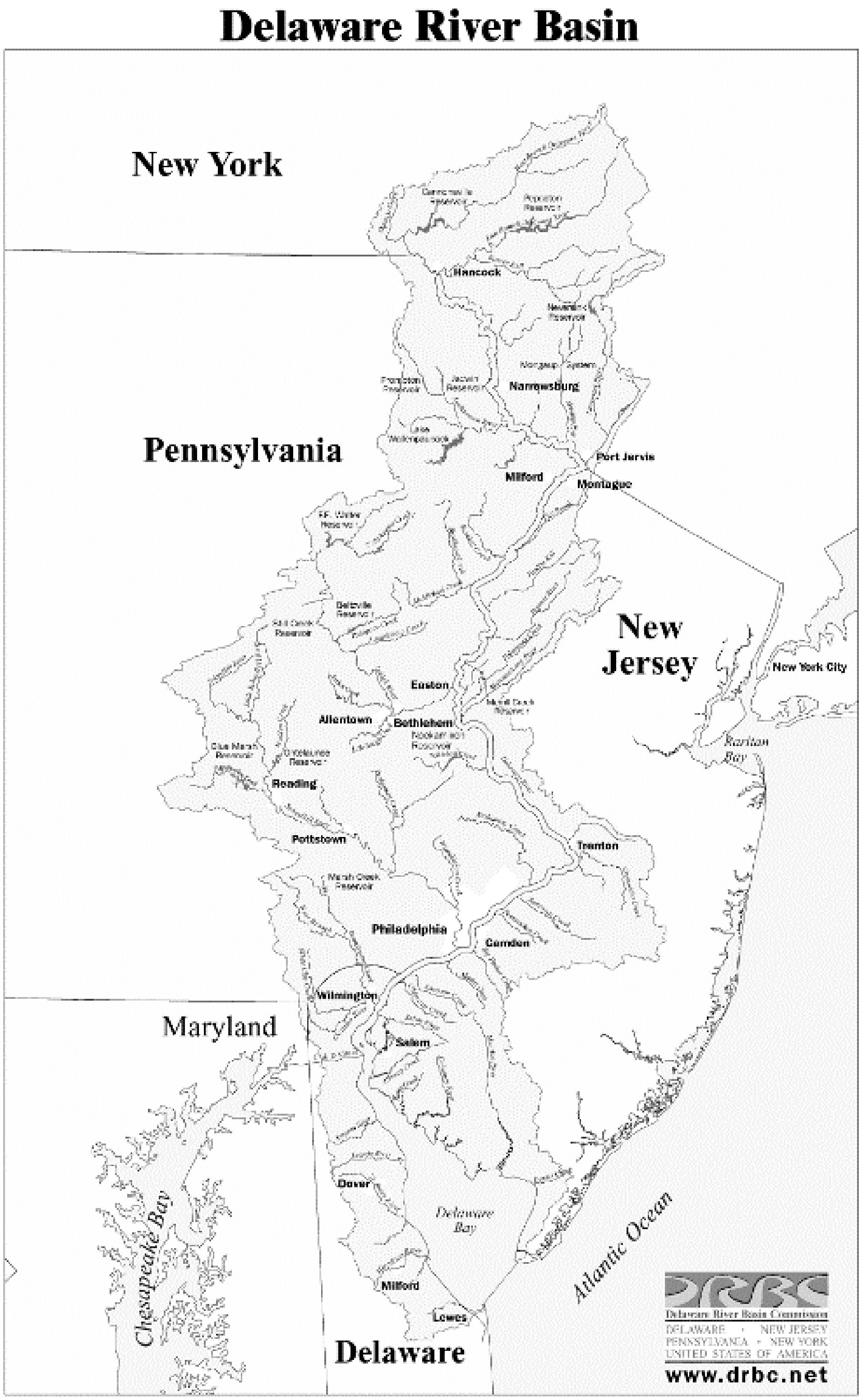

Figure 1. Map of the Delaware River basin.

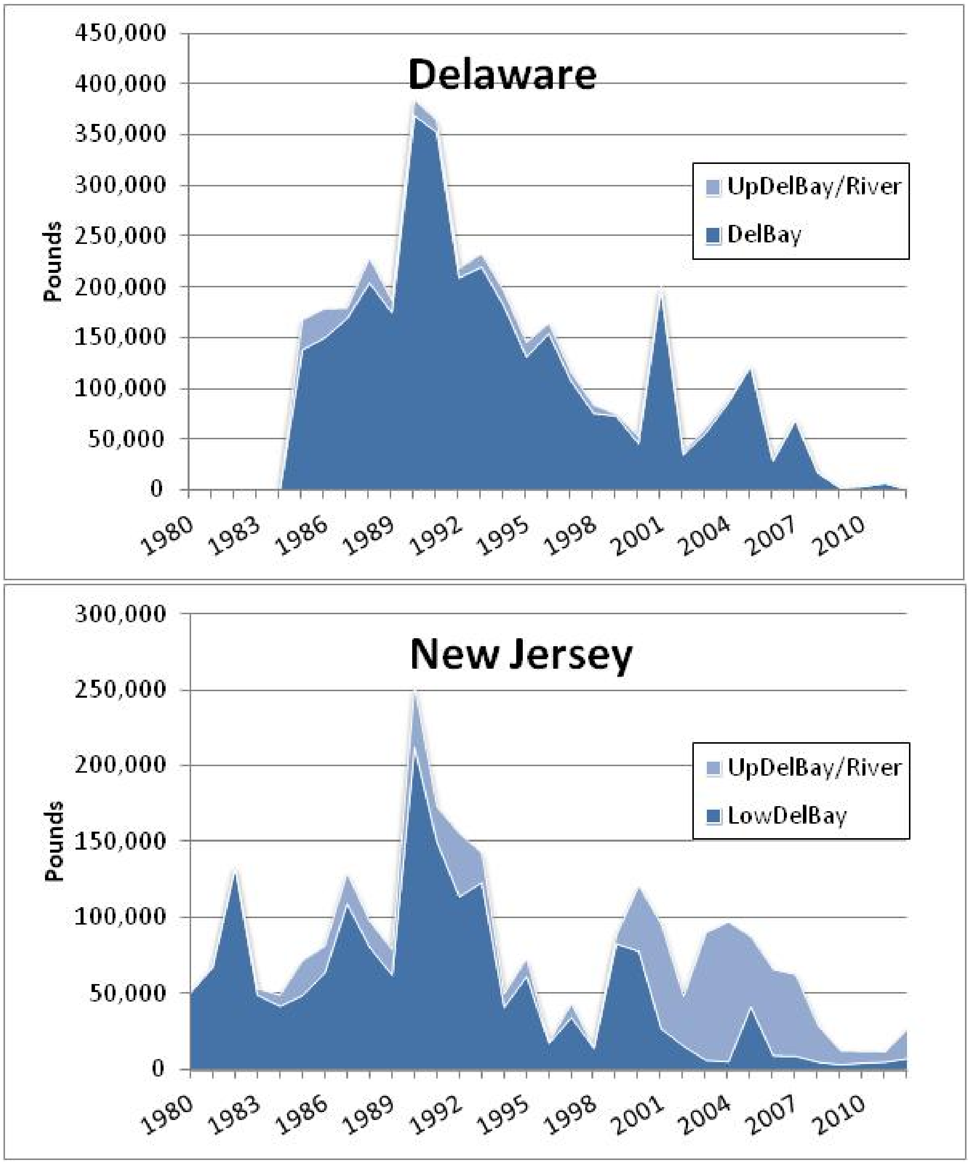

Figure 2. American shad commercial harvest for the states of Delaware and New Jersey, in pounds: 1980-2012.

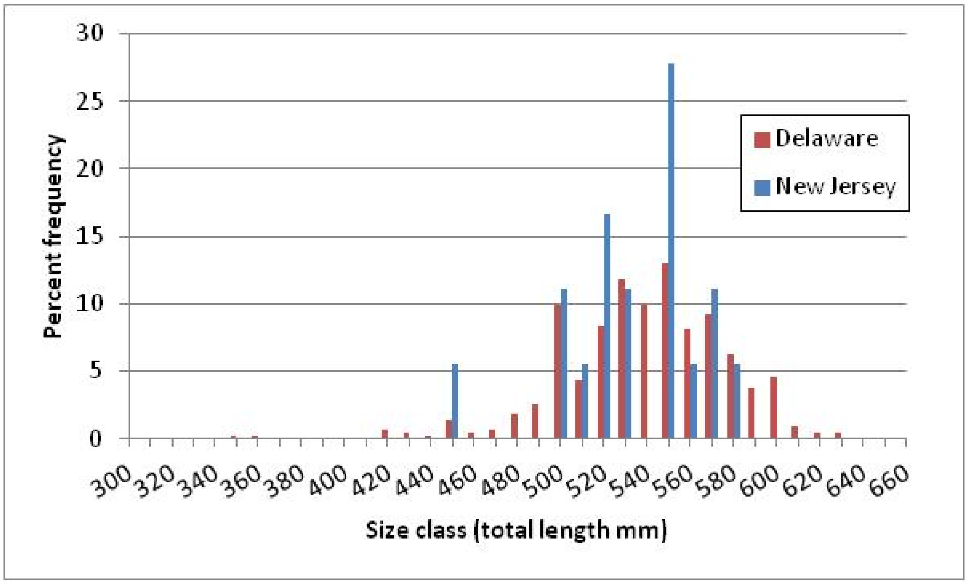

Figure 3. Delaware Bay American shad length frequencies (sexes combined) for 2012. Length frequencies reported by Delaware were collectedfrom purchased shad from New Jersey fishhouses. Length frequencies reported by New Jersey were collected from fishery-independent sampling with similar gill net gear and methodology as the directed commercial fishery.

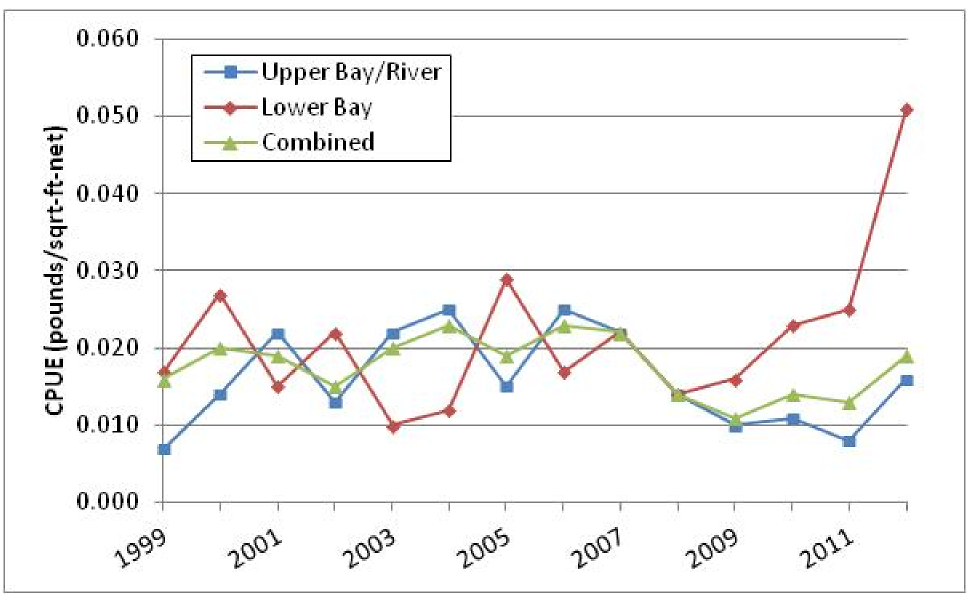

Figure 4. CPUE (pounds/square foot of net set) in New Jeresy's American shad commercial gill net fishery: 1999-2012.

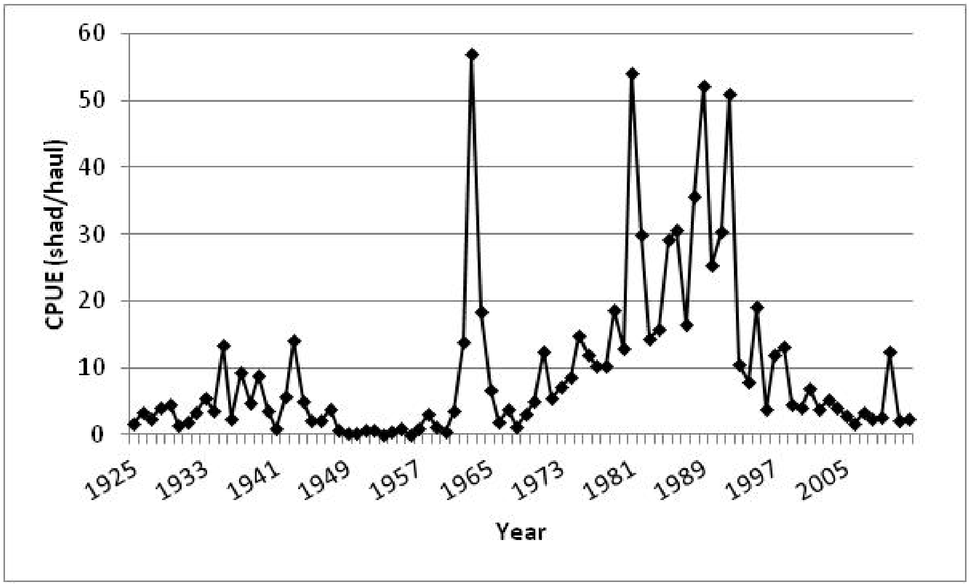

Figure 5. CPUE in the Lewis haul seine, Delaware River: 1925-2012.

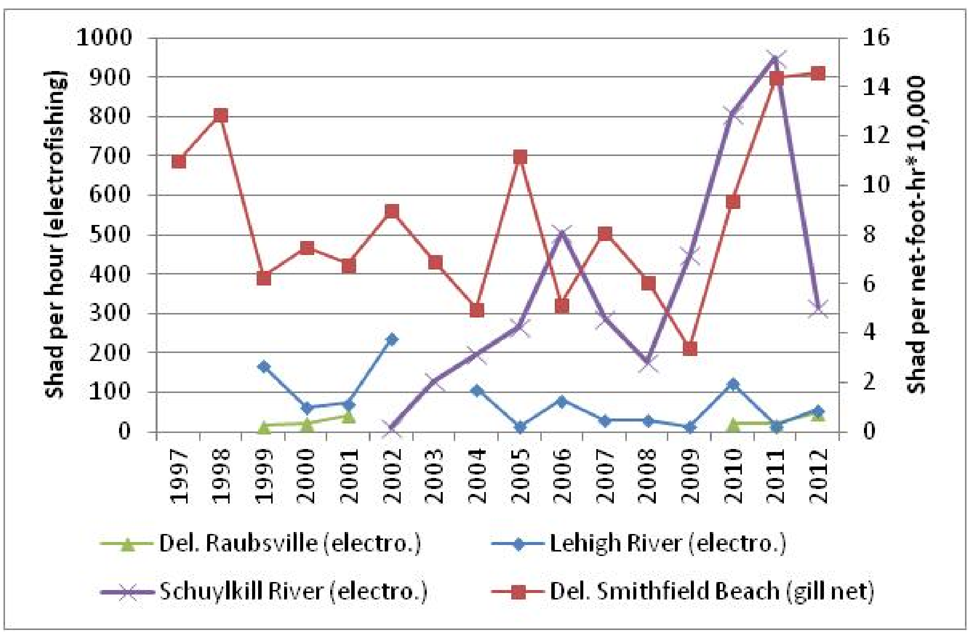

Figure 6. Fishery-independent relative abundance estimates of American shad in the Delaware, Lehigh, and Schuylkill rivers.

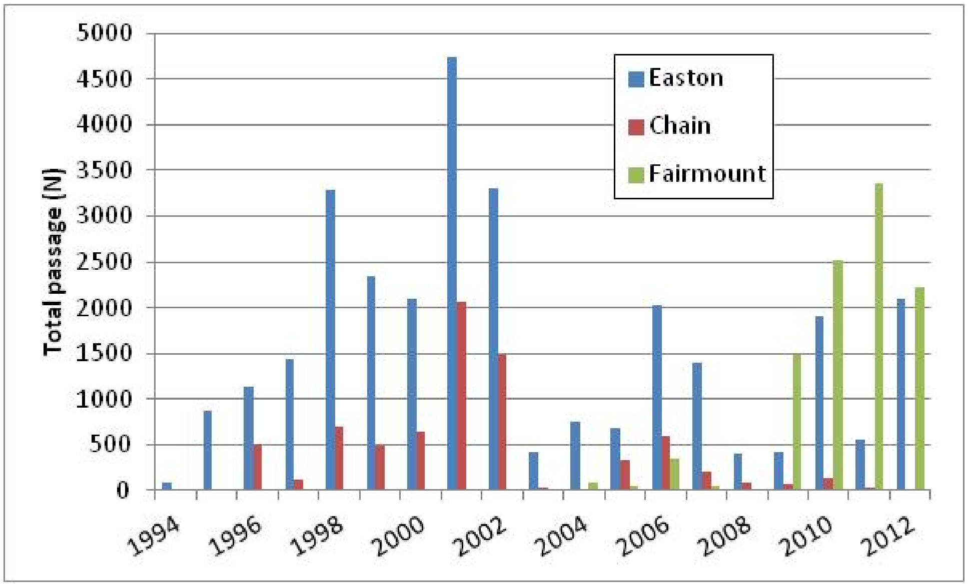

Figure 7. Total number of shad passage through the Easton and Chain fishways (1994-2012) on the Lehigh River and Fairmount fishway (2004 – 2012) on the Schuylkill River.

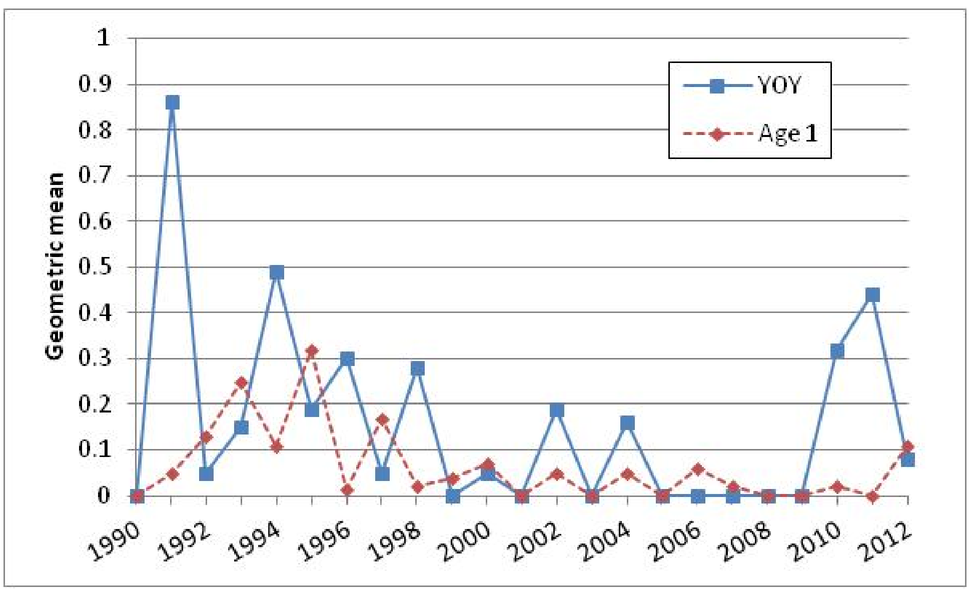

Figure 8. Juvenile (YOY and Age 1) American shad CPUE (geometric mean) for the Delaware Estuary and Bay from Delaware's bottom trawl survey: 1980-2012.

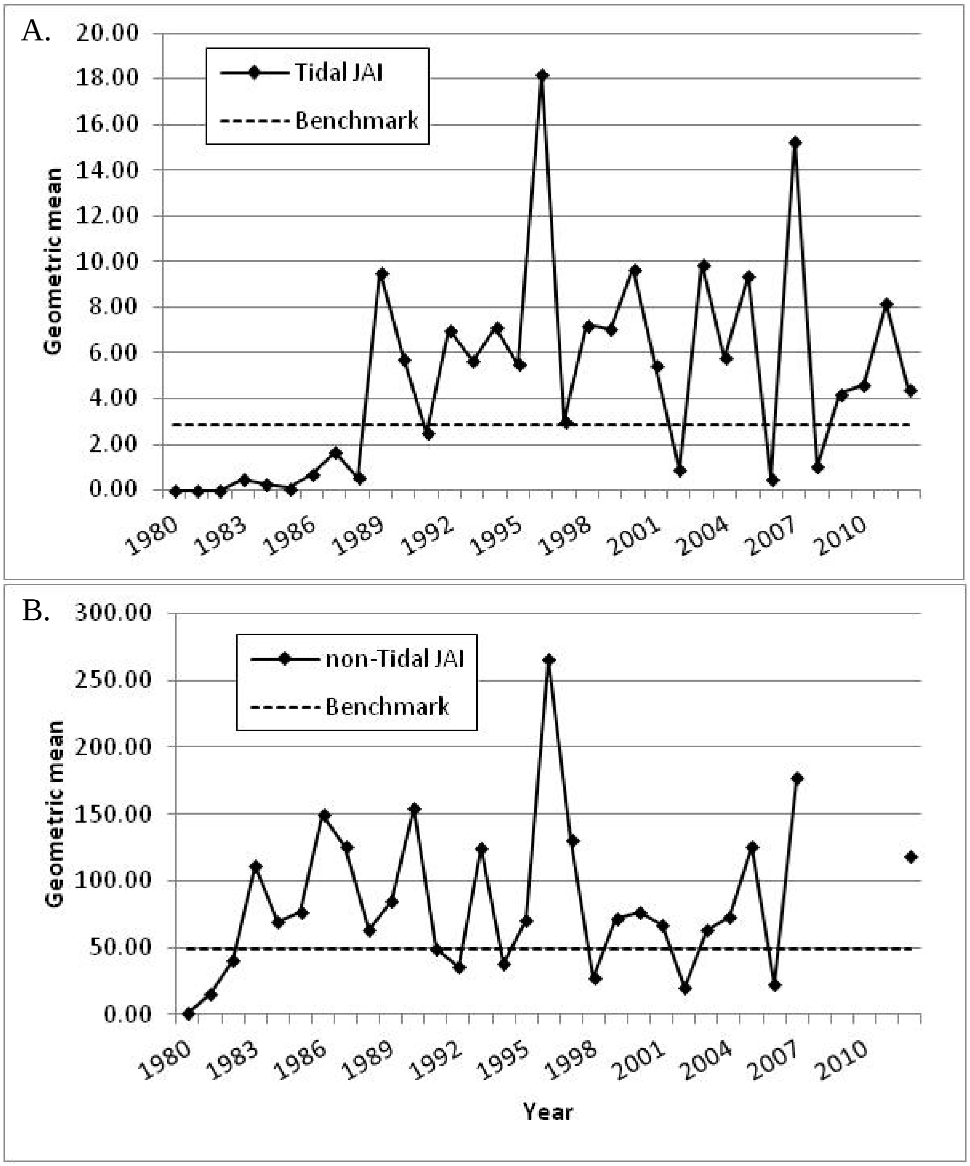

Figure 9. Juvenile American shad CPUEs (geometric mean) for the upper tidal (A) and non-tidal Delaware River (B) : 1980 – 2012. The 25th percentile benchmark defined in the Coop American Shad Sustainability Plan is illustrated as the dashed line in each illustration. The benchmark was derived from data inclusive of 1987 – 2010 for the upper tidal JAI and 1980 – 2007 for the non-tidal JAI.

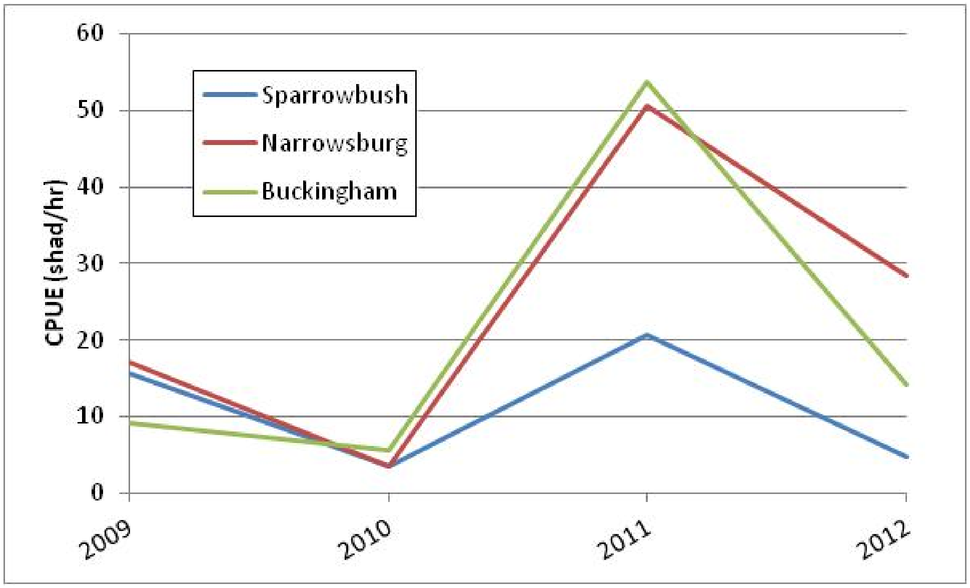

Figure 10. Electrofishing CPUE (shad/hr) of American shad in the Upper Delaware Scenic and Recreation River in three selected pools, 2009 - 2012.

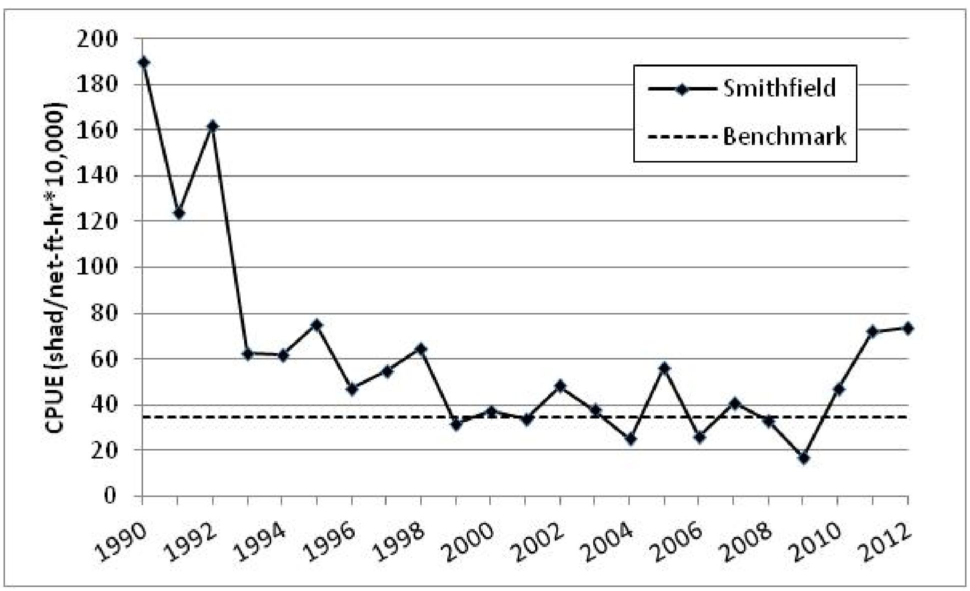

Figure 11. The Delaware River spawning adult American shad index at Smithfield Beach (1990 – 2012) with 25th percentile benchmark defined in the Coop American Shad Sustainability Plan. The benchmark was derived from data inclusive of 1987 – 2011.

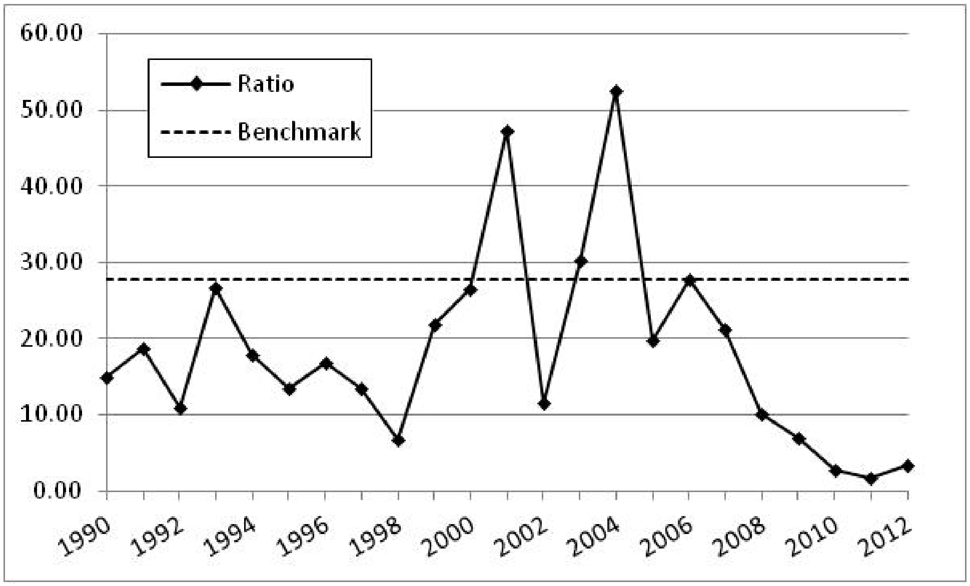

Figure 12. Ratio of harvest to Smithfield Beach relative abundance (1990-2011) with 85th percentile benchmark defined in the Coop American Shad Sustainability Plan. The benchmark was derived from data inclusive of 1987 – 2010.

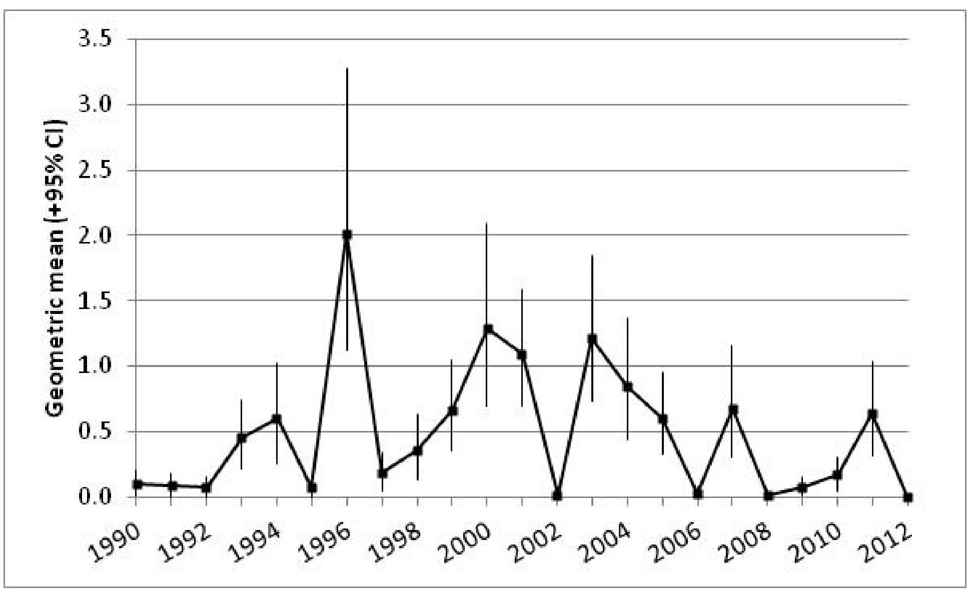

Figure 13. Annual young-of-the-year alewife relative abundance (geometric mean catch per tow) for the Delaware River and upper Bay.

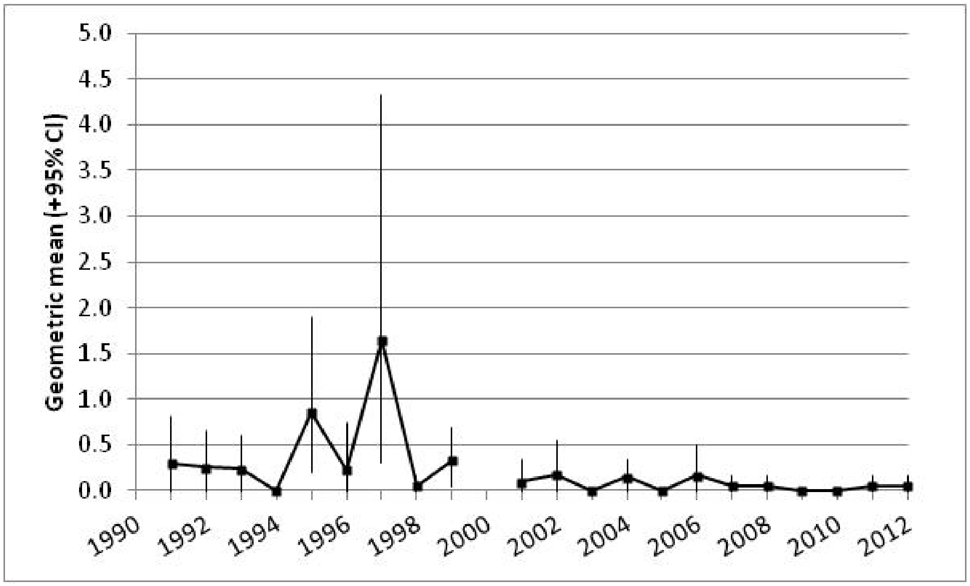

Figure 14. Annual Age 1 alewife relative abundance (geometric mean catch per tow) for the Delaware River and upper Bay. The 2000 Age 1 annual abundance estimate was not available due to sampling missed in April.

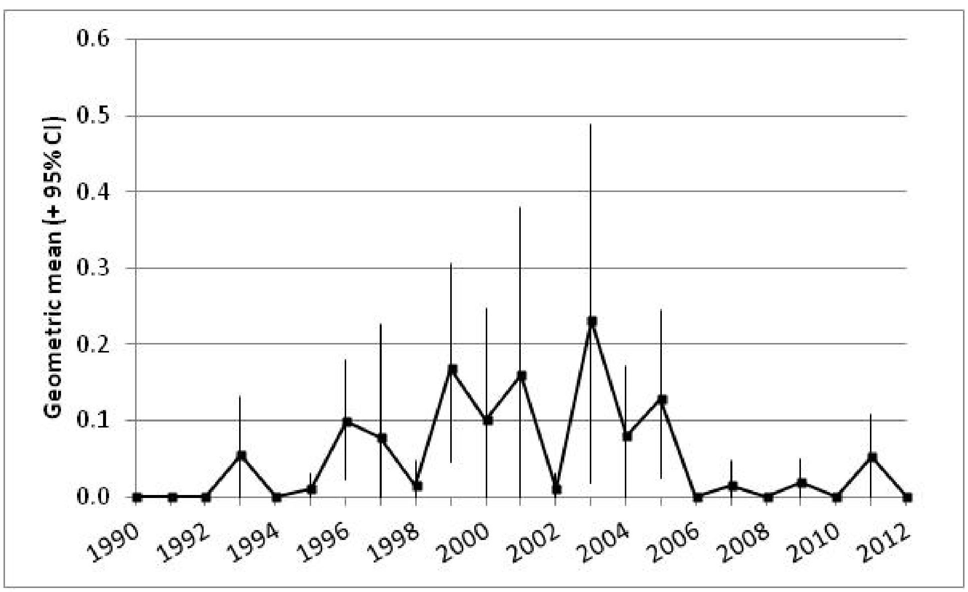

Figure 15. Annual young-of-the-year blueback herring relative abundance (geometric mean catch per tow) for the Delaware River and upper Bay.

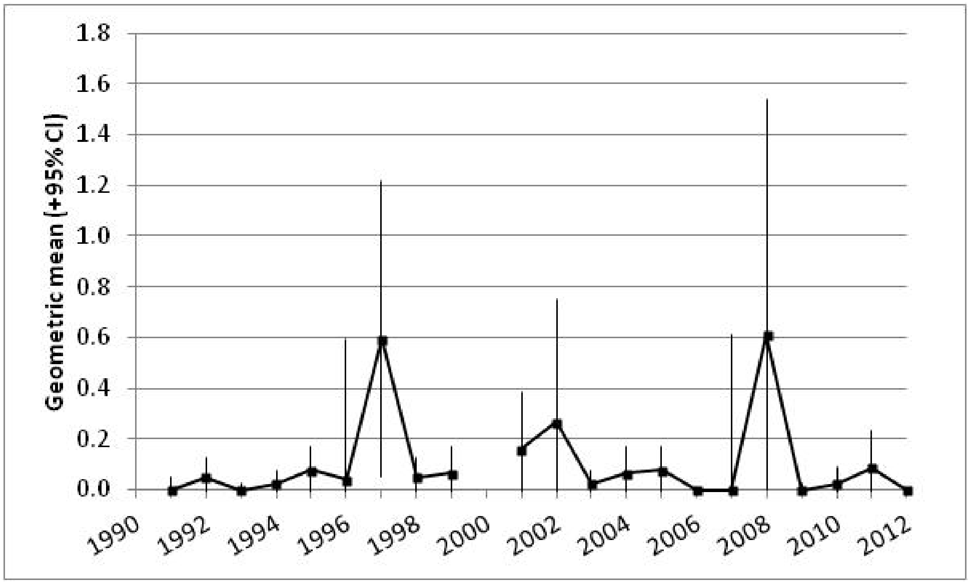

Figure 16. Annual Age 1 blueback herring relative abundance (geometric mean catch per tow) for the Delaware River and upper Bay. The 2000 Age 1 annual abundance estimate was not available due to sampling missed in April.

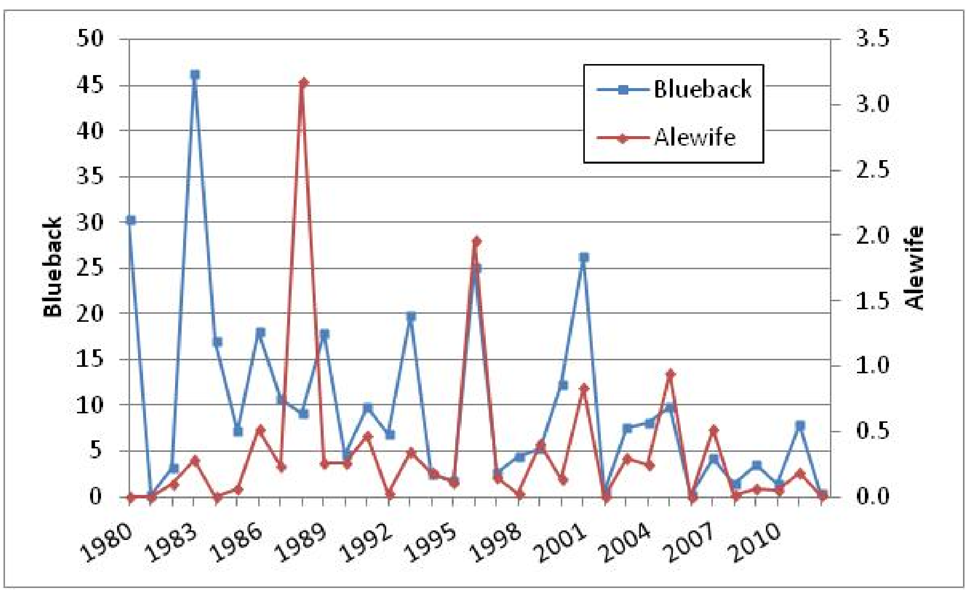

Figure 17. Delaware River juvenile river herring indices from New Jersey's beach seine collections, geometric mean: 1990 – 2012.

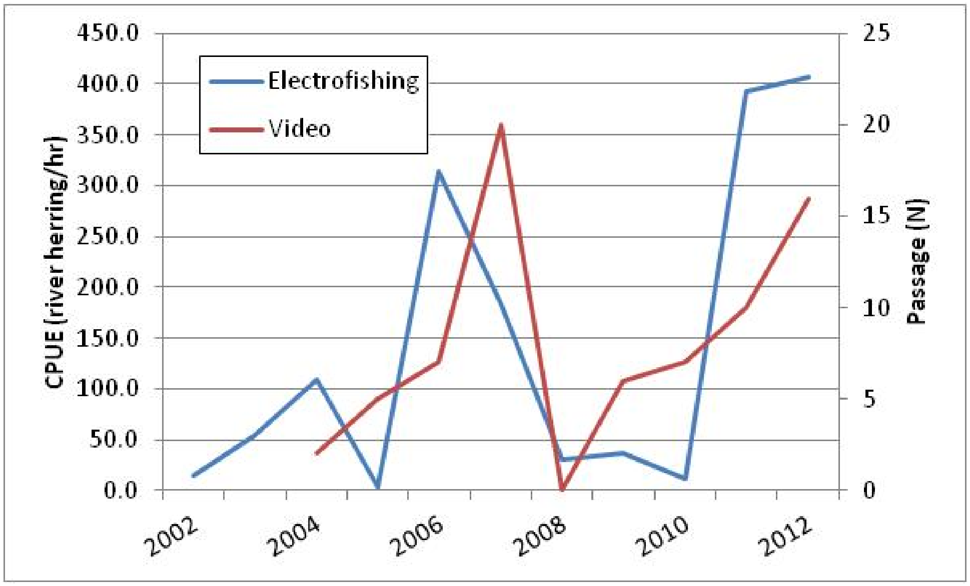

Figure 18. Fishery-independent relative abundance estimates (electrofishing and fishway passage counts) of river herring in the Schuylkill River.

Table 1. New Jersey's net regulations for the harvest of American shad: 2012.

System	Season	Gear Limits	Mandatory Reporting	Other Restrictions
Delaware Bay & River	Gill nets: Feb 1-Dec 15	Stretch mesh min.: 2.75" Feb 1-Feb 29 *3.25" Mar 1-Dec 15 Length: 2400' Feb 12-May 15 1200' May 16-Dec 15	YES	Limited entry; gear restrictions in defined areas
	Haul Seine: Nov 1-Apr 30	2.75" min. stretch mesh, max length 420'		

*except with special permit

Table 2. American shad commercial harvest for the states of Delaware and New Jersey, in pounds: 1980-2012. Landings are averaged for various date ranges at the end of the table.

	Upper Bay / River			**Lower Bay**			
Year	NJ	DE	Comb	NJ	DE	Comb	Total
1980	0		25,000	50,600		50,600	75,600
1981	0		30,000	67,600		67,600	97,600
1982	1,100		1,100	132,900		132,900	134,000
1983	4,300		4,300	49,300		49,300	53,600
1984	7,400		7,400	41,900		41,900	49,300
1985	23,100	29,293	52,393	48,900	139,159	188,059	240,451
1986	17,700	28,616	46,316	63,900	150,861	214,761	261,076
1987	20,200	10,262	30,462	109,400	169,922	279,322	309,784
1988	17,300	24,407	41,707	80,700	204,851	285,551	327,259
1989	16,800	12,247	29,047	62,500	175,506	238,006	267,053
1990	40,364	15,796	56,160	212,749	368,988	581,737	637,897
1991	23,092	11,713	34,805	150,209	352,621	502,830	537,635
1992	41,765	9,246	51,011	114,035	209,717	323,752	374,763
1993	19,552	13,005	32,557	123,428	220,392	343,820	376,377
1994	9,066	14,345	23,411	41,305	181,758	223,063	246,475
1995	11,811	14,290	26,101	61,621	132,005	193,626	219,727
1996	1,100	10,095	11,195	17,563	155,111	172,674	183,869
1997	9,250	8,472	17,722	34,549	108,023	142,572	160,294
1998	75	8,047	8,122	14,180	76,751	90,931	99,053
1999	5,670	2055	7,725	83,036	74,114	157,150	164,875
2000	43,299	6,867	50,166	78,132	47,000	125,132	175,298
2001	69,098	3,677	72,775	27,040	198,114	225,154	297,929
2002	32,746	2,511	35,257	15,671	36,193	51,864	87,121
2003	84,198	4,749	88,947	6,322	57,617	63,939	152,886
2004	92,073	3,016	95,089	5,385	87,062	92,447	187,536
2005	46,543	677	47,220	41,441	122,909	164,350	211,569
2006	56,847	575	57,422	9,307	29,943	39,250	96,672
2007	53,818	1817	55,635	9,010	69,608	78,618	134,253
2008	23,877	260	24,137	5,157	18,069	23,226	47,363
2009	9,264	97	9,361	3,381	3,349	6,730	16,091
2010	7,721	119	7,840	4,499	4,899	9,398	17,238
2011	6,855	561	7,416	5,199	8,122	13,321	20,737
2012	19,923	842	20,765	7,445	1,776	9,221	29,986
1980-2012	24,724	8,488	33,593	53,890	121,587	157,055	190,648
2003-2012	40,112	1,271	41,383	9,715	40,335	50,050	91,433
2008-2012	13,528	376	13,904	5,136	7,243	12,379	26,283

Table 3. New Jersey's commercial gill net shad landings in the Delaware Bay, roe vs. buck: 1996–2012.

	Delaware Bay	
Year	% Roe	% Buck
1996	-	-
1997	-	-
1998	-	-
1999	82.6	17.4
2000	86.0	14.0
2001	83.8	16.2
2002	69.4	30.6
2003	80.3	19.7
2004	77.9	22.1
2005	73.9	26.1
2006	79.5	20.5
2007	80.6	19.4
2008	77.5	22.5
2009	80.4	19.6
2010	67.2	32.8
2011	76.4	23.6
2012	85.6	14.4
AVG	78.7	21.4

Table 4. Delaware's gill net effort for the American shad commercial fishery: 2012.

Effort	DE Bay - Anchored	DE Bay - Drift net	DE River – Drift net
No. of fisherman	7	8	3
No. Vessels Trips	52	45	28
LB Harvested	1,094	682	842
Net-Yards fished	19,200	28,800	13,650
LB per net-yard	0.06	0.02	0.06

Table 5. New Jersey's gill net effort data for the American shad commercial fishery: 2012.

	Upper Bay	Lower Bay	Combined
No. of Fishermen	8	3	11
No. of Man-days	44	38	82
Square Feet of Net	1,338,500	117,600	1,456,100
Pounds Harvested	21,406	5,962	27,368
Lbs/Sq Ft	0.016	0.051	0.019

Table 6. CPUE (lbs/ft^2) in New Jersey's American shad commercial gill net fishery: 1999-2012.

	Delaware Bay		
Year	Upper	Lower	Combined
1999	0.007	0.017	0.016
2000	0.014	0.027	0.020
2001	0.022	0.015	0.019
2002	0.013	0.022	0.015
2003	0.022	0.010	0.020
2004	0.025	0.012	0.023
2005	0.015	0.029	0.019
2006	0.025	0.017	0.023
2007	0.022	0.022	0.022
2008	0.014	0.014	0.014
2009	0.010	0.016	0.011
2010	0.011	0.023	0.014
2011	0.008	0.025	0.013
2012	**0.016**	**0.051**	**0.019**
mean	0.016	0.019	0.018

Table 7. CPUE in the Lewis haul seine, Delaware River: 1925-2012.

Year	# hauls	# shad caught	CPUE (hauls)	Year	# hauls	# shad caught	CPUE (hauls)
1925	458	742	1.62	1969	29	90	3.10
1926	208	661	3.18	1970	25	122	4.88
1927	436	1,061	2.43	1971	54	664	12.30
1928	543	2,174	4.00	1972	64	348	5.44
1929	616	2,706	4.39	1973	69	496	7.19
1930	362	470	1.30	1974	49	417	8.51
1931	501	887	1.77	1975	117	1,738	14.85
1932	450	1,442	3.20	1976	123	1,470	11.95
1933	420	2,325	5.54	1977	110	1,120	10.18
1934	520	1,796	3.45	1978	121	1,226	10.13
1935	328	4,417	13.47	1979	107	2,003	18.72
1936	392	951	2.43	1980	148	1,920	12.97
1937	448	4,161	9.29	1981	118	6,392	54.17
1938	693	3,240	4.68	1982	127	3,789	29.83
1939	506	4,439	8.77	1983	100	1,444	14.44
1940	170	611	3.59	1984	152	2,383	15.68
1941	162	129	0.80	1985	69	2,022	29.30
1942	193	1,096	5.68	1986	99	3,036	30.67
1943	215	3,025	14.07	1987	111	1,830	16.49
1944	45	226	5.02	1988	78	2,778	35.62
1945	144	295	2.05	1989	89	4,646	52.20
1946	118	254	2.15	1990	92	2,332	25.35
1947	358	1,358	3.79	1991	76	2,312	30.42
1948	59	43	0.73	1992	94	4,790	50.96
1949	32	3	0.09	1993	33	347	10.52
1950	51	9	0.18	1994	49	387	7.90
1951	38	25	0.66	1995	66	1,257	19.05
1952	43	27	0.63	1996	57	209	3.67
1953	31	0	0.00	1997	46	550	11.96
1954	26	9	0.35	1998	49	647	13.20
1955	43	36	0.84	1999	43	198	4.60
1956	32	0	0.00	2000	45	183	4.07
1957	12	10	0.83	2001	32	219	6.84
1958	18	54	3.00	2002	52	200	3.85
1959	24	27	1.13	2003	56	293	5.23
1960	19	6	0.32	2004	54	220	4.07
1961	26	90	3.46	2005	36	104	2.89
1962	18	250	13.89	2006	44	73	1.66
1963	70	3,983	56.90	2007	21	71	3.38
1964	90	1,646	18.29	2008	37	83	2.24
1965	48	319	6.65	2009	43	108	2.51
1966	44	77	1.75	2010	35	431	12.31
1967	65	243	3.74	2011	26	50	2.01
1968	27	33	1.22	**2012**	**36**	**142**	**2.32**
						Mean	**9.67**

Table 8. Harvest Losses (number and weight in pounds) of American shad in the Delaware River and Estuary: 2012.

	Number	Mean Weight	Pounds
Delaware			
Commercial (gill net)	2,618	4.24[1]	11,105
Recreational	N/A	N/A	N/A
C/R Mortality	N/A	N/A	N/A
Poaching	N/A	N/A	N/A
Total	2,618		11,105
New Jersey			
Commercial (gill net)	6,842	4.00[2]	27,368
Commercial (seine)	142	3.65[3]	518
Recreational	N/A	N/A	N/A
C/R Mortality	N/A	N/A	N/A
Poaching	N/A	N/A	N/A
Total	6,984	-	27,886
New York			
Commercial	0	0	0
Recreational	Unknown	Unknown	Unknown
C/R Mortality	Unknown	Unknown	Unknown
Poaching	Unknown	Unknown	Unknown
Research	67	2.49	149
Total			
Pennsylvania			
Commercial	0	0	0
Recreational	Unknown	Unknown	Unknown
C/R Mortality	Unknown	Unknown	Unknown
Poaching	Unknown	Unknown	Unknown
Research	1,060	2.96	3,143
Total	1,060	2.96	3,143
Grand Total	10,729		42,283

1) Based on 2012 commercial landings

2) Based on mean weight data from Delaware Bay sampling in 2012

3) Based on 2008 Delaware River haul seine data

Table 9. Harvest Losses (number and weight in pounds) of American shad in the Lehigh and Schuylkill rivers: 2012.

	Number	Mean wt	Pounds
Lehigh River			
Commercial	0	…	0
Recreational	Unknown	…	…
C/R Mortality	Unknown (expected to be nominal)	…	…
Poaching	Unknown (expected to be nominal)	…	…
Research	62	3.34	207
Total	62	3.34	207
Schuylkill River			
Commercial	0	…	0
Recreational	Unknown	…	…
C/R Mortality	Unknown (expected to be nominal)	…	…
Poaching	Unknown (expected to be nominal)	…	…
Research	25	3.16	79
Total	25	3.16	79

Table 10. CPUE for American shad captured by gill net at Smithfield Beach, Delaware River, by electrofishing at Raubsville, Delaware River, by electrofishing at Chain Dam, Lehigh River, and electrofishing below Fairmount Dam, Schuylkill River.

	Del R (Smithfield Bch) Effort			Del R (Raubsville) Effort			Lehigh River Effort			Schuylkill River Effort		
Year	No shad	(foot-hrs)	CPUE	No. shad	(hrs)	CPUE	No. shad	(hrs)	CPUE	No. shad	(hrs)	CPUE
1997	1269	1156	11		No collections							
1998	1257	977	12.9	82	??							
1999	713	1126	6.30	153	10.1	13.7	101	0	168.3			
2000	541	724	7.50	130	6	30.8	100	1.6	62.5			
2001	923	1363	6.80	145	3.4	49.3	109	1.5	72.7			
2002	400	446	9.00	No collections			95	0.4	237.5	63	6.5	9.7
2003	523	762	6.90	No collections			No collections			535	4.2	128.9
2004	427	854	5.00	No collections			62	0.57	109.2	47	2.4	197.2
2005	904	804	11.20	No collections			13	0.97	13.4	1047	3.9	265.7
2006	356	680	5.20	No collections			49	0.62	79.5	1950	3.9	505.0
2007	764	945	8.10	No collections			40	1.32	30.3	1046	3.6	287.1
2008	699	1145	6.10	No collections			39	1.32	29.5	1082	6.1	177.7
2009	372	1090	3.40	No collections			27	1.93	14	3090	6.9	449.7
2010	812	866	9.40	110	5	22.9	123	1.01	122.4	4988	6.2	806.0
2011	1010	701	14.40	66	3.4	20.9	16	1.04	15.4	5271	5.6	948.0
2012	979	665	14.70	152	4.5	47.7	62	1.10	55.9	2399	7.6	315.7

Table 11. Number of American shad counted at fish passage facilities on the Lehigh and Schuylkill rivers. No monitoring occurs for Hamilton St fishway on the Lehigh River, and Flat Rock and Norristown fishways on the Schuylkill Rivers. While monitored, passage of fishes through Black Rock by Normandeau Assoc. for Exelon Corp. in recent years, is not available.

	Lehigh River				Schuylkill River			
	Easton	Chain	Hamilton St	Cementon	Fairmount	Flat Rock	Norristown	Black Rock
River mile	0	3	14	24	8.5	15.6	24	36.6
Operational fishway	Vertical slot	Vertical slot	Vertical slot	None	Vertical slot	Denil	Denil	Denil
Observation window	Yes	Yes	Yes	None	Yes	Yes	Yes	Yes
1994	87	No monitoring						
1995	873	No monitoring						
1996	1,141	496						
1997	1,428	126						
1998	3,293	694						
1999	2,346	479						
2000	2,094	645						
2001	4,740	2,057						
2002	3,314	1,479						
2003	422	40						
2004	754	No monitoring			91			
2005	675	324			41			
2006	2,023	588			345			
2007	1,397	215			56			
2008	408	84			0			
2009	425	60			1,485			
2010	1,910	129			2,521			
2011	558	29			3,366			
2012	2,096	No monitoring			2,227			

Table 12. Number of juvenile American shad released into the Delaware and Lehigh Rivers above barriers to adult migration.

	Number of American shad larvae stocked		
Year	Delaware	Lehigh	Schuylkill
1985		600,000	251,980
1986		549,880	246,400
1987		489,980	194,575
1988		340,400	
1989		2,087,700	316,810
1990		793,000	285,100
1991		793,000	75,000
1992		353,000	3,000
1993		789,600	
1994		642,200	
1995		1,044,000	
1996		993,000	
1997		1,247,000	
1998		948,000	
1999		501,000	410,000
2000		447,900	535,990
2001		675,625	490,901
2002		85,025	2,000
2003		783,013	1,000,448
2004		366,414	521,583
2005	169,802	668,792	545,459
2006	52,782	293,083	253,729
2007	47,587	276,000	540,655
2008	158,151	696,785	486,774
2009		210,584	161,938
2010		347,522	380,000
2011		473,366	643,361
2012		301,112	200,429

Table 13. Hatchery contribution for adult American shad collected from the Delaware, Lehigh, and Schuylkill rivers.

Location	Smithfield Beach		Raubsville		Lehigh R		Schuylkill R	
Gear	gill net		electro.		electro.		electro.	
River mile	218.0		176.6		3.0		8.0	
Year	N	Percent	N	Percent	N	Percent	N	Percent
1997	88	0.0%	No collections		No collections			
1998	234	3.8%	No collections		No collections			
1999	208	0.0%	8	5.3%	104	91.0%		
2000	330	3.0%	14	10.9%	99	91.0%		
2001	198	4.0%	12	8.3%	103	92.0%		
2002	378	1.1%	No collections		99	89.0%		
2003	245	7.8%	No collections		No collections			
2004	414	1.2%	No collections		60	80.0%		
2005	776	0.5%	No collections		13	62.0%		
2006	350	1.4%	No collections		55	73.0%		
2007	746	2.8%	No collections		40	58.0%	22	91.6%
2008	667	1.0%	No collections		41	51.0%	28	100%
2009	367	1.1%	No collections		27	63.0%	24	96.0%
2010	470	0.2%	1	0.9%	96	67.0%	25	100%
2011	409	0.5%	0	0.0%	16	56.0%	22	88.0%
2012	412	1.0%	80	2.5%	62	42.6%	21	84.0%

Table 14. Length frequency of American shad collected by gillnet in the Delaware River at Smithfield Beach, RM 218.0.

Males

TL	375	400	425	450	475	500	525	550	575	600	625	Total	mean
1996			3	22	53	83	36	16	6	2		**221**	**511**
1997		3	23	89	77	62	16	3				**273**	**483**
1998		1	1	34	101	85	13					**235**	**495**
1999			1	15	28	26	6					**76**	**493**
2000		1	9	60	85	51	15	3	1			**225**	**489**
2001			6	28	99	78	25	2				**238**	**496**
2002		2	1	8	29	62	42	7	1			**152**	**512**
2003			5	34	69	64	51	12	1			**236**	**504**
2004			1	8	36	79	28	4	1			**157**	**509**
2005	1	3	22	48	81	110	79	12	2			**358**	**502**
2006			12	40	49	26	7	1	1			**136**	**483**
2007		1	9	48	112	88	28	3				**289**	**495**
2008			6	51	98	67	28	4	2			**256**	**496**
2009		3	18	63	26	20	2	3				**135**	**473**
2010			8	101	194	76	3	2				**384**	**485**
2011			2	9	57	94	35	3				**200**	**507**
2012				15	36	35	20	2				**108**	**501**

Females

TL	375	400	425	450	475	500	525	550	575	600	625	Total	mean
1996			1	2	26	70	255	200	78	11		**643**	**547**
1997				21	82	219	296	283	81	14		**996**	**537**
1998			1	4	50	284	448	182	49	3	1	**1022**	**534**
1999				1	21	162	310	127	13	3		**637**	**535**
2000				2	4	42	92	117	53	6		**316**	**551**
2001				1	8	99	263	229	77	8		**685**	**547**
2002			1		1	11	56	102	62	15		**248**	**562**
2003			1	1	5	23	31	93	87	40	6	**287**	**570**
2004					1	25	74	82	70	15	3	**270**	**560**
2005				1	7	39	127	222	121	27	3	**547**	**560**
2006				1	14	37	47	67	41	12	1	**220**	**551**
2007				2	24	72	167	136	64	9	1	**475**	**527**
2008			1	2	26	101	158	1	115	36	3	**443**	**539**
2009			1	3	25	58	83	51	11	4		**236**	**533**
2010				7	64	208	119	27	5			**430**	**518**
2011				2	19	154	366	238	30	2		**811**	**540**
2012				1	15	61	82	82	51	8		**300**	**547**

Table 14. (continued)

Sexes combined												
TL	**375**	**400**	**425**	**450**	**475**	**500**	**525**	**550**	**575**	**600**	**625**	**Total**	**mean**
1996	0	0	4	24	79	153	291	216	84	13	0	**864**	**537**
1997	0	3	23	110	159	281	312	286	81	14	0	**1269**	**525**
1998	0	1	2	38	151	369	461	182	49	3	1	**1257**	**527**
1999	0	0	1	16	49	188	316	127	13	3	0	**713**	**531**
2000	0	1	9	62	89	93	107	120	54	6	0	**541**	**525**
2001	0	0	6	29	107	177	288	231	77	8	0	**923**	**534**
2002	0	2	2	8	30	73	98	109	63	15	0	**400**	**543**
2003	0	0	6	35	74	87	82	105	88	40	6	**523**	**540**
2004	0	0	1	8	37	104	102	86	71	15	3	**427**	**541**
2005	1	3	22	49	88	149	206	234	123	27	3	**905**	**537**
2006	0	0	12	41	63	63	54	68	42	12	1	**356**	**525**
2007	0	1	9	50	136	160	195	139	64	9	1	**764**	**527**
2008	0	0	7	53	124	168	186	5	117	36	3	**699**	**523**
2009	0	3	19	66	51	78	85	54	11	4	0	**371**	**511**
2010	0	0	8	108	258	284	122	29	5	0	0	**814**	**502**
2011	0	0	2	11	76	248	401	241	30	2	0	**1011**	**534**
2012	0	0	0	16	51	96	102	84	51	8	0	**408**	**535**

Table 15. Length frequency of American shad collected by electrofisher in the Delaware River at Raubsville, RM 176.6.

Males														
TL	**325**	**350**	**375**	**400**	**425**	**450**	**475**	**500**	**525**	**550**	**575**	**600**	**Total**	**mean**
1997	1		8	9	21	32	16		5				**92**	**452**
1998				6	14	10	11	14	2	1			**58**	**486**
1999			1		16	29	17	16	3		1		**83**	**473**
2000				1	13	16	26	24	2		1		**83**	**476**
2001				1	13	16	26	24	2		1		**83**	**483**
2010				3	7	29	36	17	1				**93**	**479**
2011					1	6	8	12	5				**32**	**497**
2012	1	1		3	12	12	15	11	1				**56**	**515**
Females														
TL	**325**	**350**	**375**	**400**	**425**	**450**	**475**	**500**	**525**	**550**	**575**	**600**	**Total**	**mean**
1997							1	10	12	7	3	1	**34**	**516**
1998							9	26	32	16	7		**90**	**541**
1999							3	9	18	11	5	1	**47**	**531**
2000						2	3	9	23	17	6	2	**62**	**543**
2001						2	3	9	23	17	6	2	**62**	**542**
2010					1	6	1	10	9				**27**	**522**
2011							5	5	20	8	1		**39**	**535**
2012					1	7		7	8		2	1	**26**	**467**
Sexes combined														
TL	**325**	**350**	**375**	**400**	**425**	**450**	**475**	**500**	**525**	**550**	**575**	**600**	**Total**	**mean**
1997	1	0	8	9	21	32	17	10	17	7	3	1	**126**	**468**
1998	0	0	0	6	14	10	20	40	34	17	7	0	**148**	**508**
1999	0	0	1	0	16	29	20	25	21	11	6	1	**130**	**509**
2000	0	0	0	1	13	18	29	33	25	17	7	2	**145**	**500**
2001	0	0	0	1	13	18	29	33	25	17	7	2	**145**	**508**
2010	0	0	0	3	8	35	37	27	10	0	0	0	**120**	**489**
2011	0	0	0	0	1	6	13	17	25	8	1	0	**71**	**518**
2012	1	1	0	3	13	19	15	18	9	0	2	1	**82**	**482**

Table 16. Length frequency of American shad collected by electrofisher in the Lehigh River below Chain Dam, RM 3.0.

Males																
TL	350	375	400	425	450	475	500	525	550	575	600	625	650	**Total**	**Mean**	**Std Dev**
1997			3	4	6	6	4	1						**24**	**470**	**36**
1998		2		8	8	8								**26**	**459**	**27**
1999		3	4	24	25	8	2							**66**	**450**	**24**
2000			2	6	13	29	13	2						**65**	**482**	**27**
2001			2	12	11	20	21	3						**69**	**481**	**31**
2002			1	5	6	11	15	5	1					**44**	**490**	**33**
2004	10		5	4	9	2		1						**31**	**420**	**49**
2005				4	1	2	1							**8**	**470**	**44**
2006				12	12	9	2							**35**	**463**	**22**
2007					3	7	2	2						**14**	**494**	**25**
2008		2	1			1	4	1						**9**	**470**	**63**
2009		1	1	11	3	2								**18**	**440**	**20**
2010			7	10	27	26		2						**72**	**466**	**26**
2011			1	2	2	3	1							**9**	**462**	**33**
2012				11	10	7	2	1						**31**	**462**	**25**
Females																
TL	350	375	400	425	450	475	500	525	550	575	600	625	650	**Total**	**Mean**	**Std Dev**
1997						1	2	3	1					**7**	**528**	**25**
1998					1	2	7	10	4					**24**	**527**	**24**
1999					2	9	12	9	6					**38**	**517**	**29**
2000						5	5	14	10	1				**35**	**533**	**28**
2001					1	3	7	8	16	5				**40**	**543**	**28**
2002					1	2	6	14	24	8	1			**56**	**551**	**29**
2004			2	1	3	8	12	5						**31**	**495**	**32**
2005							2	1	2					**5**	**532**	**23**
2006					1	8	7	4						**20**	**503**	**21**
2007					3	2	6	4	9	2				**26**	**532**	**35**
2008						3	3	14	8	5				**33**	**543**	**27**
2009				1	1	1	1	2	2	1				**9**	**522**	**53**
2010				1	2	4	13	5						**25**	**505**	**23**
2011					1	1	1	3	1					**7**	**519**	**33**
2012						3	10	11	6				1	**30**	**532**	**33**
Sexes combined																
TL	350	375	400	425	450	475	500	525	550	575	600	625	650	**Total**	**Mean**	**Std Dev**
1997			3	4	6	7	6	4	1					**31**	**483**	**42**
1998		2		8	9	10	7	10	4					**50**	**492**	**42**
1999		3	4	24	27	17	14	9	6					**104**	**474**	**41**
2000			2	6	13	34	18	16	10	1				**100**	**500**	**36**
2001			2	12	12	23	28	11	16	5				**109**	**504**	**43**
2002			1	5	7	13	21	19	25	8	1			**100**	**524**	**43**
2004	10	0	7	5	12	10	12	6						**62**	**457**	**56**
2005				4	1	2	3	1	2					**13**	**494**	**48**
2006				12	13	17	9	4						**55**	**478**	**29**
2007					6	9	8	6	9	2				**40**	**518**	**36**
2008		2	1			4	7	15	8	5				**42**	**528**	**48**
2009		1	1	12	4	3	1	2	2	1				**27**	**467**	**52**
2010			7	11	29	30	13	7						**97**	**476**	**30**
2011			1	2	3	4	2	3	1					**16**	**487**	**43**
2012	0	0	0	11	10	10	12	12	6	0	0			61	**497**	**46**

Note: No collections in 2003

Table 17. Length frequency of American shad collected by electrofisher in the Schuylkill River below Fairmount Dam, RM 8.5.

Males

TL	350	375	400	425	450	475	500	525	550	575	600	Total	Mean
2007		1	1	5	2	5	8					22	474.1
2008		1	5	4	6	4	1	2				23	456.1
2009				3	8	6	1	1				19	470.3
2010					7	7	1					15	474.6
2011					1	2	7	1				14	498.2
2012			2	2	4	1	1	3				13	456.9

Females

TL	350	375	400	425	450	475	500	525	550	575	600	Total	Mean
2007							1		2			3	546.3
2008					2	1	1			2		6	517.5
2009					1		2	1	1		1	6	529.6
2010						1	4	1				6	517.5
2011						1	2	7	1			11	530.4
2012					2		1	3	4	1		11	531.4

Sexes combined

TL	350	375	400	425	450	475	500	525	550	575	600	Total	Mean
2007		1	1	5	2	5	9		2			25	482.8
2008		1	5	4	8	5	2	2		2		29	468.0
2009				3	9	6	3	2	1		1	25	475.0
2010					8	10	5	1				24	485.1
2011					1	7	8	8	1			25	512.4
2012			2	2	6	1	2	6	4	1		24	489.7

Table 18. Age frequency for American shad collected by gill net in the Delaware River at Smithfield Beach, RM 218.0.

	Otolith Age										
Males	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**??**	**Total**	**Mean Age**
1996			4	20	12	3			188	**227**	**5.3**
1997		3	13	10	5	1			241	**273**	**4.6**
1998		1	18	45	10	4			157	**235**	**5.0**
1999			22	30	7				17	**76**	**4.7**
2000		4	37	65	33	3	1		82	**225**	**4.7**
2001		3	64	95	28	4			44	**238**	**4.8**
2002		2	14	58	51	12	2		13	**152**	**5.5**
2003		4	87	73	60	9	2	1		**236**	**5.0**
2004		2	26	97	23	5	1		3	**157**	**5.0**
2005		7	80	130	92	8			41	**358**	**5.0**
2006			51	74	11					**136**	**4.7**
2007		1	26	149	93	6	1			**276**	**5.3**
2008			35	84	104	19				**242**	**5.4**
2009		2	64	41	19	4			5	**135**	**4.7**
2010			34	314	18				18	**384**	**5.0**
2011			3	13	48	1			9	**74**	**5.7**
2012			3	66	7	22	3	1	1	**103**	**5.6**
Females	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**??**	**Total**	**Mean Age**
1996		1	4	22	14	9	4		593	**647**	**5.7**
1997			10	12	13	7			954	**996**	**5.4**
1998			7	69	36	11	9		890	**1022**	**5.6**
1999		1	33	64	46	2			492	**638**	**5.1**
2000			5	57	81	45	6		122	**316**	**5.9**
2001		1	77	270	166	28	7		138	**687**	**5.3**
2002			7	57	124	34	10	1	15	**248**	**5.9**
2003			15	59	154	55	4			**287**	**5.9**
2004			22	102	76	59	5		6	**270**	**5.7**
2005		3	63	210	155	22	7	1	86	**547**	**5.3**
2006		2	30	72	61	45	3		7	**220**	**5.6**
2007		2	28	169	222	26	9	2		**458**	**5.6**
2008		1	30	128	200	49	3			**411**	**5.7**
2009			27	64	102	32	5		6	**236**	**5.7**
2010			11	342	55	9	2		10	**429**	**5.2**
2011			4	32	281	9			1	**327**	**5.9**
2012			1	99	22	158	3	1	1	**285**	**6.3**

Table 18. (continued)

Sexes combined	2	3	4	5	6	7	8	9	??	Total	Mean Age
1996	0	1	8	42	26	12	4	0	781	**874**	**5.6**
1997	0	3	23	22	18	8	0	0	1195	**1269**	**5.1**
1998	0	1	25	114	46	15	9	0	1047	**1257**	**5.4**
1999	0	1	55	94	53	2	0	0	509	**714**	**5.0**
2000	0	4	42	122	114	48	7	0	204	**541**	**5.5**
2001	0	4	141	365	194	32	7	0	182	**925**	**5.2**
2002	0	2	21	115	175	46	12	1	28	**400**	**5.8**
2003	0	4	102	132	214	64	6	1	0	**523**	**5.5**
2004	0	2	48	199	99	64	6	0	9	**427**	**5.5**
2005	0	10	143	340	247	30	7	1	127	**905**	**5.2**
2006	0	2	81	146	72	45	3	0	7	**356**	**5.2**
2007	0	3	54	318	315	32	10	2	0	**734**	**5.5**
2008	0	1	65	212	304	68	3	0	0	**653**	**5.6**
2009	0	2	91	105	121	36	5	0	11	**371**	**5.3**
2010	0	0	45	656	73	9	2	0	28	**813**	**5.1**
2011	0	0	7	45	329	10	0	0	10	**401**	**5.9**
2012	0	0	4	165	29	180	6	2	2	**388**	**6.1**

Table 19. Age frequency for American shad collected by electrofisher in the Delaware River at Raubsville, RM 176.6.

	Otolith Age										
Males	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**??**	**Total**	**Mean Age**
1999		2	30	22					2	**56**	**4.4**
2000		8	28	29	12	5			1	**83**	**4.7**
2001		2	37	35	6				1	**81**	**4.6**
2010		2	3	73	1	1			3	**83**	**5.0**
2011			6	5	20				1	**32**	**5.5**
2012		3	3	43	1	6				**56**	**5.1**
Females	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**??**	**Total**	**Mean Age**
1999			25	47	18	2			1	**93**	**5.0**
2000			3	14	20	7	3			**47**	**5.9**
2001			8	35	18	2			1	**64**	**5.2**
2010				21	4	1			1	**27**	**5.2**
2011			1	9	28					**38**	**5.7**
2012			1	9		12			3	**25**	**6.0**
Sexes combined	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**??**	**Total**	**Mean Age**
1999	0	2	55	69	18	2	0	0	3	**149**	**4.7**
2000	0	8	31	43	32	12	3	0	1	**130**	**5.0**
2001	0	2	45	70	24	2	0	0	2	**145**	**4.9**
2010	0	2	3	94	5	2	0	0	4	**110**	**5.0**
2011	0	0	7	14	48	0	0	0	1	**70**	**5.6**
2012	0	3	4	52	1	18	0	0	3	**81**	**5.3**

Table 20. Age frequency for American shad collected by electrofisher in the Lehigh River below Chain Dam, RM 3.0.

	Otolith Age											
Males	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**	**Mean Age**
1999		2	48	7	5						**62**	**4.0**
2000		1	7	54	2		1				**65**	**4.9**
2001		4	35	43	7	1					**90**	**5.0**
2002		1	7	19	16						**43**	**5.2**
2004		7	3	8	8	3	2				**31**	**5.1**
2005		7	64	28	22	3	1				**125**	**5.0**
2006			3	28	2						**33**	**5.0**
2007		1	25	16	9						**51**	**5.9**
2008			2	1	2	26	1				**32**	**5.4**
2009		1	14	2	1						**18**	**4.2**
2010		3	19	49							**71**	**4.6**
2011			1	1	5						**7**	**5.6**
2012			17	11	2	1					**31**	**4.6**
Females	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**	**Mean Age**
1999			6	14	14	1					**35**	**5.3**
2000			1	23	10	1					**35**	**5.3**
2001			21	60	35	4					**120**	**5.9**
2002			5	21	8	18	1	1			**54**	**5.9**
2004		1	2	5	11	11	1				**31**	**6.0**
2005		2	18	33	71	16	4	1			**145**	**6.2**
2006			2	15	2	1					**20**	**5.1**
2007			10	29	57	3	2				**101**	**6.2**
2008			1	1	2	26	1				**31**	**6.8**
2009			3			5	1				**9**	**6.1**
2010			4	18	3						**25**	**5.0**
2011			2	6	1						**9**	**4.9**
2012				8	10	13					**31**	**6.2**
Sexes Combined	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**	**Mean Age**
1999		2	54	21	19	1					**97**	**4.5**
2000		1	8	77	12	1	1				**100**	**5.1**
2001		4	56	103	42	5					**210**	**5.3**
2002		1	12	40	24	18	1	1			**97**	**5.6**
2004		8	5	13	19	14	3				**62**	**5.6**
2005		9	82	61	93	19	5	1			**270**	**5.5**
2006			5	43	4	1					**53**	**5.0**
2007		1	35	45	66	3	2				**152**	**6.1**
2008			3	2	4	52	2				**63**	**6.5**
2009		1	17	2	1	5	1				**27**	**4.8**
2010		3	23	67	3						**96**	**4.7**
2011			3	7	6						**16**	**5.2**
2012			17	19	12	14					**62**	**5.4**

Table 21. Age frequency for American shad collected by electrofisher in the Schuylkill River below Fairmount Dam, RM 8.0.

Males — Otolith Age

	3	4	5	6	7	8	9	?	Total	Mean
2007	2	7	3	9	1				22	5.0
2008	2	14	4	2	1				23	4.3
2009		9	9	1					19	4.6
2010		1	14						15	4.9
2011			2	12					14	5.8
2012	1	4	4	1	4				14	5.2

Females — Otolith Age

	3	4	5	6	7	8	9	?	Total	Mean
2007			1	2					3	5.6
2008		2	2	2					6	5.0
2009			4	1			1		6	5.8
2010			3	3					6	5.5
2011				9				1	10	6.1
2012		2	1	2	4	2			11	6.3

Sexes combined — Otolith Age

	3	4	5	6	7	8	9	?	Total	Mean
2007	2	7	4	11	1				25	5.1
2008	2	16	6	4	1				29	4.5
2009		9	13	2			1		25	4.9
2010		1	21	3					25	5.1
2011			2	21	1			1	25	5.9
2012	1	6	5	3	8	2			25	5.7

Table 22. Total length at age for American shad collected by gill net in the Delaware River at Smithfield Beach, RM 218.0.

			Total Length (mm) at Age						
Year	**Gender**	**Statistic**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1997	**Male**	Mean	428	463	493	527	544		
		N	3	11	9	5	1		
		SE	13.5	5.8	12.6	8.1			
	Female	Mean		489	517	566	575		
		N		10	12	12	5		
		SE		6.7	9.0	10.8	12.0		
1998	**Male**	Mean	513	488	492	510	511		
		N	1	18	43	8	4		
		SE		4.0	3.5	9.5	7.5		
	Female	Mean		521	529	553	568	574	
		N		6	67	35	10	8	
		SE		14.0	3.6	4.7	7.1	5.2	
1999	**Male**	Mean		481	497	507			
		N		20	30	7			
		SE		4.7	3.7	5.9			
	Female	Mean	498	524	536	542	510		
		N	1	33	63	45	1		
		SE		5.2	3.6	4.3			
2000	**Male**	Mean	452	476	490	512	528		
		N	4	36	65	31	2		
		SE	8.1	3.8	2.8	3.5	2.5		
	Female	Mean		519	535	554	567	576	
		N		5	57	79	45	6	
		SE		3.2	2.9	2.9	3.8	10.8	
2001	**Male**	Mean	484	488	497	510	517		
		N	3	62	94	27	3		
		SE	9.6	3.1	2.0	4.0	8.9		
	Female	Mean	542	532	541	559	570	558	
		N	1	77	270	165	28	7	
		SE		2.4	1.3	1.5	4.2	6.1	
2002	**Male**	Mean	423	494	507	518	510	535	
		N	2	12	53	49	11	2	
		SE	0.5	10.5	2.6	2.8	4.9	5.0	
	Female	Mean		530	552	564	568	563	
		N		7	56	124	34	9	
		SE		19.3	3.3	1.7	3.2	8.9	

Table 22. (continued).

Year	Gender	Statistic	Total Length (mm) at Age						
			3	4	5	6	7	8	9
2003	**Male**	Mean	475	482	506	528	537	540	574
		N	4	87	73	60	9	2	1
		SE	6.8	2.1	3.0	2.4	7.7	15.5	…
	Female	Mean		510	549	575	591	594	
		N		15	59	154	55	4	
		SE		7.1	3.8	1.9	3.1	9.0	
2004	**Male**	Mean	519	506	506	519	514	550	
		N	2	26	97	23	5	1	
		SE	5.5	4.8	2.0	5.1	6.8		
	Female	Mean		539	550	567	579	572	
		N		22	102	76	59	5	
		SE		3.8	2.3	3.0	2.8	19.8	
2005	**Male**	Mean	448	476	510	514	508		
		N	7	80	130	92	8		
		SE	14.5	3.6	2.2	2.3	8.1		
	Female	Mean	530.33	548	560	562	573	572	608
		N	3	63	210	155	22	7	1
		SE	5.0	3.6	1.8	2.1	7.1	7.8	
2006	**Male**	Mean		470	490	499			
		N		51	74	11			
		SE		3.1	2.6	9.7			
	Female	Mean	508	528	538	562	571	565	
		N	2	30	72	61	45	3	
		SE	21.0	5.6	3.1	3.9	4.1	3.7	
2007	**Male**	Mean	422	480	492	505	510	480	
		N	1	26	149	93	6	1	
		SE		2.9	1.9	2.3	9.3		
	Female	Mean	530	528	534	553	566	579	608
		N	2	28	169	222	26	9	2
		SE	15.5	4.6	1.6	1.7	5.5	5.5	1.5
2008	**Male**	Mean		480.5	495	498.4	515		
		N		35	84	104	19		
		SE		9.3	2.4	2.3	7.7		
	Female	Mean	528	526	531	542	555.9	562	
		N	1	30	1128	200	49	3	
		SE		2.3	1.7	2.9	5.8	11.2	

Table 22. (continued).

			Total Length (mm) at Age						
Year	**Gender**	**Statistic**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2009	**Male**	Mean	462	461	474	503	509		
		N	2	64	41	19	4		
		SE	24.0	2.6	3.7	7.5	10.7		
	Female	Mean	497	524	542	551	543		
		N	27	64	102	32	5		
		SE	3.5	3.5	2.0	5.3	9.9		
2010	**Male**	Mean		476	485	504			
		N		34	314	18			
		SE		1	2.7	1			
	Female	Mean		503	516	529	539	546	
		N		11	342	55	9	2	
		SE		7.2	1	3	7.2	6	
2011	**Male**	Mean		446	513	508	508		
		N		3	13	48	1		
		SE		2.2	3.4	3.0	-		
	Female	Mean		506	534	541	549		
		N		4	32	281	9		
		SE		2.3	4.0	1.3	5.7		
2012	**Male**	Mean		465	494	522	517	522	535
		N		3	66	7	22	3	1
		SE		0.1	3.0	0.3	1.0	0.1	-
	Female	Mean		516	528	539	560	561	520
		N		1	99	22	158	3	1
		SE		-	4.3	0.9	6.7	0.1	-
			Total Length (mm) at Age						
Year	**Gender**	**Statistic**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1997-2012	**Male**	Mean	452	474	489	507	512	528	574
		N	29	576	1293	613	79	7	1
		SE	6.0	1.2	0.7	1.1	3.6	13.2	
	Female	Mean	519	521	531	549	560	564	593
		N	11	372	1729	1788	443	75	3
		SE	5.8	1.6	0.7	0.7	1.6	3.6	12.1

Table 23. Total length at age for American shad collected by electrofisher in the Delaware River at Raubsville. RM 176.6.

			Total Length (mm) at Age					
Year	**Gender**	Statistic	**3**	**4**	**5**	**6**	**7**	**8**
1999	**Male**	Mean	417	461	495			
		N	2	32	22			
		SE	4.5	5.5	6.4			
	Female	Mean		521	533	536	585	
		N		22	48	17	2	
		SE		5.6	3.6	4.5	3.5	
2000	**Male**	Mean	451	463	485	492	497	
		N	8	28	29	12	5	
		SE	3.5	4.1	4.7	7.3	25.2	
	Female	Mean		523	522	551	564	564
		N		3	14	20	7	3
		SE		11.7	5.4	6.1	12.0	3.7
2001	**Male**	Mean	450	473	491	500	583	
		N	2	38	35	6	1	
		SE	19.5	4.4	4.3	12.5	…	
	Female	Mean		520	540	551	569	
		N		7	35	18	1	
		SE		14.9	5.0	6.1	…	
2010	**Male**	Mean	428	438	480	487	550	
		N	2	3	83	1	1	
		SE	12.5	18.7	2.2			
	Female	Mean			521	534	561	
		N			21	4	1	
		SE			6.0	10.7		
2011	**Male**	Mean		477	512	500		
		N		6	5	20		
		SE		13.7	12.7	5.1		
	Female	Mean		480	525	540	545	
		N		1	9	28	2	
		SE		-	9.2	3.8	3.0	
2012	**Male**	Mean	384	453	471	463	491	
		N	3	3	43	1	6	
		SE	0.2	0.1	2.0	-	0.3	
	Female	Mean		605	489		529	
		N		1	9		12	
		SE		-	11.2		11.7	
1999-2012	**Male**	Mean		439	468	484	498	494
		N		5	53	127	34	3
		SE		8.8	3.9	2.1	4.1	35.2
	Female	Mean		512	531	543	571	561
		N		9	70	56	6	1
		SE		12.6	3.5	3.2	11.0	

Table 24. Total length at age for American shad collected by electrofisher, in the Lehigh River, below Chain Dam, RM 3.0.

				Total Length (mm) at Age							
Year	**Structure**	**Gender**	**Statistic**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1999	Otolith	F	Mean			481	517	535			
			N			6	17	14			
			SE			6	6	6			
		M	Mean		386	448	467	482			
			N		3	49	6	5			
			SE		3	2	10	11			
2000	Otolith	F	Mean			478	523	563	532		
			N			1	22	10	1		
			SE				5	4			
		M	Mean		426	447	487	504		497	
			N		1	7	54	2		1	
			SE			9	3	7			
2001	Otolith	F	Mean			513	499	551	558		
			N			1	6	31	2		
			SE				7	4	3		
		M	Mean			456	478	507			
			N			18	31	19			
			SE			7	4	6			
2002	Otolith	F	Mean			515	544	547	572	573	
			N			4	22	8	17	1	
			SE			16	6	9	4		
		M	Mean		406	464	490	505			
			N		1	7	19	16			
			SE			11	5	7			
2004	Otolith	F	Mean		411	446	489	500	506	527	
			N		1	2	5	11	11	1	
			SE			4	7	13	7		
		M	Mean		360	378	438	437	485	454	
			N		7	3	8	8	3	2	
			SE		4	17	8	15	21	15	
2005	Otolith	F	Mean				509	546	529		
			N				1	2	2		
			SE					6	12		
		M	Mean			435	446	520			
			N			3	2	3			
			SE			4	8	7			

Table 24. (continued).

				Total Length (mm) at Age							
Year	**Structure**	**Gender**	**Statistic**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2006	Otolith	F	Mean			485	506	504	504		
			N			2	15	2	1		
			SE			3	6	20			
		M	Mean			445	466	466			
			N			3	28	2			
			SE			2	4	13			
2007	Otolith	F	Mean					527	566		576
			N					23	2		1
			SE					7.1	8.5		
		M	Mean				481	497	497		
			N				3	10	1		
			SE				8.4	8.9			
2008	Otolith	F	Mean			478	483	548	546	567	
			N			1	1	5	21	3	
			SE					26.4	21.5	10.4	
		M	Mean		394	375	497	519			
			N		2	1	2	3			
			SE		15.5		5.0	3.0			
2009	Otolith	F	Mean			462			569	535	
			N			3			3	3	
			SE			13.5			16.7	17.1	
		M	Mean		419	437	447	483			
			N		1	14	2	1			
			SE			4.5	18.5				
2010	Otolith	F	Mean			493	505	523			
			N			4	18	3			
			SE			17.0	4.9	9.5			
		M	Mean		418	452	474				
			N		3	19	49				
			SE		5.5	6.0	3.0				
2011	Otolith	F	Mean			466	492	534.8			
			N			1	1	5			
			SE			-	-	9.3			
		M	Mean			423	469	501			
			N			2	6	1			
			SE			22.0	9.7	-			
2012	Otolith	F	Mean				519	514	555		
			N				8	10	13		
			SE				5.5	6.9	9.8		
		M	Mean			449	479	473	483		
			N			17	11	2	1		
			SE			2.7	8.5	30	-		

Table 24. (continued).

All Fish				Total Length (mm) at Age							
Year	**Structure**	**Gender**	**Statistic**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1995-2012	Otolith	F	Mean		411	478	510	534	543	543	576
			N		1	16	78	108	64	7	1
			SE			6.5	2.5	3.1	3.7	8.9	-
		M	Mean		386	445	476	488	498	468	
			N		14	91	198	57	10	3	
			SE		8.1	2.8	1.9	4.8	9.9	22.4	

Table 25. Total length at age for American shad collected by electrofisher, in the Schuylkill River, below Fairmount Dam, RM 8.5.

				Total Length (mm) at Age							
Year	**Structure**	**Gender**	**Statistic**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**?**
2007	Otolith	F	Mean			518.0	560.5				
			N			1	2				
			SE				0.49				
		M	Mean	412.5	445.5	499	498.2	515.0			
			N	2	7	3	9	1			
			SE	22.49	11.88	13.57	5.33				
2008	Otolith	F	Mean		478.5	491.5	582.5				
			N		2	2	2				
			SE		4.49	21.49	7.49				
		M	Mean	405.5	451.6	458.7	504.0	514.0			
			N	2	14	4	2	1			
			SE	14.49	9.45	10.87	20.99				
2009	Otolith	F	Mean			501.7	563.0			608.0	
			N			4	1			1	
			SE			14.92					
		M	Mean		459.5	473.0		544.0			
			N		9	9		1			
			SE		5.70	6.48					
2010	Otolith	F	Mean			524.0	511.0				
			N			3	3				
			SE			5.77	9.50				
		M	Mean		477.0	474.4					
			N		1	14					
			SE			3.68					
2011	Otolith	F	Mean				527.3	553.0			536.0
			N				9	1			1
			SE				5.73				
		M	Mean			497.5	498.4				
			N			2	12				
			SE			5.49	6.40				
2012	Otolith	F	Mean		482	471	562.5	549.7	543		
			N		2	1	2	4	2		
			SE		2.2		12.5	8.6	7.0		
		M	Mean	415	442	401.7	538	517.2			
			N	1	4	4	1	4			
			SE		10.3	70.2		15.7			

Table 25. (continued).

				Total Length (mm) at Age							
Year	**Structure**	**Gender**	**Statistic**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**?**
2007-2012	Otolith	F	Mean		480.2	504.6	539.6	550.4	543.0	608.0	536.0
			N		4	11	19	5	2	1	1
			SE		9.2	7.8	6.2	6.7	7.0		
		M	Mean	410.2	452.0	467.5	500.0	520.2			
			N	5	35	36	24	7			
			SE	8.7	4.8	8.5	3.7	9.3			

Table 26. Mean weight at age for American shad collected by gill net, Delaware River, Smithfield Beach, RM 218.0.

				Weight (grams) at Age						
Year	**Gender**	**Structure**	**Statistic**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1997	**Male**	**Otolith**	Mean	739	992	1196	1438	1495		
			N	3	11	9	5	1		
			SE	69	48	78	29			
	Female	**Otolith**	Mean		1262	1463	1845	2099		
			N		10	12	12	5		
			SE		64	75	86	123		
1998	**Male**	**Otolith**	Mean	1323	1066	1096	1176	1173		
			N	1	18	43	8	4		
			SE		37	21	56	21		
	Female	**Otolith**	Mean		1538	1449	1638	1668	1863	
			N		6	67	35	10	8	
			SE		125	34	54	113	140	
1999	**Male**	**Otolith**	Mean		972	1096	1139			
			N		20	30	7			
			SE		38	31	31			
	Female	**Otolith**	Mean	1250	1463	1486	1550	1450		
			N	1	33	63	45	1		
			SE		52	43	51			
2000	**Male**	**Otolith**	Mean	816	967	1064	1164	1106		
			N	4	34	60	30	2		
			SE	52	28	26	28	106		
	Female	**Otolith**	Mean		1564	1545	1718	1766	1972	
			N		5	54	75	42	6	
			SE		146	46	46	66	161	
2001	**Male**	**Otolith**	Mean	994	986	1032	1099	1158		
			N	3	62	94	27	3		
			SE	27	19	15	35	17		
	Female	**Otolith**	Mean	1177	1328	1399	1498	1505	1469	
			N	1	77	270	165	28	7	
			SE		31	17	23	56	91	
2002	**Male**	**Otolith**	Mean	727	1116	1151	1235	1268	1511	
			N	2	12	53	49	11	2	
			SE	9	65	22	29	50	92	
	Female	**Otolith**	Mean		1284	1493	1602	1606	1567	
			N		7	56	124	34	9	
			SE		147	50	33	69	179	

Table 26. (continued).

				Weight (grams) at Age						
Year	**Gender**	**Structure**	Statistic	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2003	**Male**	**Otolith**	Mean	879	986	1141	1312	1334	1333	1674
			N	4	87	72	60	9	2	1
			SE	67	13	22	20	55	25	…
	Female	**Otolith**	Mean		1186	1520	1814	2012	1877	
			N		15	59	154	55	4	
			SE		54	41	30	51	188	
2004	**Male**	**Otolith**	Mean	1061	1161	1126	1212	1103	1353	
			N	2	26	97	23	5	1	
			SE	9	34	17	40	39		
	Female	**Otolith**	Mean		1459	1438	1546	1739	1623	
			N		22	102	76	59	5	
			SE		51	33	45	48	221	
2005	**Male**	**Otolith**	Mean	838.9	996	1218	1207	1213		
			N	7	80	130	92	8		
			SE	59.16	21.18	17.64	19.17	79.45		
	Female	**Otolith**	Mean	1441	1558	1706	1703	1809	1639	1922
			N	3	63	210	155	22	7	1
			SE	280.4	39.3	23.8	29.0	83.9	158.9	
2006	**Male**	**Otolith**	Mean		925	1031	1131			
			N		51	74	11			
			SE		20.1	15.3	64.6			
	Female	**Otolith**	Mean	1479	1438	1536	1654	1741	1750	
			N	2	30	72	61	45	3	
			SE	149.0	62.9	38.5	51.2	65.9	245.0	
2007	**Male**	**Otolith**	Mean	650	984.8	1106	1174	1159	1091	
			N	1	26	149	93	6	1	
			SE		27.51	14.68	24.38	66.24		
	Female	**Otolith**	Mean	1269	1396	1444	1670	1812	1857	2487
			N	2	28	169	222	26	9	2
			SE	231.5	52.4	22.6	24.1	93.0	114.6	76.0
2008	**Male**	**Otolith**	Mean		943.7	1096	1134	1198		
			N		35	84	104	19		
			SE		23.3	18.0	19.3	63.2		
	Female	**Otolith**	Mean	1609	1434	1419	1539	1573	1636	
			N	1	30	128	200	49	3	
			SE		61.4	27.0	21.8	44.4	8.8	

Table 26. (continued).

				Weight (grams) at Age						
Year	**Gender**	**Structure**	Statistic	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2009	**Male**	**Otolith**	Mean	932	888	984	1101	1260		
			N	2	64	41	19	4		
			SE	169	15	25	49	51		
	Female	**Otolith**	Mean	1130	1366	1444	1554	1555		
			N	27	64	102	32	5		
			SE	30	32	41	62	150		
2010	**Male**	**Otolith**	Mean		950	1040	1143			
			N		34	314	18			
			SE		17	7	32			
	Female	**Otolith**	Mean		981	1192	1346	1412	1556	
			N		11	342	55	9	2	
			SE		55	11	37	106	302	
2011	**Male**	**Otolith**	Mean		754	1106	1124	1254		
			N		3	13	48	1		
			SE		87	31	23	-		
	Female	**Otolith**	Mean		1309	1343	1306	1413		
			N		4	32	281	9		
			SE		100	45	16	102		
2012	**Male**	**Otolith**	Mean		866	1022	1173	1098	1160	1176
			N		3	66	7	22	3	1
			SE		17	32	19	65	38	101
	Female	**Otolith**	Mean		950	1319	1324	1484	1668	1035
			N		1	99	22	158	3	1
			SE			23	66	25	141	
1997-2012	**Male**	**Otolith**	Mean	792	903	1027	1086	1163	1375	1674
			N	27	572	1278	606	78	7	1
			SE	48	10	7	13	35	61	
	Female	**Otolith**	Mean	1155	1198	1285	1463	1661	1669	1596
			N	11	372	1727	1786	440	75	3
			SE	146	22	10	11	24	73	587

Table 27. Mean otolith age of American shad, Lehigh River, below Chain Dam, RM 3.0. Repeat spawning determined from scales.

Males	N collected	N otolith aged	Mean oto age	Repeat %
1995	16	16	5.4	…
1996	24	…	…	9.1
1997	31	…	…	…
1998	26	…	…	4.2
1999	66	66	4.0	3.0
2000	65	65	4.9	13.8
2001	69	69	5.0	7.2
2002	44	44	5.2	13.6
2003	no collections			
2004	31	31	5.1	3.2
2005	8	8	5.0	25.0
2006	35	33	5.0	8.6
2007	14	14	5.9	0.0
2008	9	9	5.4	33.0
2009	18	18	4.2	27.8
2010	72	71	4.6	-
2011	9	9	4.9	0.0
2012	31	31	4.6	0.0
Females				
1995	18	17	6.4	…
1996	8	…	…	25.0
1997	20	…	…	…
1998	24	…	…	21.7
1999	38	38	5.3	2.6
2000	35	35	5.3	8.6
2001	40	40	5.9	0.0
2002	56	55	5.9	22.2
2003	no collections			
2004	31	31	6.0	3.2
2005	5	5	6.2	40.0
2006	20	20	5.1	5.0
2007	26	26	6.2	7.7
2008	33	33	6.8	60.0
2009	9	9	6.3	55.6
2010	25	25	5.0	-
2011	7	7	5.6	0.0
2012	31	31	5.4	3.1

Table 27. (continued).

Sexes combined	N collected	N otolith aged	Mean oto age	Repeat %
1995	34	33	5.9	…
1996	32	…	…	13.3
1997	51	…	…	…
1998	50	…	…	12.8
1999	104	104	4.5	2.9
2000	100	100	5.1	12.0
2001	109	109	5.3	4.6
2002	100	99	5.6	18.4
2003	no collections			
2004	62	62	5.6	3.2
2005	13	13	5.5	30.8
2006	55	53	5.0	7.3
2007	40	40	6.1	5.0
2008	42	42	6.5	54.8
2009	27	27	4.9	37.0
2010	97	96	4.7	-
2011	16	16	5.2	0.0
2012	62	62	5.4	1.6

Table 28. Percent repeat spawners as determined by scale characteristics, for the Lehigh (below Chain Dam RM 3.0) and Schuylkill (below Fairmount Dam RM 8.5) rivers.

	Lehigh River		Schuylkill River	
Year	**N**	**Percent Repeat Spawners**	**N**	**Percent Repeat Spawners**
1998	47	12.5		
1999	96	3.1		
2000	99	13.5		
2001	18	3.7		
2002	98	18.4		
2003	No collections			
2004	62	3.2		
2005	13	30.8		
2006	55	7.3		
2007	40	5	25	36.0
2008	42	54.8	29	17.2
2009	27	33.3	25	20.0
2010	92	0	25	0.0
2011	16	0	25	20.0
2012	62	1.6	25	20.0

Table 29. Otolith age and repeat spawning for American shad collected by electrofisher below the Chain Dam, Lehigh River. Repeat spawning determined from scales.

Year	Repeat spawns	Otolith Age								Electrofishing Effort
		2	3	4	5	6	7	8	9	(hrs)
1999	0		3	53	22	19	1			0.6
	1			2						0.6
	2				1					0.6
2000	0		1	8	66	10	1	1		1.6
	1				9	1				1.6
	2				2	1				1.6
2001	0			19	36	47	2			1.5
	1				2	3				1.5
	2									1.5
2002	0		1	9	34	21	12	1		0.4
	1		0	2	5	3	6		1	0.4
	2									0.4
2003	0	no samples								
	1									
	2									
2004	0		8	5	11	19	14	3		0.57
	1			2						0.57
	2									0.57
2005	0			3	3	1	2			0.97
	1					4				0.97
	2									0.97

Table 29. (continued).

Year	Repeat	Otolith Age								Electrofi
		2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**(hrs)**
2006	0			3	37	4	1			0.62
	1				4					0.62
	2									0.62
2007	0				3	31	3		1	1.32
	1					2				1.32
	2									0.00
2008	0		2	2	1	3	8			1.32
	1						7			1.32
	2						7			1.32
	3					1	7			1.32
	4									1.32
	5							1		1.32
2009	0		1	13	1	1	1	1		1.93
	1			4	1					1.93
	2						2	2		1.93
2010	0		3	23	67	3				1.005
	1									
	2									
2011	0			3	7	6				1.041
	1									
	2									
2012	0			17	18	12	14			1.11
	1				1					1.11
	2									

Table 30. Sex ratio (male:female) of American shad collected in the Delaware, Lehigh, and Schuylkill rivers.

	Delaware R., Smithfield, gill net, RM 218	Delaware R., Raubsville, electrofishing, RM 176.6	Lehigh R., Chain Dam, electrofishing, RM 3.0	Schuylkill R., Fairmount Dam, electrofishing, RM 8.5
Year	**M:F ratio**	**M:F ratio**	**M:F ratio**	**M:F ratio**
1997	1: 3.6		1: 0.6	
1998	1: 4.3	1: 0.7	1: -0.9	
1999	1: 8.4	1: 1.6	1: 0.6	
2000	1: 1.4	1: 0.6	1: 0.5	
2001	1: 2.9	1: 0.7	1: 0.7	
2002	1: 1.6		1: 1.3	
2003	1: 1.2		No collections	
2004	1: 1.7		1: 1.0	
2005	1: 1.5		1: 0.6	
2006	1: 1.6		1: 0.6	
2007	1: 1.6		1: 1.9	1: 0.1
2008	1: 1.7		1: 3.6	1: 0.2
2009	1: 1.7		1: 0.5	1: 0.3
2010	1: 1.1	1: 0.3	1: 0.3	1: 0.4
2011	1: 4	1: 1.3	1: 0.8	1: 0.8
2012	1: 28	1: 0.5	1: 1.0	1: 0.8

Table 31. YOY and Age 1 index values (geometric mean catch per tow) for American shad collected during 16-ft. bottom trawl sampling in the Delaware River and upper Bay.

Year	YOY	Age 1+
1990	0	-
1991	0.86	0.05
1992	0.05	0.13
1993	0.15	0.25
1994	0.49	0.11
1995	0.19	0.32
1996	0.3	0.016
1997	0.05	0.17
1998	0.28	0.02
1999	0	0.04
2000	0.05	0.07
2001	0	0
2002	0.19	0.05
2003	0	0
2004	0.16	0.05
2005	0	0
2006	0	0.06
2007	0	0.02
2008	0	0
2009	0	0
2010	0.32	0.02
2011	0.44	0
2012	0.08	0.11

Table 32. Juvenile American shad CPUE (geometric means) for the upper tidal and non-tidal Delaware River collected from beach seine sampling: 1980-2012. The upper tidal seining derives from New Jersey's striped bass sampling recruitment survey. The non-tidal seining was historically accomplished by the State of New Jersey and more recently reinitiated by the Delaware River Fish and Wildlife Management Cooperative.

	Upper Tidal		Non-Tidal	
Year	Shad GM	Rank	Shad GM	Rank
1980	0.00	31	1.15	29
1981	0.00	31	15.80	28
1982	0.00	31	40.62	22
1983	0.49	28	111.19	10
1984	0.25	29	68.87	17
1985	0.08	30	76.09	13
1986	0.67	25	149.12	4
1987	1.68	22	125.39	7
1988	0.56	26	63.74	19
1989	9.54	5	84.73	11
1990	5.74	13	154.74	3
1991	2.49	21	49.43	21
1992	7.02	11	35.86	24
1993	5.66	14	124.41	8
1994	7.14	9	37.85	23
1995	5.51	15	70.14	16
1996	18.21	1	265.95	1
1997	3.02	20	130.40	5
1998	7.23	8	27.46	25
1999	7.07	10	71.13	15
2000	9.69	4	76.57	12
2001	5.45	16	66.95	18
2002	0.89	24	19.78	27
2003	9.90	3	62.78	20
2004	5.81	12	72.34	14
2005	9.38	6	125.64	6
2006	0.53	27	22.53	26
2007	15.30	2	176.75	2
2008	1.05	23		
2009	4.21	19		
2010	4.61	17		
2011	8.18	7		
2012	**4.39**	**18**	**118.91**	**9**
1980 - 2012	4.90		84.36	
2003 - 2012	6.34		96.49	
2008 - 2012	4.49			

Table 33. Mean length (fl, mm) of juvenile American shad in the Delaware River beach seining: 2012.

	Aug1	Aug2	Sept1	Sept2	Oct1	Oct2
Upper Tidal (Regions 1 & 2)	64.8	67.7	69.3	69.9	70.8	72.5
Non-Tidal (Trenton, NJ – Milford, PA)	60.8		71.2		73.6	

Table 34. Catch-per-unit effort and sex ratio of shad caught by electrofishing in the Upper Delaware Scenic and Recreational River.

	Sparrowbush			Narrowsburg			Buckingham		Sex Ratio
Year	N	CPUE		N	CPUE		N	CPUE	F:M
2009	35	15.64		35	17.04		23	9.12	1:2.8
2010	1	3.59		8	3.57		6	5.66	1:1.1
2011	30	20.76		50	50.56		47	53.65	1:1.6
2012	5	4.86		37	28.44		25	14.10	1:1.5

Table 35. Length frequency (total length) of American shad collected by electrofisher in the Delaware River from three pools combined in the Upper Delaware Scenic and Recreational River.

Males										
	400	425	450	475	500	525	550	575	Total	Avg
2009	5	28	19	8	1	1			62	451.4
2010				1						485
2011	1	2	8	16	15	12			54	497.7
2012		3	8	21	7	1			40	482.6
Females										
2009	1		1	4	4	9	3		22	518.4
2010				2	2	1			5	514.4
2011					2	13	17	4	36	551.6
2012				1	7	7	10	2	27	537.8
Combined sexes										
2009	6	28	20	12	5	10	3		84	468.9
2010				3	2	1			6	509.5
2011	1	2	8	16	17	25	17	4	90	495.5
2012		3	8	22	14	8	10	2	67	505.7

Table 36. Age frequency estimated from otolith microstructures for American shad collected by electrofisher in the Delaware River from three pools combined in the Upper Delaware Scenic and Recreational River.

Males										
	3	4	5	6	7	8	9	??	Total	Avg
2009	1	40	15	1	1			4	62	4.3
2010		1							1	4
2011		10	16	26				2	54	5.3
2012			26	7	7	1			41	5.6
Females										
	3	4	5	6	7	8	9	??	Total	Avg
2009		2	11	5	1		1	1	22	5.5
2010		1	3					1	5	4.7
2011			6	25	3			1	36	5.9
2012			10	3	10		1		24	6.1
Combined sexes										
	3	4	5	6	7	8	9	??	Total	Avg
2009	1	42	26	6	3		1	5	84	4.6
2010		3	9					2	14	4.7
2011		10	22	51	3			3	90	5.5
2012			36	10	17	1	1		65	5.7

Table 37. New Jersey commercial river herring and hickory shad landings (pounds): 1995-2012.

Year	River Herring	Hickory Shad
1995	795	26
1996	4,449	0
1997	4,515	140
1998	7,371	2,743
1999	1,377	1,326
2000	2,246	0
2001	2,881	0
2002	1,303	0
2003	3,439	327
2004	4,583	127
2005	3,247	0
2006	2,945	125
2007	223	808
2008	1,890	0
2009	489	N/A
2010	1,322	N/A
2011	1,855	N/A
2012	**39**	**N/A**

Table 38. Delaware River and upper Bay YOY and age 1 river herring indices from Delaware's trawl collections, geometric mean: 1990 – 2012.

	Alewife		Blueback	
Year	YOY	Age 1	YOY	Age 1
1990	0.10181		0	
1991	0.08317	0.29444	0	0
1992	0.06902	0.25451	0	0.05076
1993	0.45799	0.23599	0.05411	0
1994	0.59602	0	0	0.02506
1995	0.07177	0.8568	0.00995	0.07709
1996	2.00894	0.22884	0.09855	0.04002
1997	0.18225	1.63878	0.07721	0.5939
1998	0.35429	0.04729	0.01582	0.05076
1999	0.66359	0.32991	0.16883	0.06608
2000	1.28653		0.10028	
2001	1.09256	0.09682	0.16034	0.15948
2002	0.01162	0.18017	0.00995	0.26708
2003	1.21753	0	0.23122	0.02506
2004	0.84706	0.1487	0.07981	0.06608
2005	0.60314	0	0.12894	0.07709
2006	0.03031	0.16591	0	0
2007	0.67765	0.04729	0.01582	0
2008	0.01162	0.04729	0	0.61174
2009	0.0758	0	0.02	0
2010	0.16942	0	0	0.02506
2011	0.6342	0.04729	0.05253	0.08571
2012	**0**	**0.04729**	**0**	**0**

Table 39. Upper tidal Delaware River juvenile river herring indices from New Jersey's beach seine collections, geometric mean: 1990 – 2012.

YEAR	Alewife	Rank	Blueback	Rank
1980	0.00	29	30.30	2
1981	0.00	29	0.26	32
1982	0.10	21	3.19	24
1983	0.28	11	46.15	1
1984	0.00	29	16.99	8
1985	0.06	22	7.17	17
1986	0.52	5	18.13	6
1987	0.23	15	10.72	10
1988	3.17	1	9.03	13
1989	0.26	12	17.90	7
1990	0.26	12	4.63	20
1991	0.47	7	9.84	11
1992	0.03	25	6.91	18
1993	0.35	9	19.78	5
1994	0.19	16	2.38	26
1995	0.11	20	1.84	27
1996	1.96	2	24.97	4
1997	0.15	18	2.58	25
1998	0.03	25	4.36	21
1999	0.41	8	5.34	19
2000	0.14	19	12.33	9
2001	0.83	4	26.33	3
2002	0.00	29	0.62	30
2003	0.30	10	7.50	16
2004	0.24	14	8.15	14
2005	0.95	3	9.79	12
2006	0.00	29	0.15	33
2007	0.52	5	4.29	22
2008	0.01	27	1.37	28
2009	0.06	2	3.55	23
2010	0.05	24	1.37	28
2011	0.19	16	7.97	15
2012	**0.01**	**27**	**0.42**	**31**
1980-2012	**0.37**		**9.37**	
2003-2012	**0.23**		**4.46**	
2007-2012	**0.06**		**2.94**	

Table 40. Delaware River hickory shad caught in number from New Jersey's beach seine collections: 1990 – 2012.

Year	Hickory shad	Year	Hickory shad
1980	0	1997	0
1981	0	1998	0
1982	0	1999	0
1983	0	2000	3
1984	0	2001	4
1985	0	2002	0
1986	0	2003	3
1987	0	2004	8
1988	2	2005	4
1989	0	2006	0
1990	0	2007	6
1991	0	2008	1
1992	0	2009	0
1993	0	2010	1
1994	0	2011	5
1995	0	**2012**	**1**
1996	0	**Total**	**37**

Table 41. Electrofishing CPUE (river herring/ hr) and fishway video passage counts of river herring in the Schuylkill River.

	Electrofishing			Video
Year	N	Effort	CPUE	N
2002	97	6.48	15.0	n/c
2003	222	4.15	53.5	n/c
2004	261	2.38	109.5	2
2005	12	3.94	3.0	5
2006	1215	3.86	314.6	7
2007	668	3.64	183.3	20
2008	190	6.11	31.1	0
2009	252	6.87	36.7	6
2010	70	6.19	11.3	7
2011	2188	5.56	393.5	10
2012	**3093**	**7.6**	**407.0**	**16**

A Summary of Virginia's River Herring Fisheries in 2012
and Results of Monitoring Programs

Annual Compliance Report to the Atlantic States Marine Fisheries Commission

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by

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INTRODUCTION

This report describes the fishery-independent and fishery-dependent monitoring programs for river herring performed in Virginia during 2012. This document follows the reporting format specified in Table 17 of Amendment 2 of the Interstate Fishery Management Plan for Shad and River Herring (ASMFC 2009). Summaries of commercial and recreational fisheries are reported by the Virginia Marine Resources Commission (VMRC), while the results from fishery-independent monitoring programs are provided by the Department of Fisheries Science of Virginia Institute of Marine Science (VIMS).

On June 28, 2011, the VMRC adopted Regulation 4 VAC20-1260-10 et seq. (http://www.mrc.state.va.us/regulations/fr1260.shtm; Appendix 1) to impose a moratorium beginning January 1, 2012, in part due to insufficient data to demonstrate sustainability of the limited fisheries. An outline of a proposal has been developed to fill these data gaps should funding for such activities become available.

I. Harvests and losses

A. Commercial Fishery

1. Characterization of fishery (season, cap, gears, regulations)

As of January 1, 2012, it is unlawful for any person to catch and retain possession of any river herring from Virginia tidal waters.

2. Characterization of directed harvest

a. Landings and method of estimation

As of January 1, 2012 it is unlawful for any person to catch and retain any river herring from Virginia tidal waters. Any river herring or its by-product, imported into Virginia, from another state or country, shall be accompanied by a bill of lading or commercial invoice that shall include the name of the seller, the date of sale, and the pounds of river herring product.

b. Catch Composition

i. Length frequency

N/A - currently no sampling is being conducted

ii. Sex ratio

N/A - currently no sampling is being conducted

iii. Degree of repeat spawning

N/A - currently no sampling is being conducted

c. Estimation of effort

N/A- unlawful to possess or retain

B. Recreational fishery

1. Characterization of fishery (season, cap, gears, regulations)

   As of January 1, 2012, it is unlawful for any person to catch and retain possession of any river herring from Virginia tidal waters.

2. Characterization of directed harvest

   Not applicable.

3. Characterization of other losses (poaching, hook-and-release mortality, etc.)

   No available data.

C. Other losses

   No available data.

D. Table 1. Harvest and Losses

Abbreviations: ALE (alewife); BBH (blueback herring); EF (electrofishing); GN (gill net); PN (pound net); N/A (not applicable); ND (no data).

Commercial Fishery				
Species	**Number**	**Pounds**	**Avg weight**	**Gear**
BBH	N/A	N/A	N/A	N/A
ALE	N/A	N/A	N/A	N/A
unspecified	N/A	N/A	N/A	N/A
Recreational Fishery				
Species	**Number**	**Pounds**	**Avg weight**	**Gear**
BBH	N/A	N/A	N/A	N/A
ALE	N/A	N/A	N/A	N/A
Other Losses				
Species	**Number**	**Pounds**	**Avg weight**	**Gear**
BBH	ND	ND	ND	EF
ALE	ND	ND	ND	EF

II. Required fishery-independent monitoring

A. Description of Requirement

Virginia is required to conduct fishery-independent monitoring of river herring in the James, York, and Rappahannock rivers, including: an annual spawning stock survey and representative sampling for biological data (excluding the York River); calculation of mortality and/or survival estimates; and an annual juvenile abundance index reported as a geometric mean.

B. Description of Work Performed

Due to lack of available funding, the annual spawning stock survey, biological sampling, and resulting calculation of mortality and/or survival estimates were not performed in 2012. Lack of funding is projected to continue in 2013. Because of the specifics of the American shad monitoring program in Virginia (e.g., gill net mesh size, position in river, etc.), the data of catches of river herring in this survey, which are very low (less than 60 individuals from all rivers combined over the 14 years of the survey), cannot be used to monitor the spawning stock of river herring in these rivers.

An index of abundance of juvenile river herring is obtained through the annual VIMS Juvenile Finfish and Blue Crab Trawl Survey in the James, York, and Rappahannock rivers. Catches from different years are standardized by calculating a juvenile abundance index (JAI) and the geometric mean catch per tow, which allows for a relative comparison of catches among years and between rivers.

In 2011, weekly fyke net sampling for juvenile American shad in the Mattaponi River was initiated by VIMS to provide an alternative measure of recruitment for alosines; this was also conducted in 2012 from May 16 to August 21.

C. Results

1. Juvenile Indices

Tables 2 (alewife) and 3 (blueback herring) report index values of juvenile abundance of river herring based on trawl surveys (1988–2012) in the James, Rappahannock, and York rivers. The geometric mean catch per tow (CV in parentheses) of juvenile alewife in 2012 was: James River, 0.09 (96.0); York River, 0.01 (68.3); Rappahannock River, 0.01 (68.3). The geometric mean catch (CV in parentheses) of juvenile blueback herring in 2012 was: James River, 0.04 (77.3); York River, 0.01 (77.3); Rappahannock River, 0.16 (52.9). It should be noted that the index values are based on low numbers of individuals in the catches and have broad confidence intervals.

In all three rivers the JAIs for alewife and blueback herring are low. There is no clear trend in juvenile abundance for either species over the time series.

In the fyke net sampling, a total of two alewife and 52 blueback herring were caught in 2012. In comparison, 466 juvenile alewife and 2,552 blueback herring were collected using the same methods in 2011.

2. Spawning Stock Assessment

No data available

3. Annual mortality rate calculation

No data available

4. Hatchery evaluation (%wild vs. hatchery)

No data available.

Table 2. Indexes of abundance of juvenile alewife collected in trawl surveys (1988-2012) on the James, York and Rappahannock rivers. The index is the geometric mean catch per tow. Abbreviations are: L, U CI, lower, upper confidence interval; CV, coefficient of variation; Rapp., Rappahannock River.

Year	**James**	**L, U CI**	**CV**	**York**	**L, U CI**	**CV**	**Rapp.**	**L, U CI**	**CV**
1988	0.00	0.00, 0.00		0.06	0.02, 0.10		0.00	0.00, 0.01	
1989	0.04	-0.03, 0.10	87.4	0.01	-0.01, 0.03	87.4	0.12	-0.09, 0.37	87.4
1990	0.03	-0.03, 0.09	100.0	0.06	-0.02, 0.14	100.0	0.16	0.02, 0.33	100.0
1991	0.00	0.00, 0.00		0.04	0.00, 0.09		0.52	-0.14, 1.68	
1992	0.00	0.00, 0.00		0.00	0.00, 0.01		0.00	0.00, 0.01	
1993	0.03	-0.03, 0.10	100.0	0.01	0.00, 0.03	100.0	0.05	-0.02, 0.13	100.0
1994	0.17	-0.01, 0.39	53.4	0.01	0.00, 0.03	53.4	0.18	-0.01, 0.41	53.4
1995	0.01	-0.01, 0.03	100.0	0.01	-0.01, 0.03	100.0	0.01	0.00, 0.02	100.0
1996	0.11	-0.03, 0.26	62.6	0.07	0.03, 0.11	62.6	0.14	-0.01, 0.32	62.6
1997	0.02	0.00, 0.04	62.0	0.01	0.00, 0.01	62.0	0.20	0.06, 0.36	62.0
1998	0.08	0.00, 0.17	52.6	0.02	0.00, 0.04	52.6	0.26	0.03, 0.55	52.6
1999	0.00	0.00, 0.00		0.00	0.00, 0.01		0.19	-0.10, 0.57	
2000	1.03	0.44, 1.86	24.4	0.03	0.01, 0.05	24.4	0.08	0.02, 0.14	24.4
2001	0.13	-0.03, 0.31	61.2	0.01	0.00, 0.03	61.2	0.26	0.08, 0.47	61.2
2002	0.01	-0.01, 0.03	100.0	0.04	0.02, 0.06	100.0	0.07	-0.01, 0.15	100.0
2003	0.19	0.06, 0.35	34.9	0.11	0.06, 0.16	34.9	0.06	-0.02, 0.14	34.9
2004	0.30	0.04, 0.63	42.2	0.09	0.06, 0.13	42.2	0.34	0.08, 0.66	42.2
2005	0.20	0.00, 0.42	48.7	0.08	0.04, 0.11	48.7	0.17	0.07, 0.27	48.7
2006	0.11	-0.02, 0.25	58.5	0.02	0.00, 0.04	58.5	0.09	0.01, 0.17	58.5
2007	0.22	0.03, 0.43	41.3	0.01	0.00, 0.03	41.3	0.16	0.05, 0.28	41.3
2008	0.26	0.05, 0.51	38.9	0.02	0.01, 0.04	38.9	0.11	-0.03, 0.28	38.9
2009	0.23	0.08, 0.39	30.8	0.02	0.00, 0.04	30.8	0.03	0.00, 0.05	30.8
2010	0.39	0.10, 0.75	35.2	0.04	0.01, 0.07	35.2	0.10	0.02, 0.19	35.2
2011	0.42	0.42, 0.42		0.00	0.00, 0.00		0.01	-0.01, 0.22	100.0
2012	0.09	-0.07, 0.27	96.0	0.01	-0.00, 0.02	68.3	0.01	0.00, 0.02	68.3

Table 3. Indexes of abundance of juvenile blueback herring collected in trawl surveys (1988-2011) on the James, York and Rappahannock rivers. The index is the geometric mean catch per tow. Abbreviations are: L, U CI, lower, upper confidence interval; CV, coefficient of variation; Rapp., Rappahannock River.

Year	**James**	**L, U CI**	**CV**	**York**	**L, U CI**	**CV**	**Rapp.**	**L, U CI**	**CV**
1988	0.99	0.72, 1.30	10.7	0.01	-0.01, 0.02	100.0	0.13	0.00, 0.28	51.1
1989	0.01	-0.01, 0.02	100.0	0.00	0.00, 0.00		0.03	-0.02, 0.09	77.5
1990	0.00	0.00, 0.00		0.01	-0.01, 0.02	100.0	0.00	0.00, 0.01	100.0
1991	0.00	0.00, 0.00		0.00	0.00, 0.00		0.06	-0.04, 0.17	78.5
1992	0.00	0.00, 0.00		0.01	0.00, 0.01	71.0	0.03	-0.02, 0.08	90.4
1993	0.45	-0.14, 1.45	69.8	0.01	0.00, 0.03	47.1	0.15	0.00, 0.31	49.9
1994	0.14	-0.03, 0.34	61.5	0.00	0.00, 0.01	100.0	0.11	0.09, 0.13	9.3
1995	0.00	0.00, 0.00		0.00	0.00, 0.01	100.0	0.00	0.00, 0.00	
1996	0.19	0.04, 0.36	38.8	0.03	0.01, 0.05	29.9	0.14	0.05, 0.25	33.2
1997	0.24	-0.11, 0.73	75.7	0.00	0.00, 0.01	100.0	0.13	0.02, 0.25	41.5
1998	0.35	-0.14, 1.12	74.9	0.02	0.00, 0.03	37.2	0.09	0.02, 0.17	40.0
1999	0.04	-0.04, 0.14	96.2	0.00	0.00, 0.00		0.01	0.00, 0.03	56.8
2000	0.44	0.09, 0.92	38.4	0.02	0.01, 0.04	34.4	0.15	0.04, 0.27	34.7
2001	0.15	0.02, 0.31	43.9	0.00	0.00, 0.00		0.07	0.02, 0.13	38.5
2002	0.17	-0.02, 0.39	55.1	0.02	0.01, 0.04	30.7	0.13	0.05, 0.22	31.6
2003	0.12	-0.05, 0.32	70.0	0.00	0.00, 0.00	100.0	0.03	0.00, 0.06	55.0
2004	0.19	0.00, 0.41	51.1	0.03	0.01, 0.05	38.4	0.26	0.00, 0.60	49.9
2005	0.08	0.00, 0.17	50.0	0.00	0.00, 0.01	100.0	0.12	0.03, 0.21	36.8
2006	0.06	-0.02, 0.13	65.4	0.00	0.00, 0.01	100.0	0.09	0.03, 0.15	30.4
2007	0.70	0.17, 1.47	35.3	0.00	0.00, 0.00		0.18	0.00, 0.40	50.9
2008	0.26	0.07, 0.49	36.1	0.03	0.01, 0.04	37.6	0.31	0.14, 0.49	24.9
2009	0.22	0.04, 0.43	39.7	0.08	0.04, 0.13	27.5	0.15	0.05, 0.25	31.3
2010	0.71	0.30, 1.25	25.7	0.02	0.00, 0.03	48.7	0.07	0.01, 0.13	40.4
2011	0.47	0.19, 0.83	28.0	0.00	0.00, 0.00		0.00	0.00, 0.00	
2012	0.04	-0.02, 0.10	77.3	0.01	0.00, 0.02	77.3	0.16	0.00, 0.37	52.9

References

Atlantic States Marine Fisheries Commission (ASMFC). 2009. Amendment 23 to the Interstate Fishery Management Plan for Shad and River Herring (River Herring Management). 166 pp.

Atlantic States Marine Fisheries Commission (ASMFC). 2012. River Herring Benchmark Stock Assessment. Stock Assessment Report no 12-02.

Appendix 1

"PERTAINING TO RIVER HERRING"
CHAPTER 4VAC20-1260-10 ET SEQ.

PREAMBLE

This chapter establishes a moratorium on River Herring. This chapter is promulgated pursuant to the authority contained in §28.2-201 of the Code of Virginia. This chapter amends, and re-adopts, as amended, previous Chapter 4 VAC 20-1260-10 et seq. which was adopted on June 28, 2011 and made effective January 1, 2012. The effective date of this chapter is March 29, 2012.

4VAC20-1260-10. Purpose.

The purposes of this chapter are to rebuild the Virginia stocks of River Herring and to comply with the requirements of the Interstate Fishery Management Plan for Shad and River Herring.

4VAC20-1260-20. Definition.

The following terms when used in this chapter shall have the following meanings unless the context clearly indicates otherwise:

"*Land" or "landing*" means to (i) enter port with finfish, shellfish, crustaceans, or other marine seafood on board any boat or vessel; (ii) begin offloading finfish, shellfish, crustaceans, or other marine seafood; or (iii) offload finfish, shellfish, crustaceans, or other marine seafood.

"River Herring" means any fish of the species *Alosa aestivalis* or *Alosa pseudoharengus.*

4VAC20-1260-30. Moratorium.

A. It shall be unlawful for any person to catch and retain possession of any river herring from Virginia tidal waters.

B. It shall be unlawful for any person to possess aboard a vessel, on Virginia tidal waters, or to land, in Virginia, any river herring.

C. Any river herring or its by-product, imported into Virginia, from another state or country, shall be accompanied by a bill of lading or commercial invoice that shall include the name of the seller, the date of sale, and the pounds of river herring product.

4VAC20-1260-40. Penalty.

As set forth in §28.2-903 of the Code of Virginia, any person violating any provision of this chapter shall be guilty of a Class 3 misdemeanor, and a second or subsequent violation of any provision of this chapter committed by the same person within 12 months of a prior violation is a Class 1 misdemeanor.

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This is to certify that the foregoing is a true and accurate copy of the chapter passed by the Virginia Marine Resources Commission, pursuant to authority vested in the Commission by §28.2-201 of the Code of Virginia, duly advertised according to statute, and recorded in the Commission's minute book, at its meeting held in Newport News, Virginia on March 27, 2012.

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION

By: ____
Jack G. Travelstead
Acting Commissioner

Subscribed and sworn to before me this ______ day of March 2012.

____
Notary Public

Delaware's Annual Report for Shad and River Herring: Nanticoke River 2012

Prepared by:
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June 2013

Submitted to the Atlantic States Marine Fisheries Commission as a Requirement of Amendment 1 to the Interstate Fisheries Management Plan for Shad and River Herring

American shad - Nanticoke River, Delaware

Introduction

Delaware closed its commercial and recreational fisheries in 2000. There were no significant changes in monitoring, regulations or harvest on the Nanticoke River in 2012.

2012 Fishery Management Program

It is unlawful for any person to take and reduce to possession any American shad or hickory shad from the Nanticoke River or its tributaries. No adult American shad were retained as bycatch during the 2012 striped bass season (February 15 to March 31). The 2012 haul seine Juvenile Abundance Index (JAI) of American shad declined from 2011. The 2012 adult electrofishing CPUE was similar to 2011 and ranked highest in the 11-year time series. Age comparisons over the past 11 years suggests that ages 5 and 6 are the dominant classes for females while ages 4 and 5 are the dominant classes for males. The total length of females has shown an increase the past four years. Approximately 378,000 American shad fry were stocked in Nanticoke River tributaries during the spring of 2012 (Stangl 2013). The percentage of hatchery-reared juvenile fish decreased by 12% from 2011. Thirty seven OTC marked otoliths were found on the 85 adult American shad otoliths (44%) analyzed from electrofishing samples and Maryland pound/fyke net samples

Planned Management Programs For 2012

No changes in monitoring are anticipated and should remain the same for 2013.

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of the Fishery

The commercial fishery was closed by regulation with no allowable take of either American shad or hickory shad permitted.

2. Characterization of Direct Harvest

N/A

3. Characterization of Other Losses

During 2012, two active striped bass gill net fishermen in the Nanticoke River were given permits to retain any American shad taken as bycatch which were in poor condition and would likely not recover if released. No adult American shad were reported as bycatch during the striped bass season.

B. Recreational Fishery

1. **Characterization of the Fishery**

The recreational fisheries for both American shad and hickory shad are closed by regulation. Any shad caught must be immediately released unharmed.

2. **Characterization of Directed Harvest**

N/A

3. Characterization of Other Losses

N/A

C. Other Losses

A total of 45 shad died during spawning stock surveys and hatchery efforts (brood stock collection and tank spawning) conducted by the Division of Fish and Wildlife during 2012. All other fish, including remaining brood stock from tank spawning were released alive.

D. Harvest and Losses
No adult American shad were kept as bycatch during the commercial striped bass season, which occurred from February 15 to March 31, 2012.

E. Protected Species
No Atlantic sturgeon or other protected species were reported from the Nanticoke River gill net fishery.

II. Fishery Independent Monitoring

A. Description of Requirements by Amendment 3

• Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock

• Calculation of mortality and/or survival estimates where possible

• JAI: Juvenile abundance survey

• Hatchery Evaluation
(Cooperative effort between Delaware and Maryland)

B. Brief Description of Work Performed

Juveniles - Annual JAI surveys were continued during 2012 for shad in Delaware's portion of the upper Nanticoke River. Sampling in 2012 was conducted at four locations using a haul seine during ebb or low slack tide. Seining occurred approximately every two weeks on the Nanticoke River and Broad Creek. The geometric mean of number sampled per seine haul was calculated as an index of relative abundance for each Alosine species. Confidence limits (95%) were applied to the geometric mean. Catch per unit of effort, recorded as fish caught per haul, and the associated standard error was calculated.

A sufficient sample (n=98) American shad for OTC mark analysis was collected to determine the proportion of wild vs. hatchery-reared young prior to out-migration. The sagittal otoliths were extracted and mounted on slides with Crystalbond© 509 adhesive. Otoliths were examined for marks under a 50x objective on a Zeiss Axioscope 40 epi-fluorescence microscope. The presence and location of a mark was recorded.

Adults - Electrofishing collections were conducted in two sections on the upper Nanticoke River to establish an annual index of abundance (CPUE). The catch rate for adult shad taken in Deep Creek during brood fish collections represented one component of the index. Catch rates from sampling in the upper Nanticoke River (Nanticoke Branch) was the second component used to calculate the index. Sampling was conducted from March 19 through June 5, 2012. Total length, sex and scale samples were collected and American shad scales were aged using techniques described by Cating (1953). Otolith analysis was performed to estimate the proportion of hatchery-reared juveniles that have returned as adults to the upper Nanticoke River and Deep Creek to spawn.

C. Results

1. Juveniles Indices

Haul Seine
A total of 110 American shad were collected in the Nanticoke River from July 16 through October 15, 2012. The 2012 haul seine JAI for American shad declined from 2011in Table 1.

Table 1. The geometric mean (GM), 95% confidence Limits (CI), CPUE (fish/haul) and standard error (SE) for juvenile American shad caught with the haul seine from the Nanticoke River and Broad Creek from 1999 through 2012.

Year	GM	95% CI	CPUE	SE
1999	0.5	-0.1, 1.3	0.9	0.5
2000	0.3	0.1, 0.6	0.6	0.3
2001	0.8	0.0, 1.3	1.5	0.5
2002	1.6	0.7, 2.9	5.8	3
2003	1.3	0.7, 2.1	2.2	0.5
2004	3.5	2.1, 5.4	7.6	2.5
2005	2.6	1.4 , 4.3	5.7	1.5
2006	3.2	1.6 , 5.9	8	2.1
2007	3.2	1.8 , 5.2	6.8	1.8
2008	2.0	1.2 , 3.0	3.2	0.7
2009	5.0	2.9 , 8.1	9.7	2.0
2010	3.9	2.2 , 6.5	8.3	2.6
2011	3.0	1.5 , 5.3	11.3	1.4
2012	2.4	1.4 , 3.7	3.9	0.9

2. Spawning Stock Assessment

Electrofishing was conducted on 22 sampling days during the shad spawning season to provide relative abundance data on the Nanticoke River shad stock. This effort yielded the largest number of adult American shad (n=505) in the time series. The 2012 electrofishing CPUE was similar to 2011 and ranked highest in the time series (Table 2). This was the 7th consecutive year of an increase in relative abundance. The majority of American shad (71%) were sampled from Nanticoke Branch (mainstem). The CPUE for American shad caught in Nanticoke Branch was 62 fish/hr; whereas, the CPUE from Deep Creek was 44 fish/hr. The CPUE for hickory shad was the highest in the time series as well.

Table 2. CPUE (f/hr) determined from adult American and hickory shad samples collected on the upper Nanticoke River and Deep Creek, 2002-2012.

	American Shad		Hickory Shad	
Year Sampled	N	CPUE	N	CPUE
2002	24	21.2	58	23.6
2003	157	48.8	98	29.9
2004	199	36.9	127	25.9
2005	197	26.0	93	12.9
2006	78	11.8	265	33.8
2007	184	24.0	419	58.3
2008	159	25.5	276	48.5
2009	286	30.6	334	35.5
2010	288	50.4	329	57.3
2011	342	52.6	157	25.4
2012	505	55.2	470	64.0

Age comparisons over the past 11 years suggests that ages 5 and 6 are the dominant classes for females while ages 4 and 5 are the dominant classes for males (Table 3). Males typically spawn for the first time a year earlier than females. The percentage of 5 year old female shad increased approximately 15% from 2011 to 2012, whereas the percentage of 6 and 7 year old females decreased by almost 10% and 8% respectively. Four year old male shad increased by approximately 11%. Five and six year old male shad decreased by approximately 10% and 12% respectively. Hence, from 2011 to 2012, there was an increase in the percentage of younger fish in the population.

Table 3. Percent frequency of age distribution from scales for female and male shad caught electrofishing 2002-2012 from the Nanticoke River.

	Age Class							
Year	3	4	5	6	7	8	9	Total
Female								
2002			66.67	33.33				3
2003		16.00	52.00	24.00	4.00	4.00		25
2004	1.79	35.71	48.21	14.29				56
2005		11.76	31.76	40.00	12.94	3.53		85
2006			5.26	47.37	39.47	7.89		38
2007		12.24	28.57	24.49	30.61	2.04	2.04	49
2008	2.04	24.49	36.73	30.61	4.08	2.04		49
2009		2.22	31.11	46.67	15.56	2.22	2.22	45
2010	1.49	5.97	61.19	29.85	1.49			67
2011		10.10	35.35	39.39	15.15			99
2012		12.67	50.67	29.33	7.33			150
Male								
2002	11.11	38.89	33.33	11.11	5.56			18
2003	5.51	29.92	44.09	17.32	3.15			127
2004	0.75	20.15	40.30	29.85	8.96			134
2005	1.05	24.21	41.05	24.21	8.42	1.05		95
2006	2.56	33.33	12.82	30.77	17.95	2.56		39
2007	22.45	27.55	27.55	20.41	2.04			98
2008	20.79	58.42	14.85	4.95	0.99			101
2009	6.03	25.86	47.84	16.38	3.02	0.43	0.43	232
2010	10.42	27.60	51.56	9.90	0.52			192
2011	9.46	31.53	36.94	21.62	0.45			222
2012	17.89	42.23	27.27	9.38	3.23			341

Approximately 57% of spawning females and 65% of spawning males were first year spawners, 33% of females and males were first time repeat spawners, 8% of spawning females and 7% of spawning males were second time repeat spawners, and only 1% of spawning females and 4% of spawning males were third time repeat spawners based on repeat spawning marks on scales (Table 4). Of the total number of American shad aged in 2012, 38% were repeat spawners, reflecting a 4% decrease from 2011. The percentage of repeat spawners returning to the Nanticoke River to spawn varied without trend.

Table 4. Frequency of occurrence of repeat spawning marks on scales from Nanticoke River American shad 2002-2012.

	Repeat mark					
Year	0	1	2	3	4	Total
Female						
2002	40.00	60.00				5
2003	72.00	16.00	8.00	4.00		25
2004	57.14	33.93	8.93			56
2005	29.41	29.41	27.06	12.94	1.18	85
2006	7.89	5.26	47.37	39.47		38
2007	20.41	36.73	28.57	12.24	2.04	49
2008	46.94	36.73	14.29	2.04		49
2009	55.56	28.89	13.33	0.00	2.22	45
2010	56.72	34.33	7.46	1.49		67
2011	68.69	23.23	7.07	1.01		99
2012	57.33	33.33	8.00	1.33		150
Male						
2002	61.11	11.11	27.78			18
2003	41.73	46.46	10.24	1.57		127
2004	39.55	38.81	18.66	2.99		134
2005	30.53	30.53	22.11	16.84		95
2006	23.08	28.21	30.77	15.38	2.56	39
2007	56.12	30.61	10.20	3.06		98
2008	65.35	27.72	5.94	0.99		101
2009	34.91	51.29	11.64	1.72	0.43	232
2010	46.35	40.10	12.50	1.04		192
2011	51.35	31.08	16.22	1.35		222
2012	64.52	25.51	6.74	2.93	0.29	341

Mean total length between both sexes was fairly consistent from 2002 through 2012 (Figure 1). The total length of females increased over the past four years.

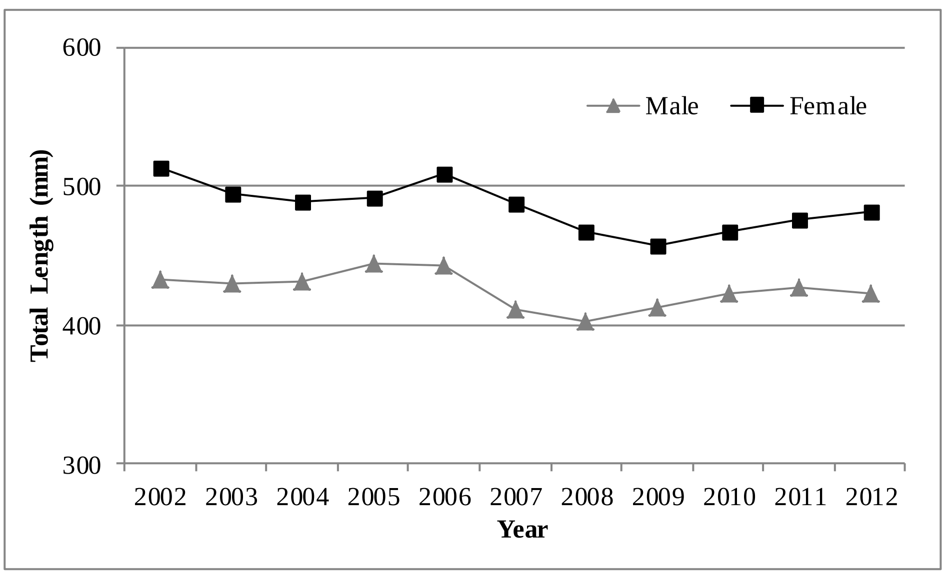

Figure 1. Mean length of American shad by sex caught on the Nanticoke River 2002-2012.

The length frequency distribution from 2012 indicated that fish ranging from 401-500mm were the most abundant (Figure 2). There was an increase of smaller fish (<450mm) in the population from 2011 to 2012.

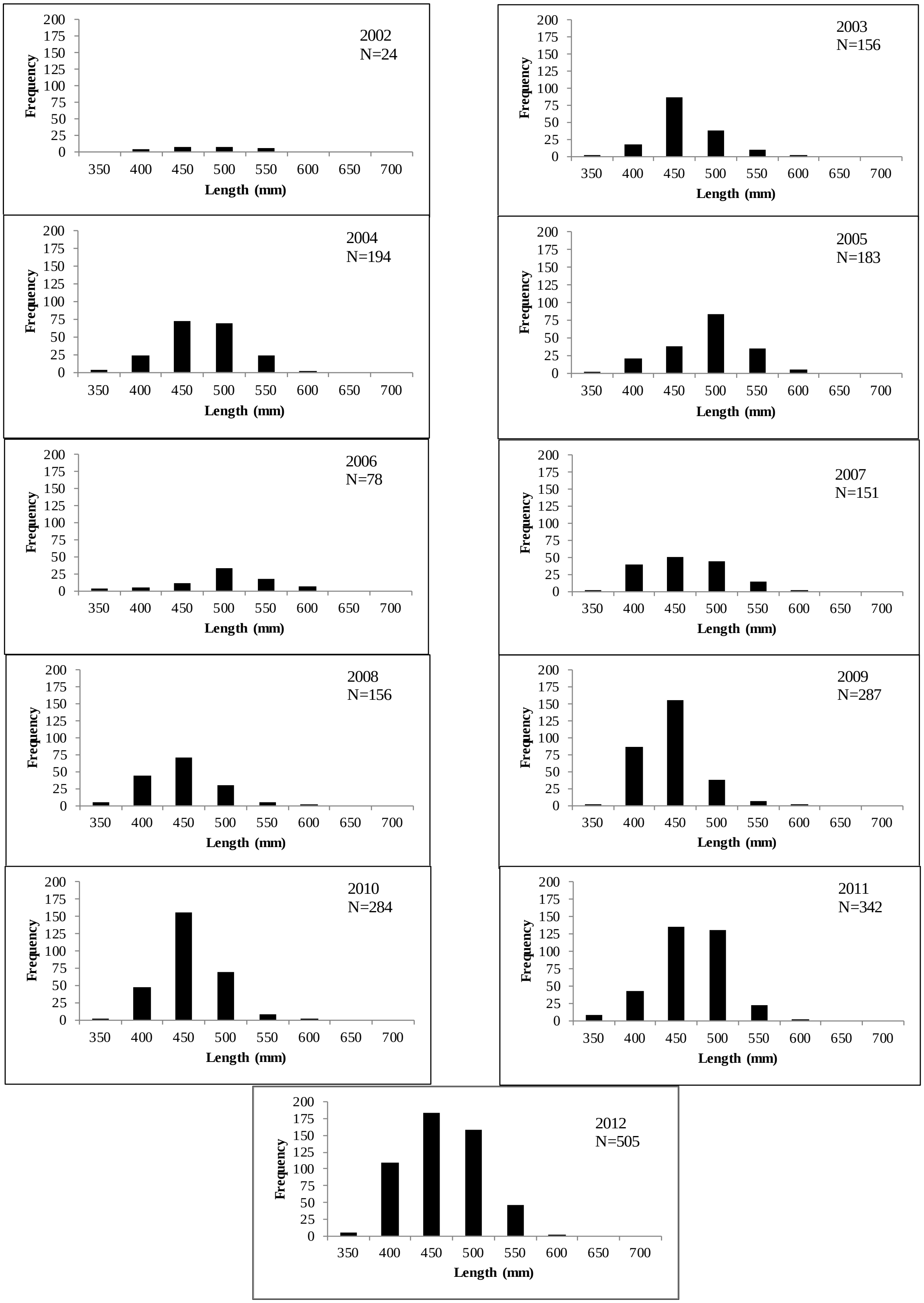

Figure 2. Length frequency distributions of all American shad sampled during spawning stock surveys and brood stock collections on the Nanticoke River 2002-2012

3. Shad Restoration

Most shad restoration efforts throughout the northeast rely on stocking programs to supplement natural reproduction and accelerate the recovery process. A total of approximately 457,000 American shad fry were stocked in Nanticoke River tributaries during the spring of 2011 (Table 5).

Table 5. Number of American shad fry stocked into Nanticoke River tributaries in Delaware 2000 – 2012.

Year	American Shad
2000	91,000
2001	89,000
2002	123,000
2003	330,000
2004	187,000
2005	672,000
2006	539,000
2007	231,000
2008	574,000
2009	713,073
2010	566,588
2011	457,000
2012	378,000
Total	**4,951,000**

4. Hatchery Evaluation

The success or survival of juvenile and adult shad stocked into the upper portion of the Nanticoke River and Broad Creek was determined through examination of otoliths from juveniles taken with the haul seine, and adult mortalities from spawning stock surveys, hatchery efforts, and the MD commercial pound/fyke net fishery.

Juvenile shad otolith analysis - The percentage of hatchery-reared juvenile shad was calculated based on the presence of an otolith mark (Table 6). A total of 17 of the 98 juvenile American shad examined was of hatchery origin. The percentage of hatchery-reared fish decreased by 12% from 2011.

Table 6. Proportion of juvenile marked and wild American shad sampled from the Nanticoke River 2000-2012.

Year Sampled	% of marked Marked American shad	% of wild Wild American shad	No. Sampled
2000	29%	71%	31
2001	0%	100%	66
2002	17%	83%	133
2003	9%	91%	55
2004	30%	70%	120
2005	37%	63%	132
2006	32%	68%	97
2007	32%	68%	100
2008	25%	75%	100
2009	30%	70%	88
2010	19%	81%	128
2011	29%	71%	100
2012	17%	83%	98

Adults - Thirty-seven OTC marked otoliths were found on the 85 adult American shad otoliths (44%) analyzed from electrofishing samples and Maryland pound/fyke net samples (Table 7). All marked fish collected possessed a day 3 mark indicative of the Nanticoke Hatchery. A higher sample size is more desirable to more accurately identify the hatchery contribution of returning adults. Only incidental mortalities are retained from Delaware waters for otolith extraction and examination due to low stock size.

Table 7. Percentage of marked adult American shad from the Nanticoke River 2005-2012.

Year	N	% Marked
2005	22	0
2006	10	0
2007*	62	12.9
2008*	40	12.5
2009*	63	20.1
2010*	35	11.4
2011*	65	31.0
2012*	85	44.0

* - Additional otolith samples provided by MD DNR

River herring - Nanticoke River

Introduction

There were no commercial landings reported from the Delaware portion of the Nanticoke River in 2012 due to the river herring closure. The new regulation closing the fishery went into effect on February 11, 2012. The new regulation states: *It shall be unlawful for any person to have in possession any blueback herring and/or alewife (Alosa aestivalis and/or Alosa pseudoharengus), collectively known as river herring, unless said person has a valid bill-of-sale or receipt from a state or jurisdiction where river herring harvest is lawful and that indicates the date said river herring were received, the number of said river herring received and the name, address and signature of the harvester who legally caught said river herring;, or a bill-of-sale or receipt from a person who is a licensed retailer and legally obtained said river herring for resale.*

2012 Fishery Management Program

Blueback herring GM decreased substantially from its highest value in 2011 to the fourth lowest in the time series in 2012. Alewife abundance remained low as the 2012 index value was slightly higher than average for the time series ($\overline{x}$ = 0.5).

Planned Management Programs For 2013

No changes in monitoring are anticipated for 2012.

I. Harvest and Losses

A. Commercial Fishery

1. Characterization of the fishery

River herring populations in the Delaware portion of the Nanticoke River consist of both alewife and blueback herring. Although both species were represented in the catch, most were probably blueback herring based on observations of relative abundance and temporal distributions within the Nanticoke River. The fishery was closed in 2012.

2. Characterization of directed harvest for all alosines

a. Landings and method of estimation

The fishery is closed so there were no commercial landings reported from the Delaware portion of the Nanticoke River in 2012.

b. Catch composition

Not applicable with the closed fishery.

i. Age frequency

ii. Length frequency

iii. Sex ratio

iiii. Degree of repeat spawning

c. Estimation of effort

Not applicable with the closed fishery.

3. Characterization of other losses

None

B. Recreational Fishery

1. Characterization of the fishery (seasons, caps, gears, regulations)

The recreational fishery is closed to harvest.

2. Characterization of Directed Harvest

a. Landings and method of estimation

Not applicable with the closed fishery.

b. Catch Composition

i. Age frequency

ii. Length frequency

No data collected

3. Characterization of Other Losses

None

C. Other Losses (Fish passage mortality, discarded males, brood stock capture, research losses etc)

None

D. Harvest and Losses Table (weight (pounds) of fish and mean weight per fish for each gear type)

No data collected

II. Required Fishery Independent Monitoring

A. Description of Requirement by Amendment 2

JAI: Juvenile abundance index (JAI)

B. Brief Description of Work Performed

Annual surveys were conducted from 1999 through 2012 to establish a JAI for juvenile river herring in Delaware's portion of the upper Nanticoke River (Stangl 2013). Sampling in 2012 was conducted at four locations using a haul seine during ebb or low slack tide. Seining occurred approximately every two weeks on the Nanticoke River and Broad Creek from July through October. The geometric mean of number sampled per seine haul was calculated. Confidence limits (95%) were applied to the geometric mean. Catch per unit of effort, recorded as fish caught per haul, and the associated standard error was calculated for each species.

C. Results

Eighty-six alewife (86) and 493 blueback herring were collected in the Nanticoke River system from July 16 through October 15, 2012. Blueback herring GM decreased substantially from its highest value in 2011 to the fourth lowest in the JAI time series (Table 9). Alewife abundance remained low, as the 2012 index value was slightly higher than average for the time series ($\overline{x}$ = 0.5). Similar to Delaware's index results, MD DNR conducted haul seine sampling downstream on the Nanticoke River and reported a substantial drop in blueback herring abundance from 2011 to 2012 as well. Discrepancies between the GM and CPUE of blueback herring are typically the effect of single large catches that result in elevated CPUE's. This pattern of a few large catches of blueback herring is typical with schooling species and has occurred every year since the Division began sampling alosines with a haul seine in 1999.

Table 9. The geometric mean (GM), 95% confidence Limits (CI), CPUE (fish/haul) and standard error (SE) for juvenile blueback herring and alewife caught with the haul seine from the Nanticoke River and Broad Creek from 1999 through 2012.

	Blueback herring				**Alewife**			
YEAR	GM	95% CI	CPUE	SE	GM	95% CI	CPUE	SE
1999	6.7	0.9, 30.4	42.0	22.9	0.9	0.1, 2.3	1.8	0.9
2000	8.2	3.3, 18.7	30.0	8.2	0.8	0.2, 1.8	2.9	1.8
2001	8.3	2.8, 21.9	116.0	51.4	1.3	0.4, 3.0	10	5.1
2002	2.0	0.5, 4.9	31.0	19	0.7	0.2, 1.4	2.1	1.0
2003	5.2	2.1, 11.3	39.0	19.2	0.2	-0.1, 0.5	1.0	0.9
2004	10.6	3.8, 26.9	173.0	83.2	0.1	-0.1, 0.2	0.1	0.1
2005	1.9	0.6, 4.2	34.0	19	0.3	0.1, 0.7	0.9	0.5
2006	3.3	1.1, 7.8	38.0	20	0.1	-0.04, 0.3	0.2	0.2
2007	6.7	2.5, 15.9	71.1	29.3	0.2	-0.08, 0.6	1.6	1.5
2008	0.6	0.1, 1.3	2.8	1.5	0.07	-0.07, 0.2	0.3	0.3
2009	10.3	4.0, 24.8	125.7	74.8	0.1	-0.02, 0.2	0.19	0.1
2010	10.7	3.7, 28.0	78.2	26.9	0.6	0.2, 1.0	1	0.3
2011	29.0	11.1,73.4	347.3	143	1.4	0.5,2.9	5.8	2.2
2012	3.0	1.1 , 6.6	17.6	7.4	0.7	0.1 , 1.5	3.1	1.9

References

Cating, J.P. 1953. Determining age of Atlantic shad from their scales. Fishery Bulletin 85, Volume 54. Fishery Bulletin of the Fish and Wildlife Service, Washington, D.C.

Stangl, M.J. 2013. Nanticoke River shad and river herring restoration. Study No.2, Activity 2 and 3 in Anadromous Species Investigations. Federal Aid in Fisheries Restoration Project F-47-R-22, Annual Performance Report. Delaware Division of Fish and Wildlife, Dover, DE.

Fisheries Research Branch

I. Introduction

Stocks of American shad and river herring were monitored by the fisheries research branch in 2012. Several sampling protocols are used to monitor both life stages of these species. Adult shad and river herring appear in the waters of the District of Columbia early in the spring at the start of their spawning run. Most adult alosines are out of District waters by June, however the young of year (YOY) use this region as a nursery area as they grow and eventually move seaward. There were no significant changes in monitoring, regulation, or harvest for the 2012 fishing season.

II. Request for de minimis, where applicable

Not applicable

III. Previous year's fishery and management program

a. Activity and results of fishery-dependent monitoring

In the past the fisheries research branch has used an angler creel survey to monitor the fisheries in the District. Currently the angler creel survey has been discontinued because of staffing shortages and a lack of useful data.

b. Activity and results of fishery-independent monitoring

The fisheries research branch conducts several surveys to monitor all life stages of American shad and river herring. Electrofishing and seining surveys are used to target both adult and juvenile American shad and river herring. These surveys are useful for determining abundance estimates and YOY indices. In addition to these surveys, a push net survey is conducted which focuses exclusively on YOY recruitment and abundance of American shad and river herring.

c. Current Regulations

The District of Columbia Fisheries & Wildlife Management Division currently has a closure on all directed recreational fisheries for American and hickory shad as well as herring.

d. Harvest broken down by commercial and recreational (when available)

There is no commercial fishery in the District of Columbia and recreational harvest data is not available.

e. Review of progress in implementing habitat recommendations

The fisheries research branch has been active in restoring and increasing available habitat in Rock Creek by removing man-made barriers which impede spawning migration of alosine species and installing a fish ladder at the Pierce Mill Dam in Rock Creek.

IV. Planned management programs for the current calendar year

Shad regulations for the 2013 fishing season will remain unchanged; there is still a moratorium prohibiting the capture of American and hickory shad, as well as herring. Monitoring programs in 2013 will also remain unchanged. Electrofishing, seining and push-net surveys will be conducted to gather data for stock assessment and recruitment analysis.

V. Shad and River Herring specific requirements

a. Harvest and Losses

i. Commercial Fishery

1. Characterization of Fishery

There is no commercial fishery in District of Columbia.

ii. Recreational Fishery

1. Characterization of Fishery

The District of Columbia's recreational fishery for American shad and hickory shad, as well as herring remained closed in 2012.

2. Characterization of Directed Harvest

There is no directed fishery for American and hickory shad, as well as herring, since both of these fisheries are presently closed.

3. Characterization of Other Losses

DDOE has no direct estimate of other losses occurring in any of the shad and river herring fisheries in the District of Columbia.

iii. Other Losses (fish passage mortality, discarded males, research losses, etc.)

DDOE has no direct estimate of any losses occurring in any of the shad and river herring fisheries in the District of Columbia.

iv. Harvest and Losses Table

None.

v. Protected Species (Atlantic sturgeon bycatch estimates)

There have been no documented sturgeon captures reported in the District of Columbia during 2012.

b. Required Fishery Independent Monitoring

i. Description of Requirements

- Annual spawning stock survey and representative sampling for biological data.
- Calculation of mortality and/or survival estimates.

ii. Description of Work Performed

As part of the annual biological survey of the fishery resources of the District of Columbia, efforts were made to collect shad and river herring to determine relative abundance of adults and juveniles. Both life stages were collected during our electrofishing and seining surveys for abundance estimates, and juveniles collected during our seining and push-net surveys were used to calculate the YOY indices.

The seining survey consists of pulling a 100’x4’x1/4” beach sein at five sites twice a month from June - October. Protocol for the sein survey was adjusted in 2010 to increase the frequency of visits to the sites from once a month to twice a month. All specimens captured are enumerated and measured for total length before being released. For large samples, lengths are taken from 50 specimens of each species and the remainder of the sample is counted.

The electrofishing survey consists of eight electrofishing sites, between the months of March and December. Four alternate electrofishing sites were sampled in May, July, September and November in the Potomac River. Each site is shocked for a total of 1200 seconds along a transect. During this survey all species of fish encountered are collected for enumeration and biological data, and then released. For the purposes of the catch per unit effort (CPUE) calculations for adult river herring, only data from the months of March-June are used, as those are the months when adult herring appear in this survey. This survey will continue in 2013.

In 2003 DDOE began a multiyear push-net survey for YOY alosine species. This sampling was conducted over 11 nights from July through September at five sites in the Potomac River and one site in the Anacostia River. These sites covered the entire distance of the Potomac within the District of Columbia’s jurisdiction. The push-net survey is conducted after sunset by pushing a 3’x4’x1/4” bag net mounted on a frame that pivots on the bow of the boat. This allows the net to be lowered into the water at a level where the net skims the top of the water as it is pushed along a transect, for five minutes. The boat is maintained at a constant speed of 5 mph covering around .83 miles. A flow meter is attached to the mouth of the net to determine the exact volume of water that passes through the net in order to calculate number of fish per volume of water sampled. This survey will continue in 2013.

iii. Results

1. Juvenile Abundance Indices

Total numbers and size range of YOY alewife and blueback herring for the three sampling methods are displayed in Table 1. Table 2 presents total numbers and size range for American shad and hickory shad YOY for the three sampling methods. Geometric and arithmetic means calculated from seining survey for alewife, blueback herring, and American shad are presented in Table 3. Table 4 presents the geometric and arithmetic means calculated from push-net survey for alewife, blueback herring, and American shad. Figures 1 and 2 displays the geometric mean for alewife, blueback herring, and American shad calculated from the seining and push-net surveys respectively. Figure 3 shows the numbers of alewife, blueback herring, and American shad collected per 1000 cubic meters of water sampled with the push-net. Due to the fact that so few hickory shad have been captured recently no geometric or arithmetic means have been calculated for this species.

2. Spawning stock assessment

a. Length frequency

Table 5 and figure 4 show a CPUE for adult river herring caught during boat electrofishing with size ranges. In figures 5 and 6, length frequency distributions for adult alewife and blueback herring are depicted respectively. Adult American and hickory shad are not typically observed or captured during our boat electrofishing survey.

b. Age frequency

District fisheries' personnel have done no aging on alosine species.

c. Sex

In 2012 DDOE determined the sex of 119 adult alewife; and calculated a ratio of 79% male and 21% female. For blueback herring, DDOE determined the sex of 48 adults; and calculated a sex ratio of 92% male and 8% female for this species. Figure 5 and 6 show the length frequency of adult river herring broken down by sex.

d. Degree of repeat spawning

No work has been done on repeat spawning of alosine species in the District.

iv. Annual mortality rate calculation

Due to the lack of data we have done no mortality rate calculations.

v. Hatchery evaluation (percent wild versus hatchery produced juveniles)

Beginning in 2005 DDOE began a hatchery program to enhance American shad stocks within the District. Evaluations of hatchery efforts are scheduled to begin in 2013.

Table 1: Number of YOY alewife and blueback herring collected during seining, boat electrofishing and push-net surveys along with total length range.

Year	Number of YOY Collected				
	Seining	**E-Fish**	**Push Net**	**Total YOY**	**Size Range (mm)**
Alewife					
2000	41	583	(N/A)	624	17-100
2001	14	1073	(N/A)	1087	40-152
2003	4	557	(N/A)	561	45-106
2004	0	49	(N/A)	49	50-87
2005	0	188	3287	3475	56-94
2006	0	1	489	490	44-95
2007	2	8	4124	4134	46-103
2008	0	5	138	143	49-188
2009	1	9	361	371	54-96
2010	33	41	1780	1854	63-97
2011	0	18	971	989	55-104
2012	0	6	89	95	54-101
Blueback Herring					
2000	935	11142	(N/A)	12077	23-103
2001	314	8242	(N/A)	8556	33-86
2003	235	4279	(N/A)	4514	44-96
2004	118	4390	(N/A)	4508	24-75
2005	152	2038	30853	33043	26-74
2006	256	1218	15008	16482	20-95
2007	384	916	86668	87968	33-75
2008	408	1296	13811	15515	33-84
2009	1743	1429	36474	39646	45-87
2010	1528	1111	52929	55568	27-80
2011	4313	1329	100105	105747	37-77
2012	1006	1076	12250	14332	23-81

Table 2: Number of YOY American shad and hickory shad collected during seining, boat electrofishing and push-net surveys along with total length range.

Year	Number of YOY Collected				
	Seining	E-Fish	Push Net	Total YOY	Size Range (mm)
American Shad					
2000	15	55	(N/A)	70	72-102
2001	1	12	(N/A)	13	68-102
2003	1	746	(N/A)	747	55-126
2004	293	1203	(N/A)	1496	39-114
2005	189	1535	5134	6858	34-107
2006	124	521	854	1499	26-135
2007	183	332	2524	3039	46-103
2008	69	321	1805	2195	44-101
2009	52	107	151	310	61-102
2010	210	53	64	327	52-108
2011	738	121	1796	3655	43-107
2012	463	638	1467	2568	38-116
Hickory Shad					
2000	0	13	(N/A)	13	74-85
2001	15	361	(N/A)	376	82-154
2003	0	0	(N/A)	0	
2004	1	4	(N/A)	5	90-230
2005	0	0	1	1	113
2006	0	0	1	1	74
2007	0	1	2	3	120-128
2008	0	0	0	0	
2009	0	0	0	0	
2010	0	0	5	5	74-100
2011	0	0	0	0	
2012	0	0	0	0	

Table 3: Geometric and arithmetic mean derived from seining survey for alewife, blueback herring, and American shad.

	Year	Number of hauls	Zero hauls	Number collected	Geometric Mean	Lower Conf. interval	Upper Conf. interval	Arithmetic Mean	SD
Alewife	2000	30	25	41	0.36	0.02	0.8	1.37	4.36
	2001	30	26	14	0.2	0	0.45	0.47	1.46
	2002								
	2003	25	24	4	0.07	-0.06	0.21	0.16	0.8
	2004	25	25	0	0	0	0	0	0
	2005	25	25	0	0	0	0	0	0
	2006	25	25	0	0	0	0	0	0
	2007	25	23	2	0.06	-0.02	0.14	0.08	0.28
	2008	25	25	0	0	0	0	0	0
	2009	25	24	1	0.03	-0.03	0.09	0.04	0.2
	2010	54	50	33	0.12	-0.02	0.27	0.61	3.95
	2011	54	54	0	0	0	0	0	0
	2012	54	54	0	0	0	0	0	0
Blueback Herring	2000	30	11	935	5.06	2.18	10.55	31.17	82.31
	2001	30	16	314	1.73	0.64	3.52	10.47	33.57
	2002								
	2003	25	16	235	1.26	0.31	2.92	9.4	29.64
	2004	25	13	118	1.08	0.33	2.23	4.72	13.06
	2005	25	16	152	1.13	0.28	2.56	6.08	14.8
	2006	25	19	256	0.78	0.08	1.94	10.24	44.66
	2007	25	17	384	1.42	0.33	3.4	15.36	59.84
	2008	25	15	408	2.28	0.65	5.53	16.32	32.45
	2009	25	11	1743	4.78	1.39	13	69.92	146.14
	2010	54	31	1533	2.34	1.11	4.29	28.39	128.69
	2011	54	24	4313	4.96	2.27	9.86	79.87	198.94
	2012	54	30	1006	2.59	1.27	4.68	18.63	43.11
American Shad	2000	30	29	15	0.1	-0.08	0.31	0.5	2.74
	2001	30	25	15	0.25	0.03	0.5	0.5	1.28
	2002								

	2003	25	24	1	0.03	-0.03	0.09	0.04	0.2
	2004	25	2	293	5.92	3.46	9.73	11.72	15.54
	2005	25	8	185	3.08	1.48	5.71	7.4	9.93
	2006	25	15	124	1.49	0.52	3.08	4.96	9.04
	2007	25	6	138	2.85	1.55	4.82	5.52	7.16
	2008	25	17	68	0.8	0.21	1.69	2.72	6.62
	2009	25	14	52	0.89	0.33	1.69	2.08	3.9
	2010	54	39	210	0.62	0.25	1.11	3.89	19.32
	2011	54	16	738	4.35	2.68	6.78	13.67	28.19
	2012	54	19	463	2.65	1.57	4.2	8.57	17.48

Table 4: Geometric and arithmetic mean derived from push-net survey for alewife, blueback herring, and American shad.

	Year	Number of hauls	Zero hauls	Number collected	Geometric Mean	Lower Conf. interval	Upper Conf. interval	Arithmetic Mean	SD
Alewife	2005	90	26	3287	7.11	4.49	11.00	36.52	85.23
	2006	78	55	489	0.80	0.36	1.39	6.27	16.28
	2007	65	18	4124	13.37	7.75	22.58	63.45	105.72
	2008	62	34	138	0.91	0.53	1.38	2.23	4.02
	2009	54	22	361	2.76	1.67	4.28	6.69	8.41
	2010	66	21	1780	5.83	3.51	9.35	26.97	55.47
	2011	66	22	971	3.25	1.97	5.08	14.71	40.12
	2012	66	49	89	0.54	0.27	0.87	1.35	2.86
Blueback Herring	2005	90	9	30853	45.45	26.95	76.20	342.81	613.99
	2006	78	29	15349	8.24	4.34	15.00	196.78	564.69
	2007	65	5	86667	128.87	64.94	254.77	1333.35	2348.03
	2008	62	13	13811	25.34	13.17	47.96	219.22	410.64
	2009	54	15	36474	41.66	17.87	95.47	675.44	1174.48
	2010	66	10	52929	80.15	39.67	160.94	801.95	1498.27
	2011	66	5	100105	113.51	55.63	230.52	1516.74	2761.8
	2012	66	31	12250	8.92	4.25	17.75	185.61	423.77
American Shad	2005	90	9	5134	28.22	20.27	39.14	57.04	96.67
	2006	78	22	882	4.25	2.84	6.19	11.31	15.82
	2007	65	8	2524	14.64	9.59	22.11	38.24	44.18
	2008	62	21	1805	7.66	4.66	12.23	27.35	39.93

	2009	54	25	151	1.22	0.73	1.86	2.8	4.94
	2010	66	44	64	0.47	0.26	0.72	0.97	2.27
	2011	66	1	2796	21.68	15.89	29.47	42.363	48.48
	2012	66	19	1467	6.31	3.90	9.91	22.23	34.06

Table 5: CPUE (fish per hour shocking) for spawning stock alewife and blueback herring.

	Alewife				Blueback Herring			
Year	Total # of Fish Caught	Total fishing time (hrs.)	CPUE (n/hr.)	Size Range (mm)	Total # of Fish Caught	Total fishing time (hrs.)	CPUE (n/hr.)	Size Range (mm)
2000	1102	9.3	118.49	127-367	1595	9.3	171.51	201-339
2001	3	9.3	0.32	249-267	317	9.3	34.09	212-319
2003	977	9.3	105.05	185-371	276	9.3	29.68	168-312
2004	3	9.3	0.32	193-307	170	9.3	18.28	203-297
2005	74	9.3	7.96	245-309	23	9.3	2.47	231-299
2006	121	9.3	13.01	154-307	114	9.3	12.26	208-278
2007	91	9.3	9.78	234-305	240	9.3	25.81	216-283
2008	29	9.3	3.12	235-321	152	9.3	16.34	212-293
2009	66	9.3	7.1	232-309	157	9.3	16.88	227-296
2010	148	9.3	15.91	230-321	323	9.3	34.73	151-285
2011	217	9.3	23.33	147-295	90	9.3	9.68	223-290
2012	130	9.3	13.98	135-305	51	9.3	5.48	148-261

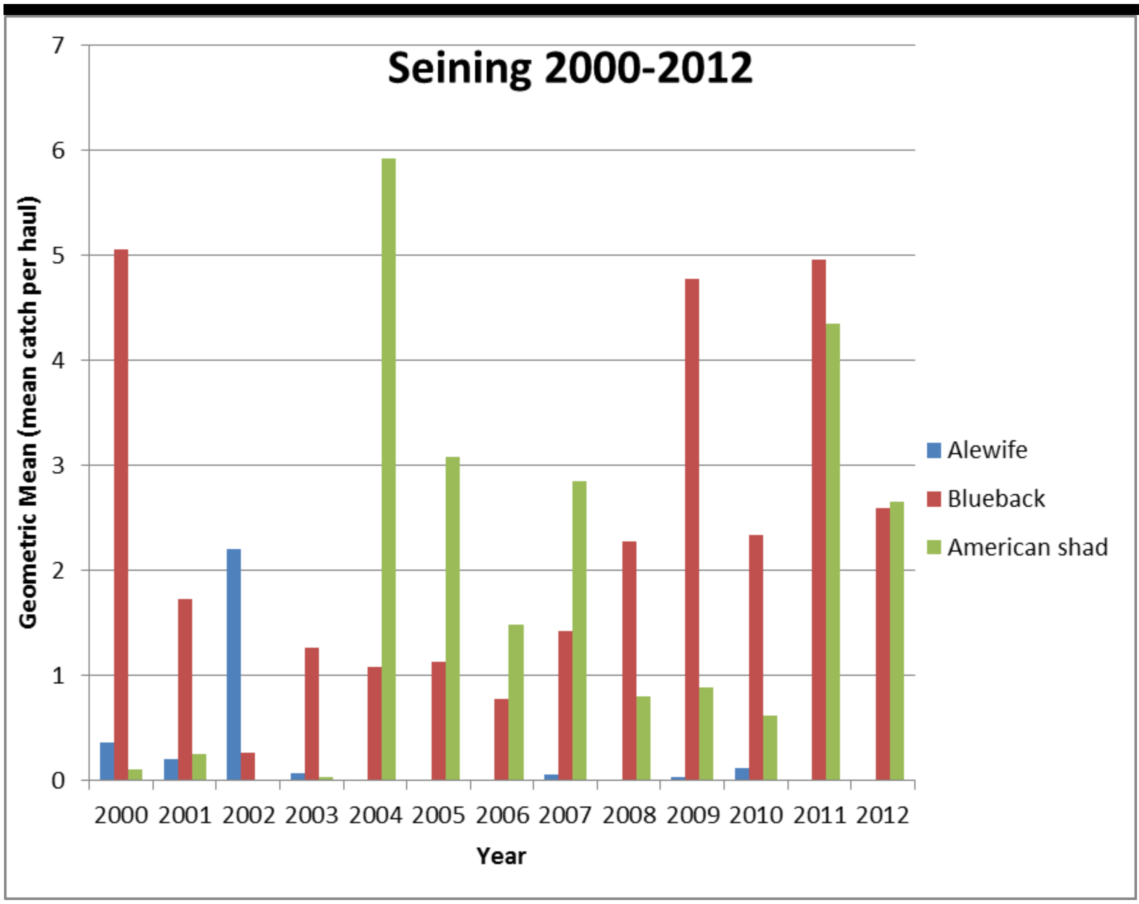

Figure 1: Geometric mean for alewife, blueback herring, and American shad captured during seining survey.

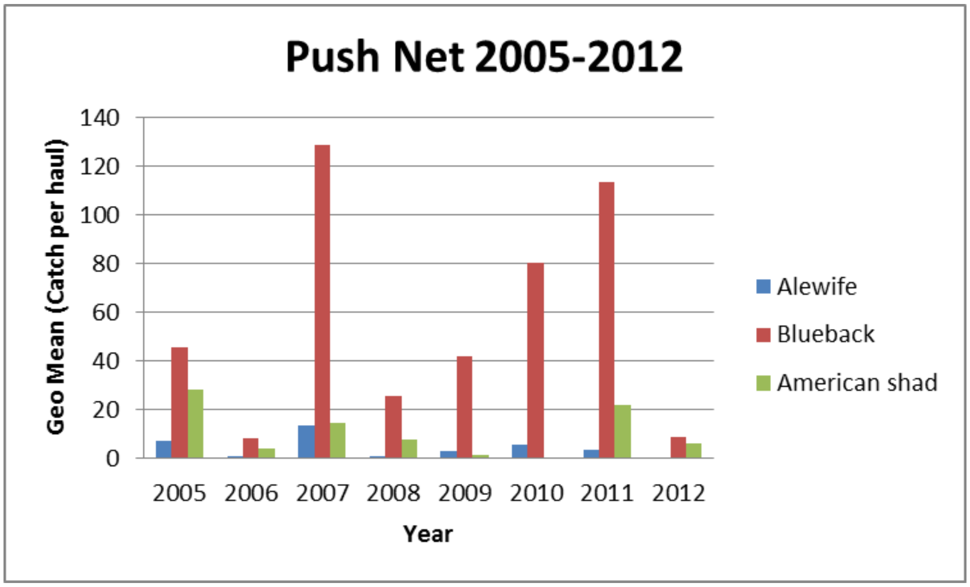

Figure 2: Geometric mean for alewife, blueback herring, and American shad captured during push-net survey.

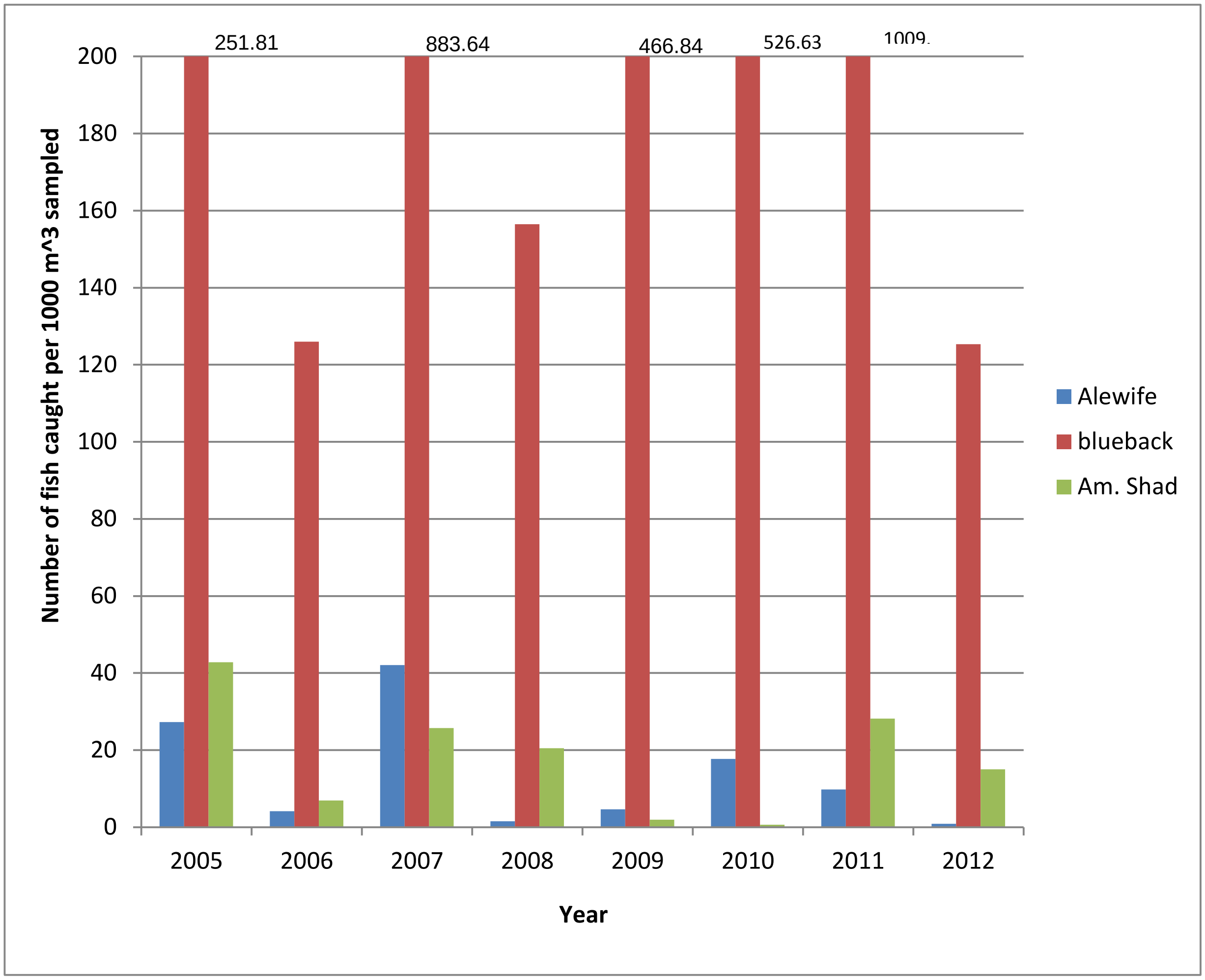

Figure 3: Number of alewife, blueback herring, and American shad caught per 1000 cubic meters of water sampled with the push-net.

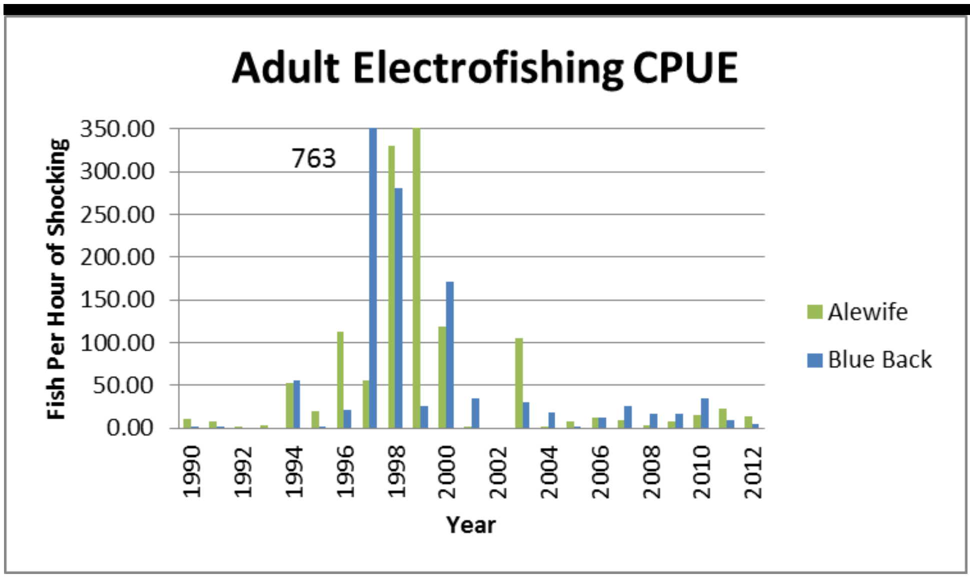

Figure 4: CPUE (fish per hour of shocking) for spawning stock Alewife and blueback herring (no data available for 2002).

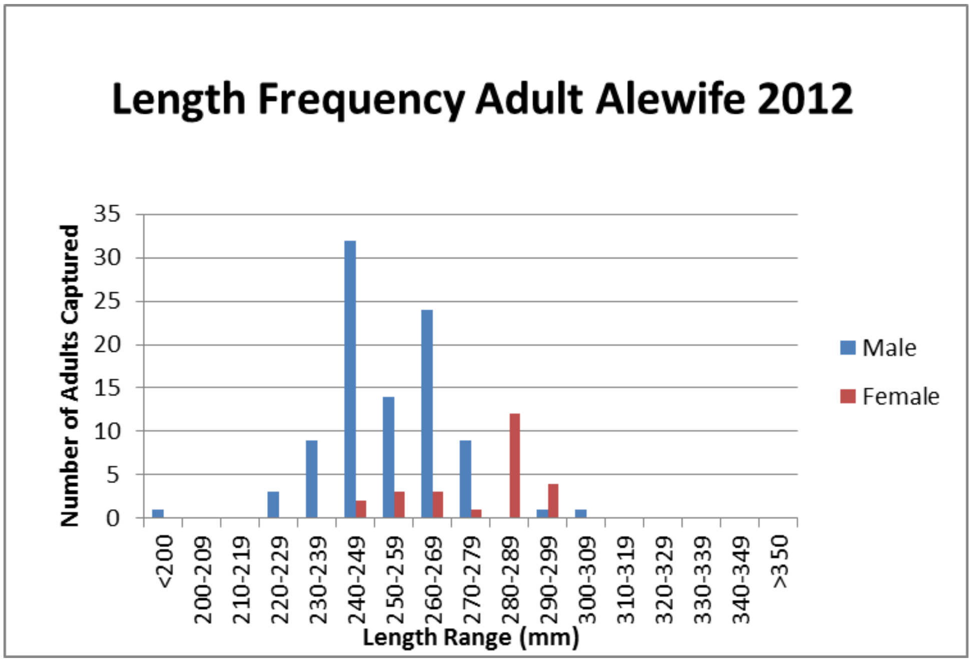

Figure 5: Length (mm) fequency for adult alewife captured during boat electrofishing survey, 2012.

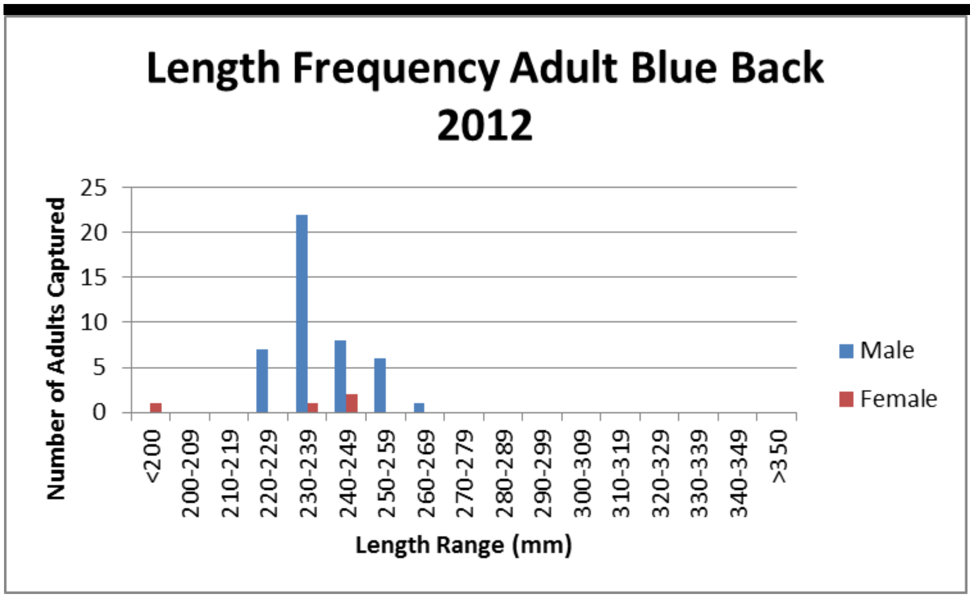

Figure 6: Length (mm) fequency for adult blueback herring captured during boat electrofishing survey, 2012.

MARYLAND - VIRGINIA
"Potomac River Compact of 1958"

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Shad and River Herring

2012 Annual State Report
June 1, 2013

I. Introduction

Summary of the year
The ASMFC American Shad restoration target of 31.1 for the Potomac River, was exceeded for the second year in a row with a value of 36.6 in 2012 (Figure 5). The YOY geometric mean index for American shad increased by about 70 percent in 2012, conversely the alewife and blueback herring indices declined. All fisheries were closed to the taking and/or possession of river herring in the Potomac River.

II. Request *de minimis*, where applicable - N/A

III. Previous calendar year's fishery and management program

1. Harvest and losses

A. Commercial fishery

(1) Characterization of fishery

The Potomac River has been closed to the directed harvest of American shad since March 1, 1982. The only allowable harvest since then has been via a pound net by-catch provision that allowed up to 2% by volume of the total catch in possession to be American shad. In 1995 the hickory shad fishery was also closed with the same by-catch provision. Starting in 1996, the by-catch provision for both species of shad was further limited to 2% by volume, but could not exceed one bushel per day per licensee. In 2004, a one-bushel limit of American or hickory shad by-catch was established for the gill net fishery. In 2012, approval was obtained to increase the by-catch limit from one bushel per day to two bushels per day because the restoration target was exceeded.

The commercial fishery for river herring (blueback herring and alewife) has been almost exclusively a pound net fishery. The pound net fishery shifted from a 'shad and herring' fishery in the 1960's and early 70's to a 'menhaden' fishery in the late 70's and early 80's. The 'deep water in-line' pound nets were replaced by 'shallow water singly set' pound nets. In 2010, the commercial harvest of river herring (blueback herring and alewife) was closed to all gear except pound nets, which were allowed a limited by-catch of 50-pounds per day per licensee. In 2012, all fisheries were closed to the taking and/or possession of river herring.

(2) Characterization of directed harvest

(a) Landings and method of estimation

There was no directed harvest of American shad, hickory shad or river herring.

(b) Catch composition - N/A

(3) Characterization of other losses

(a) Estimate and method of estimation

The non-directed Potomac River by-catch landings in 2012 included 4,742 pounds of American shad, 446 pounds of hickory shad, and no river herring (Table 1). The PRFC's mandatory commercial daily harvest reporting system is the source of these data, collecting harvest as well as discards or releases. The discards/released by-catch of American shad in excess of the daily landing limit from pound nets, gill nets and other commercial gear was 32,559 pounds (Table 2). The discards/released by-catch of hickory shad was 12 pounds, and river herring was 1,727 pounds. The release of an unknown amount of small river herring may be attributed to the mandatory use of fish cull panels in pound nets and the resulting escapement of small fish (Anecdotal information).

(b) Estimate of composition

Sixty-five percent of the American shad landings were reported as roe shad, and thirty-five percent as buck shad. No American shad or hickory shad age/length data is available.

(c) Estimation of effort

Pound net effort is expressed as "pound net fishing day" which is one net fished one time.

During 2012, a total of 100 pound nets were licensed in the Potomac River. The pound net fishery is a 'limited entry' fishery capped at 100 licenses (each net is licensed separately). Effort included 177 pound net fishing days for the American shad by-catch harvest, and two pound net fishing days for the hickory shad by-catch harvest.

B. Recreational fishery

(1) Characterization of fishery

The PRFC established a moratorium on river herring for recreational and charter fishing in 2010. The Potomac River recreational and charter boat fisheries for American and hickory shad remained closed during 2012. The American shad fishery has been closed since 1982 and the hickory shad fishery since 1995.

(2) Characterization of directed harvest

We know of no directed recreational harvest of American shad, hickory shad or river herring in the Potomac River, under our jurisdiction.

(3) Characterization of other losses

No estimate available.

C. Other Losses

There are no dams, either manmade or natural, within the Potomac River under our jurisdiction. One possible source of mortality could be entrapment of the young of the year fish in the two electric power generating plants' cooling water withdrawals, but we are not aware of any information specific to shad or herring.

American shad have been taken from the Potomac River as brood stock for hatchery production by several agencies under special collection permits issued by the PRFC since 1995. In 2012, the Interstate Commission on the Potomac River Basin (ICPRB) collected 858 American shad for their brood stock program, and stocked 537,000 fry back into the Potomac River. The Maryland DNR collected 3,078 adult American shad from the Potomac River in 2012, and a subsample of fish were sexed, measured and aged. The MD DNR mitigation stocking effort included 165,000 fry back into the Potomac River in 2012. The U.S. Fish & Wildlife Service collected and kept 1,187 adult American shad from the Potomac River in 2012. Scales and otoliths were taken on five percent of the kept fish for aging.

D. Harvest and Losses – Tables 2, 3 and 4

Table 2 shows American shad annual harvest by pound net, broken down by sex and effort (net-days), and annual harvest by gill net. The discard section of the table illustrates annual losses by gear type and by sex.

Table 3 reveals the hickory shad annual harvest by gear type, as well as discard (losses) by gear type.

Table 4 provides river herring annual harvest by gear type and the discard (losses) data that is available.

E. Sturgeon Bycatch Report

In 2012, there were no Atlantic sturgeon captures in the Potomac River.

2. Required fishery independent monitoring programs

A. Description of requirement

Maryland is required to collect a juvenile index for the Potomac River and several other river systems throughout the Chesapeake Bay.

B. Brief description of work performed

Maryland DNR personnel have conducted an annual juvenile abundance survey since 1954. American shad and river herring data dates from 1959 to present. Fixed stations and some auxiliary stations are used each year for a beach haul seine survey in which the juveniles of all species encountered are identified and recorded.

C. Results

(1) Juvenile indices

The American shad juvenile index for the Potomac is derived from the Maryland DNR state wide annual young of the year survey. The geometric mean indices for the Potomac River American Shad are presented (Figure 1). The 2012 value of 2.87 is significantly higher than the 2011 value of 1.99.

The river herring juvenile indices for the Potomac are derived from the MD DNR statewide annual young of the year survey. The geometric mean indices for the Potomac River alewife herring are presented in Figure 2. The 2012 value was 0.02, a decrease from 0.75 in 2011. In Figure 3, the 2012 geometric mean index for the blueback herring was 0.37, a significant decrease from 5.40 in 2011.

Note: Figures 1 - 3 originated on the Maryland DNR web site: http://www.dnr.state.md.us/fisheries/juvindex/index.html

(2) Spawning stock assessment – submitted separately.

III. Planned management programs for the current calendar year

A. Summarize regulations that will be in effect

The commercial pound net and gill net by-catch of shad increased from one bushel to two bushels per day.

A total moratorium was established for the commercial harvest of river herring.

All pound nets in the Potomac River must have at least six PRFC approved fish cull panels properly installed in each pound net to help release undersize fish. These fish cull panels were being used by some pound netters on a voluntary basis prior to 2011. As a conservation measure, fish cull panels installed in the upper side panels of pound nets may allow escapement of most small river herring.

Recreational and charter fisheries are under moratoria for American shad, hickory shad, and river herring.

B. Summarize monitoring programs that will be performed -

We expect MD will continue the annual juvenile abundance survey and the striped bass spawning stock survey. The ICPRB, MD DNR, and USFWS were permitted again this year to collect American shad as brood stock for hatchery production and stocking efforts. Biological data on a portion of the fish collected will be provided to the PRFC.

C. Highlight any changes from the previous year -

A total moratorium was established for river herring.

IV. Tables and Figures

A. List of Tables

B. List of Figures

Table 1

Potomac River
Shad and River Herring Commercial Harvest

Year	American Shad	Hickory Shad	River Herring
1964	466,293	2,199	8,162,444
1965	438,831	5,328	9,959,891
1966	243,012	576	11,127,487
1967	214,882	299	8,580,234
1968	393,872	792	7,477,581
1969	302,274	305	3,433,438
1970	405,884	527	6,184,858
1971	359,014	180	5,858,125
1972	421,318	622	5,720,951
1973	203,717	537	2,005,057
1974	83,955	176	3,529,221
1975	144,465	250	5,758,824
1976	120,302	119	1,308,222
1977	87,290	11	473,531
1978	67,967	11	1,467,743
1979	27,758	222	997,360
1980	17,328	1,314	1,686,203
1981	4,237	127	84,143
1982	2,133	123	493,039
1983	3,722	255	1,728,810
1984	2,531	39	899,275
1985	287	0	261,675
1986	478	0	1,198,669
1987	810	10	1,164,854
1988	1,894	17	182,656
1989	1,068	5	97,047
1990	2,282	7	49,734
1991	1,918	2,207	365,966
1992	1,553	604	162,885
1993	2,927	0	144,752
1994	1,305	16	80,258
1995	2,641	34	113,504
1996	2,292	6	80,447
1997	5,206	844	59,949

Table 1 continued

Year	American Shad	Hickory Shad	River Herring
1998	2,372	7	18,501
1999	1,966	595	26,656
2000	1,508	2	33,370
2001	4,882	489	35,723
2002	2,762	46	55,086
2003	8,641	197	20,132
2004	5,344	174	19,739
2005	6,820	3	8,507
2006	4,669	0	6,819
2007	8,914	0	6,011
2008	6,975	0	5,476
2009	5,214	0	8,925
2010	3,922	365	898*
2011	2,419	36	1,672*
2012	4,742	446	0**

* Moratorium established on the harvest of river herring in 2010, except for the limited pound net bycatch of 50 lbs per day.

** Moratorium established on the harvest / possession of river herring in 2012.

Table 2

POTOMAC RIVER FISHERIES COMMISSION
AMERICAN SHAD
Commercial Harvest (pounds) and Discard (pounds)

	HARVEST					DISCARD						
Year	Pound Net				Gill Net	Pound Net		Gill Net		Other Gear		Total
	Roe	Buck	Total	Net-days	Total	Roe	Buck	Roe	Buck	Roe	Buck	
1988	766	1,128	1,894	2,021								
1989	543	525	1,068	1,574								
1990	1,299	983	2,282	1,361								
1991	1,062	856	1,918	1,208								
1992	939	526	1,465	703								
1993	1,480	1,447	2,927	611								
1994	677	628	1,305	758								
1995	1,458	1,180	2,638	743								
1996	1,357	935	2,292	553								
1997	2,773	2,310	5,083	737								
1998	1,680	571	2,251	335								
1999	1,049	917	1,966	388		376	213	14	10			613
2000	897	611	1,508	258		28	56	55				139
2001	3,347	1,492	4,839	433		800	56	53		25		934
2002	1,727	1,035	2,762	348			59	25	2			86
2003	6,971	1,170	8,141	547		22,790	17,566	9,393	670	204	73	50,696
2004	4,408	643	5,051	493	293	1,800	1,100	1,053	54			4,007
2005	5,255	764	6,019	493	801	15,171	3,008	170	0			18,349
2006	3,847	409	4,256	260	413	10,178	4,000	17	4			14,199
2007	5,662	942	6,604	388	2,310	8,622	1,323	90		4		10,039
2008	6,310	505	6,815	274	160	8,282	2,000					10,282
2009	4,402	603	5,005	197	209	19,150	5,500			2		24,652
2010	3,790	95	3,885	117	31	3,907	131					4,038
2011	2,167	252	2,419	77		2,015	450					2,465
2012	2,478	1,641	4,119	177	623	21,515	11,040			4		32,559

Table 3

POTOMAC RIVER FISHERIES COMMISSION
HICKORY SHAD
Commercial Harvest (pounds) and Discard (pounds)

	HARVEST					DISCARD				
Year	Pound Net	Fyke Net	Haul Seine	Gill Net	Total	Pound Net	Fyke Net	Haul Seine	Gill Net	Total
1988	17				17					
1989	5				5					
1990	7				7					
1991	2,207				2,207					
1992	604				604					
1993										
1994	2			14	16					
1995	34				34					
1996	6				6					
1997	334		510		844					
1998	7				7					
1999	545	50			595	7				7
2000	2				2	4				4
2001	39	450			489			15		15
2002	46				46					
2003	32	90	75		197				2	2
2004	12	162			174	15				15
2005	3				3	20				20
2006										
2007										
2008										
2009										
2010				365	365					
2011	36				36					
2012	65			381	446		2	10		12

Table 4

POTOMAC RIVER FISHERIES COMMISSION
RIVER HERRING
Commercial Harvest (pounds) and Discard (pounds)

	HARVEST				DISCARD			
Year	Pound Net	Gill Net	Other	Total	Pound Net	Gill Net	Other	Total
1981	79,926	3,176	-	83,102	-	-	-	-
1982	486,597	5,849	593	493,039	-	-	-	-
1983	1,710,923	17,867	20	1,728,810	-	-	-	-
1984	898,455	820	-	899,275	-	-	-	-
1985	261,675	-	-	261,675	-	-	-	-
1986	1,198,667	2	-	1,198,669	-	-	-	-
1987	1,164,854			1,164,854	-	-	-	
1988	182,650		6	182,656				
1989	97,047			97,047				
1990	49,734			49,734				
1991	365,964		2	365,966				
1992	162,885			162,885				
1993	144,752			144,752				
1994	80,258			80,258				
1995	113,504			113,504				
1996	80,437		10	80,447				
1997	59,837		112	59,949				
1998	18,497		4	18,501				
1999	26,501		155	26,656				
2000	33,343		27	33,370				
2001	35,702		21	35,723				
2002	51,624	3,320	142	55,086			1	1
2003	19,332		800	20,132				
2004	19,679		60	19,739				
2005	8,472		35	8,507				
2006	6,818		1	6,819				
2007	5,938		73	6,011				
2008	5,476			5,476				
2009	8,925			8,925				
2010	898			898	790	30		820
2011	1,672			1,672				
2012					1,727			1,727

Figure 1- MD DNR state wide annual young of the year survey

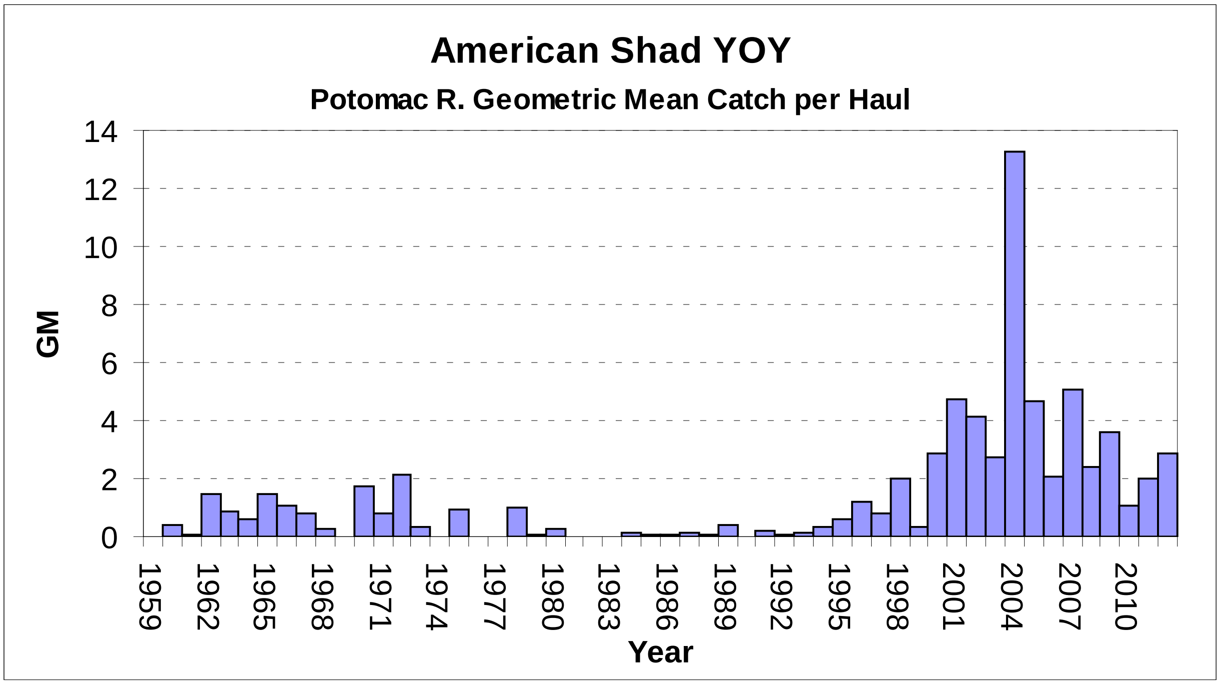


Figure 2- MD DNR state wide annual young of the year survey

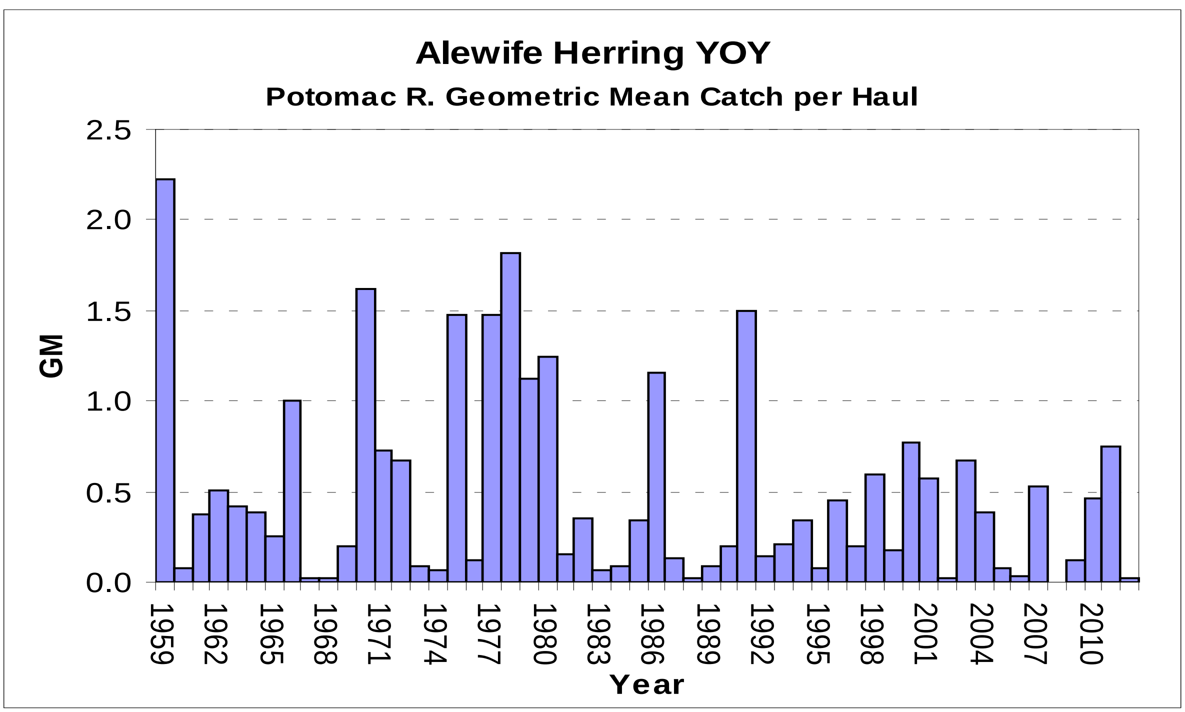


Figure 3- MD DNR state wide annual young of the year survey

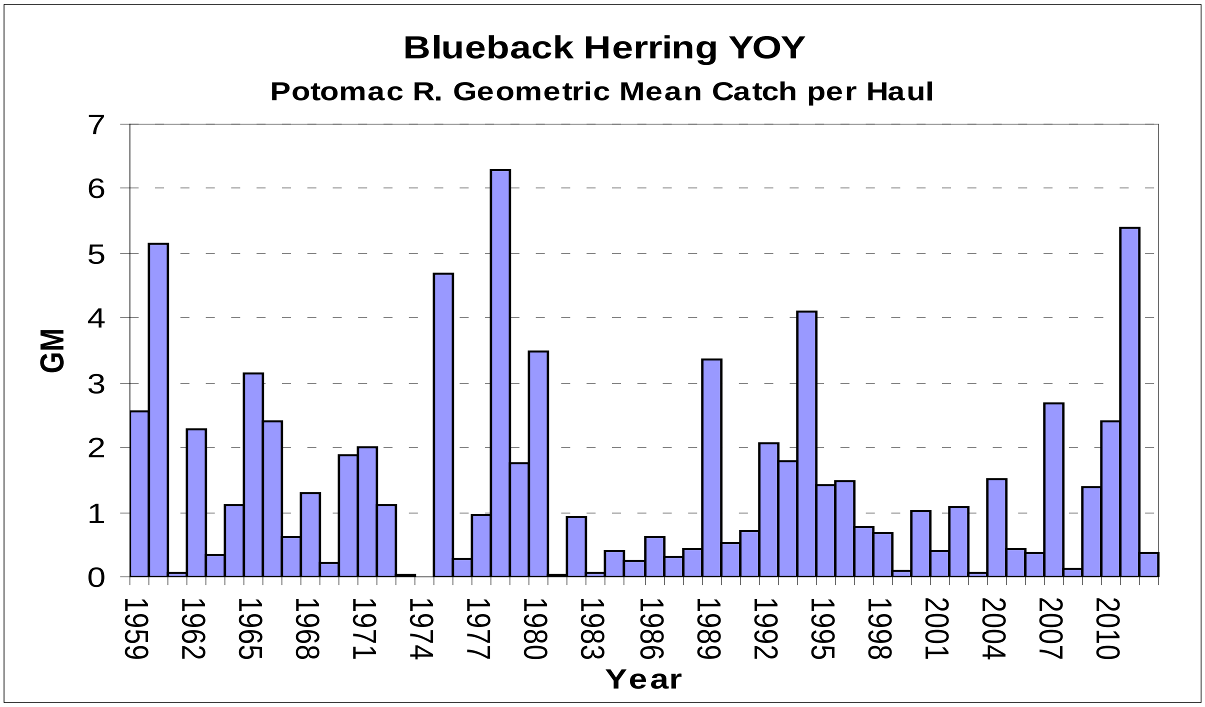
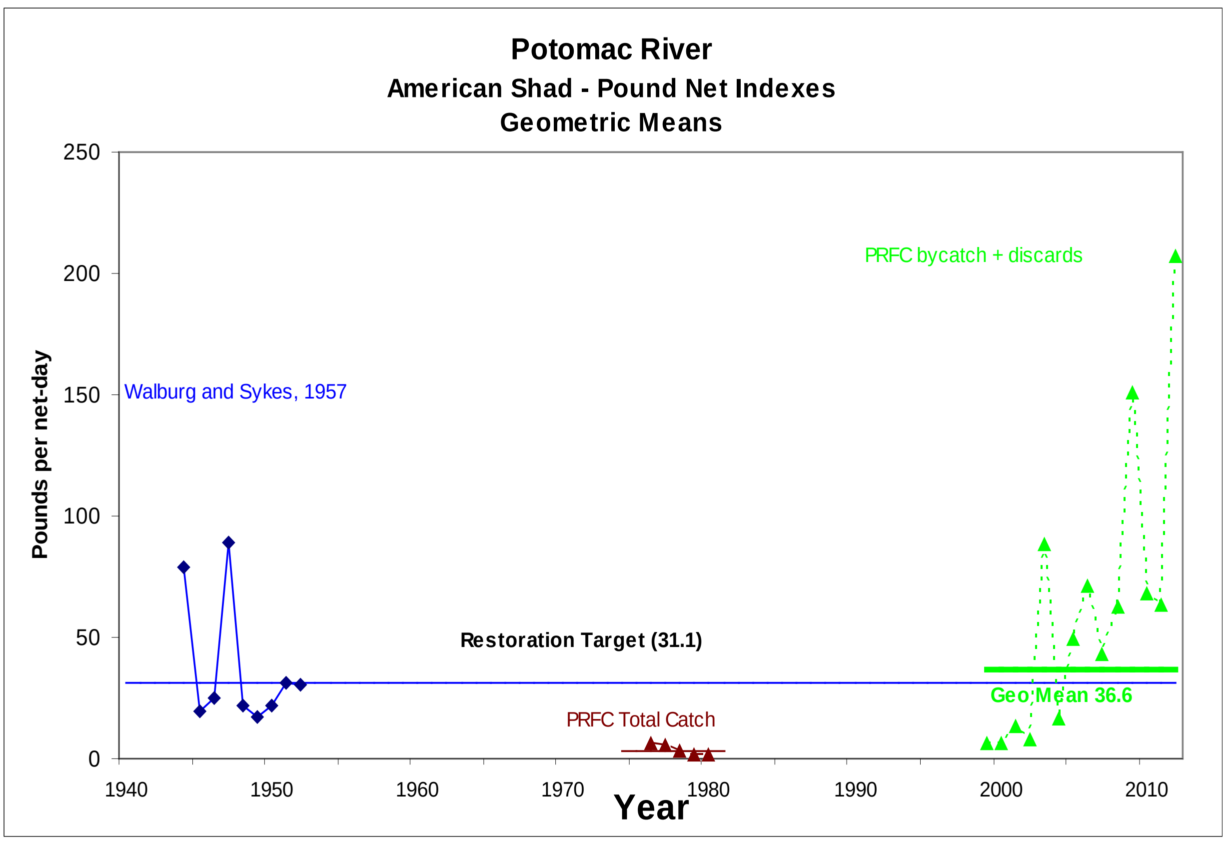


Figure 4



North Carolina Shad and River Herring Compliance Report-2012

Report to the

Atlantic States Marine Fisheries Commission

North Carolina Department of Environment and Natural Resources
Division of Marine Fisheries
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June 2013

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AMERICAN SHAD

I.HARVEST AND LOSSES

A. Commercial Fishery

1*. Characterization of Fishery – American Shad*

The North Carolina Marine Fisheries Commission (MFC) enacted a rule in 1995, which established a closed season for American shad (*Alosa sapidissima*) and hickory shad (*Alosa mediocris*). It is unlawful to take these species by any method except hook-and-line from April 15 through December 31. The ocean intercept fishery for American shad was closed to all harvest January 1, 2005 (ASMFC 2002).

In the Albemarle Sound Management Area (ASMA) (Figure 1), floating gill nets of 5.25 inch stretch mesh (ISM) to 6 ISM (shad float nets), were limited to 1,000 yards and could only be utilized from February 1 through April 14, 2012. The western portion of Albemarle Sound was closed to gill netting from February through mid-November (Figure 2). The large mesh net restrictions were imposed for striped bass conservation but also provided measures of protection for American shad. Unattended gill nets of 3.00 ISM were not allowed due to the river herring closure, except during the discretionary river herring harvest season (Chowan River only). Gill nets with a mesh length of 3.25 ISM could not exceed 800 yards and were allowed the entire spring. Attendance for small mesh gill nets was required May 14-Nov 11, 2012.

In areas outside of the ASMA there is a rule that limits the amount of large mesh (5.0 ISM and greater) gill net set in internal coastal waters to 3,000 yards. In an effort to reduce sea turtle interactions, that rule has been suspended in the majority of internal coastal waters and net yardage allowance has been reduced to 2,000 yards in the Tar-Pamlico and Neuse systems and 1,000 yards in the Cape Fear system. Nets can be set in lengths no greater than 100 yards and must have at least a 25-yard space between each individual length of net. Only single overnight sets are allowed; nets can be set one hour prior to sunset and must be retrieved within one hour of sunrise, with no sets allowed Friday, Saturday or Sunday evenings. Additionally, in certain areas of the Tar-Pamlico and Neuse rivers, gill nets with a mesh size less than 5.0 ISM must be attended at all times.

In November of 2011 interim management measures were implemented for spotted seatrout that make it unlawful to use gill nets of any size in the joint waters of the state (with the exception of the ASMA) on the weekends.

In May of 2012 the ASMFC Shad and River Herring Management Board approved NC's Sustainable Fishery Management Plan (SFP; that includes data through 2011) which will allow commercial and recreational American shad fisheries to remain open in the Albemarle, Tar-Pamlico and Neuse River systems and the Cape Fear River system with additional season restrictions. Currently all systems are within the sustainability thresholds that were outlined in the SFP. The North Carolina Division of Marine Fisheries (NCDMF) presented the SFP to the NC Marine Fisheries Commission advisory committees in the fall of 2012.The final regulations, effective January 1, 2013, include a commercial season from February 15 to April 14, in all areas except the Cape Fear River. The commercial season there would begin on February 20 and extend to April 11. Further reductions in the Cape Fear area were necessary to achieve the sustainability targets (NCDMF 2012).

a. Sustainability Parameters

A variety of potential sustainability parameters were evaluated for each area of the state, using data derived from fishery independent and fishery dependent monitoring programs, including NCDMF independent gill net surveys, electrofishing surveys conducted by NC and commercial landings data collected by the NCDMF Trip Ticket Program. Along with the parameters, thresholds were chosen to trigger management action if any one of the thresholds (with the exception of the Albemarle/Roanoke system) is exceeded for three consecutive years. Sustainability parameters for female CPUE used a threshold of the 25^{th} percentile (above which 75% of values occur). Sustainability parameters for female relative *F* used a threshold of the 75% (above which 25% of values occur).

<u>Albemarle Sound</u>

The sustainability parameters chosen for Albemarle Sound were female CPUE based on the North Carolina Wildlife Resources Commission (NCWRC) electrofishing survey, female CPUE based on the NCDMF Independent Gill Net Survey (IGNS) and female relative *F* based on the IGNS (Figure 3 and 4). Exceeding the threshold for Female CPUE (NCDMF IGNS) or Female Relative *F* (NCDMF IGNS) will trigger management action. Female CPUE (NCWRC electrofishing survey) will be used in conjunction with a second index for triggering management action. Female IGNS CPUE has been below the 25^{th} percentile for the last two years, but it has been above the threshold in the electrofishing index (Figure 3). Female relative *F* has been above the 75^{th} percentile since 2010 (Figure 4). While this represents three years above the threshold and would normally trigger additional management action, new fishing regulations were just implemented January 1, 2013 as per the SFP (and prior to the availability of the 2012 survey data). Technically, DMF implemented management changes prior to a trigger being reached, and therefore recommends no additional management restrictions until 2013 data are complete and existing measures can be evaluated.

Tar-Pamlico River

The sustainability parameters selected for the Tar-Pamlico River were the female CPUE index and female relative *F,* both from the electrofishing survey. Female CPUE has been above the 25th percentile threshold for the last three years (Figure 5). Female relative *F* has been below the 75th percentile for the last two years, although in 2012, it was very close to the threshold (Figure 6).

Neuse River

The sustainability parameters selected for the Neuse River were the female CPUE and female relative *F*, both derived from NCWRC electrofishing surveys. Female CPUE has been above the threshold for the last two years, while female relative *F* has been well below the threshold for several years (Figure 7 and 8).

Cape Fear River

Sustainability parameters chosen for the Cape Fear River were the female CPUE index and female relative *F*, both derived from NCWRC electrofishing surveys. The female CPUE had been near or on the threshold since 2006, but in 2012, it was well above it (Figure 9). Female relative *F* was above the threshold in 2009 and 2010, but has fallen below the threshold in 2011 and 2012 (Figure 10).

2. ***Characterization of Directed Harvest***

a. Landings

Commercial landings are reported from the NCDMF Trip Ticket Program (TTP). This program requires dealers to complete a trip ticket for each transaction with a fisherman and to submit these reports to the NCDMF on a monthly basis.

The North Carolina American shad landings and value for 1972-2012 are presented in Table 1. The 2012 American shad landings in North Carolina (NC) totaled 235,861 pounds with a value of $257,748. The ASMA accounted for 75.5% of the state's total harvest, contributing the highest percentage of the in-river fisheries. Gill nets contributed 88.6% of the overall harvest.

Table 2 shows the American shad landings by area, relative to the number of participants, positive trips, and the percentage by poundage from all gears to the harvest for 2012. The TTP data indicates that 238 pounds of American shad were landed and sold from the Atlantic Ocean even though the fishery was closed.

b. Catch Composition

Albemarle Sound

A total of 441 samples was obtained from the ASMA commercial fishery. Males comprised 35.4% of the samples and ranged from 235-476 mm FL. Females comprise 64.6% of the samples and ranged from 397-552 mm FL (Figure 11). Of the 125 samples that were aged, male American shad were 4 through 8 years old (235-445 mm FL) and females were 4 through 8 years old (397-552 mm FL). Mean, min, and max lengths at age can be found in Table 3. Virgin fish comprised 68.8% of the aged sample and none of the fish sampled had more than one spawning mark (Table 4).

Pamlico River

A total of 313 samples was collected from the Pamlico River commercial gill net fishery. Males comprised 12.5% of the samples and ranged from 335-496 mm FL (Figure 12). Females comprised 87.5% of the samples and ranged from 399 to 514 mm FL (Figure 12). Mean, min, and max lengths at age can be found in Table 3. One hundred twenty-six samples were aged. Males ranged from 4 through 7 years old (338-496 mm FL). Females ranged in age from 4 to 7 (421-514 mm FL). Virgin fish comprised 65.8% of the aged sample and 2.4% of the fish sampled had more than one spawning mark (Table 5).

Neuse River

A total of 584 samples was collected from the Neuse River commercial gill net fishery. Males comprised 17.6% of the samples and ranged from 339-468 mm FL. Females comprised 82.4% of the samples and ranged from 401-512 mm FL (Figure 13). Of the 129 samples that were aged, males ranged from 4 through 6 years old (353-432 mm FL) and females were 4 through 8 years old (417-506 mm FL). Mean, min, and max lengths at age can be found in Table 3. Virgin fish comprised 56.6% of the aged sample and 3.1% of the fish sampled had more than one spawning mark (Table 6).

Cape Fear River

A total of 196 samples was collected from the Cape Fear River commercial gill net fishery. Males comprised 31.1% of the samples and ranged from 359-462 mm FL. Females comprise 68.9% of the samples and ranged from 396-500 mm FL (Figure 6). Of the 144 samples that were aged, male American shad were 3 through 6 years old (359-462 mm FL) and females were 4 through 8 years old (396-495 mm FL). Mean, min, and max lengths at age can be found in Table 3. Virgin fish comprised 72.2% of the aged sample and no fish had more than one spawning mark (Table 7).

c. Estimation of Effort

Effort in the American shad commercial fishery is characterized in Table 2 as number of positive trips, number of participants and percentage by poundage for all gears. Albemarle Sound area had the highest number of positive trips (2,320), followed by the Pamlico (462), Neuse (302) and Cape Fear (134) systems. The number of participants varied by system and ranged from 364 for Albemarle Sound to 24 for the Cape Fear River.

d. Mortality Estimates

Estimates of mortality were calculated for the Albemarle Sound (40.3%), Pamlico River (42.1%), Neuse River (33.9%) and Cape Fear River (46.9%) commercial fisheries (Table 8).

3. ***Characterization of other losses***

No reliable estimates of bycatch are available from the American shad commercial fishery. However, gear restrictions implemented in Albemarle Sound following the closure of shad season and those implemented in the other areas of the state for sea turtle conservation likely reduce bycatch to a minimal level. NCDMF began an observer program in 2012, which may provide information regarding bycatch of non-target and endangered species in the commercial fisheries of Albemarle Sound.

B. Recreational Fishery

1. Characterization of Fishery

Recreational Commercial Gear License (RCGL)

The NCDMF offers an annual license that allows holders a limited amount of commercial gear to be used to harvest fish for personal consumption only. These fish may not be sold and RCGL holders must adhere to the recreational limits for all species.

In 2011 RCGL harvest data was not collected due to budgetary constraints. The average landings for the years 2002-2008 was 14,623 lbs.

Hook and Line Harvest

American shad and hickory shad hook-and-line creel limits are 10 fish per person per day in the aggregate except in the inland waters of the Roanoke River where the daily creel limit for American shad is one fish. A new rule implementing a 1-fish limit for American shad in the inland waters of the Neuse River became effective in August, 2012. The 10-fish American and hickory shad aggregate creel limit is in effect throughout the waters of the Tar-Pamlico and

Cape Fear rivers. Proposed 2013 measures (effective January 1, 2013) in the Sustainable Fisheries Plan (NCDMF/NCWRC 2012) included a one-fish recreational creel limit for American shad in joint and coastal waters of the Roanoke and Neuse rivers to complement the NCWRC 1-fish limit in inland waters of those rivers. For the Cape Fear River, 2013 measures include a reduction in the daily creel limit for American shad to five fish in inland, joint and coastal waters. This should achieve the harvest reductions necessary to meet the SFP target.

2. Characterization of Directed Harvest

Recreational Harvest Monitoring

Through coordination by the NCWRC and NCDMF in the fall of 2011, the monitoring programs for recreational hook and line fishery for American shad were changed from the previous rotating basis among the Roanoke, Tar, Neuse and Cape Fear Rivers to a more consistent approach of monitoring multiple systems in the same year. In 2012, methods were developed to conduct recreational creel surveys on the Roanoke, Tar and Neuse River. With a recent American shad creel survey completed for the Cape Fear (Ashley and Rachels 2011) and the need to adjust logistics for appropriate coverage on all four river systems, the Cape Fear River was excluded in 2012, with plans to conduct recreational creel surveys on all four major coastal rivers in North Carolina in 2013. With this broad change in the recreational monitoring program, estimates for 2012 and 2013 effort, catch and harvest of American shad will be included in the 2013 compliance report.

Recreational creel surveys were conducted on the Roanoke, Tar-Pamlico and Neuse Rivers with a non-uniform probability stratified access-point creel survey from March through May 2012 (Pollock et al. 1994). Site probabilities were set in proportion to the likelihood of angler use of the site according to time of day, day of the week, and season. On the Tar-Pamlico and Neuse Rivers, the probabilities were based on both boat and bank angler use whereas the probabilities were based on boat angler use due to the low level of bank angling on the Roanoke during the spring months. Probabilities were adjusted during the survey period according to angler counts to provide more accurate estimates. Morning and afternoon periods were assigned unequal probabilities of conducting interviews, with each period representing half a fishing day. A fishing day was defined as the period from one hour after sunrise until one hour after sunset. Due to the migratory patterns of anadromous fish and response by anglers to the upstream migration, each river was divided into zones and sites within each zone were assigned probabilities based on angling effort within each zone. The Roanoke and Tar-Pamlico Rivers were divided into two zones whereas the Neuse River was divided into three zones. One creel clerk was assigned to each zone of the Tar/Pamlico River and Neuse Rivers whereas two creel clerks were assigned to cover both zones on the Roanoke River.

Returning fishing parties were interviewed by a creel clerk at the assigned access point upon trip completion to obtain information regarding party size, angler origin, effort, total number of fish harvested and/or released, primary fishing method, and location. Harvested fish were identified, enumerated, measured (nearest mm total length), and weighed to the nearest 0.1 kg, while information on discarded fish was obtained from the angler(s) to acquire the number and status of fish caught and released. Scale collections were taken from available fish to determine age of catch on the Tar-Pamlico and Neuse; no ageing structures were collected by creel clerks on the Roanoke. On the Tar-Pamlico and Neuse Rivers, creel clerks also obtained socioeconomic information from the angler(s), including age, state and county of residence, sex, ethnic background, marital status, number of individuals within household, and trip information and expenditures.

Information on the recreational harvest for 2011 was inadvertently left out of the 2012 report. It is included here. During the 2011 creel period on the Cape Fear River, a total of 328 angler parties (644 total anglers) were interviewed, 58% of which were fishing specifically for American shad (Ashley and Rachels 2011). Boat anglers accounted for 83.5% of all shad anglers with bank anglers comprising the remaining 16.5%. Sixty-four percent of all shad angling activity took place on weekdays while the remaining 36% occurred on weekend days; preference for weekday fishing was observed for both boat anglers and bank anglers. An estimated 25,706 angler hours (SE=4,093) were exerted specifically for American shad in 2011. In comparison, a total of 19,839 angler hours (SE=4,809) were expended by Cape Fear River shad anglers during a 10-week intensive creel survey of boat and bank anglers conducted on the river between 5 March and 19 May 2002 (NCDMF 2003). Total recreational catch of Cape Fear River American shad in 2011 was 22,312 fish (SE=2,938) with an estimated harvest of 14,888 (SE=1,813) shad weighing 9,346 kg (SE=1,274) or 20,604 lb (SE=2,809 lb). Anglers harvested 66.7% of the total catch. Boat anglers accounted for 96.8% of all American shad caught and 95.0% of all American shad harvested during the 2 month creel survey. Total lengths ranged from 333 to 598 mm and were consistent with shad lengths collected at the same time by independent stock assessment sampling conducted by NCWRC using electrofishing gear. Male American shad were smaller, exhibiting a peak at 430 mm while females showed a peak at 490 mm. Surveyed Cape Fear American shad were 54% male and 46% female. Anglers targeting American shad had a success rate of 1.0 fish caught per hour of fishing (boat and bank anglers combined).

3. Characterization of Other Losses

<u>Brood Stock Collection</u>

For 2012, a total of 303 adult American shad was collected for (NCWRC Watha State Fish Hatchery) use as brood stock from the Roanoke River. The broodfish (138 females and 165 males) were sacrificed to avoid the possibility of broodfish spawning in the wild, maintaining the integrity of genetic markers. Weights of the 303 American shad broodstock removed from the Roanoke River were approximately 132.0 kg of males (average individual weight 0.8 kg) and 182.8 kg of females (average individual weight 1.32 kg) for a total weight of 314.8kg. US Fish and Wildlife Service Edenton National Fish Hatchery received 97 American shad as broodfish from the Neuse River. Forty-four broodfish males (average individual weight 0.8 kg) were sacrificed to ensure integrity of genetic markers, whereas females were released back to the

Neuse River. Seven female American shad died (average individual weight1.2 kg) while at the hatchery. The weight of these American shad losses was approximately 34.9 kg and 8.1 kg, respectively (Table 9). NCWRC staff sacrificed a total of 457 adult American shad for ageing purposes in 2012. Removals per river were 41 fish (39.6 kg) from the Roanoke (in addition to hatchery losses), 60 fish (62.7 kg) from the Tar, 130 (134.1 kg) from the Neuse (in addition to hatchery losses), and 226 (252 kg) from the Cape Fear.

C. Other Losses

See Appendix A

D. Harvest and Losses

See Appendix A

E. Protected species- Atlantic Sturgeon

Atlantic sturgeon bycatch in American shad fisheries and the IGNS will be included in the annual sturgeon compliance report.

II. REQUIRED FISHERIES INDEPENDENT MONITORING

A. Description of Required Independent Monitoring

According to Amendment 3 to the Shad and River Herring FMP (ASMFC 2010), North Carolina is required to conduct an annual spawning stock survey and representative sampling for biological data as well as calculate survival and mortality estimates required from Albemarle Sound and its tributaries, Tar-Pamlico, Neuse, and Cape Fear rivers for American shad. These programs will continue for 2013.

1. Description of Work Performed

Spawning Stock Assessment

NCWRC collected American shad from the Roanoke, Tar, Neuse, and Cape Fear river systems from February to June 2012 (Figure 15). A boat–mounted electrofishing unit (Smith–Root 7.5 GPP) with one dip netter on the Tar, Neuse and Cape Fear rivers and two dip netters on the Roanoke River was used to capture fish during daylight hours and electrofishing effort was recorded. To minimize size selection during sampling, American shad were netted as they were encountered. Relative abundance of each year class was indexed by catch-per-unit-effort (CPUE) and expressed as number of fish captured per hour of electrofishing. American shad broodstock collections to support fry production were not included in calculations of CPUE. Sex was determined for each captured American shad by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs. Each fish was measured for total length (TL mm). Five otoliths from each 10-mm length bin by sex were collected for aging. All otoliths were aged by a primary reader and were photographed using a Wolfe DigiVu CM 2.0 stereomicroscope. A secondary reader aged all otolith photographs. Otoliths were aged without knowledge of fish sex or length. Differences between readers were resolved with a concert read of digital images until 100% agreement was reached. Proportions of each age class within each 10-mm length bin were computed and expanded to the total number of American shad collected within each length bin by sex. Age distributions and CPUE by age-class were then calculated for each river. Mean lengths at age were calculated for the entire sample following methods described by Bettoli and Miranda (2001). Daily and overall CPUE, sex, and length frequency (TL mm) information for both species were collected for each stream sampled.

Juvenile Abundance Index

See river herring section for a description of methods.

Albemarle Sound Fishery Independent Gill Net Survey

Since 1990, NCDMF has been conducting an independent gill net survey (IGNS) throughout the Albemarle Sound area. The survey was designed for striped bass data collection. However, American shad are captured during the survey and size, age, and sex data are collected. Gill nets from 2.5 through 7.0 ISM, in half-inch increments and 8.0, and 10.0 ISM are utilized. The IGNS is conducted from November through May, but results for shad and river herring are reported for January through May, because catches of these fish at other times are rare. Areas fished, sampling effort and sampling frequency vary seasonally. Each unit of effort is one 40-yard net, fished for 24-hours.

In Pamlico, Pungo, Neuse and Cape Fear rivers and Pamlico Sound, the IGNS runs February 15 to December 15. An array of nets consists of 30-yard segments of 3.0 to 6.5 ISM, in half-inch increments. The soak time is 12 hours. For Atlantic Ocean sampling, an array of nets consists of 30-yard segments of 2.5 to 6.5 ISM. Gear is deployed within an hour of sunset and fished overnight for a soak time of 12 hours from October to March. Gill nets are fished for two hours from April through September.

2. Results

1. Juvenile Indices - see River Herring section for results

2. Spawning Stock Assessment

Roanoke River

From 27 February 2012 to 11 June 2012, 966 American shad were collected from the Roanoke River spawning grounds near the Gaston boating access area (Table 10). Males comprised 92% of the sample (N=884) while females accounted for only 8% (N=82; Figure 16). Overall CPUE was 145 fish/h, the highest catch rate with two dip netters since 2009 (Table 10). In 2003, 2004, 2010, and 2011, only one dip netter was used whereas two dip netters were used during 2005−2009 and 2012 sampling (Table 10). Otolith age was determined for 252 individuals (145 females, 102 of which were obtained from separate broodstock collections, and 107 males, 100 of which were obtained from separate broodstock collections). Initial agreement between otolith readers was 64%; however, upon a second concert read agreement was 100%. Otolith analysis showed an age distribution ranging 2–7 years for males and 3–7 years for females (Table 11). Male American shad from the 2008 year class (age 4) were most abundant (43% of the total), while the majority of female American shad were from the 2006 and 2007 year classes (age-5 and age-6). Overall, spawning stock size distribution ranged from 337 to 570 mm (Figure 17). The length frequency distribution for males was unimodal with a peak between 410−460 mm. The female length frequency distribution was unimodal as well with a peak between 490−510 mm. Length-at-age analysis indicated mean total lengths of the most abundant year classes of age-4 males and age-6 females were 437 mm and 506 mm, respectively (Table 11).

Tar River

A total of 286 American shad was collected from the Tar River during the spring of 2012. Of this total, age was estimated for 58 individuals using otoliths. All aged fish were read by primary and secondary readers. American shad collections began as water temperature approached 5 C, with CPUE values peaking at 15 C. Overall CPUE was 117 fish/h, which was greater than the 2011 value (79 fish/hr). (Table 10). Weather conditions and river flows likely influence the variability in catch rates among years. In 2012, males comprised 73% (N=210) of the sample while females accounted for 27% (N=76; Figure 18). Male American shad ranged in age 3–6 years, while females ranged in age 4–6 years (Table 12). For both males and females, the 2007and 2008 cohorts accounted for the majority of the total catch (Figure 18). American shad collected in the 2012 sample ranged in total length from 376–551 mm (Figure 19). The length frequency distribution for males showed most individuals occurring between 430 and 460 mm length intervals, while the majority of females were between 480 and 520 mm length intervals. Mean length at age analysis for Tar River American had indicated that males between ages 3–5 had growth rates that ranged from approximately 10 to 25 mm per year (Table 12). Female American shad were consistently larger than males of the same cohort, although growth rates only averaged from 1 to 13 mm per year (Table 12). However, these growth rates were based on a fairly small subsample of only 3 year classes.

Neuse River

A total of 792 American shad was collected from the Neuse River during spring 2012. Otolith ages were determined for 125 fish. Initial agreement between otolith readers was 79%; however, upon a second concert read agreement was 100%. With the exception of one female in the 400–409 mm size group, ages were assigned to 791 American shad collected using a gender specific age-length key. Overall CPUE was 39 fish/h, which is the highest CPUE recorded since 2003 (Table 10). In 2012, males comprised 68% of the catch (N=540) while females contributed 32% (Figure 20). Five male cohorts ranging in age from 3 to 7 and four female cohorts ranging in age from 4 to 7 were documented (Table 13). Overall, 95% of the total catch was supported by the 2006 to 2008 year classes. Size distributions for both sexes were unimodal with the location of the mode approximated by the mean length of fish in the dominant year classes (Figure 21). Age-5 males were most abundant and corresponded to a size distribution mode ranging from 440 to 449mm. Most females were age-6 and corresponded with a size distribution mode from 500mm to 509 mm. American shad ranged in length from 340 mm to 556 mm; 96% of all fish larger than 500 mm were females. Although females were larger than males of the same age, average annual incremental growth of adult American shad returning to the spawning grounds averaged 17 mm per year (range=13–22 mm per year; Table 13). Small incremental growth suggests slowed growth after maturity for the Neuse River spawning stock.

Cape Fear River

A total of 488 American shad was collected from the Cape Fear River in 2012. Otolith age was estimated for 198 individuals, with the remaining American shad assigned ages from a gender specific age-length key. Initial agreement between otolith readers was 85%; however, upon a second concert read agreement was 100%. Overall CPUE was 65 fish/h, the highest CPUE observed since 2004 (1046 fish/h) and was almost double the long term average CPUE of 39 fish/h (Table 10). In 2012, males comprised 80% (N=392) of the sample while females accounted for 20% (N=96; Figure 23). Males from the 2007–2009 year classes (ages 3–5) accounted for 77% of this year's sample, whereas females from the 2006–2008 year classes (ages 4–6) accounted for an additional 18% of all American shad collected. Male American shad ranged in age from 3–7 years, while females ranged from 4–8years (Table 14, Figure 22). American shad collected in the 2012 sample ranged from 334 to 572 mm total length (Figure 23). The peaks in the length-frequency histogram for males occurred at 410 mm and 440 mm. For females, the size distribution peaked at 500 mm and 530 mm. Mean total length-at-age analysis for Cape Fear River American shad indicated that males between ages 3–7 had growth rates that ranged 22–34 mm per year (Table 14). Female American shad were consistently larger than males of the same cohort, with growth rates for age 4–7 female American shad averaging 1–26 mm per year (Table 14).

Albemarle Sound Fishery Independent Gill Net Survey

A total of 81 American shad was captured during the 2012 IGNS. Mean, min, and max length and age can be found in Table 15. The 3.0 through 4.5 ISM gill nets were the most productive; accounting for 69% of the catch (Table 16). None of these mesh sizes are allowed unattended in the ASMA commercial fishery. Males ranged from 337-437 mm FL and females from 404-500 mm FL (Figure 24). Of the 72 shad that were aged, males ranged from 3 through 6 years old, while females ranged from 4 through 6 years of age. Virgin fish accounted for 77.8% of the aged sample and 2.8% had more than one spawning mark (Table 17).

Other Areas Independent Gill Net Survey

Through an independent gill net survey in the other areas of the state, 36 American shad were captured in the Pamlico River and 46 in the Neuse River. Thirty-five American shad were aged from the Pamlico River; 31% were males (351-422 mm FL). 69% were females (408-498 mm FL). Males ranged from 4 to 6 years of age, while females ranged from 5 to 8 years of age (Table 18). Only two American shad were captured in the Atlantic Ocean, which were not aged.

Forty-six American shad were aged from the Neuse River; 22% were males (360-438 mm FL) ranging from ages 4-6 with zero fish aged having more than one spawning mark (Table 18). 68% were females (368-5488 mm FL) comprised of ages 4-7 with no fish having more than one spawning mark. Mean, min, and max length at age, by sex is presented in Table 15.

3. Annual Mortality Rate Calculation

Estimates of mortality were completed for the Albemarle Sound IGNS (54.6%). Data were not sufficient to estimate survival from any other independent data source.

4. Hatchery Evaluation

Methods

American shad fry reared at the USFWS Edenton National Fish Hatchery (ENFH) and at the NCWRC Watha State Fish Hatchery have been stocked annually into the Roanoke River since 1998 (Table 21). This restoration project was initiated by NCWRC and funded by the North Carolina Department of Transportation as mitigation for aquatic habitat damages resulting from highway bridge construction on the Roanoke River (see North Carolina's 1999 Shad and River Herring Report for full details). For details on the history of North Carolina shad production between 1998 and 2011 reference NCWRC (2011).

Following protocols of other states involved in American shad restoration efforts as well as those developed in North Carolina (Evans 2010), broodstock for fry production were obtained from nearby rivers having adequate shad stocks. American shad broodfish were collected in 2011 with boat electrofishing from the Tar, Cape Fear, and Roanoke rivers. Since 2009, no broodfish were injected with hormone upon arrival at the hatcheries based on successful shad culture experimentation without hormone injections in 2008 (Evans 2010).

From 1998 to 2010, American Shad fry reared and stocked in the Roanoke River were evaluated using oxytetracycline (OTC) marks (NCWRC 2011). Beginning in 2011, OTC marking was replaced with genetic marking to evaluate hatchery contribution. Benefits of genetic microsatellite markers include greater precision and accuracy compared to OTC marks as well as a non-lethal method to determine origin. Discrete batches of broodfish were fin clipped at the hatchery and catalogued (Table 22 and Table23). Out-migrating juvenile American shad were sampled and fin clipped each fall in the lower Roanoke River near Plymouth, NC. These fin clips from adult and juvenile American shad were sent to a genetics laboratory (NC Museum of Natural Sciences in 2011 and 2012) for genotyping with specific genetic markers to compare with genetic material from each discrete batch of broodfish. This “parentage analysis” allows for the conclusive determination of hatchery contribution by each cohort. This process will alsobe used to evaluate the contribution of returning adult cohorts to the spawning ground population over time. Sources of juvenile fin clips include NCWRC electrofishing in the Roanoke River and NCDMF seine surveys in the Albemarle Sound. Adult American shad fin clips will be collected from the Roanoke River spawning grounds. A pilot, fry stocking-based, American shad restoration project was initiated on the Neuse River in 2012. Protocols regarding broodstock collection and evaluation of hatchery contribution were similar to those established for the Roanoke River American shad restoration plan. Endemic broodfish (target 100 adults) were collected from the Neuse River and tank spawned at the USFWS ENFH (Table 24). Stocking evaluations will intensify in 2015 when genetically identifiable hatchery reared adult American Shad are likely to return to Neuse River spawning grounds. Preliminary evaluations will involve determining the hatchery contribution of outmigrating juveniles, also utilizing the genetic markers and parentage analysis

Results

Fry Production and Locations Stocked.

Success in tank spawning and fry production varied annually yet generally improved over time. Refinement of production methods including cessation of hormone use, use of heated water, and recirculating hatchery systems has brought improved production efficiency. These refined methods have led to great success in fry production.

The strategy of stocking fry both in the Staunton River above John H. Kerr Reservoir and in the mainstem Roanoke River below Roanoke Rapids Dam continued from 2004 to 2009 at a 1:1 ratio. In 2010, the proportion of fry stocked upstream of the reservoirs was reduced in response to lower hatchery contributions of fry stocked above the reservoir to the out-migrating fall juvenile samples (NCWRC 2010; Table 21). Therefore, the goal in 2012 was to stock 1 million fry above Kerr Reservoir and 4 million fry downstream of the reservoirs using approximately 400 endemic broodstock. During 2012, 3,757,816 fry were stocked into the Roanoke River downstream of Roanoke Rapids Dam at Weldon, NC. An additional 1,041,852 fry were stocked upstream of John H. Kerr Dam in the Staunton River near Clover Landing, VA. The total number of American shad fry stocked into the Roanoke River system in 2012 was 4,799,668 (Table 23).

Evaluation of Hatchery Contribution.

Due to the time lag involved with processing genetic samples the 2011 genetic data will be included in this report. Readers will find the 2012 genetic data in the 2013 report. Fin clips from 82 juvenile American shad collected from the Roanoke River during fall 2011 were processed to determine hatchery contribution of the 2011 cohort to juvenile out-migration. Seventy-eight juvenile shad were collected with nighttime boat electrofishing near Plymouth, NC, and the remaining four were collected during routine electrofishing surveys in other portions of the lower Roanoke River. The microsatellite markers were a conclusive match with hatchery broodfish for 31 of the 82 samples; analysis further revealed that all of the recaptured hatchery fish were stocked at Weldon in 2011 (Table 25). Overall hatchery contribution to the Roanoke River out-migration was 38% in 2011. In addition to the lower Roanoke River juvenile shad sample, Dominion Power and Virginia Department of Game and Inland Fisheries provided seven juvenile American shad that were collected during October and November near Clover, VA, in the Staunton River upstream of Kerr Reservoir and one juvenile shad collected from Kerr Reservoir. All eight shad exhibited hatchery parentage from broodstock collected in 2011 and used to produce fry for stockings above the reservoirs. The presence of hatchery-origin juvenile shad upstream of Kerr Reservoir in late fall 2011 in addition to the absence of these shad in NCWRC collections from the lower Roanoke River suggests that under current conditions American shad stocked in the Staunton River, VA, were less likely to emigrate through the series of reservoirs and join the migratory population of American Shad.

Neuse River American Shad Restoration.

A total of 573,582 American Shad fry were stocked in the Neuse River at the NC Hwy 117 bridge near Goldsboro, NC. All fish were catalogued for genetic markers (Table 24). Evaluation of stockings will be similar to adult American shad evaluations conducted on the Roanoke River and will begin in spring 2015. Juvenile collections from 2012 will be compared with 2012 Neuse River parentage analysis in 2013 to determine the hatchery contribution to out-migrating American shad.

<u>FERC Relicensing Update</u>

State and federal fisheries management agencies in North Carolina and Virginia finalized negotiations with Dominion/N.C. Power with regards to relicensing of the Gaston and Roanoke Rapids lakes hydroelectric dams through the Federal Energy Regulatory Commission (FERC). Among the mitigative measures required by relicensing was a long-term, well-funded, and coordinated program to restore American shad in the Roanoke River basin. Measures outlined in this effort included improvements in hatchery production of fry, continued intensive monitoring of fry stocking success upstream and downstream of the mainstem reservoirs, and an assessment of American shad population size, using hydroacoustic techniques, as it pertains to providing upstream passage facilities. The addition of 2012 data to the CPUE time series indicates a slight increase in overall American Shad abundance may be occurring (Table 10). However, the low contribution of females to the spawning population at Roanoke Rapids (8%) remains a concern (Table 11). In addition, based on hydroacoustic estimates of shad population size, the American Shad Working Group associated with implementation of Dominion's Settlement Agreement has determined that the Roanoke River American shad population is not yet large enough to begin upstream passage of spawning adults. Consequently, the design and construction of fish passage facilities at Roanoke Rapids Dam has been delayed. The gill net survey designed to assess holdover of sub-adult shad in John H. Kerr Reservoir was completed in 2012; although captures of American shad with this gear were very low (5 fish total measuring 135-197 mm), electrofishing gear used in the lower Staunton River collected 26 American shad (100-133 mm in length), therefore some stocked American shad do not appear to be getting downstream of Kerr Dam in their first year of life. Alteration of above-reservoir shad fry stocking locations may be used in the future to further investigate the issue of holdover in reservoirs and subsequent emigration success. Major improvements in American shad fry marking techniques occurred in 2012 as the use of OTC marks transitioned to the use of microsatellite markers, allowing more accurate measurements of hatchery contribution.

HICKORY SHAD

I. HARVEST AND LOSSES

A. Commercial Fishery

1. Characterization of Directed Harvest

See American shad section for seasons and regulations information.

2. Characterization of Directed Harvest

a. Landings and Method of Estimation

Hickory shad landings and value for 1972-2012 are presented in Table 26. A total of 65,645 lbs was harvested in 2012 worth $22,389. Albemarle Sound accounted for 48% of the total harvest and Pamlico Sound 37%.

b. Catch Composition

No data available

c. Estimation of Effort

The 2012 hickory shad landings from ,Albemarle Sound , and other coastal areas relative to number of participants, the total number of positive trips and the percentage by poundage from all gears to the harvest are presented in Table 27.

3. Characterization of Other Losses

No data available

B. Recreational Fishery

1. Characterization of Fishery

See American shad section.

2. Characterization of Directed Harvest

No Recreational Commercial Gear License data was collected in 2012 due to budgetary cuts and restraints.

3. Characterization of Other Losses

No data available.

II. REQUIRED FISHERIES DEPENDENT MONITORING

A. Description of Requirement

There is no Amendment 1 compliance requirement for hickory shad.

B. Description of Work

See the American shad section for a description of the IGNS and see the river herring section for a description of juvenile sampling.

C. Results

Table 28 shows the catch rate for hickory shad in the IGNS. In 2012, 365 hickory shad were caught, for an overall CPUE of 0.17. Figure 25 shows the length frequency distribution of hickory shad in the IGNS.

Juvenile hickory shad data is presented in the river herring section for Albemarle Sound area.

RIVER HERRING

I. HARVEST AND LOSSES

A. Commercial Fishery

1. Characterization of Fishery

In 2006, NCWRC implemented a no-harvest provision for river herring greater than six inches in inland waters. The North Carolina MFC, through development and approval of Amendment I to the NC River Herring FMP (NCDMF 2007), approved a no harvest provision for commercial and recreational river herring (blueback, *Alosa aestivalis*, and alewife, *Alosa pseudoharengus*), harvest in waters under their jurisdiction. The ASMFC approved the North

Carolina River Herring Sustainable Fishery Plan in 2010 which outlined a maximum 7,500 lb limited research set aside to be allocated at the NCDMF Director's discretion in order to collect data necessary for stock analysis, and to provide availability of some local product for the Jamesville Herring Festival, Jamesville, NC and other local festivals. In order to implement the harvest of this discretionary amount, a Discretionary Herring Fishing Permit (DHFP) was created. Individuals interested in participating had to meet the following requirements: (1) obtain a DHFP, (2) harvest only from the Joint Fishing Waters of Chowan River on April 2-5, 2012, (3) hold a North Carolina Standard Commercial Fishing License (SCFL) or a Retired SCFL, and (4) participate in statistical information and data collection programs.

2. Characterization of Directed Harvest

a. Landings

A total of 18 DHFP was issued and the allocation for each permit holder was 150 lb for the four day season. A total of 678 lb was harvested with a value of $678 for the period (Table 29).

b. Catch Composition

Samples from the research set-aside harvest are collected in conjunction with the Chowan River pound net survey; see the Required Fishery Independent Monitoring section for results.

c. Annual Mortality Rate Calculation

For mortality rate calculation, see the Chowan River Pound Net Survey.

B. Recreational Fishery

In the Coastal and Joint waters of the state a no harvest provision was in place on river herring and no harvest was reported. The NCWRC has also prohibited the harvest and possession of river herring greater than 6 inches in the Inland Waters (coastal drainages) while fishing or boating. This rule takes effect August 1, 2013.

1. Characterization of Directed Harvest – No data available.

2. Characterization of Other Losses – See Appendix A.

II. REQUIRED FISHERY INDEPENDENT MONITORING

A. Description of Requirement

According to Amendment 2 of the ASMFC Shad and River Herring FMP (ASMFC 2009), North Carolina is required to annually conduct independent sampling programs. These programs include an annual spawning stock survey, mortality and survival estimates, and a juvenile abundance index.

B. Brief Description of Work

Juvenile Abundance Index (JAI)

Eleven seine stations were sampled monthly with an 18.5 m (60 ft) bag seine in the western Albemarle Sound area during June-October 2012 (Figure 26). One unit of effort is one haul of the seine. Samples were sorted by species and 30 randomly selected individuals of each alosine species present were measured. Other species present were also noted. Water temperature, salinity, and other environmental characteristics were measured and recorded

Albemarle Sound Independent Gill Net Survey

See American Shad section.

Chowan River Pound Net Survey

In 2012 four commercial fishermen were contracted to fish commercial pound net sets in the Chowan River, NC during the traditional river herring commercial harvest season. All fishermen were required to obtain a weekly unculled adult sub-sample of approximately 20 pounds of river herring from their contracted pound nets. In addition, each fisherman includes a visual estimate of the total daily catch of river herring in pounds from all of the pound nets set regardless of whether it was a designated contracted net or not. Adult samples were sorted to species and all individuals of each alosine species present were measured (mm, FL, TL), weighed (kg), sexed, spawning maturity was determined, and an ageing sample was taken.

NCWRC Electrofishing Survey

The NCWRC conducted boat-electrofishing surveys for river herring in the Chowan, Tar, Neuse and Cape Fear River basins (Figure 28). A boat-mounted electrofishing unit (Smith-Root 7.5 GPP) with one dip netter was used to capture fish during daylight hours and electrofishing time was recorded. Relative abundance of each year class was indexed by catch-per-unit-effort (CPUE) and expressed as number of fish captured per hour of electrofishing.

C. Results

1. Juvenile Abundance

During 2012 sampling of the eleven core seine sites, 30 blueback herring, 36 alewife, 10 American shad and 2 hickory shad were captured. Juvenile Abundance Indices have been calculated for the eleven core stations from 1972 through the 2012 year classes of blueback herring, alewife, American shad and hickory shad. The 2012 year class JAI was 0.55 (0.10 GM) for blueback herring 0.65 (0.20 GM) for alewife, 0.18 (0.07GM) for American shad and 0.04 (0.02 GM) for hickory shad (Tables 30-33). Juvenile American and hickory shad catches have been consistently low since the survey began in 1972. Adequate sampling of the areas utilized by these species has not occurred, nor the specific areas determined.

2. Spawning Stock Assessment

<u>Albemarle Sound Independent Gill Net Survey</u>

The NCDMF has conducted an IGNS in the ASMA since 1991. A total number of blueback herring and alewife captured in the 2.5 and 3 ISM gill nets by year are shown in Figure 27.

Because of staff shortages, ages for 2011 were not included in the 2012 compliance report. They are included here (Tables 34 and 35). For blueback herring, 138 fish were aged (19.6% male, 80.4% female). Males ranged from age 3 to age 5. Females ranged from age 3 to age 6. Virgin fish comprised 58.7% of the sample, while 4.3% had more than one spawning mark (Table 34).

For alewife, 231 fish were aged. Males ranged from age 4 to 7, while females ranged from age 3 to age 8. Virgin fish comprised 14.7% of the sample, while 39.8% of aged fish had more than one spawning mark (Table 35).

During 2012, 294 blueback (102 age samples) and 360 alewife (155 age samples) were collected from the IGNS throughout the ASMA. Male blueback herring comprised 31.9% of the samples and females comprised 68.1%. Male lengths ranged from 212-258 mm FL and weights from 0.14-0.26 kg. Female lengths ranged from 208-310 mm FL and weights from 0 .11-0.42 kg. Male blueback herring ranged from age 3 to 6, while females ranged from age 3 to age 8. Virgin fish comprised 49% of the sample, while 9.8% of the sample had more than one spawning mark (Table 36).

Male alewife comprised 21.9% of the samples and females accounted for 78.1 % of the samples collected. Male alewife lengths ranged from 200-267 mm FL and weights ranged from 0.12-0.32 kg. Female alewife lengths ranged from 222-305 mm FL and weights ranged from0 .120-0.46 kg. Male alewife ranged in age from 3 to 8. Females ranged from age 4 to 8.

Virgin fish comprised 23.9% of the sample, while 32.1% had more than one spawning mark (Table 37).

Chowan River Pound Net Survey

Because of staff shortages, 2011 ages for the Chowan River Pound Net survey were not included in last year's report. They are included here (Tables 38 and 39). For blueback herring, 470 samples were aged (64% males, 36% females). Males ranged in age from 3 to 6, and females also ranged in age from 3 to 6. Virgin fish comprised 56.6% of the sample, while 1.3% had more than one spawning mark (Table 38). For alewife, 661 samples were aged (33.4% male, 66.6% female). Males ranged in age from 3 to 8, while females ranged in age from 3 to 7. Virgin fish comprised 20.9% of the sample, while 30.6% had more than one spawning mark.

During 2012, NCDMF obtained unculled blueback herring and alewife samples from the Chowan River pound net fishermen under contract from February through mid-May. A total of 364 blueback herring and 572 alewife samples were obtained from the contracted Chowan River pound net fishermen. Male blueback herring accounted for 59.6% and females 41.4% of the samples collected from the Chowan River pound net survey. Male lengths ranged from 200-250 mm FL and weights from 0.07-0.23 kg. Female lengths ranged from 180-265 mm FL and weights from 0.06-0.27 kg. Both males and females ranged in age from 3 to 6. Virgin fish comprised 65.6% of the sample, while 2.5% had more than one spawning mark (Table 40).

Male alewife accounted for 36.0% and females 64% of the samples collected from the Chowan River pound net survey. Males lengths ranged from 190-272 mm FL and weights from 0.08-0.31 kg. Female lengths ranged from 212-286 mm FL and weights from 0.10-0.40 kg. Both males and females ranged in age from 3 to 8. Virgin fish comprised 32.9% of the sample, while 36.8% had more than one spawning mark.

NCWRC Electrofishing Survey

Chowan River Basin, Indian Creek.

Weekly boat-electrofishing surveys for river herring were conducted from February to March 2012 at four sample sites in Indian Creek, a tributary of the Chowan River. Alewives were first collected on 1 March 2012 and blueback herring were first collected on 20 March 2012. A total of 24 alewives were collected during the survey period. Alewife relative abundance was 6.9 fish/h (Table 42), and the peak in alewife relative abundance occurred on 13 March 2012 at 12.8°C. Male alewives were 6.7 times more abundant than female alewife. Male Alewife lengths ranged from 229 to 289 mm and female alewife lengths ranged from 250 to 287 mm (Figure 20). The apparent low abundance of alewife in Indian Creek indicates the need for continued restricted harvest. Blueback herring were first observed in Indian Creek on 12 March 2012, the point at which standardized sampling ceased and broodstock collections began in support of supplemental stockings in this system.

Chowan River Basin, Bennetts Creek.

Weekly boat-electrofishing surveys for river herring were conducted from February to March 2012 at four sample sites in Bennetts Creek, a tributary of the Chowan River. Alewife were first collected on 1 March 2012 and blueback herring on 13 March 2012. A total of 67 alewives was collected during the survey period. Alewife relative abundance, indexed by overall CPUE, was 20.2 fish/h (Table 42). Two peaks in alewife relative abundance occurred on 15 February 2012 at 9.1°C and 13 March 2012 at 13.3°C. Male alewife were 6.4 times more abundant than female alewife. Male alewife lengths ranged from 222 to 298 mm and female alewife lengths ranged from 240 to 325 mm (Figure 30). Similar to Indian Creek, the apparent low abundance of alewife in Bennetts Creek indicates poor stock health. Blueback herring were first observed in Bennetts Creek on 13 March 2012, the point at which standardized sampling ceased and broodstock collections began in support of supplemental stockings in this system.

Tar River Basin, Chicod and Bear creeks.

River herring were not collected during 2012 spring surveys in Chicod Creek or Bear Creek, both tributaries of the Tar River (Table 42). Although river herring relative abundance estimates have been low in previous years, 2012 marks the first year that no river herring were collected since NCWRC began sampling for river herring in the Tar River Basin in 2006. The highest CPUE to date occurred in 2006 and was 3.48 fish/h. Chicod Creek has been sampled each year since 2006 and Bear Creek has been sampled since 2010. To date, only one river herring has been collected from Bear Creek in 2011. All other river herring collected in past surveys have been from Chicod Creek. Additionally, blueback herring is the only species of river herring collected to date in the Tar River Basin.

Neuse River Basin, Core Creek

A total of 37 adult blueback herring were collected from Core Creek, a tributary of the Neuse River, in the spring of 2012. Overall CPUE of Core Creek blueback herring was 10.5 fish/h (Table 42). Blueback herring collected from Core Creek ranged in length from 222 to 270 mm (Figure 31). Seventy-eight percent of fish were between 230 and 260 mm.

Neuse River Basin, Village Creek.

A total of 125 adult blueback herring were collected from Village Creek, a tributary of the Neuse River, in the spring of 2012. Overall CPUE was 36.7 fish/h (Table 42). Blueback herring ranged in length from 212 to 292 mm with 66% of fish between 230 and 260 mm (Figure 32).

Neuse River Basin, General collections

Five additional blueback herring were collected while conducting other anadromous spawning stock surveys. One individual was collected as far inland as Raleigh in Wake County, NC. For all Neuse River Basin sites combined, the adult catch was comprised primarily of males (N=123) while females were less frequently encountered (N=47). Blueback herring ranged in length from 212 to 292 mm; 68% of fish exceeding 260 mm were females. The length-frequency distribution was unimodal with most fish ranging in length from 230 to 250 mm. All creeks were characterized with low levels of abundance, suggesting poor stock health.

Cape Fear River Basin, Town and Rice's creeks.

A total of 270 blueback herring was collected from Town Creek and Rice's Creek in 2012. Overall CPUE was 17.8 fish/h (Table 42). The 2012 catch rate was the highest recorded since the inception of the blueback herring surveys in 2006. In 2012, males comprised 90% (N=242) of the sample while females accounted for only 10% (N=28). These results are similar to a sex ratio of 82% males and 18% females for all other sample years (2006–2010) with the exception of 2009 when males comprised 99% of the sample and females only 1%. Blueback herring collected in the 2012 sample ranged from 230 to 308 mm total length (Figure 33). The peak in the length-frequency histogram for males occurred between 230 and 270 mm. The peak for females occurred between 270 and 290 mm. The increase in numbers of blueback herring collected from Rice's Creek (N=131) compared to 2011 (N=69) suggests modest population improvements, assuming this is not a function of weekly sampling variability.

CPUE Limitations.

River herring abundances can vary widely among sampling trips. Weather related factors like water temperature, precipitation, and stream flow contribute substantially to this variability. However, at low population levels, there is added variability associated with the reduced likelihood of electrofishing gear even encountering river herring. Therefore, caution should be exercised in interpreting this data. CPUE information has the potential to become more meaningful once river herring populations begin to expand and gross increases in abundance are measured.

Chowan River Blueback Herring Restoration Plan–Hatchery Evaluation

Fry Production and Locations Stocked.

Success in blueback herring tank spawning and fry production has been tested with varying results in previous years. 2012 was the first year of a planned 10-year restoration project involving the introduction of hatchery-reared blueback herring in the Chowan River Basin, North Carolina. Blueback herring were cultured at the USFWS Edenton National Fish Hatchery, Edenton, North Carolina. NCWRC and USFWS staff collected blueback herring broodstock via electrofishing from Indian and Bennetts creeks, tributaries of the Chowan River. Each tributary was thoroughly sampled to collect two batches of broodstock for a total of four individual tanks at the hatchery. The collection goal for each batch was 60 fish (30 males, 30 females) which would result in four genetically unique batches to assist with the stocking evaluation. Due to a truncated spawning run caused by rapidly increasing water temperatures, total collection of broodfish was lower than the goal. Only two batches of 32 and 39 males and 34 and 32 females were collected from Indian Creek, and one batch of 33 males and 17 females was collected from Bennetts Creek for fry production (Table 43). Each batch was maintained separately during broodstock collection, egg and fry production, and ultimately stock-out to assure that chain of custody remained intact throughout the process. Broodstock collection and hatchery efforts resulted in 696,653 blueback herring fry stocked in Indian Creek and 14,430 blueback herring fry stocked in Bennetts Creek in 2012. The total number stocked in both creeks combined was 711,083. Fry stocking dates, locations, and number of herring fry stocked per trip are listed in Table 44.

Evaluation of Hatchery Contribution

This project utilized genetic markers to identify annual stocked cohorts. All blueback herring broodstock and a subsample of fry from each production batch were genotyped to establish parentage for each tank. Each tank of larval fry was stocked into the stream where their parents were originally collected as broodfish (endemic source). Beginning in 2015, returning adult blueback herring will be fin clipped and their genetic markers will be compared with past broodstock collections. Results of hatchery contribution will be included in future reports. If blueback herring spawning migrations within two tributaries of the Chowan River can be enhanced with supplemental stockings, then opportunities for expansion of this program throughout the Chowan River Basin and into other North Carolina systems can be considered.

3. Annual Mortality Rate

Mortality rates were calculated following the method of Robson and Chapman (1961).The 2011 mortality rate for blueback herring in the IGNS was 70.8% and for alewife it was 39.4%. The 2011 mortality rate in the Chowan River Pound Net Survey was 66.7% for bluebacks and 39.4% for alewife. 2012 mortality rates for blueback herring and alewife in the IGNS were 53.7% and 39.4%, respectively. In the Chowan River Pound Net Survey, the mortality rates were 70% for blueback herring and 44.1%.

4. Protected Species- Atlantic Sturgeon

Bycatch of sturgeon in river herring fisheries and the IGNS will be included in the sturgeon compliance report.

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Table 1. Commercial landings and value of American shad in North Carolina, 1972-2012.

Year	Landings							State Total	
	Atlantic Ocean	Albemarle Sound Area	Cape Fear River	Neuse River	Pamlico River	Pamlico Sound	Other Areas	Lbs	$
1972	--	130,399	66,968	81,715	92,799	92,069	4,534	468,484	111,609
1973	--	80,770	32,120	69,526	30,300	105,237	3,047	321,000	85,491
1974	--	116,502	20,219	61,091	32,167	132,926	5,928	368,833	105,668
1975	--	87,063	22,949	27,764	34,157	69,307	0	241,240	82,815
1976	1,547	78,301	7,288	34,161	32,150	13,743	0	167,190	65,227
1977	--	79,594	16,106	6,144	13,432	3,171	2,575	121,022	54,764
1978	5,000	158,908	32,999	31,726	40,908	124,243	8,233	402,017	144,986
1979	25,064	85,158	52,104	31,611	10,971	69,486	3,676	278,070	121,662
1980	3,943	68,695	45,486	11,615	6,430	44,564	18,473	199,206	88,112
1981	107,415	66,732	52,911	15,549	9,761	97,106	2,026	351,500	189,793
1982	63,979	118,794	78,184	18,129	5,080	122,898	4,788	441,852	183,483
1983	3,788	216,058	65,728	45,378	53,794	58,324	2,809	445,879	187,360
1984	13,511	227,308	69,040	70,305	108,410	85,177	10,552	584,843	241,009
1985	3,159	148,555	17,788	56,620	40,675	52,607	10,235	329,639	152,547
1986	63,085	120,367	37,048	70,880	18,138	49,357	14,919	373,794	228,819
1987	41,162	149,923	14,003	47,117	22,640	50,168	2,633	327,646	215,115
1988	50,088	128,061	5,266	15,110	46,607	33,485	4,433	283,050	171,962
1989	38,548	208,807	12,719	13,452	17,012	27,158	5,700	323,396	214,896
1990	37,064	214,954	26,519	11,543	6,520	14,803	2,147	313,550	170,161
1991	19,217	209,900	30,040	2,860	2,568	9,827	2,095	276,507	221,880
1992	23,956	131,499	44,250	13,808	14,231	8,546	2,872	239,162	194,629
1993	28,122	73,631	62,278	8,538	3,033	3,102	86	278,790	149,739
1994	33,895	49,713	10,871	7,216	4,039	4,944	297	110,975	95,703
1995**	102,984	60,953	11,180	15,311	9,573	5,232	634	205,867	188,541
1996**	58,167	65,953	26,818	24,439	8,672	9,115	5,969	199,133	171,625
1997**	98,312	63,736	15,584	17,154	8,985	12,126	3,633	219,530	149,203
1998**	118,017	168,444	11,144	11,715	11,698	5,008	1,533	327,559	233,761
1999**	32,970	70,071	6,804	7,719	6,920	6,054	1,083	131,621	108,142
2000**	110,907	129,584	11,098	9,220	14,671	15,814	6,593	297,887	212,929
2001**	11,839	95,005	12,583	10,674	6,417	9,788	4,779	151,085	108,536
2002**	8,377	175,103	19,185	40,176	14,973	13,902	2,942	274,658	174,141
2003**	12,515	280,687	34,540	36,109	17,279	11,407	2,717	395,251	251,532
2004**	6,724	181,574	27,925	33,636	17,238	1,633	556	269,063	180,428
2005**	*	126,890	17,310	24,282	14,697	5,465	2,396	191,263	205,300
2006**	*	121,890	16,130	34,981	6,184	4,709	1,135	184,965	201,026
2007**	*	211,293	29,449	30,743	18,949	9,368	230	300,032	280,582
2008**	*	79,872	15,912	10,789	7,682	4,011	705	118,971	168,826
2009**	60	118,020	19,227	12,017	11,268	6,715	325	167,632	204,142
2010**	266	184,896	23,718	10,802	5,644	6,727	1,214	233,267	190,348
2011**	315	160,081	22,496	15,246	4,930	868	149	204,085	182,894
2012**	3,475	178,002	10,341	23,981	12,936	6,880	244	235,861	257,748

*Denotes confidential data **Closed season April 15-December 31

Table 2. American shad landings from North Carolina, by area, number of participants, number of positive trips, and percent poundage of harvest from all gear, for 2012.

				Percent by poundage for all gears				
System	Total Pounds	Number of Participants	Total Number of Positive Trips	0-100	101-200	201-400	401-700	701-3,000
Albemarle	178,002	364	2,320	32.8	25.95	22.82	11.45	6.97
Cape Fear	10,341	24	134	49.56	40.58	9.86	0	0
Neuse	23,985	52	302	43.79	26.31	15.38	14.52	0
Pamlico	19,862	100	462	57.08	25.68	14.58	2.66	0
Other	3,671	26	48	14.68	25.61	32.8	26.91	0

Table 3. Mean, min, max fork length at age of American shad sampled from the commercial harvest NC, 2012.

		Male			Female		
System	Age	Mean	Min	Max	Mean	Min	Max
Albemarle Sound	4	366	334	419	411	397	427
	5	380	235	435	447	400	552
	6	399	345	445	448	423	472
	7	400	355	438	464	444	485
	8	366	366	366	456	456	456
	9	--	--	--	--	--	--
Pamlico River	4	390	358	405	462	436	484
	5	416	338	495	457	421	488
	6	414	414	414	464	435	514
	7	466	436	496	479	466	503
Neuse River	4	406	406	406	450	430	472
	5	392	353	432	452	427	493
	6	425	425	425	456	417	484
	7	--	--	--	465	421	506
	8	--	--	--	458	438	490
Cape Fear River	4	405	359	440	435	396	463
	5	424	395	462	456	423	487
	6	419	400	445	466	440	494
	7	--	--	--	488	480	495
	8	--	--	--	460	460	460

Table 4. Age and spawning frequency of American shad from the ASMA commercial fisheries, NC, 2012.

		Spawning Marks					
		0		1		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female
4	2008	9	3	2	1	11	4
5	2007	20	17	9	8	29	25
6	2006	16	8	9	6	25	14
7	2005	7	5	2	1	9	6
8	2004	1	--	--	1	1	1
Total		53	33	22	17	75	50
Percent		70.7	66	29.3	34		
Percent combined		68.8		31.2			

Table 5. Age and spawning frequency of American shad from the Pamlico River commercial fisheries NC, 2012.

		Spawning Marks							
		0		1		2		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female
4	2008	4	6	1	3	--	--	5	9
5	2007	11	36	2	20	1	--	14	56
6	2006	3	20	--	12	--	1	3	33
7	2005	2	1	--	2	--	1	2	4
Total		20	63	3	37	1	2	24	102
Percent		83.3	61.7	12.5	36.3	4.2	2		
Percent combined		65.8		31.7		2.4			

Table 6. Age and spawning frequency of American shad from the Neuse River commercial fisheries, NC, 2012.

		Spawning Marks							
		0		1		2		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female
4	2008	1	3	--	--	--	--	1	3
5	2007	3	24	--	10	--	--	3	34
6	2006	--	29	1	24	--	1	1	54
7	2005	--	12	--	15	--	2	0	29
8	2004	--	1	--	2	--	1	0	4
Total		4	69	1	51	0	4	5	124
Percent		80	55.7	20	41.1	0	3.2		
Percent combined		56.6		40.3		3.1			

Table 7. Age and spawning frequency of American shad from the Cape Fear River commercial fisheries, NC, 2012.

		Spawning Marks					
		0		1		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female
3	2009	2	--	--	--	2	0
4	2008	11	7	--	--	11	7
5	2007	22	43	2	23	24	66
6	2006	4	14	1	12	5	26
7	2005	--	--	--	2	0	2
8	2004	--	1	--	--	0	1
Total		39	65	3	37	42	102
Percent		93	63.7	7	36.3		
Percent combined		72.2		27.8			

Table 8. American shad survival and mortality estimates based on 2012 commercial samples utilizing Robson and Chapman (1961).

	Percent	
System	Survival	Mortality
Albemarle Sound	59.7	40.3
Pamlico River	57.9	42.1
Neuse River	66.1	33.9
Cape Fear River	53.1	46.9

Table 9. Characterization of American Shad losses by river for North Carolina, 2012.

	Hatchery Brood Fish Losses				Other Research Losses			
River	Roanoke		Neuse		Roanoke	Tar	Neuse	Cape Fear
Sex	Male	Female	Male	Female	Male	Female	Male	Female
Number	165	138	44	7	41	60	130	226
Pounds	132	182.8	34.9	8.1	39.6	62.7	134.1	252
Average Weight	0.8	1.3	0.8	1.2	1.0	1.0	1.0	1.1

Table 10. Annual overall American shad electrofishing CPUE (fish/h) for Roanoke, Tar, Neuse, and Cape Fear rivers, 2003 - 2012.

Year	Roanoke	Tar	Neuse	Cape Fear
2003	43	308	21	54
2004	49	190	15	104
2005	72*	131	22	44
2006	89*	43	16	18
2007	97*	38	22	16
2008	135*	103	25	14
2009	196*	29	21	34
2010	55	75	31	29
2011	73	79	31	24
2012	145*	117	39	65

* Use of two dip netters during sampling

Table 11. Mean total length (mm) at age for American shad males and females collected from the NCWRC electroshocking survey Roanoke River, NC, spring 2012.

Year		Male				Female			
Class	Age	N	Mean	Min	Max	N	Mean	Min	Max
2010	2	13	423	367	441	--	--	--	--
2009	3	225	411	362	447	5	448	443	497
2008	4	377	437	400	463	12	482	430	542
2007	5	230	452	399	499	28	487	445	546
2006	6	33	454	480	487	30	506	456	543
2005	7	2	515	513	518	6	516	492	538

Table 12. Mean total length (mm) at age for American shad males and females collected from the NCWRC electroshocking survey Tar River, NC, spring 2012.

Year		Male				Female			
Class	Age	N	Mean	Min	Max	N	Mean	Min	Max
2009	3	5	420	376	465	--	--	--	--
2008	4	18	444	415	494	6	512	408	525
2007	5	15	452	407	505	6	513	475	551
2006	6	4	533	400	455	4	526	493	547

Table 13. Mean total length (mm) at age for American shad males and females collected from the NCWRC electroshocking survey Neuse River, NC, spring 2012.

Year		Male				Female			
Class	Age	N	Mean	Min	Max	N	Mean	Min	Max
2009	3	17	420	383	438	--	--	--	--
2008	4	227	433	340	496	37	476	417	544
2007	5	253	449	360	507	98	490	451	541
2006	6	35	471	460	510	104	507	35	549
2005	7	8	491	485	518	12	526	518	556

Table 14. Mean total length (mm) at age for American shad males and females collected from the NCWRC electroshocking survey Cape Fear River, NC, spring 2012.

Year		Male				Female			
Class	Age	N	Mean	Min	Max	N	Mean	Min	Max
2009	3	92	410	352	496	--	--	--	--
2008	4	204	432	388	476	13	509	451	551
2007	5	86	466	415	522	54	509	451	551
2006	6	12	489	454	558	24	531	498	570
2005	7	3	508	504	512	8	530	496	572
2004	8	--	--	--	--	1	498	498	498

Table 15. Mean fork length and range at age of American shad sampled from NCDMF independent gill net surveys, NC, 2012.

		Male			Female		
System	Age	Mean	Min	Max	Mean	Min	Max
Albemarle Sound	3	376	376	376	--	--	--
	4	378	337	433	439	417	450
	5	391	347	437	435	404	456
	6	394	390	398	473	458	496
Pamlico River	4	390	373	406	--	--	--
	5	392	351	422	445	408	470
	6	422	422	422	452	420	482
	7	--	--	--	479	461	498
	8	--	--	--	458	458	458
Neuse River	4	382	382	382	392	368	415
	5	388	360	428	448	412	474
	6	409	380	438	453	426	488
	7	425	425	425	463	444	477

Table 16. Catch effort, by mesh size, for American shad from NCDMF Independent Gill Net Survey, Albemarle Sound, NC January-May 2012.

Mesh Size (ISM)	Effort	CPUE	SE	STDEV	CV	Min	Max	Sum	PSE
2.5	179	0.00	0.00	0.00		0	0	0	
3	176	0.01	0.01	0.11	935.40	0	1	2	71
3.5	178	0.07	0.02	0.35	483.28	0	3	13	36
4	179	0.11	0.03	0.45	429.43	0	3	19	32
4.5	179	0.13	0.03	0.39	289.30	0	2	24	22
5	178	0.02	0.01	0.16	589.88	0	1	5	44
5.5	179	0.07	0.02	0.25	374.1	0	1	12	27
6	179	0.03	0.01	0.16	591.59	0	1	5	44
6.5	178	0.01	0.01	0.01	1334.2	0	1	1	100
7	179	0.00	0.00	0.00		0	0	0	
8	179	0.00	0.00	0.00		0	0	0	
10	180	0.00	0.00	0.00		0	0	0	
Total	2,143	0.04	0.01	0.16	628.39	0	3	81	

Table 17. Age and spawning frequency of American shad captured during the NCDMF Independent Gill Net Survey throughout the Albemarle Sound Area, NC, 2012.

		Spawning Marks							
		0		1		2		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female
3	2009	1	--	--	--	--	--	1	0
4	2008	19	2	2	1	--	--	21	3
5	2007	22	8	2	3	--	--	24	11
6	2006	2	2	1	5	--	2	3	9
Total		44	12	5	9	0	2	49	23
Percent		89.8	52.2	10.2	39.1		8.7		
Percent combined		77.8		19.4		2.8			

Table 18. Age and spawning frequency of American shad captured during the NCDMF Independent Gill Net Survey throughout the Pamlico River area, NC, 2012.

		Spawning Marks					
		0		1		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female
4	2008	3	--	--	--	3	0
5	2007	5	5	2	5	7	10
6	2006	1	8	--	3	1	11
7	2005	--	2	--	--	0	2
8	2004	--	--	--	1	--	1
Total		9	15	2	9	11	24
Percent		81.0	62.0	18.0	38.0		
Percent combined		68.0		32.0			

Table 19. Age and spawning frequency of American shad captured during the NCDMF Independent Gill Net Survey throughout the Neuse River area, NC, 2012.

		Spawning Marks					
		0		1		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female
4	2008	--	3	1	1	1	4
5	2007	4	7	3	--	7	7
6	2006	2	18	--	3	2	21
7	2005	--	4	--	--	1	4
Total		6	32	4	4	10	36
Percent		60.0	89.0	40.0	11.0		
Percent combined		82.6		27.4			

Table 20. American shad survival and mortality estimates based on 2012 independent gill net samples utilizing Robson and Chapman (1961).

	Percent	
System	Survival	Mortality
Albemarle Sound	45.4	54.6
Pamlico River	61.5	38.5
Neuse River	60.0	40.0

Table 21. American shad fry produced in North Carolina and stocked into the Roanoke River Basin from 1998-2012.

Year	Edenton NFH	Watha Hatchery	Total
1998	481,000*	-	481,000
1999	225,000	50,000	275,000
2000	535,000	308,000	843,000
2001	700,000	1,369,000	2,069,000
2002		820,000	820,000
2003	612,000	1,673,629	2,285,629
2004	589,822	1,740,000	2,329,822
2005	1,346,834	1,226,000	2,572,834
2006	1,088,936	1,332,000	2,420,936
2007	772,780	3,540,051	4,312,831
2008	3,126,098	5,093,517	8,219,615
2009	3,665,345	5,132,326	8,797,671
2010	3,729,433	4,153,031	7,882,464
2011	2,741,726	1,715,423	4,457,149
2012		4,800,118	4,800,118
Totals	19,613,975	32,953,095	52,567,070

*eggs collected and fertilized in the field

Table 22. Number of American shad fry stocked (in millions) by year, hatchery, stocking location, broodstock genotype availability and the OTC mark assigned in the Roanoke River, North Carolina. Age class represents the expected age of stocked American shad at-large in 2012.

Year	Millions Stocked	Hatchery	Stocking Location	Microsatellite Marker available	OTC Mark	Age Class at-Large
1998	0.5	Edenton	Weldon, NC	No	3	14
1999	0.3	Edenton/Watha	Weldon, NC	No	3,6,12	13
2000	0.9	Edenton/Watha	Weldon, NC	No	3,6,12	12
2001	2.1	Edenton/Watha	Weldon, NC	No	3,6,12	11
2002	0.8	Watha	Weldon, NC	No	3	10
2003	1.2	Edenton/Watha	Weldon, NC	No	3	9
2004	1.2	Edenton/Watha	Weldon, NC	No	6	8
2005	1.3	Edenton	Weldon, NC	No	9	7
2006	1.4	Edenton/Watha	Weldon, NC	No	3	6
2007	2.1	Edenton/Watha	Weldon, NC	No	6	5
2007	0.1	Watha	Weldon, NC	No	9	5
2008	4.3	Edenton/Watha	Weldon, NC	No	9	4
2009	4.6	Edenton/Watha	Weldon, NC	No	3	3
2010	6.9	Edenton/Watha	Weldon, NC	Yes	6	2
2011	4.0	Edenton/Watha	Weldon, NC	Yes	6	1
2012	3.8	Watha	Weldon, NC	Yes	6	0
Subtotal	35.3					
2003	1.2	Watha	Altavista, VA	No	3,6	9
2004	1.2	Edenton/Watha	Altavista, VA	No	6,9	8
2005	1.2	Watha	Altavista, VA	No	3,9	7
2006	1.0	Watha	Altavista, VA	No	3,6	6
2007	2.1	Watha	Altavista, VA	No	6,9	5
2008	3.9	Watha	Altavista, VA	No	3,9	4
2009	4.1	Watha	Altavista, VA	No	3,6	3
2010	0.9	Edenton	Altavista, VA	Yes	6,9	2
2011	0.4	Edenton	Clover Landing, VA	Yes	3,6	1
2012	1	Watha	Clover Landing, VA	Yes	3,6	0
Subtotal	16.8					
Total	52.1					

Table 23. Date, stocking location, hatchery tank, OTC mark sequence, and number of American shad fry produced at the NCWRC Watha State Fish Hatchery and stocked per trip in the Roanoke River Basin, 2012.

Date	Location	Genetic Mark/Watha Hatchery Tank	OTC Mark	Number Stocked
4/10/2012	Roanoke River at Weldon	Tank 1,2,3	6d	209,749
4/12/2012	Roanoke River at Weldon	Tank 1,2,3	6d	309,276
4/15/2012	Roanoke River at Weldon	Tank 1,2,3	6d	366,656
4/17/2012	Staunton River at Clover	Tank 4	3,6d	106,389
4/18/2012	Roanoke River at Weldon	Tank 1,2,3	6d	578,261
4/21/2012	Roanoke River at Weldon	Tank 1,2,3	6d	370,800
4/23/2012	Staunton River at Clover	Tank 4	3,6d	191,399
4/24/2012	Roanoke River at Weldon	Tank 1,2,3	6d	373,092
4/26/2012	Staunton River at Clover	Tank 4	3,6d	238,336
4/27/2012	Roanoke River at Weldon	Tank 1,2,3	6d	342,194
4/30/2012	Roanoke River at Weldon	Tank 1,2,3	6d	364,873
5/1/2012	Stauton River at Clover	Tank 4	3,6d	105,716
5/2/2012	Roanoke River at Weldon	Tank 1,2,3	6d	362,410
5/7/2012	Staunton River at Clover	Tank 4	3,6d	152,413
5/8/2012	Roanoke River at Weldon	Tank 1,2.3	6d	218,707
5/10/2012	Roanoke River at Weldon	Tank 1,2,3	6d	261,798
5/14/2012	Stauton River at Clover	Tank 4	3,6d	247,599
Total				4,799,668

Table 24. Date, stocking location, hatchery, genetic mark, OTC mark sequence, and number produced of American shad fry stocked per trip in the Neuse River Basin in 2012.

Date	Location	Hatchery	Genetic Mark/Edenton Hatchery Tank	OTC Mark	Number Stocked
4/7/2012	Goldsboro, NC	Edenton	Tank 1	6	90,851
4/17/2012	Goldsboro, NC	Edenton	Tank 1	6	147,634
5/2/2012	Goldsboro, NC	Edenton	Tank 1	6	246,151
5/8/2012	Goldsboro, NC	Edenton	Tank 1	6	66,700
5/15/2012	Goldsboro, NC	Edenton	Tank 1	6	22,246
Total					573,582

Table 25. Number of juvenile American shad collected during annual fall emigration sampling from the lower Roanoke River with weekly boat electrofishing during evening hours. Following sampling, juvenile American Shad fin clips were processed and checked for genetic microsatellite markers. The start and end collection dates and the total number of days of the collection period are also listed for each year.

Year	Total Collected Genetics Evaluated	Hatchery Origin	Weldon Stocking	Virginia Stocking	Collection Begin Date	Collection End Date	Collection Period (Days)
2010	Analysis in progress				9/8	11/9	63
2011	82	31	31	0	9/29	11/17	50
2012	Analysis in progress				9/6	11/15	71

Table 26. Commercial landings and value of hickory shad in North Carolina 1972-2012.

	Landings							State Total	
Year	Atlantic Ocean	Albemarle Sound Area	Cape Fear River	Neuse River	Pamlico River	Pamlico Sound	Other Areas	Lbs.	$
1972	--	32,310	2,585	5,423	13,927	14,091	854	69,190	3,725
1973	2,692	20,673	842	11,751	6,670	18,215	5,130	65,973	3,186
1974	--	19,827	255	1,771	5,019	14,640	213	41,725	2,635
1975	--	12,132	729	2,048	500	13,552	241	29,202	2,485
1976	--	13,054	--	3,204	600	1,858	--	18,716	1,797
1977	--	14,470	103	3,115	4,421	--	--	22,109	1,755
1978	--	14,143	49	5,635	--	680	--	20,507	3,790
1979	203	24,921	--	3,071	72	3,016	433	31,716	5,163
1980	1,321	62,873	--	16,592	1,137	7,503	2,075	91,501	12,680
1981	1,813	54,968	--	2,382	106	18,774	3,269	81,312	11,831
1982	--	20,286	--	1,698	*	2,758	--	24,742	5,006
1983	--	59,177	--	9,390	*	1,399	--	69,966	14,841
1984	431	42,778	--	9,755	4,126	2,572	36	59,698	13,300
1985	4,537	21,385	--	11,945	1,823	1,696	462	42,121	8,898
1986	3,046	7,078	--	8,236	1,296	1,091	75	20,822	3,899
1987	*	30,724	--	8,530	3,635	2,124	328	45,341	10,204
1988	2,499	76,685	--	6,997	889	3,962	1,890	92,922	28,919
1989	56	13,944	--	3,220	652	458	130	18,510	4,254
1990	*	7,311	--	294	73	3,711	89	11,478	1,575
1991	444	6,422	--	4,056	252	2,867	2,425	16,466	10,425
1992	141	3,960	--	8,453	4,489	1,044	516	18,603	4,919
1993	3,337	27,244	--	36,974	6,803	970	47	75,375	25,203
1994	3,513	5,806	*	25,618	5,030	15,870	1,706	57,543	17,263
1995**	17,627	19,770	*	10,758	3,186	15,379	849	67,569	19,301
1996**	62,018	55,946	*	21,830	13,401	28,879	5,813	187,887	40,326
1997**	27,009	29,841	--	13,361	4,109	57,528	6,381	138,229	17,405
1998**	23,937	23,788	--	8,740	2,876	29,460	4,704	93,505	18,312
1999**	16,721	39,747	--	3,731	7,114	43,067	1,760	112,140	20,769
2000**	16,528	35,051	--	2,069	7,392	27,887	3,637	92,564	14,502
2001**	6,968	41,550	*	43,277	3,076	69,097	8,271	172,239	24,992
2002**	3,641	20,544	*	4,559	2,038	19,449	929	51,160	8,286
2003**	2,865	20,214	*	12,012	2,387	25,486	5,964	68,928	18,540
2004**	5,927	42,907	*	52,967	7,673	63,137	14,853	187,464	32,111
2005**	1,855	23,718	125	57,353	2,390	66,780	21,558	173,779	39,673
2006**	4,383	19,583	*	9,270	658	19,832	1,056	54,782	10,636
2007**	1,259	13,643	*	6,386	1,145	12,931	444	35,808	7,726
2008**	1,837	31,170	*	10,219	2,913	18,538	2,090	66,767	11,665
2009**	375	24,031	*	9,706	4,811	43,653	4,084	86,660	22,963
2010**	1,957	23,889	19	7,588	797	54,109	19,673	108,032	20,951
2011	1,056	7,621	*	5,228	630	64,016	6,545	85,096	23,607
2012	612	31,541	--	7,631	1,202	24,439	220	65,645	22,389

*Denotes confidential data **Closed season April 15-January 1

Table 27. Hickory shad landings from North Carolina by area, number of participants, number of positive trips, and percent poundage of harvest from all gear, for 2012.

				Percent by poundage for all gears					
System	Total Pounds	Number of Participants	Total Number of Positive Trips	0-100	101-200	201-400	401-700	701-3,000	>3000
Albemarle	31,541	244	1,440	44.3	7.2	7.3	4.5	25.0	11.7
Neuse	7,631	28	133	36.9	22.8	17.1	23.2	0	0
Pamlico	25,795	120	564	36.4	16.9	12.9	12.7	21.1	0
Other	678	37	64	100	0	0	0	0	0

Table 28. Catch effort, by mesh size, for hickory shad from NCDMF Independent Gill Net Survey, Albemarle Sound, NC January-May 2012.

Mesh Size (ISM)	Effort	CPUE	SE	STDEV	CV	Min	Max	Sum	PSE
2.5	179	0.195531	0.061792	0.826718	422.8073	0	7	35	32
3	176	0.573864	0.155843	2.06749	360.2754	0	22	101	27
3.5	178	0.786517	0.203278	2.712065	344.8197	0	30	140	26
4	179	0.290503	0.064946	0.86892	299.1089	0	6	52	22
4.5	179	0.150838	0.038172	0.510713	338.5839	0	3	27	25
5	178	0.005618	0.005618	0.074953	1334.166	0	1	1	100
5.5	179	0.011173	0.007878	0.105406	943.3832	0	1	2	71
6	179	0	0	0		0	0	0	
6.5	178	0.033708	0.023768	0.3171	940.7294	0	4	6	71
7	179	0.005587	0.005587	0.074744	1337.909	0	1	1	100
8	179	0	0	0		0	0	0	
10	180	0	0	0		0	0	0	
Total	2,143	0.17	0.05	0.63	702.42	0	30	365	

Table 29. Commercial landings and value of discretionary river herring harvest in North Carolina, 2001-2012.

Year	# of Permits Issued	Quota (lbs/permit/period)	Harvest (lbs)	Value ($)
2007	15	200	1,103	856
2008	13	250	1,292	775
2009	27	125	643	836
2010	30	125	1,765	1,765
2011	23	150	1,611	1,611
2012	18	150	678	678
Average	21	167	1,182	1,086
Total	126		7,092	6,521

Table 30. Blueback herring juvenile abundance index, from the 11 core stations, Albemarle Sound area, NC, 1972-2012.

Year	# caught	# samples	JAI	Std. Dev.	Geo. Mean
1972	4,166	13	320.46	1101.91	8.63
1973	16,209	39	415.62	878.68	33.13
1974	3,008	48	62.67	144.46	7.90
1975	6,641	48	138.35	312.27	13.15
1976	7,788	46	169.30	839.45	6.04
1977	5,784	50	115.68	319.35	11.32
1978	4,626	49	94.41	188.49	8.16
1979	4,693	35	134.09	263.10	14.42
1980	12,054	46	262.04	882.66	20.16
1981	55	50	1.10	4.21	0.25
1982	3,541	49	72.27	195.39	7.58
1983	12,561	50	251.22	1075.76	3.80
1984	1,038	52	19.96	60.16	1.81
1985	7,124	51	139.69	533.63	2.47
1986	758	55	13.78	64.92	1.16
1987	1,378	55	25.05	91.91	1.25
1988	602	52	11.58	44.70	0.95
1989	1	55	0.02	0.13	0.01
1990	505	55	9.18	31.80	0.99
1991	1,196	55	21.75	154.18	0.40
1992	51	55	0.93	6.35	0.10
1993	3,571	39	91.56	560.17	0.93
1994	0	32	0.00	0.00	0.00
1995	63	55	1.15	4.49	0.31
1996	827	55	15.04	79.77	1.18
1997	404	55	7.35	25.76	1.05
1998	22	55	0.40	2.22	0.12
1999	97	54	1.80	10.29	0.20
2000	85	55	1.55	5.44	0.42
2001	228	55	4.15	14.66	0.59
2002	43	55	0.78	2.97	0.23
2003	71	55	1.29	5.36	0.34
2004	812	55	14.76	56.21	1.19
2005	354	55	6.44	36.64	0.53
2006	28	55	0.51	3.25	0.11
2007	1	55	0.02	0.13	0.01
2008	143	55	2.60	19.28	0.10
2009	56	55	1.02	5.10	0.18
2010	29	55	0.53	3.78	0.08
2011	3	55	0.05	0.40	0.03
2012	30	55	0.55	2.99	0.10
Total	100,646	2,068	48.7		

Table 31. Alewife juvenile abundance index, from the 11 core stations, Albemarle Sound area, NC, 1972-2012.

Year	# caught	# samples	JAI	Std. Dev	Geo. Mean
1972	64	13	4.92	16.87	0.53
1973	320	39	8.21	26.95	0.73
1974	49	48	1.02	2.76	0.37
1975	410	48	8.54	40.18	0.74
1976	64	46	1.39	4.79	0.39
1977	391	50	7.82	23.46	1.66
1978	608	49	12.41	23.36	2.56
1979	170	35	4.86	17.53	1.17
1980	663	46	14.41	46.47	2.25
1981	249	50	4.98	33.63	0.26
1982	28	49	0.57	1.15	0.32
1983	105	50	2.10	10.03	0.36
1984	38	52	0.73	2.39	0.25
1985	200	51	3.92	20.10	0.46
1986	131	55	2.38	8.88	0.62
1987	1	55	0.02	0.13	0.01
1988	10	52	0.19	0.90	0.12
1989	3	55	0.05	0.30	0.04
1990	33	55	0.60	4.18	0.11
1991	0	55	0.00	0.00	0.00
1992	1	55	0.02	0.13	0.01
1993	0	39	0.00	0.00	0.00
1994	0	32	0.00	0.00	0.00
1995	8	55	0.15	1.08	0.04
1996	219	55	3.98	10.91	0.86
1997	1	55	0.02	0.13	0.01
1998	68	55	1.24	6.98	0.16
1999	16	54	0.30	1.27	0.14
2000	23	55	0.42	1.41	0.19
2001	289	55	5.25	32.50	0.41
2002	7	55	0.13	0.47	0.08
2003	81	55	1.47	4.38	0.42
2004	118	55	2.15	8.98	0.41
2005	48	55	0.87	5.28	0.17
2006	1	55	0.02	0.13	0.01
2007	4	55	0.07	0.42	0.04
2008	0	55	0.00	0.00	0.00
2009	0	55	0.00	0.00	0.00
2010	227	55	4.13	12.20	0.67
2011	44	55	0.80	3.70	0.17
2012	36	55	0.65	2.28	0.20
Total	4,728	2068	2.29		

Table 32. American shad juvenile abundance index, from the 11 core stations, Albemarle Sound area, NC, 1972-2012.

Year	# caught	# samples	JAI	Std. Dev.	Geo. Mean
1972	3	13	0.23	0.60	0.15
1973	7	39	0.18	0.60	0.10
1974	0	48	0.00	0.00	0.00
1975	9	48	0.19	1.04	0.07
1976	0	46	0.00	0.00	0.00
1977	21	50	0.42	2.97	0.06
1978	17	49	0.35	0.97	0.18
1979	14	35	0.40	0.98	0.22
1980	31	46	0.67	2.24	0.23
1981	3	50	0.06	0.42	0.03
1982	24	49	0.49	2.87	0.12
1983	1	50	0.02	0.14	0.01
1984	8	52	0.15	0.61	0.09
1985	94	51	1.84	9.86	0.31
1986	6	55	0.11	0.50	0.06
1987	8	55	0.15	0.59	0.09
1988	7	52	0.13	0.53	0.08
1989	1	55	0.02	0.13	0.01
1990	0	55	0.00	0.00	0.00
1991	0	55	0.00	0.00	0.00
1992	0	55	0.00	0.00	0.00
1993	1	39	0.03	0.16	0.02
1994	0	32	0.00	0.00	0.00
1995	1	55	0.02	0.13	0.01
1996	0	55	0.00	0.00	0.00
1997	43	55	0.78	2.39	0.26
1998	10	55	0.18	1.35	0.04
1999	19	54	0.35	1.81	0.11
2000	13	55	0.24	0.90	0.12
2001	35	55	0.64	2.59	0.21
2002	30	55	0.55	1.50	0.27
2003	252	55	4.58	18.58	0.59
2004	17	55	0.31	0.94	0.16
2005	82	55	1.49	3.79	0.51
2006	14	55	0.25	1.24	0.09
2007	1	55	0.02	0.13	0.01
2008	15	55	0.27	0.85	0.14
2009	6	55	0.11	0.69	0.05
2010	16	55	0.29	1.30	0.12
2011	35	55	0.64	2.92	0.20
2012	10	55	0.18	0.70	0.07
Total	854	2,068	0.41		

Table 33. Hickory shad juvenile abundance index, from the 11 core stations, Albemarle Sound area, NC, 1972-2012.

Year	# caught	# samples	JAI	Std. Dev.	Geo. Mean
1972	0	13	0.00	0.00	0.00
1973	0	39	0.00	0.00	0.00
1974	1	48	0.02	0.14	0.01
1975	8	48	0.17	0.91	0.07
1976	1	46	0.02	0.15	0.02
1977	4	50	0.08	0.57	0.03
1978	10	49	0.20	1.04	0.08
1979	0	35	0.00	0.00	0.00
1980	7	46	0.15	0.76	0.07
1981	0	50	0.00	0.00	0.00
1982	0	49	0.00	0.00	0.00
1983	0	50	0.00	0.00	0.00
1984	0	52	0.00	0.00	0.00
1985	0	51	0.00	0.00	0.00
1986	0	55	0.00	0.00	0.00
1987	0	55	0.00	0.00	0.00
1988	0	52	0.00	0.00	0.00
1989	0	55	0.00	0.00	0.00
1990	0	55	0.00	0.00	0.00
1991	0	55	0.00	0.00	0.00
1992	0	55	0.00	0.00	0.00
1993	0	39	0.00	0.00	0.00
1994	0	32	0.00	0.00	0.00
1995	0	55	0.00	0.00	0.00
1996	25	55	0.45	1.97	0.14
1997	42	55	0.76	3.93	0.13
1998	4	55	0.07	0.38	0.04
1999	9	54	0.17	0.83	0.08
2000	6	55	0.11	0.57	0.06
2001	8	55	0.15	1.08	0.04
2002	1	55	0.02	0.13	0.01
2003	4	55	0.07	0.33	0.05
2004	1	55	0.02	0.13	0.01
2005	1	55	0.02	0.13	0.01
2006	1	55	0.02	0.13	0.01
2007	1	55	0.02	0.13	0.01
2008	0	55	0.00	0.00	0.00
2009	13	55	0.24	1.75	0.05
2010	0	55	0.00	0.00	0.00
2011	1	55	0.02	0.13	0.01
2012	2	55	0.04	0.27	0.02
Total	150	2,068	0.07		

Table 34. Age and spawning frequency of blueback herring in NCDMF independent gill net sampling, Albemarle Sound area, NC, 2011.

		Spawning Marks							
		0		1		2		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female
3	2008	5	10	--	--	--	--	5	10
4	2007	9	44	8	17	--	--	17	61
5	2006	1	10	4	22	--	--	5	32
6	2005	--	2	--	--	--	6	0	8
Total		15	66	12	39	0	6	27	111
Percent		55.6	59.5	44.4	35.1		5.4		
Percent combined		58.7		37.0		4.3			

Table 35. Age and spawning frequency of alewife in NCDMF independent gill net sampling, Albemarle Sound area, NC, 2011.

		Spawning Marks									
		0		1		2		3		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
3	2008	--	1	--	--	--	--	--	--	--	1
4	2007	5	9	2	--	--	--	--	--	7	9
5	2006	2	17	13	65	1	12	--	--	16	94
6	2005	--	--	5	20	14	36	--	--	19	56
7	2004	--	--	--	--	1	13	2	11	3	24
8	2003	--	--	--	--	--	--	--	2	--	2
Total		7	27	20	85	16	61	2	13	45	186
Percent		15.6	14.5	44.4	45.7	35.6	32.8	4.4	7.0		
Percent combined		14.7		45.5		33.3		6.5			

Table 36. Age and spawning frequency of blueback herring in NCDMF independent gill net sampling, Albemarle Sound area, NC 2012.

		Spawning Marks									
		0		1		2		3		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
3	2009	2	4	--	--	--	--	--	--	2	4
4	2008	14	23	2	--	--	--	--	--	16	23
5	2007	1	6	11	18	--	--	--	--	12	24
6	2006	--	--	4	7	1	3	--	--	5	10
7	2005	--	--	--	--	--	3	--	--	--	3
8	2004	--	--	--	--	--	--	--	3	--	3
Total		17	33	17	25	1	6	--	3	35	67
Percent		48.6	49.3	48.6	37.3	2.9	9.0		4.5		
Percent Combined		49.0		41.2		6.9		2.9			

Table 37. Age and spawning frequency of alewife in NCDMF independent gill net sampling, Albemarle Sound area, NC, 2012.

		Spawning marks									
		0		1		2		3		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
3	2009	7	--	--	--	--	--	--	--	7	--
4	2008	9	14	--	--	--	--	--	--	9	14
5	2007	1	6	11	20	--	--	--	--	12	26
6	2006	--	--	2	26	4	36	--	--	6	62
7	2005	--	--	--	--	2	7	1	--	3	7
8	2004	--	--	--	--	--	--	2	7	2	7
Total		17	20	13	46	6	43	3	7	39	116
Percent		43.6	17.2	33.3	39.7	15.4	37.1	7.7	6.0		
Percent combined		23.9		38.1		31.6		6.5			

Table 38. Age and spawning frequency of blueback herring in the Chowan River Pound Net Survey, NC, 2011.

		Spawning Marks							
		0		1		2		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female
3	2008	42	35	--	--	--	--	42	35
4	2007	123	55	19	12	--	--	142	67
5	2006	7	4	79	43	1	--	87	47
6	2005	--	--	30	15	--	5	30	20
Total		172	94	128	70	1	5	301	169
Percent		57.1	55.6	42.5	41.4	0.3	1.7		
Percent combined		56.6		42.1		1.3			

Table 39. Age and spawning frequency of alewife in the Chowan River Pound Net Survey, NC, 2011.

		Spawning Marks									
		0		1		2		3		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
3	2008	4	8	--	--	--	--	--	--	4	8
4	2007	57	52	--	1	--	--	--	--	57	53
5	2006	10	5	34	96	--	--	--	--	44	101
6	2005	--	--	56	105	37	103	--	1	93	209
7	2004	--	--	--	24	18	33	--	2	18	59
8	2003	--	--	--	--	4	--	1	--	5	
Total		71	65	90	226	59	136	1	3	221	430
Percent		32.1	15.1	40.7	52.6	26.7	31.6	0.0	0.7		
Percent combined		20.9		48.5		30.0		0.6			

Table 40. Age and spawning frequency of blueback herring in the Chowan River Pound Net Survey, NC, 2012.

		Spawning marks							
		0		1		2		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female
3	2009	47	21	2	--	--	--	49	21
4	2008	93	67	6	4	--	--	99	71
5	2007	E 3	7	58	20	--	--	61	27
6	2006	--	--	6	20	2	7	8	27
Total		143	95	72	44	2	7	217	146
Percent		65.9	65.1	33.2	30.1	0.9	4.8		
Percent Combined		65.6		32.0		2.5			

Table 41. Age and spawning frequency of alewife in the Chowan River Pound Net Survey, NC, 2012.

		Spawning Marks											
		0		1		2		3		4		Total	
Age	Year Class	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
3	2009	10	3	--	--	--	--	--	--	--	--	10	3
4	2008	72	68	--	4	--	--	--	--	--	--	72	72
5	2007	16	17	31	76	--	4	--	--	--	--	47	97
6	2006	2	--	45	16	18	155	--	--	--	--	65	171
7	2005	--	--	--	--	11	12	--	10	--	--	11	22
8	2004	--	--	--	--	1	--	--	--	--	1	1	1
Total		100	88	76	96	30	171		10		1	206	366
Percent		48.5	24.0	36.9	26.2	14.6	46.7		2.7		0.3		
Percent combined		32.9		30.1		35.1		1.7		0.2			

Table 42. Alewife and blueback herring effort, catch, and CPUE (total catch/total effort), in NCWRC electrofishing survey, spring 2012..

Location	Total Effort (h)	Catch ALE	CPUE ALE (#/h)	Catch BBH	CPUE BBH (#/h)
Chowan R.- Indian Creek	3.48	24	6.90	8	2.30
Chowan R.- Bennett's Creek	3.31	67	20.20	1	0.30
Tar R. - Bear Creek	2.50	0	0.00	0	0.00
Tar R. - Chicod Creek	2.50	0	0.00	0	0.00
Neuse R.- Core Creek	3.53	0	0.00	37	10.50
Neuse R. - Village Creek	3.41	0	0.00	125	36.70
Cape Fear R. - Town/Rice's Creek	15.19	0	0.00	270	17.80
Total	33.92	91	2.68	441	13.00

Table 43. Blueback herring broodstock tank composition for Indian Creek and Bennetts Creek 2012 at Edenton National Fish Hatchery.

Broodstock Source	Tank	Male	Female
Indian Creek	A	32	34
Indian Creek	B	39	32
Bennetts Creek	Y	33	17
Total		104	83

Table 44. Date, stocking location and number of blueback herring fry stocked per trip in the Chowan River Basin in 2012. Fry were 3 days old when stocked.

Date	Location	Number Fry Stocked
3/27/2012	Indian Creek	377,545
3/28/2012	Indian Creek	319,108
3/30/2012	Bennetts Creek	14,430
Total		711,083

Figure 1 Albemarle Sound Management Area, NC.

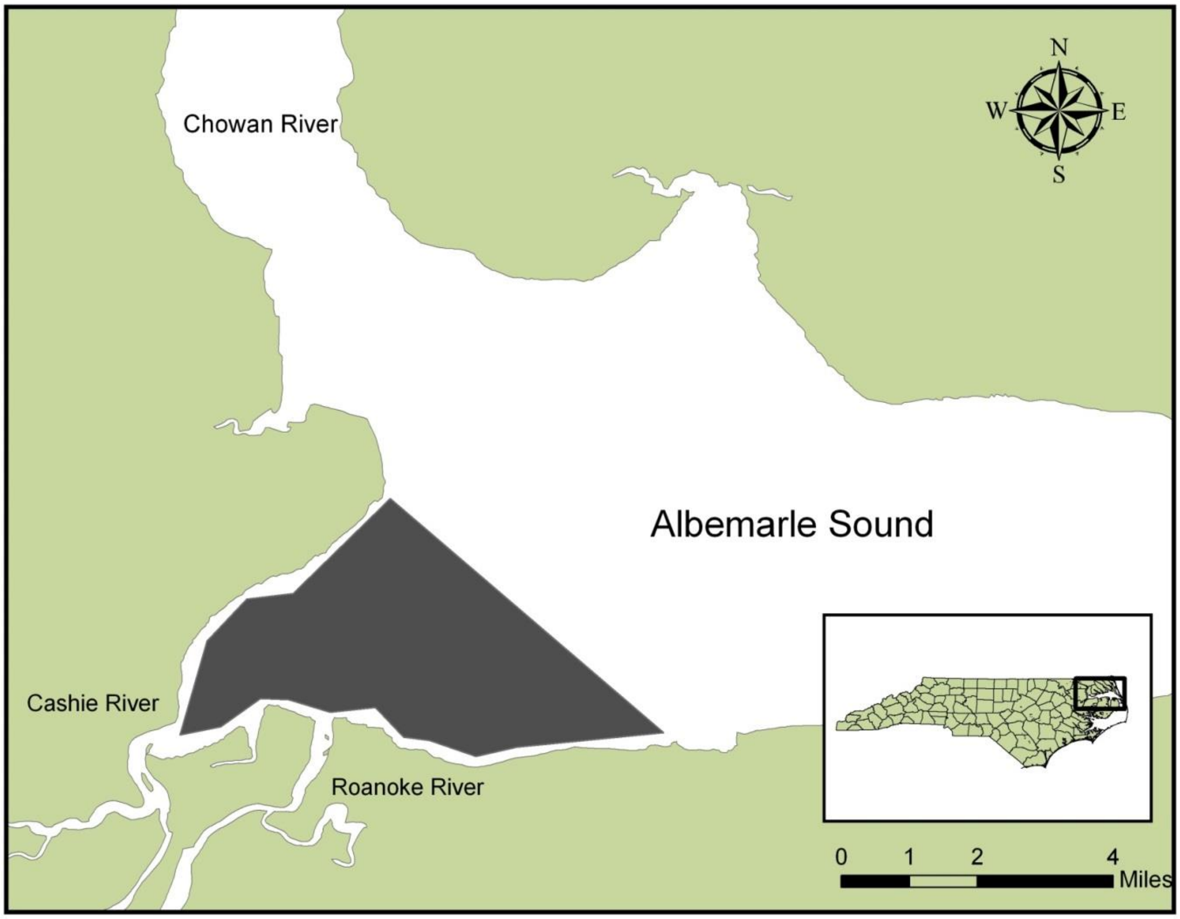
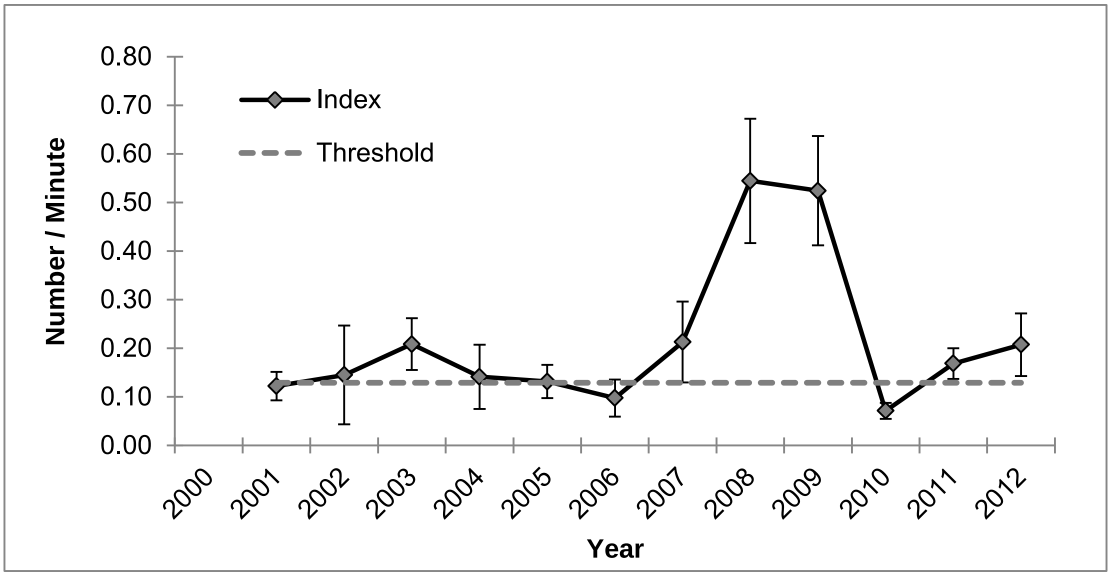


Figure 2. Area in western Albemarle Sound that is closed to gill net fishing from February through mid- November, NC 2012.



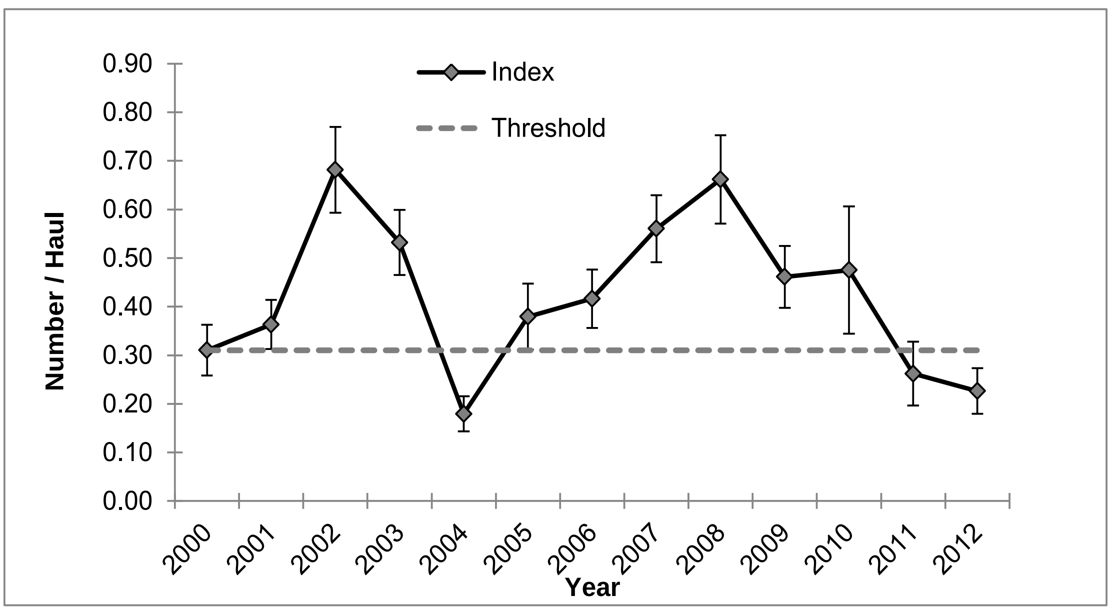


Figure 3. Female CPUE index based on electrofishing (top) and female CPUE based on IGNS (bottom) and sustainability thresholds (dotted line) for Albemarle Sound, NC, 2000-2012.

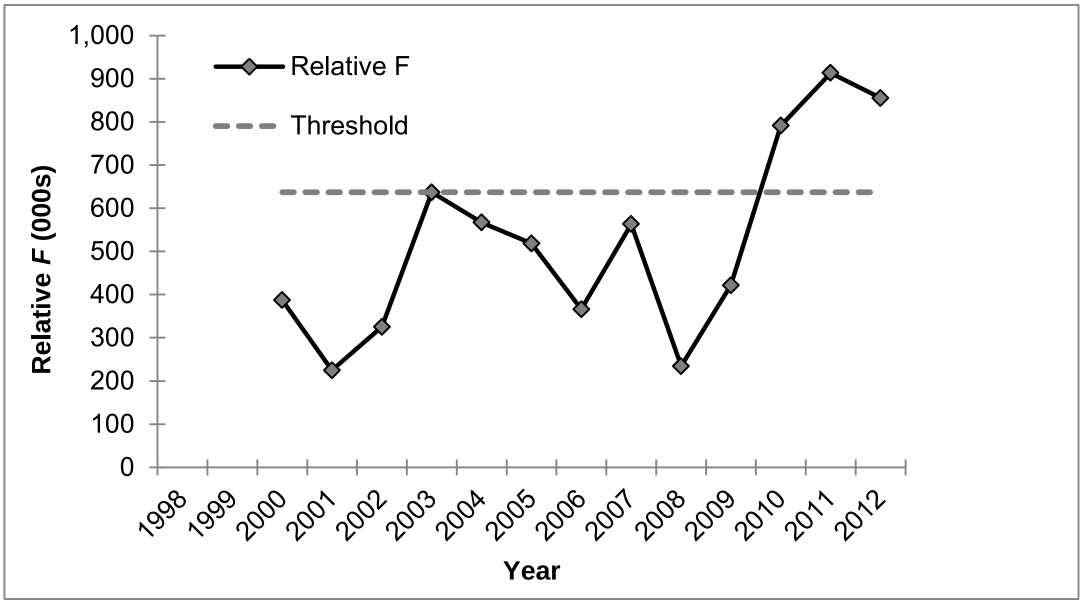


Figure 4. Female American shad relative *F* and sustainability threshold (dotted line) for Albemarle Sound 1998-2012.

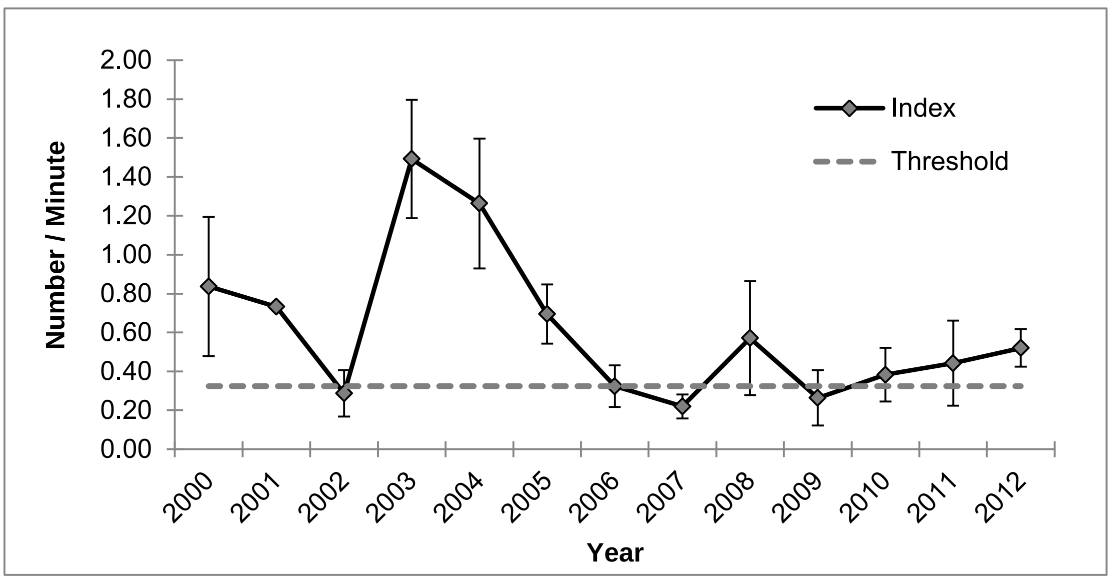


Figure 5. Female CPUE index based on electrofishing survey and sustainability threshold (dotted line) for the Tar-Pamlico River, 2000-2012.

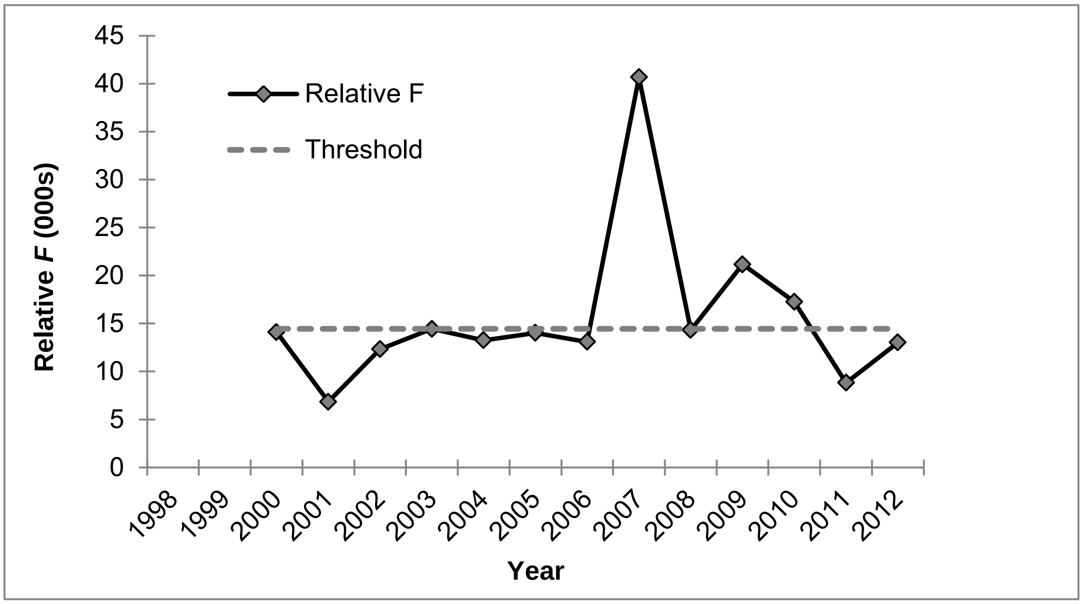


Figure 6. Female relative *F* and sustainability threshold (dotted line) for American shad in the Tar-Pamlico River, 1998-2012.

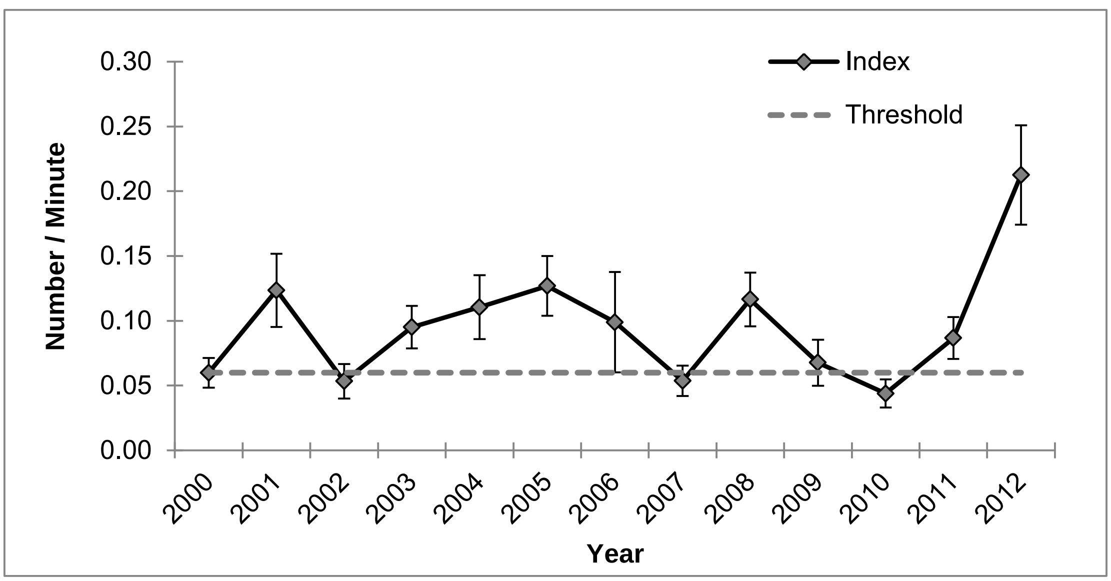


Figure 7. Female electrofishing CPUE index and sustainability threshold (dotted line) for the Neuse River, 2000-2012.

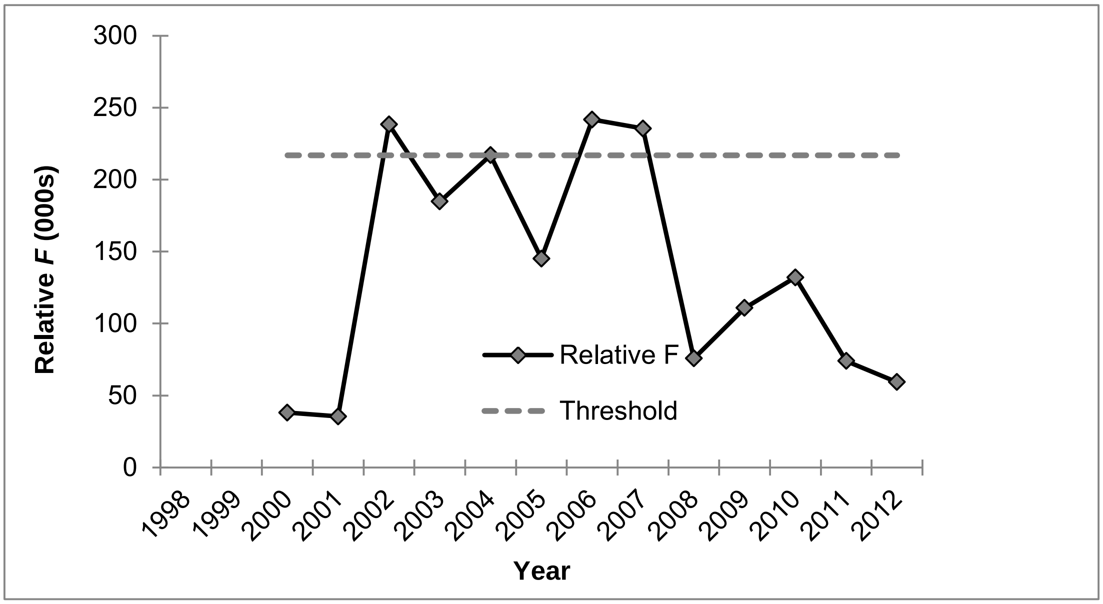


Figure 8. Female relative *F* (bottom) and sustainability threshold (dotted line) for the Neuse River, 1998-2012.

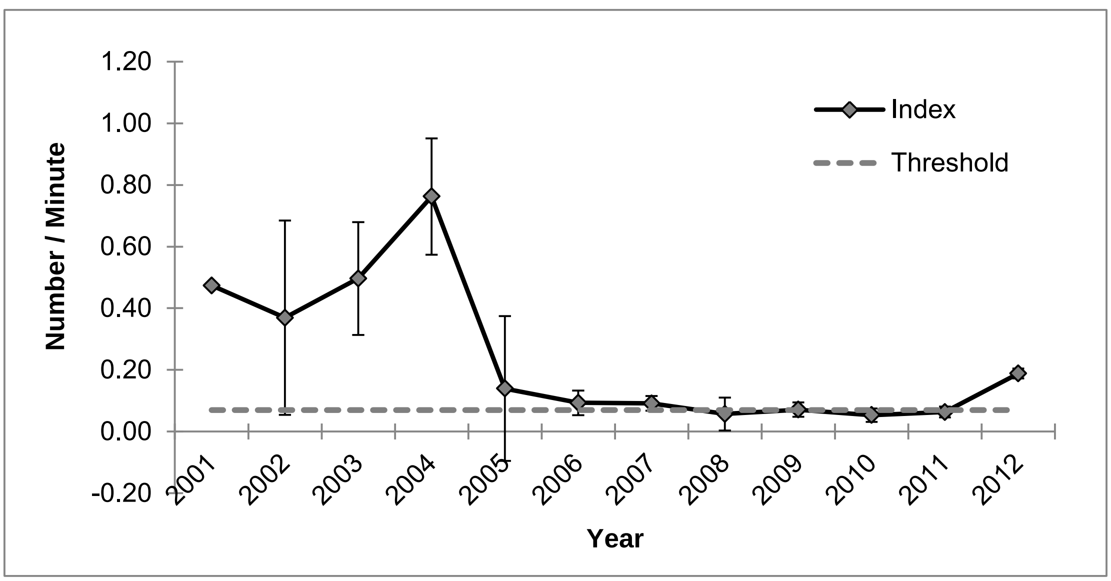


Figure 9. Female electrofishing CPUE and sustainability threshold (dotted line) for the Cape Fear River, 2001-2012.

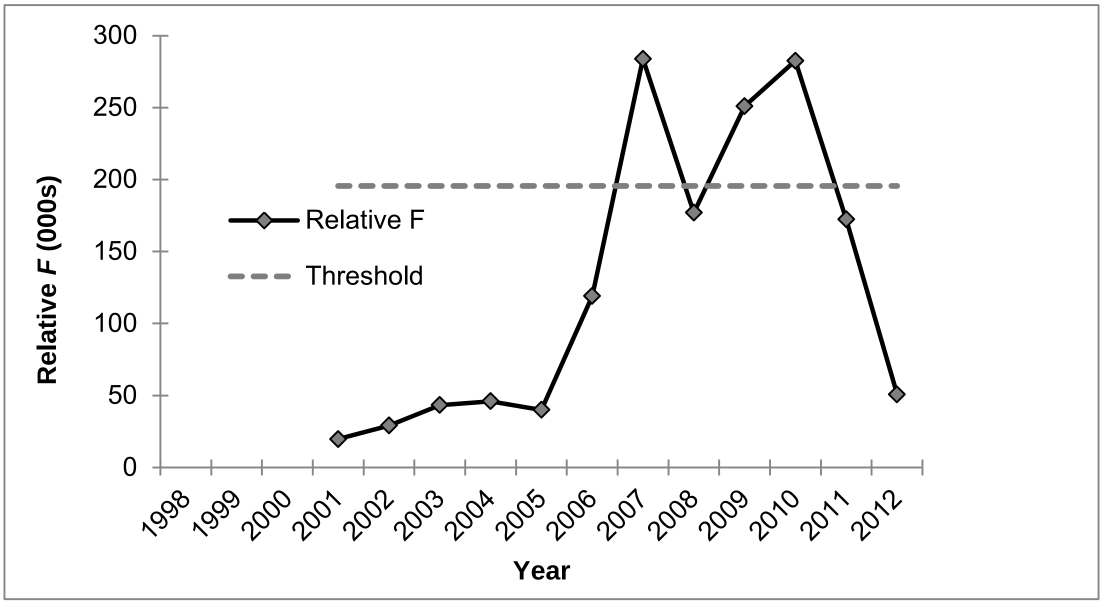


Figure 10. Female relative *F* and sustainability threshold (dotted line)for the Cape Fear River, 1998-2012.

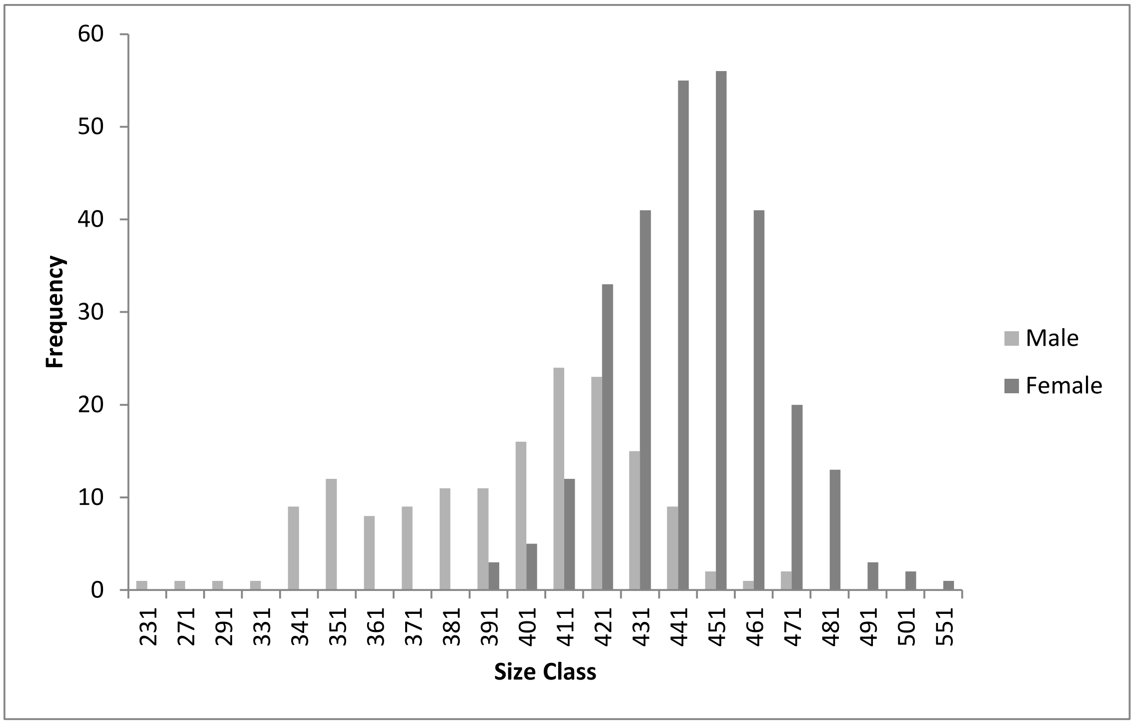


Figure 11. Length frequency distribution of American shad from the ASMA commercial harvest, 2012.

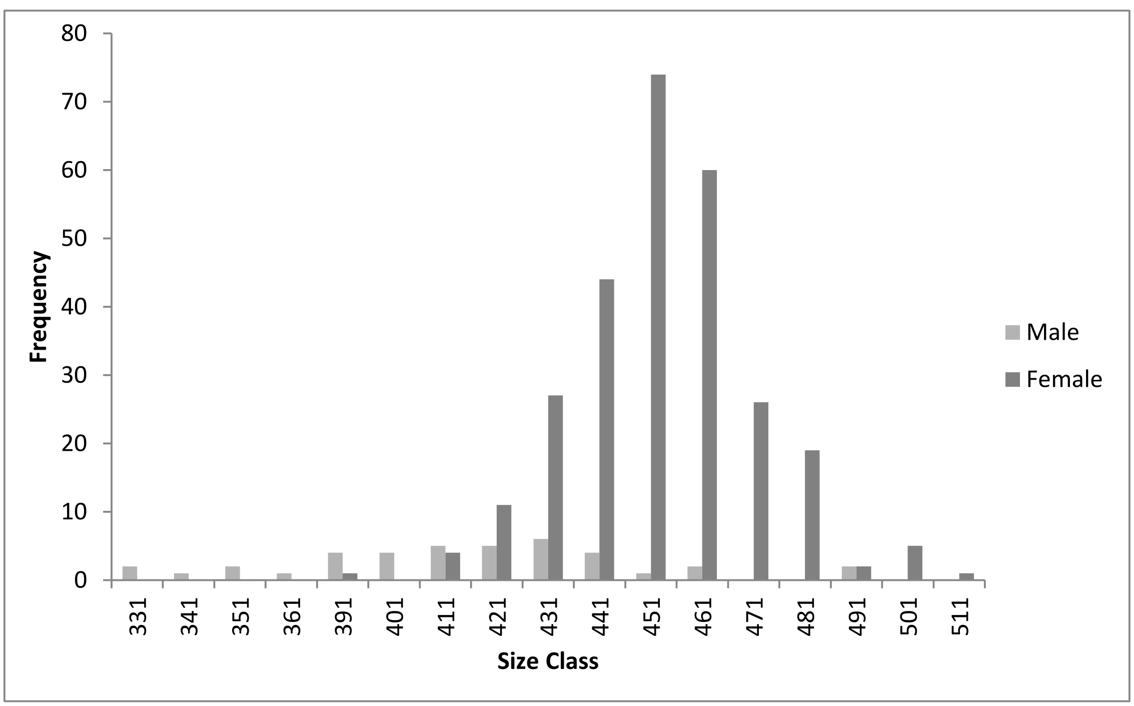


Figure 12. Length frequency distribution of American shad from the Pamlico River commercial harvest, 2012.

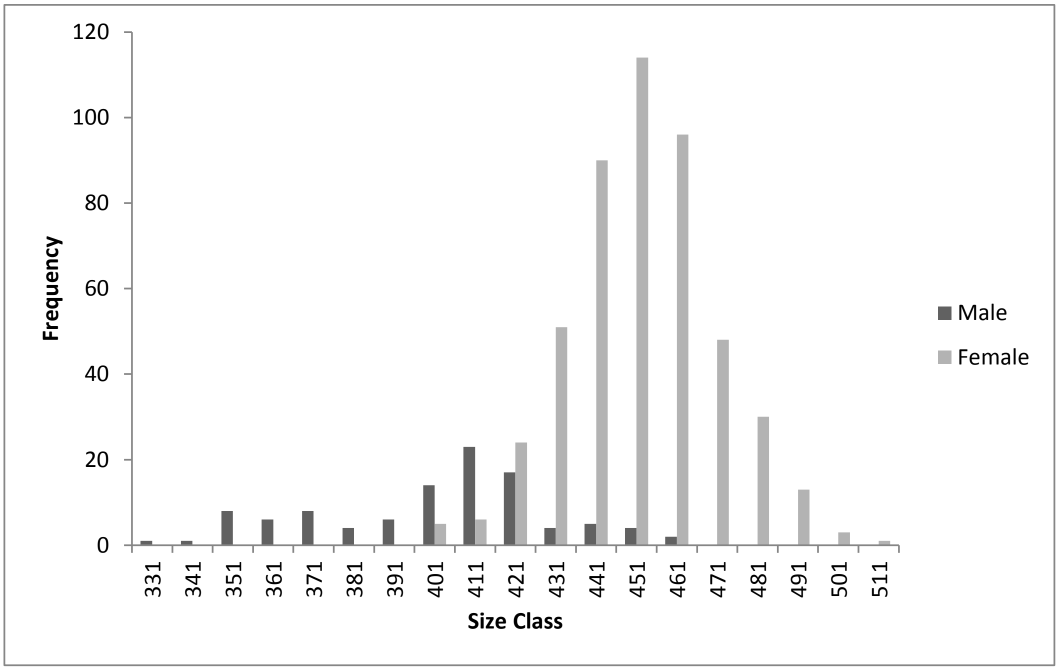


Figure 13. Length frequency distribution of American shad from the Neuse River commercial harvest, NC, 2012.

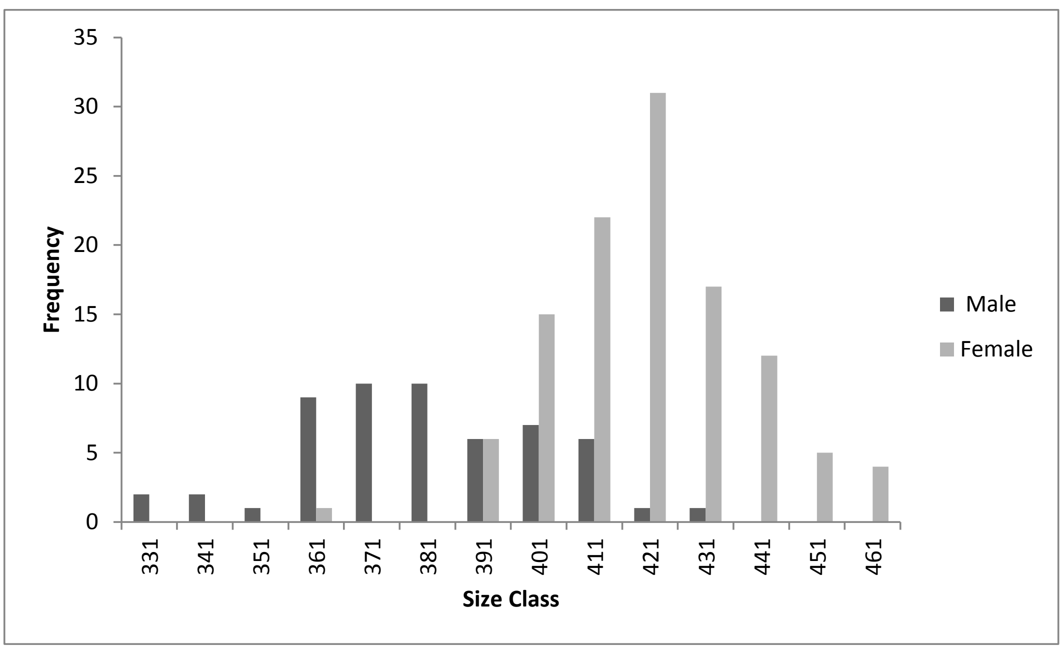


Figure 14. Length frequency distribution of American shad from the Cape Fear River commercial harvest, NC, 2012.

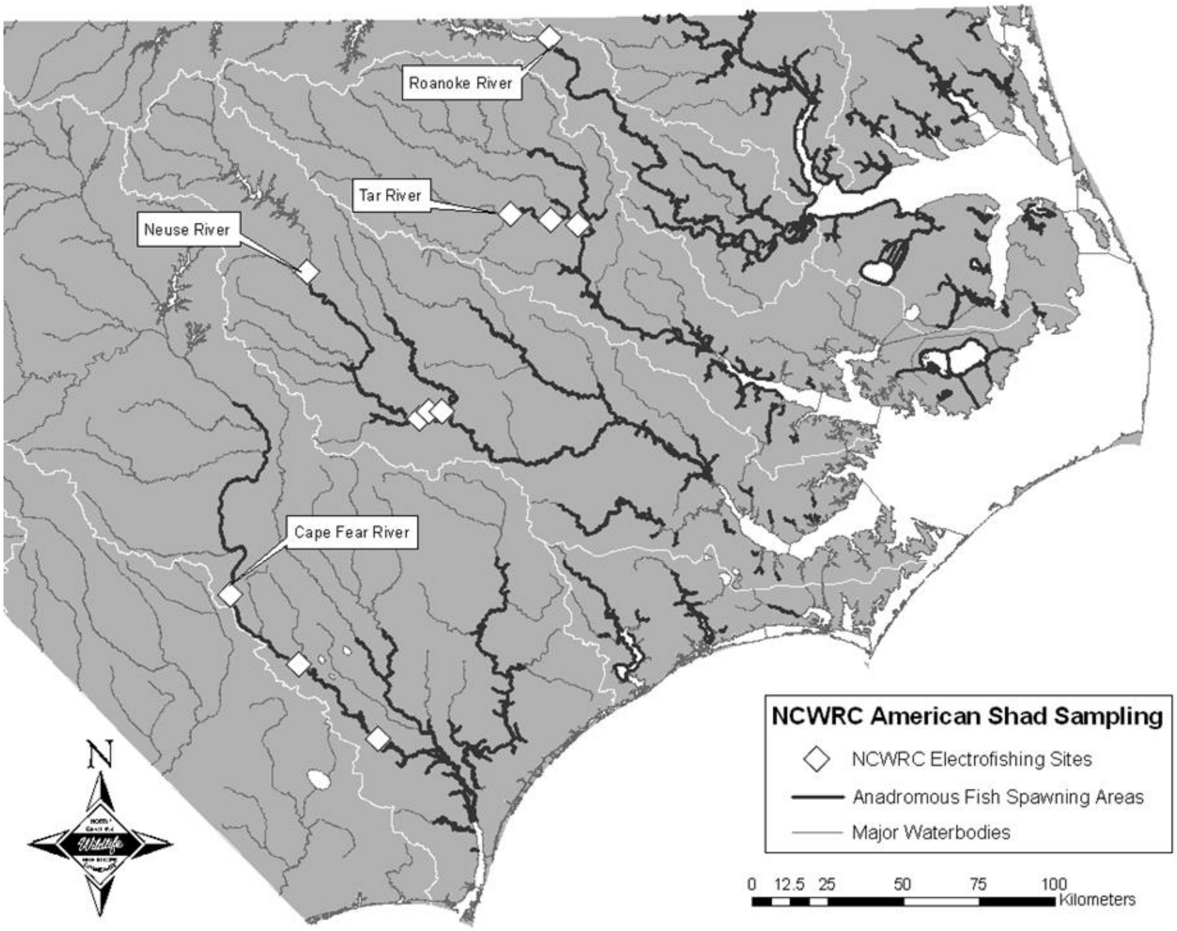


Figure 15. Sampling sites where American shad were collected during NCWRC electroshocking survey, spring 2012.

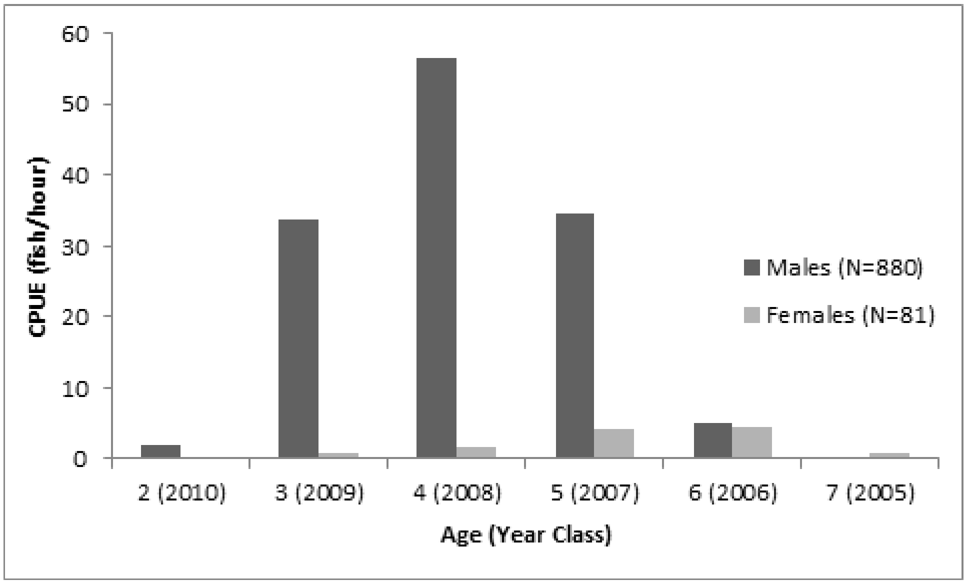


Figure 16. Relative abundance (CPUE) of American shad collected from the NCWRC electroshocking survey, Roanoke River, NC, spring 2012.

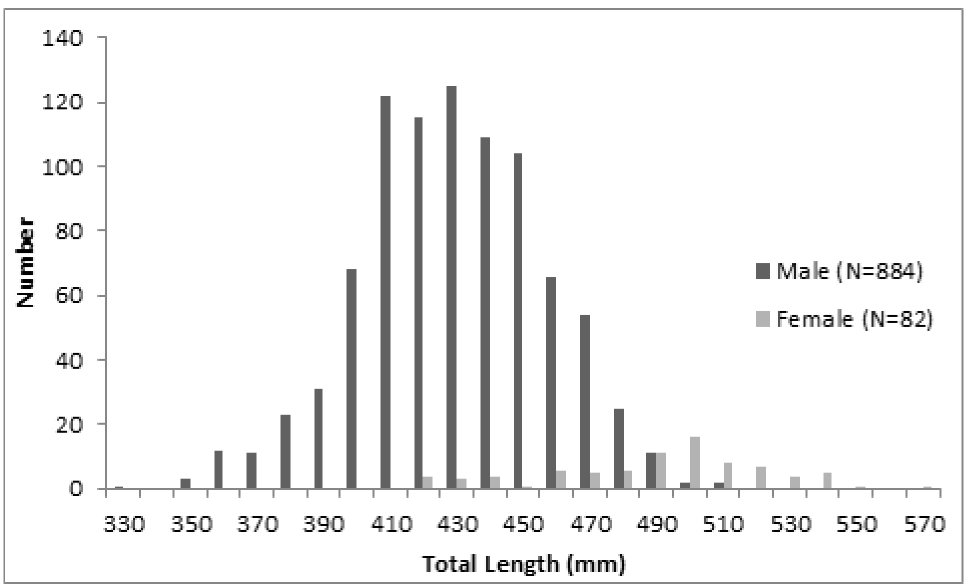


Figure 17. Length frequency for American shad collected from the NCWRC electroshocking survey, Roanoke River, NC, spring 2012.

Figure 18. Relative abundance (CPUE) of American shad collected from the NCWRC electroshocking survey Tar River, NC, spring 2012.

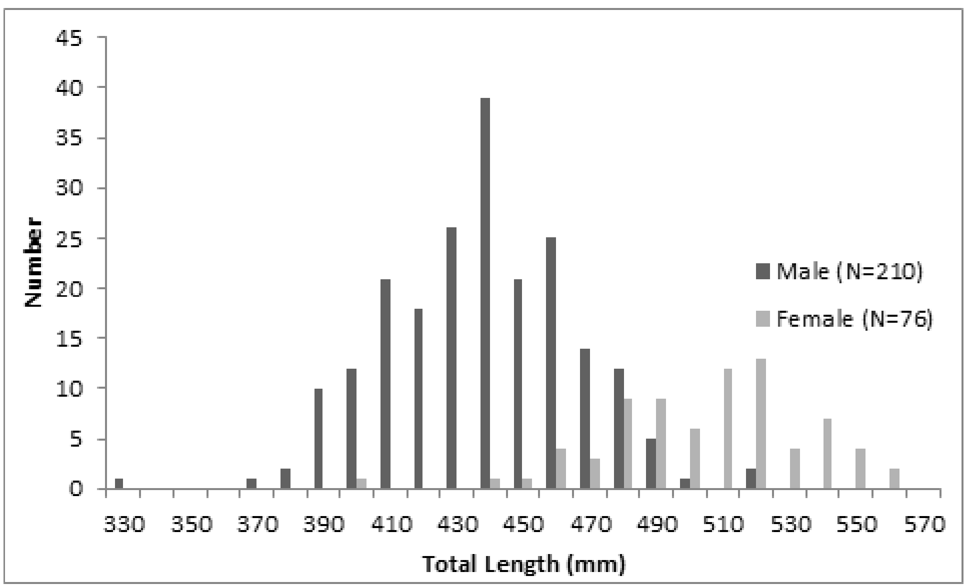


Figure 19, Length frequency for American shad collected from the NCWRC electroshocking survey, Tar River, NC, spring 2012.

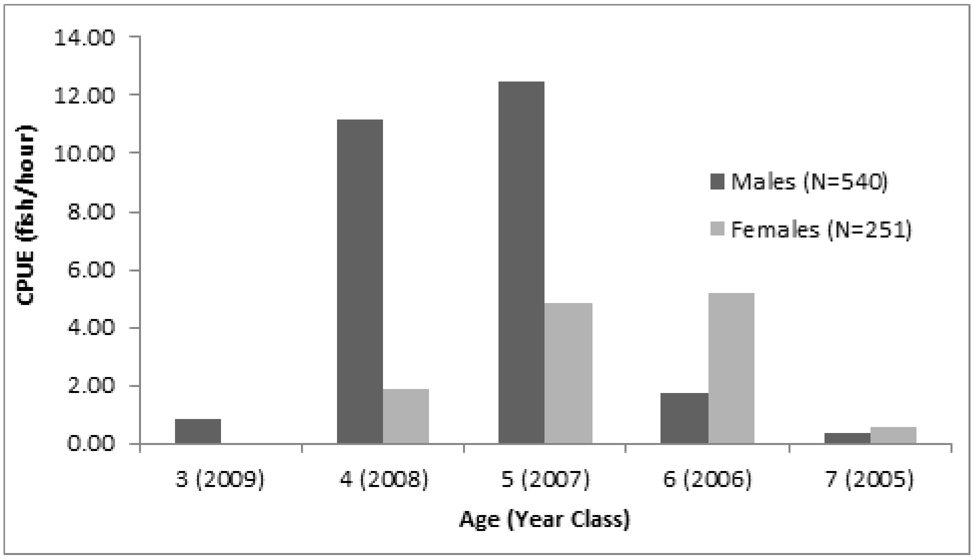


Figure 20 Relative abundance (CPUE) of American shad collected from the NCWRC electroshocking survey, Neuse River, NC, spring 2012.

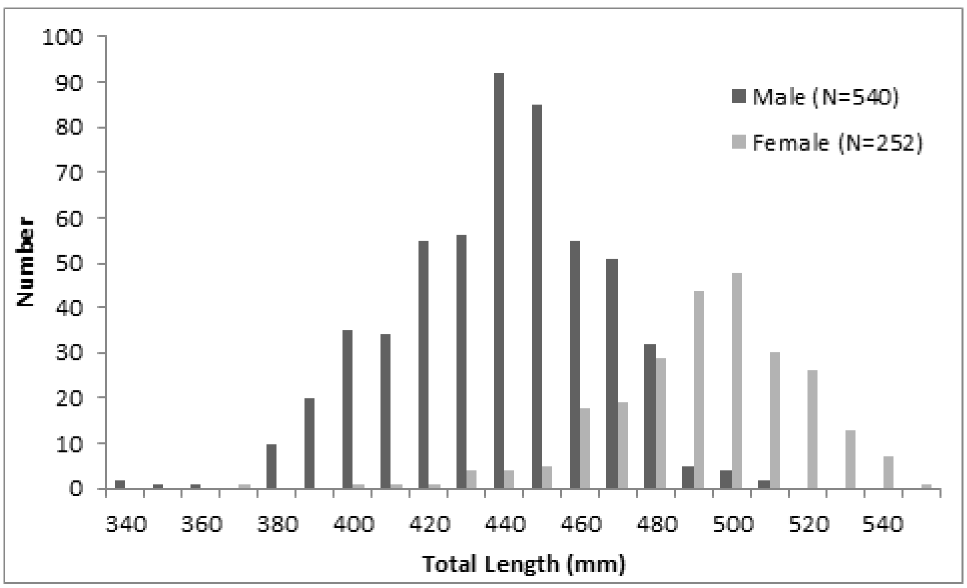


Figure 21. Length frequency for American shad collected from the NCWRC electroshocking survey Neuse River, NC, spring 2012.

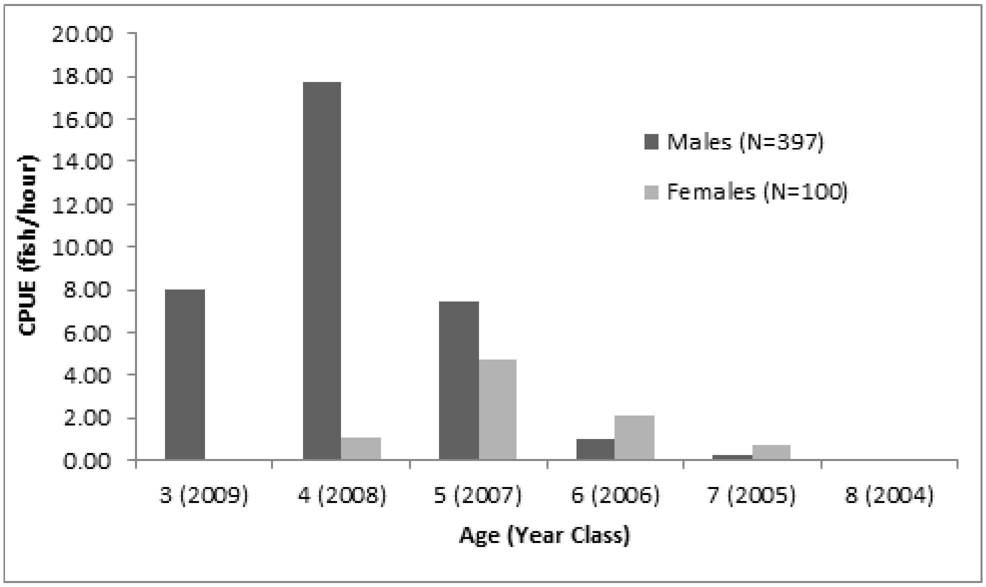


Figure 22. Relative abundance (CPUE) of American shad collected from the NCWRC electroshocking survey, Cape Fear River, NC, spring 2012.

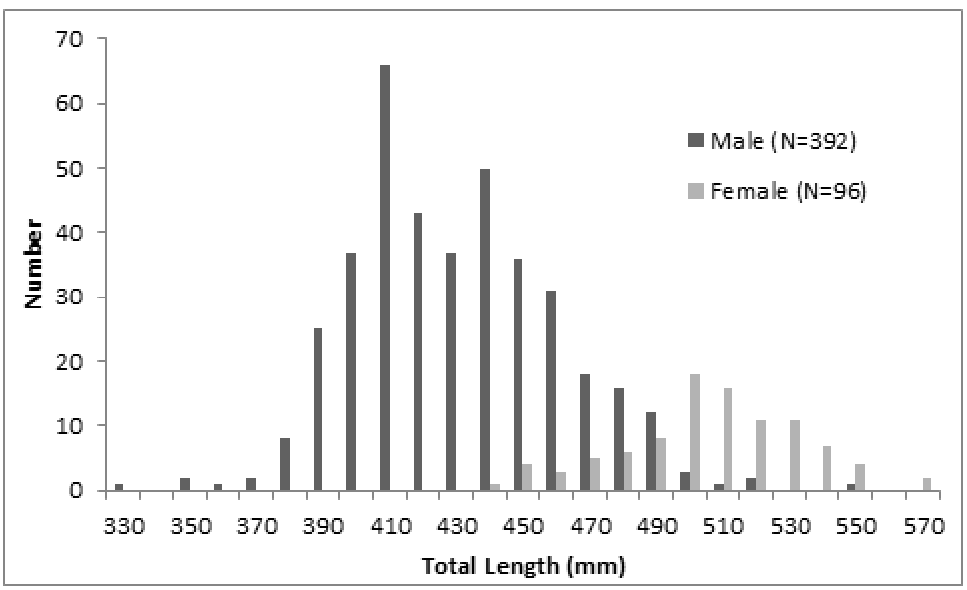


Figure 23. Length frequency for American shad collected from the NCWRC electroshocking survey Cape Fear River, NC, spring 2012.

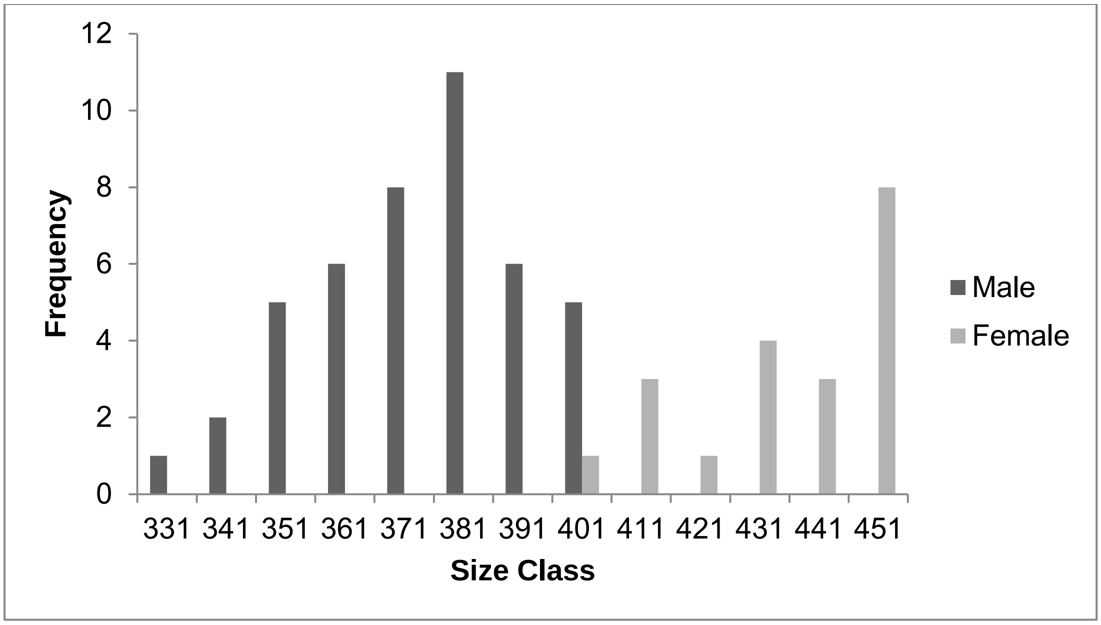


Figure 24. Length frequency of American shad from the NCDMF Independent Gill Net Survey, Albemarle Sound, NC, 2012.

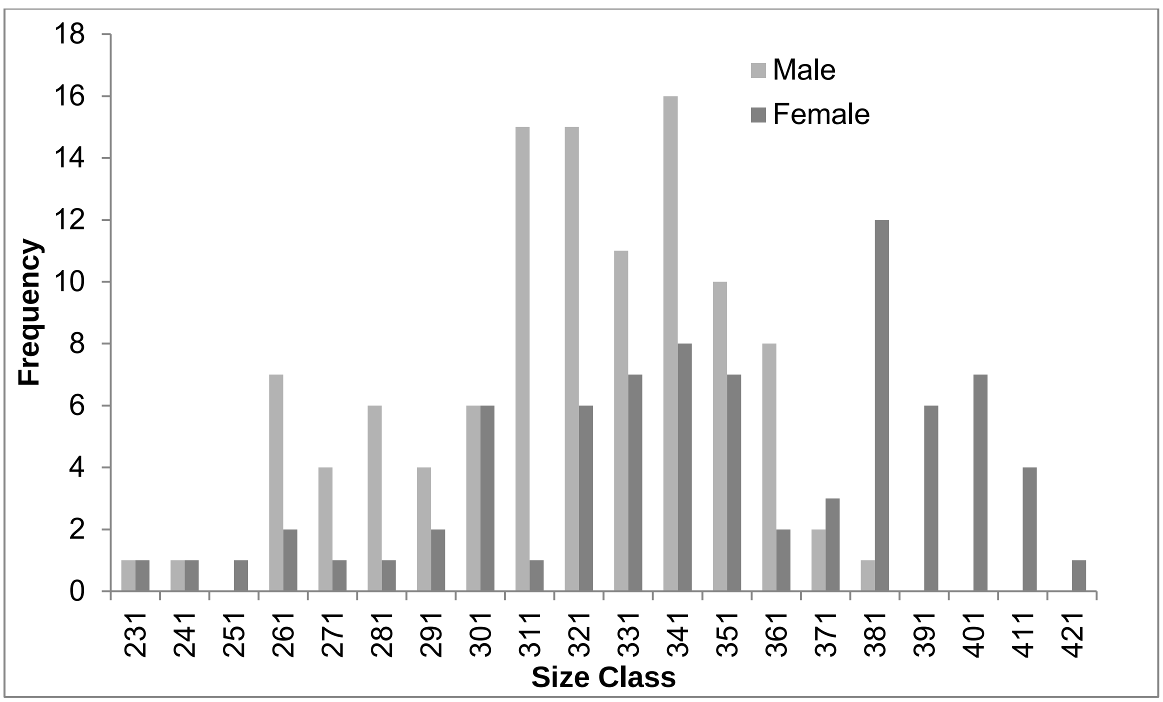


Figure 25. Length frequency of hickory shad from the NCDMF Independent Gill Net Survey, Albemarle Sound area, NC, 2012.

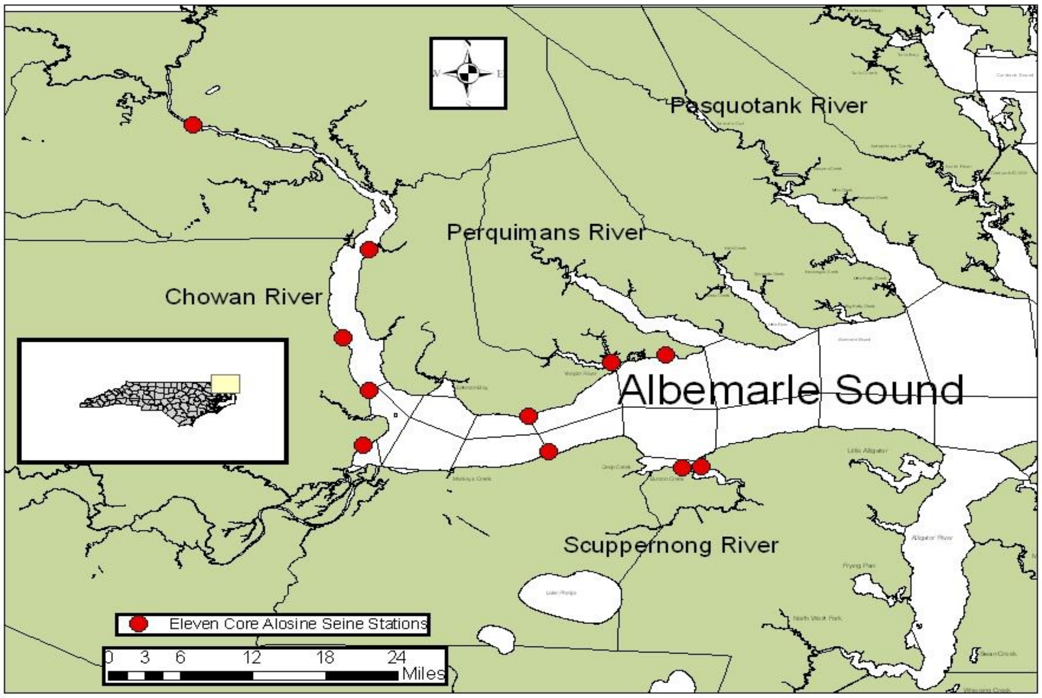


Figure 26. Alosine nursery area sampling sites in the Albemarle Sound area, NC, 1972-2012.

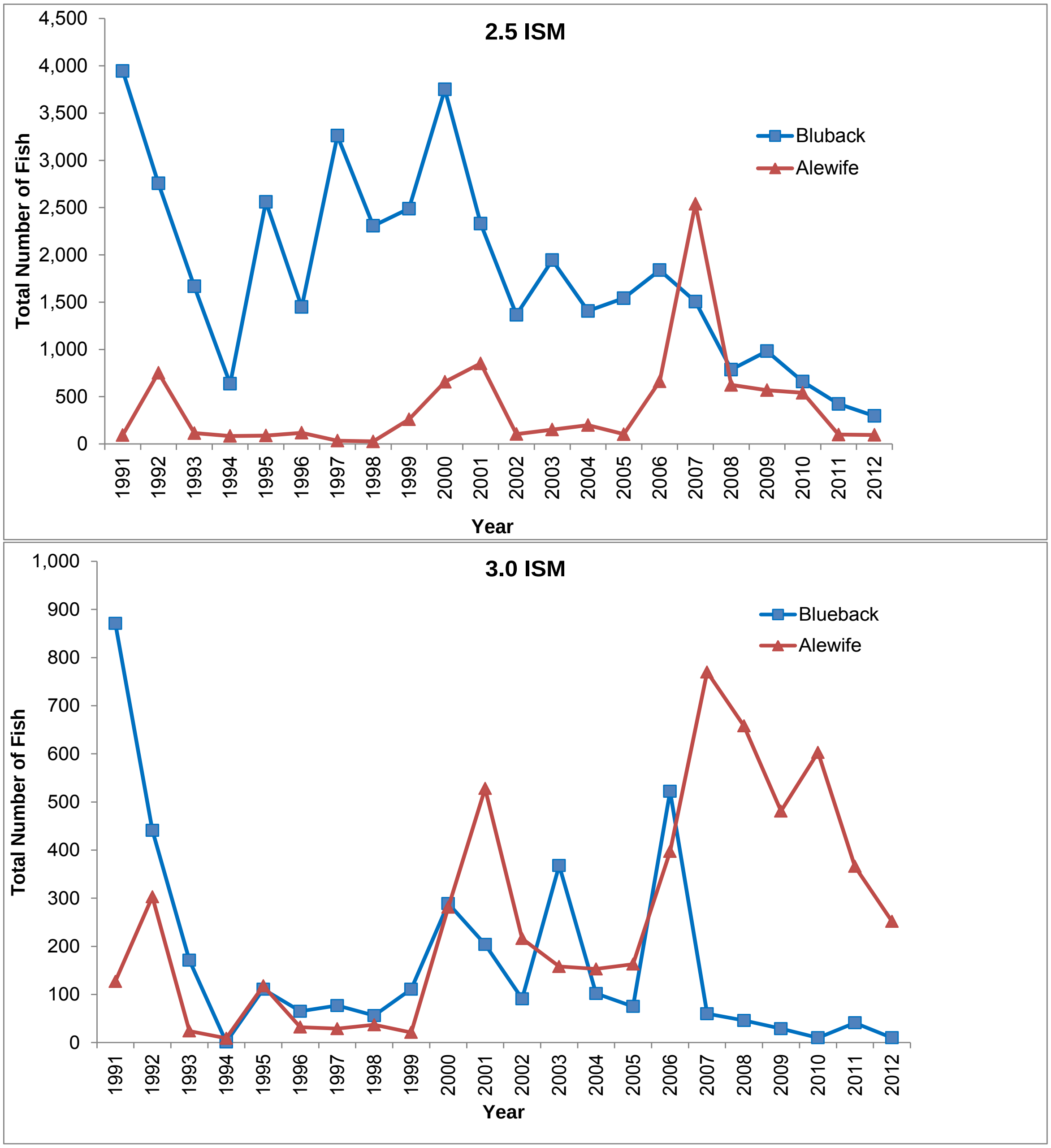


Figure 27. Blueback herring and alewife collection number from NCDMF Independent Gill Net Survey in the 2.5 and 3.0 ISM, ASMA, NC, 1991-2012.

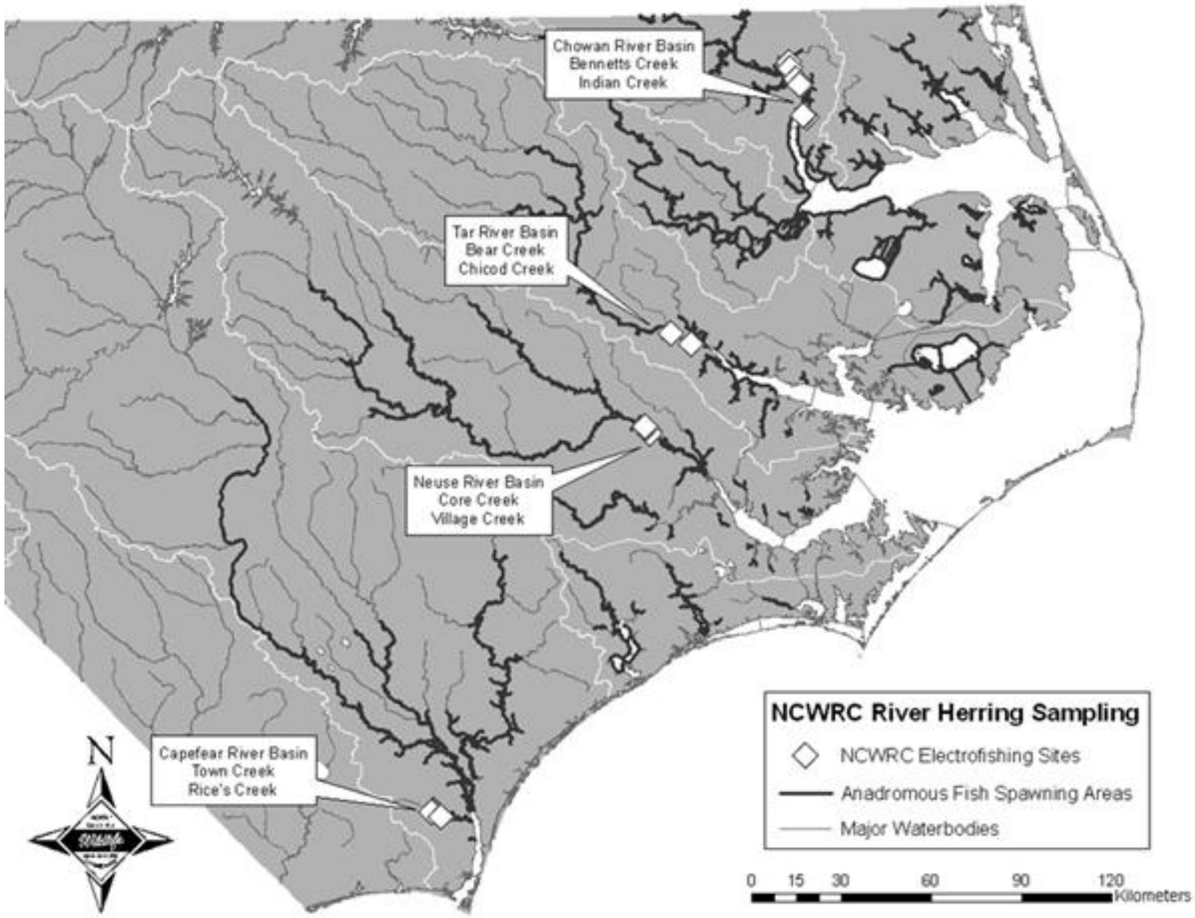


Figure 28. Sampling sites in coastal North Carolina where river herring were collected during spring 2012.

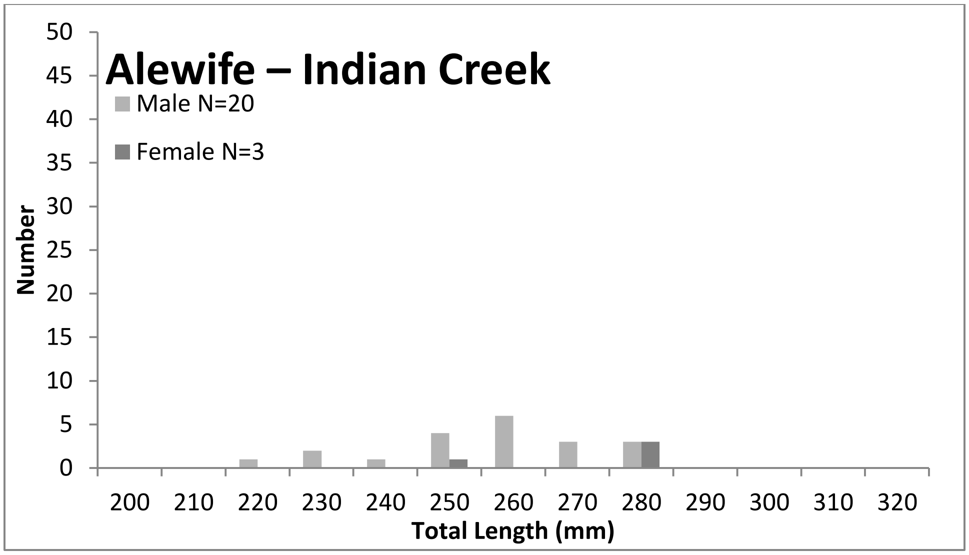


Figure 29. Length frequency histogram for alewife collected from Indian Creek, Chowan River, spring 2012.

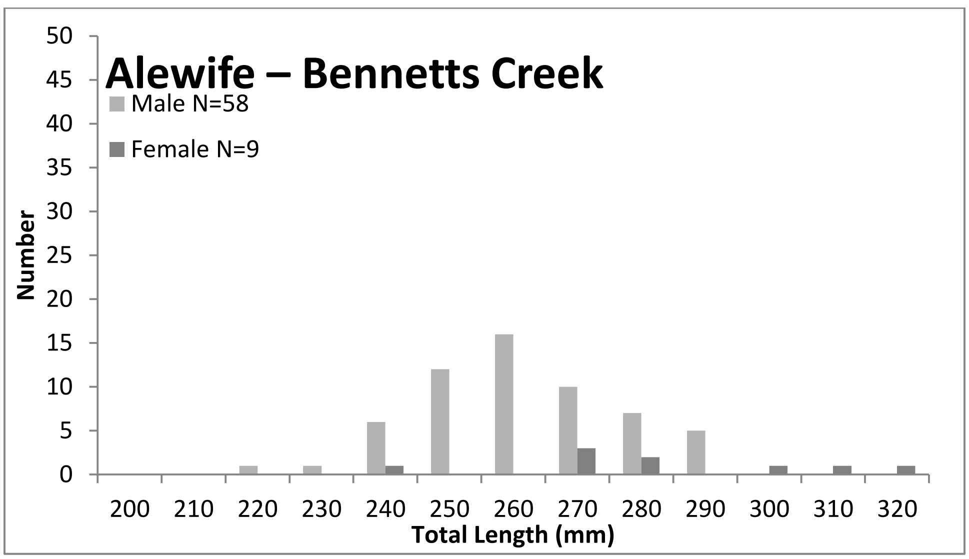


Figure 30. Length frequency histogram for alewife collected from Bennetts Creek, Chowan River, Spring 2012.

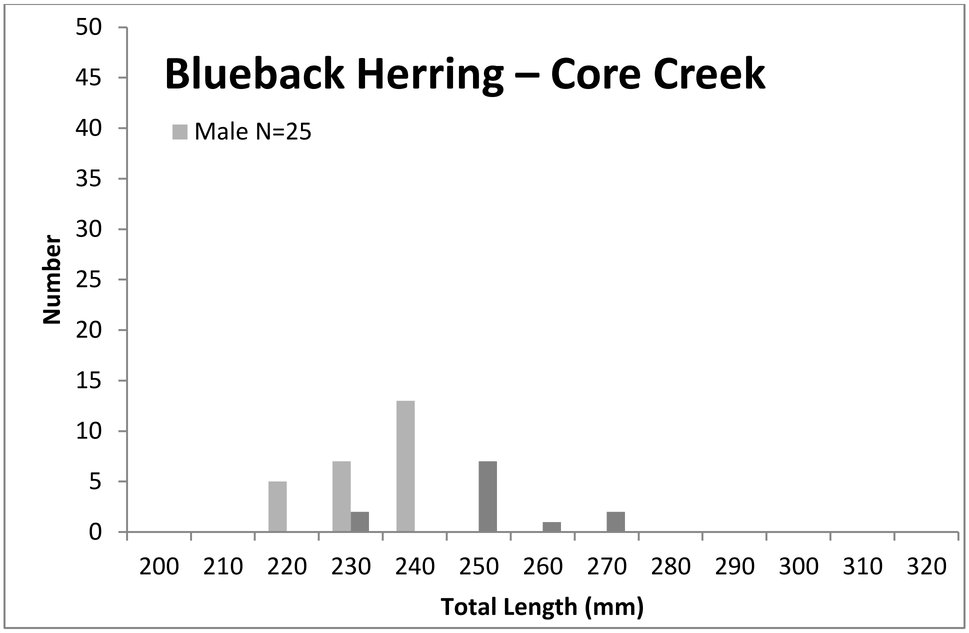


Figure 31. Length frequency histogram for alewife collected from Core Creek, Neuse River, spring 2012. No bluebacks were collected.

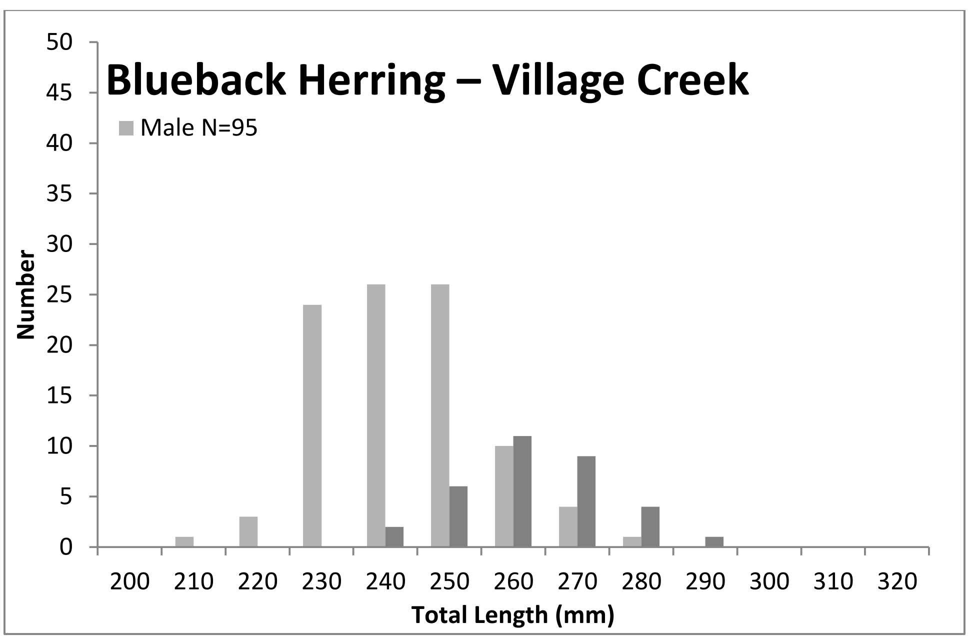


Figure 32. Length frequency histogram for blueback herring collected from Village Creek, Neuse River, spring 2012. No alewife were collected.

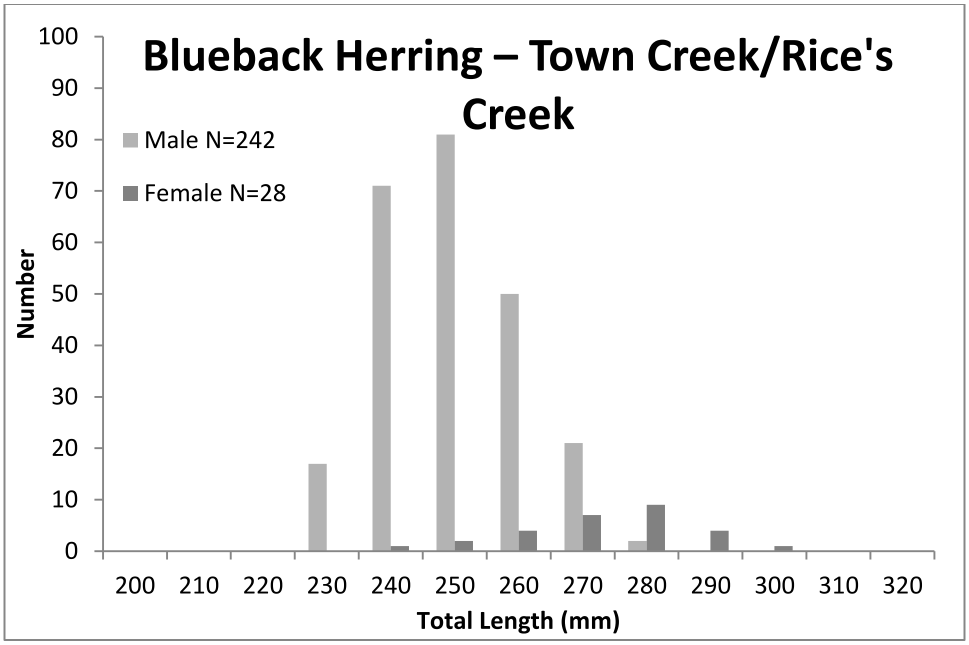


Figure 33. Length frequency histogram for blueback herring collected from Town/Rice's Creek, Cape Fear River, spring 2012. No alewife were collected.

APPENDIX A. 2012 HARVEST AND LOSSES

Harvest and losses (number and weight in pounds) of American shad in North Carolina, 2012.

	Number	Mean Weight (lb)	Total Weight (lb)
Commercial Harvest			
Gill Net	73,048	2.86	208,917
Pound Net	11,017	1.96	21,595
Other	2,729	1.96	5,349
Recreational Harvest	14,888	1.40	20,604
Other (Hatchery)	354	2.23	788
Research	655	2.45	1,605

Harvest and losses (number and weight in pounds) of River Herring in North Carolina, 2011.

	Number	Mean Weight (lb)	Total Weight (lb)
Commercial Harvest			
Gill Net	505	0.53	445
Pound Net	555	0.42	233
Recreational Harvest	NO RECREATIONAL HARVEST ALLOWED		
Other (Hatchery)	187	0.42	78
Research	1,590	0.42	668

SOUTH CAROLINA ANNUAL REPORT FOR THE 2012 FISHERIES TO THE ASMFC FOR COMPLIANCE TO AMENDMENTS 2 AND 3 TO THE INTERSTATE MANAGEMENT PLAN FOR SHAD & RIVER HERRING

Office of Fisheries Management
Marine Resources Division &
Fresh Water Fisheries Section
South Carolina Department of Natural Resources

July 2013

SUSTAINABLE FISHERY MANAGEMENT PLAN (SMFP) FOR SHAD

South Carolina's SMFP was approved by the shad and herring technical committee and board in 2011. The plan closed those fisheries that were not shown to be sustainable, it identified sustainability targets for those fisheries that remain open, and specified actions if those targets were not met. An amended version of the plan was approved by the same bodies in 2012. In order to comply with South Carolina's approved SMFP, the South Carolina Department of Natural Resources (SCDNR) made regulatory changes to this fishery in 2012. These changes will take effect for the 2013 fishing year.

PART 1 - AMERICAN & HICKORY SHAD – 2012 FISHING YEAR

I. Harvest and losses

A. Commercial fishery

1. Characterization of fishery (seasons, caps, gears, regulations):

a. Seasons:
The open American shad/hickory shad season in South Carolina is 15 January – 15 April in the Savannah and Edisto Rivers; 15 January – 31 March in the Combahee River; 1 February – 31 March in the Ashepoo River; 1 February – 1 March in the Ashley River; 1 February – 31 March in Charleston Harbor; and 1 February - 30 April in other State inland waters. The lower ~40-mile section of most rivers closes on 31 March.

b. Caps:
There are no caps in effect in South Carolina.

c. Gears:
The only approved commercial gears are anchored (set or stationary) and drift gill-nets.

d. Regulations:
There is a weekly lift period in effect for all State waters during the open netting season that varies from 48 to 144 hours by river or river section. The entire Coosawhatchie River is closed to commercial gear. Gill-nets are considered as commercial gear in South Carolina, fishermen must have a boat decal displayed to carry such gear aboard their vessel. Gill-nets are licensed by length at $10 per 100 yards or fraction thereof. In order to legally sell their catch, fishermen must purchase one of two license types. A $25 or $50 (depending on where the individual is fishing) license is required to sell to a licensed wholesale dealer. If fishermen sell to anyone other than a licensed wholesale dealer, they must possess a $100 wholesale dealer

license themselves. All previously listed license fees are for State residents. Nonresident license fees for the individual commercial license and the wholesale seafood dealer licenses are $300 and $500, respectively.

Beginning with the 1998 commercial shad-netting season, all licensed fishermen are required to report their daily catch and effort to the South Carolina Department of Natural Resources (SCDNR). In 2002, South Carolina initiated a permit system for all commercial shad and herring fishery participants. In 2010, legislation passed to include recreational fishermen using commercial gear (nets) in the permitting/reporting process.

2. Characterization of directed harvest for American (including hickory) shad

   a. Landings and methods of estimation:
   The recorded statewide commercial landings for 2012 (as reported to NMFS, and <u>including other recorded losses</u>) was 299,528 pounds (sexes combined). In-river fisheries accounted for 100% of the total landings. Table 17 also includes adjustments to the landings for 2012 from estimated or actual losses or mortalities from research activities and fish passage. Such adjustments have not been reported in the NMFS landings for this or previous years.

   Landings of hickory shad reported separately in 2012 by the wholesale dealer system were 8.61 pounds.

   The mandatory reporting system yielded a lower estimate for 2012 statewide landings (294,331) pounds of American shad, sexes combined. Landings from the mandatory reporting system should generally exceed those from wholesale dealer reports since some fishermen claim not to sell their catch. The mandatory licensee reports also accounted for approximately 787 pounds of hickory shad, sexes combined.

   b. Catch composition

      i. Age frequency:
      Such data were collected during 1979-1985, and will be collected annually as initiated in 2000 for individual water areas on a rotational basis as required in Amendment 3. However, this year, due to growing concerns concerning Atlantic coast shad stocks, American shad sampling took place in the Santee and Waccamaw Rivers

      NOTE: All American shad scale samples were aged by strictly following the Cating method, which likely results in an underestimation of mean age and of individual age, particularly for shad over age 4.

      Santee River
      Scale samples were taken from a random sample of 109 shad (106 females and 3 males) from the commercial gill-net fishery, with collections distributed

throughout the open netting season (Figure 1). These fish were all taken by 5 ½” stretched mesh gill-net. Mean age for females was 4.04 years, with the range 3-5. The mean age for males was 3.33 years, with the range between 3-4 years old.

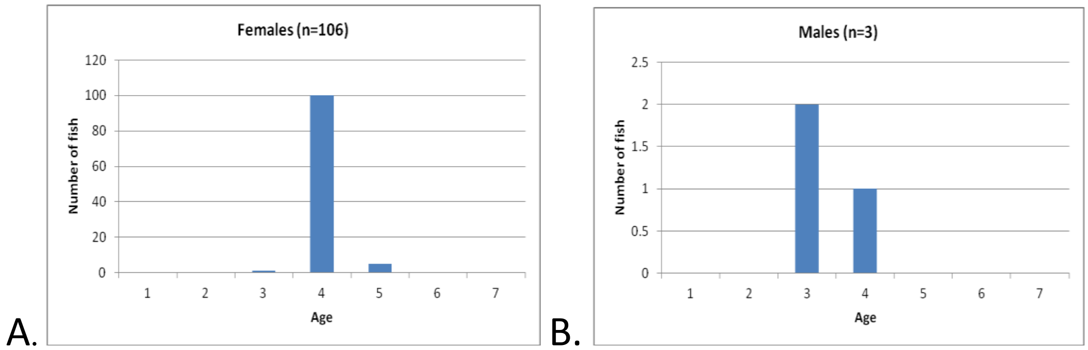


Figure 1. Age frequency distribution for 2012 Santee River fishery dependent sampling for A. Female and B. Male shad.

Waccamaw River

Scale samples were taken from a random sample of 53 shad (38 females and 15 males) from the commercial gill-net fishery, with collections distributed throughout the open netting season (Figure 2). These fish were all taken by 5 ½” stretched mesh gill-net. Mean age for females was 4.00 years, with the range 3-5. The mean age for males was 3.60 years, with the range between 3-4 years old.

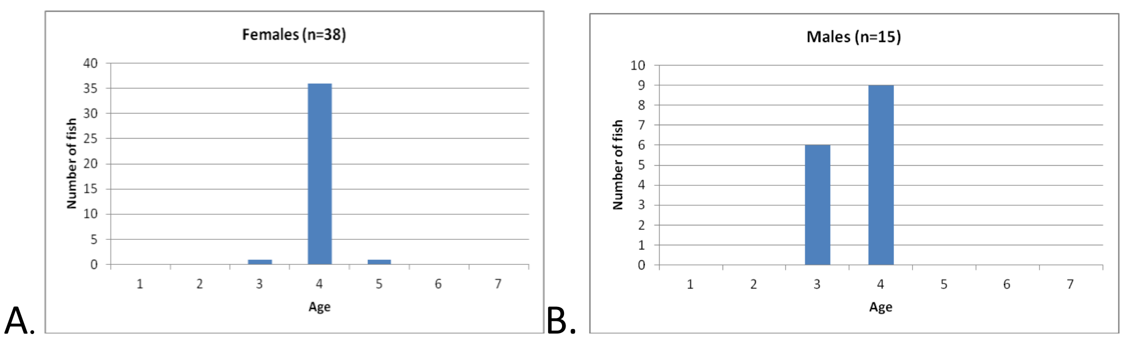


Figure 2. Age frequency distribution for 2012 Santee River fishery dependent sampling for A. Female and B. Male shad.

ii. Length frequency:

Such data were collected during 1979-1985, and will be collected annually as initiated in 2000 for individual water areas on a rotational basis as required in Amendment 3. However, this year, due to growing concerns concerning Atlantic coast shad stocks, American shad sampling took place in the Santee and Waccamaw Rivers.

Santee River

Fork length (FL), total length, and weight were determined for a random sample of 110 shad (107 females and 3 males) from the commercial gill-net fishery, with collections distributed throughout the open netting season (Figure 3). These fish were all taken by 5 ½” stretched mesh gill-net. The results for 2012 are presented for females and males in the figure below. Mean FL for females was 457 mm, with the range 410-502 mm. The FL for males was 395 mm, with a range of 341-463 mm.

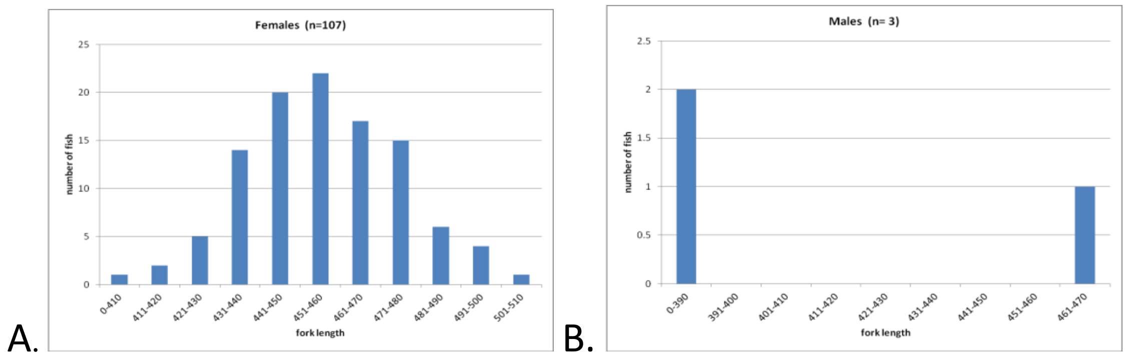


Figure 3. Length frequency distribution for 2012 Santee River fishery dependent sampling for A. Female and B. Male shad.

Waccamaw River

Fork length (FL), total length, and weight were determined for a random sample of 54 shad (39 females and 15 males) from the commercial gill-net fishery, with collections distributed throughout the open netting season (Figure 4). These fish were all taken by 5 ½” stretched mesh gill-net. The results for 2012 are presented for females and males in the figure below. Mean FL for females was 451 mm, with the range 294-496 mm. The FL for males was 399 mm, with a range of 350-477 mm.

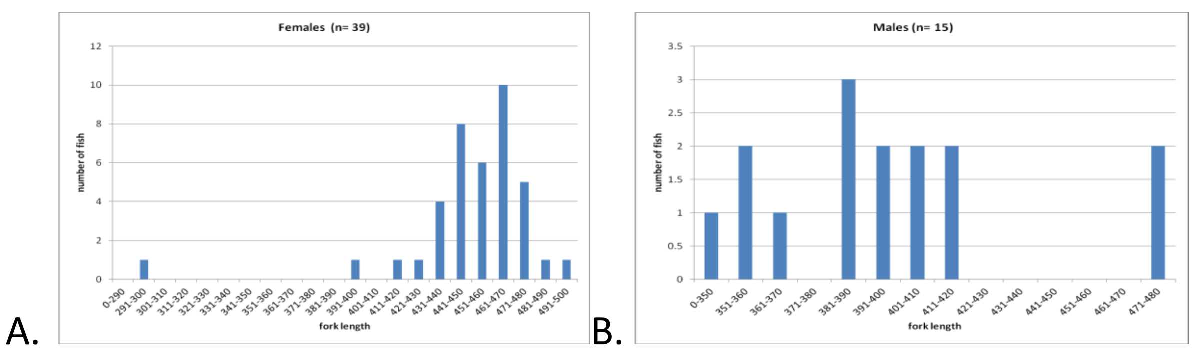


Figure 4. Length frequency distribution for 2011 Waccamaw River fishery dependent sampling for A. Female and B. Male shad.

iii. Sex ratio:

Based on statewide reported commercial landings, the sex ratio for American shad in 2012 was 5.92 females per male. Such data will be collected annually by water area on a rotational basis as prescribed in Amendment 1. Fishery dependent sex ratio data were recorded for commercial gill-net fishery (5 ½” stretched mesh) specimens from the Santee and Waccamaw Rivers. In 2012, observed sex ratios were 35.6 females per males in the Santee River and 2.6 per males in the Waccamaw River. The high occurrence of females in these samples is most likely due to the marketability of females vs. males.

iv. Degree of repeat spawning (estimated from scale data):

No definitive spawning marks were detected on scales taken from shad sampled from the Santee or Waccamaw Rivers in 2012; however it should be noted that current personnel conducting ageing techniques were not instructed to analyze scales for spawning marks because shad are thought to be semelparous in SC.

c. Estimation of effort:

South Carolina instituted a mandatory reporting system for all licensed commercial shad and herring fishermen beginning with the 1998 netting season. Data for 2012 also include recreational fishers using commercial gear. Reports include area fished, gear type (drift or set gill-net, cast net, etc.), net head-rope length (yds), hours fished, and species and sex of catch. A total of 127 individuals were licensed for the 2012 shad netting season. However, 46 of those fishermen bought licenses and never fished and 61 fished only one month during the season. Licenses do not limit individuals by area fished. Therefore, the number of licensees by area is simply the number of individuals reportedly fishing in a given area. Effort reported by those complying with the mandatory reporting system corresponds to the landings of American shad reported by the same system. However, some reports contained incomplete effort data, and determinations of total catch-per-unit of effort by area would likely produce unreliable values. S.C. made a conscious effort to contact fishermen when incomplete data occurred. While not all fishermen were contacted, it is believed data for 2012 is more reliable than past years. Reported effort by heavily fished areas and major rivers follows:

Table 1. Commercial and recreational shad netting effort for SC major rivers in 2012.

Area Fished	Licensees	Trips	Yd-Hrs of Net	Catch (lbs)	CPUE
Winyah Bay	5	88	933,947	13,492	0.01
Black River	2	14	38,071	465	0.001
Pee Dee River	40	666	767,524	35,614	0.05
Waccamaw River	22	316	626,527	64,464	0.1
Santee River	31	667	3,251,287	169,982	0.05
Combahee River	2	33	20,560	495	0.02
Edisto River	14	343	116,131	2,241	0.02
Savannah River	11	239	123,973	7,578	0.06
TOTAL	**127**	**2,366**	**5,878,020**	**294,331**	**0.05**

3. Characterization of other losses (poaching, by-catch, etc.)

a. Estimate and method of estimation:
No estimate of such harvest is available. Poaching losses are unknown, though presumably minimal. By-catch is believed to be negligible in State waters or offshore waters along the South Carolina coast. There is an unknown level of by-catch/poaching of both American and hickory shad by a non-game fish netting fishery using 4 1/2" gill-nets in portions of some state rivers prior to the open shad netting season. However, the magnitude of such catches is believed to be of little consequence relative to stock status or population management. In past years, the only recorded by-catch is from the herring fishery in the Rediversion Canal of Santee River and the Tailrace Canal of the Cooper River. However, beginning in 2010, these “incidental” landings were not allowed and fishers were required to release shad.

b. Estimate of composition (length and/or age):
No age data for shad are available, because incidental landings were not permitted.

B. Recreational fishery

1. Characterization of fishery (seasons, caps, gears, regulations):

   a. Seasons:
      There is no closed season for hook & line, rod & reel fishing.

   b. Caps:
      A 10-fish aggregate daily creel limit was put in place for all South Carolina waters beginning in 2001, with the exception of the Santee River, including the Rediversion Canal below St. Stephen Dam, where a 20-fish aggregate creel was initiated. Georgia portions of the Savannah River have an 8-fish per angler per day creel limit in place. South Carolina submitted a conservation equivalency plan for the Santee River to the ASMFC in 2000. The plan was based on a substantial reduction in available commercial fishing time for this river as prescribed in a comprehensive marine fisheries bill passed in 2000 and on the adoption of a recreational creel limit. Both of these actions became effective with the 2001 shad season, and the State's equivalency plan was accepted by the ASMFC.

   c. Gears:
      Hook & line, one gill net, and skim-bow nets are the only legal recreational gears. Only hook & line is allowed in Georgia portions of Savannah River.

   d. Regulations:
      Fishermen taking shad recreationally must possess the appropriate recreational fishing license (freshwater) or (salt water). Sanctuary lines are established and posted below major dams in the State where strong and rapidly changing flow rates create potential danger to fishermen and watercraft. Recreationally landed shad may not be legally sold. There are no further regulations in effect for the recreational take of shad.

2. Characterization of directed harvest

   a. Landings and methods of estimation:
      The most substantial hook & line fisheries occur in the Savannah River immediately below New Savannah Lock & Dam at Augusta, Georgia, in the Tailrace Canal of the Cooper River immediately below Pinopolis Dam, and Lake Moultrie. Also, depending on the partitioning and intensity of water releases from the Santee-Cooper lakes, recreational hook & line shad fisheries occur in the Santee River below and within several kilometers of Santee Dam (Wilson's landing), Hwy 52, Lake Marion, and within several kilometers downstream of St. Stephen Dam on the Rediversion Canal between Lake Moultrie and the river.

The Wildlife and Freshwater Fisheries Division (WFFD) of the SCDNR performs creel surveys in the vicinity of the Tailrace Canal of the Cooper River (CRTC), Rediversion Canal (RD Canal), Hwy 52 (Santee River), and Wilson's Landing (Santee River) (Post, 2012). As part of new requirements for Amendment 3, data are also included for the Savannah River. The number of days when surveys took place for CRTC was 56 days (1135 surveys) in 2012. The estimated catches (retained) for the 2012 Cooper River recreational (hook & line) fishery was 7,965 fish. In certain years, particularly when the run is strong and water flow conditions are extremely low, anglers are attracted to Wilson's landing rather than the RD Canal for shad angling.

Another source of directed harvest comes from recreational gill netters. Fishermen are allowed to fish one 100 ft. gill net for shad without purchasing a commercial license. However, they must not sell their catch it must be used for personal consumption. Prior to 2008, SC did not capture landings data for this type of gear. In 2009, recreational fishers using commercial gear were issued reporting forms. In order to extrapolate data for these fishermen, only records from the mandatory reporting where it was specified no catch was sold or if the sold to portion was not specified were used. There were assumptions using this method, however, it was the only method at the time to capture directed harvest data from those fishers using commercial gear. In 2010, legislation was passed to make it a requirement for recreational fishermen using commercial gear (nets) report their shad landings. Landings from fishermen using recreational nets are now captured in the mandatory reporting system.

b. Catch composition

i. Age frequency:

No age data were collected prior to 2008; however due to growing concerns, SCDNR began collecting scale samples in 2009 and will continue for subsequent years. Scale samples were taken from random samples while conducting recreational creel surveys. Age data were collected for the Santee, Cooper, and Savannah Rivers in 2012.

NOTE: All American shad scale samples were aged by strictly following the Cating method, which likely results in an underestimation of mean age and of individual age, particularly for shad over age 4.

Santee River-Rediversion Canal

Scale samples were taken from a random sample of 231 shad (33 females and 198 males) from the hook and line recreational fishery (Figure 5). Mean age for females was 4.09 years, with the range 3-5. The mean age for males was 3.96 years, with the range between 3-5 years old.

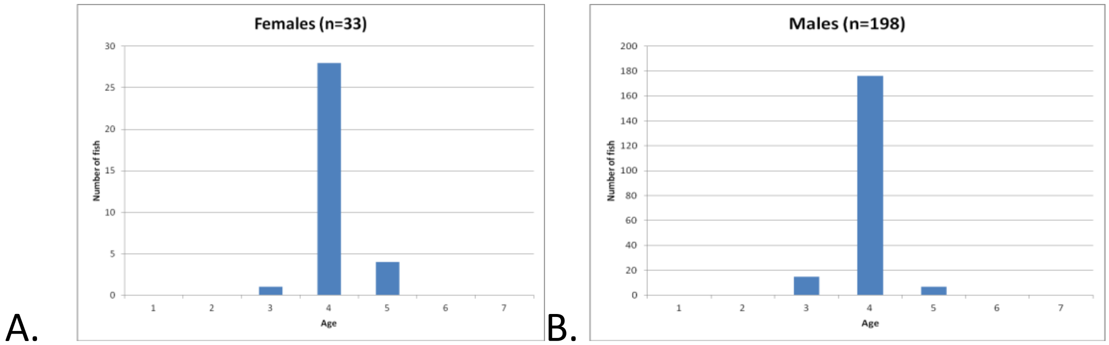


Figure 5. Age frequency distribution for 2012 Santee River-Rediversion fishery dependent sampling for A. Female and B. Male shad.

Santee River-Wilson Landing

Scale samples were taken from a random sample of 124 shad (8 females and 116 males) from the hook and line recreational fishery (Figure 6). Mean age for females was 4.13 years, with the range 4-5. The mean age for males was 3.84 years, with the range between 3-5 years old.

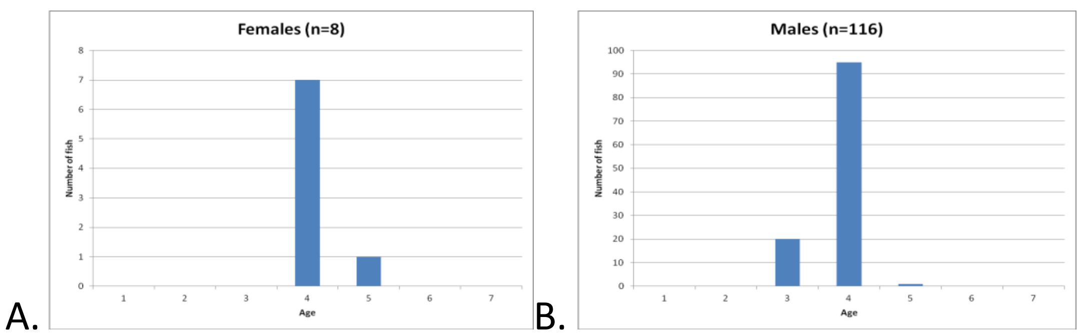


Figure 6. Age frequency distribution for 2012 Santee River-Wilson fishery dependent sampling for A. Female and B. Male shad.

Cooper River Tailrace Canal

Scale samples were taken from random samples 492 shad (125 females and 367 males) while conducting recreational creel surveys (Figure 7). Cooper River samples were collected from the Cooper River Tailrace Canal (CRTC) fishery. Mean age for females was 4.11 years, with a range of 4-5. The mean age for males was 3.92 years, with the range 3-5.

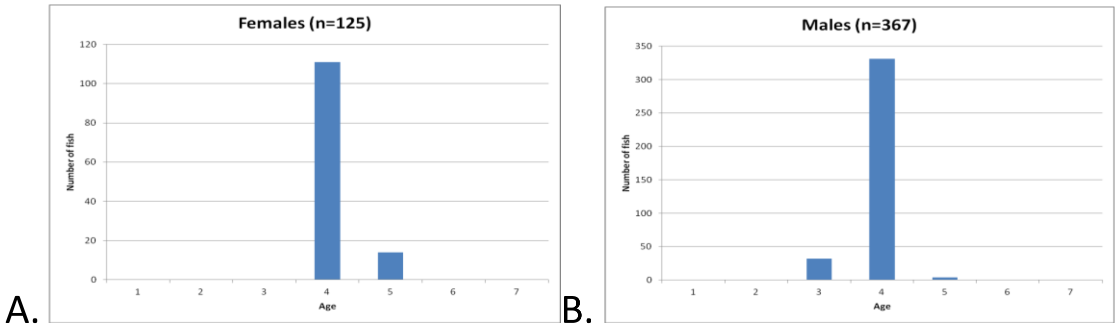


Figure 7. Age frequency distribution for 2012 CRTC fishery dependent sampling for A. Female and B. Male shad.

Savannah River

Scale samples were taken from a random sample of 58 shad (7 females and 51 males) from the hook and line recreational fishery (Figure 8). Mean age for females was 4.00 years, with the range 4. The mean age for males was 3.63 years, with the range between 3-4 years old.

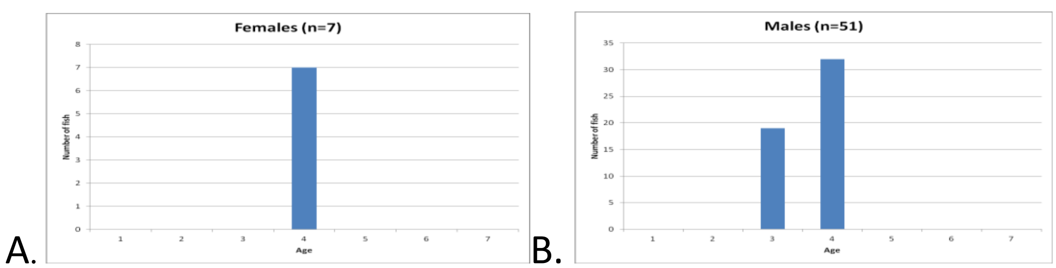


Figure 8. Age frequency distribution for 2012 Savannah River fishery dependent sampling for A. Female and B. Male shad.

ii. Length frequency:

Length data were recorded from random samples while conducting recreational creel surveys. Data were collected for the Santee, Cooper, and Savannah Rivers in 2012.

Santee River-Rediversion Canal

Fork length (FL), total length, and weight were determined for a random sample of 301 shad (39 females and 262 males) from the recreational hook and line fishery (Figure 9). Results for 2012 are presented for females and males in the figure below. Mean FL for females was 451 mm, with the range 294-496 mm. The FL for males was 380 mm, with a range of 320-432 mm.

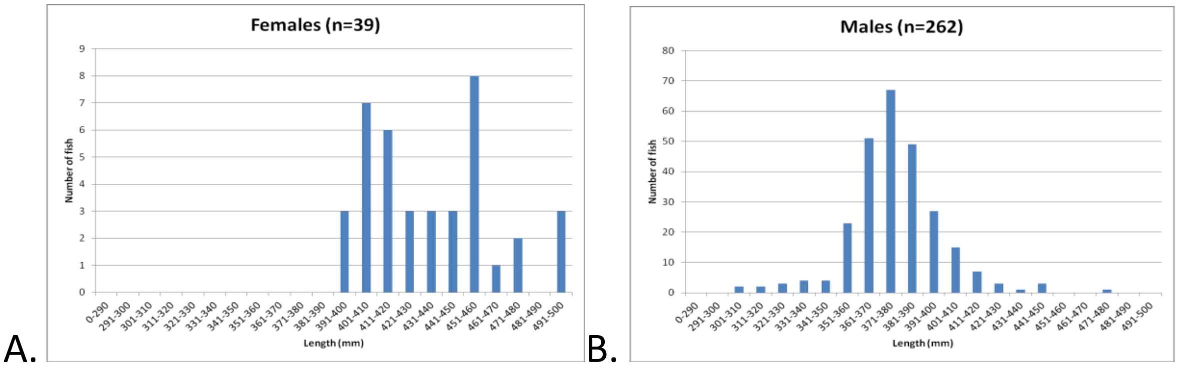


Figure 9. Length frequency distribution for 2012 Santee River-Rediversion fishery dependent sampling for A. Female and B. Male shad.

Santee River-Wilson Landing

Fork length (FL), total length, and weight were determined for a random sample of 136 shad (10 females and 126 males) from the recreational hook and line fishery (Figure 10). Results for 2012 are presented for females and males in the figure below. Mean FL for females was 427 mm, with the range 395-468 mm. The FL for males was 376 mm, with a range of 331-439 mm.

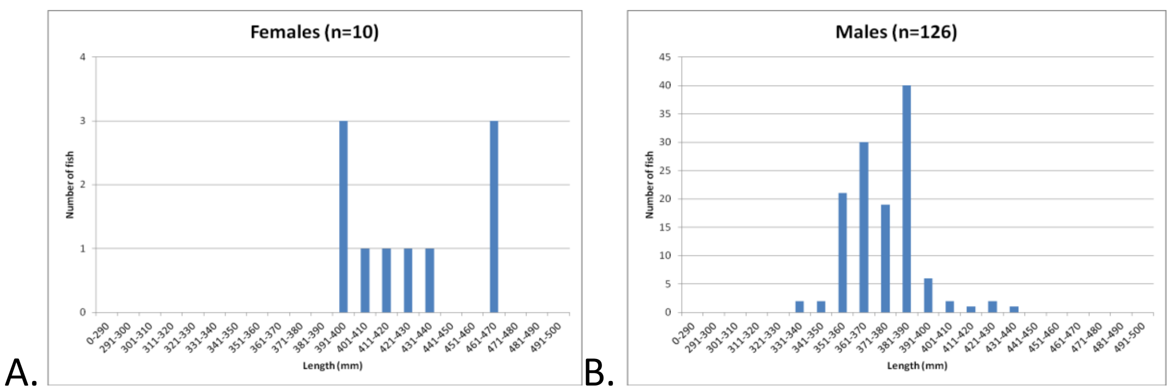


Figure 10. Length frequency distribution for 2012 Santee River-Wilson fishery dependent sampling for A. Female and B. Male shad.

Cooper River Tailrace Canal (CRTC)

Since 2009, the majority of fishers have been located at CRTC and sampled catches were low in other locations. Fork length (FL), total length, and weight were determined for a random sample of 962 shad (206 females and 756 males) from the recreational hook and line fishery (Figure 11). Mean FL for females was

445 mm, with the range 355-557 mm. The FL for males was 387 mm, with a range of 302-475 mm.

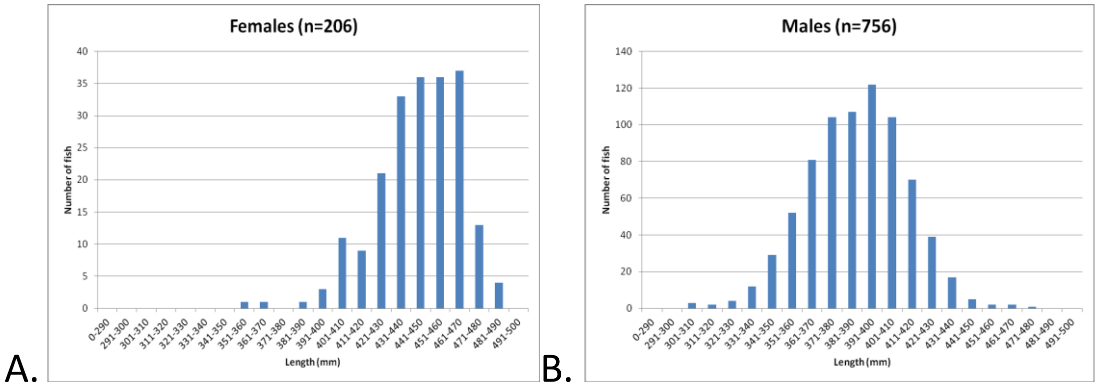


Figure 11. Length frequency distribution for 2012 CRTC fishery dependent sampling for A. Female and B. Male shad.

Savannah River

Fork length (FL), total length, and weight were determined for a random sample of 58 shad (7 females and 51 males) from the recreational hook and line fishery (Figure 12). Results for 2012 are presented for females and males in the figure below. Mean FL for females was 451 mm, with the range 294-496 mm. The FL for males was 380 mm, with a range of 320-432 mm.

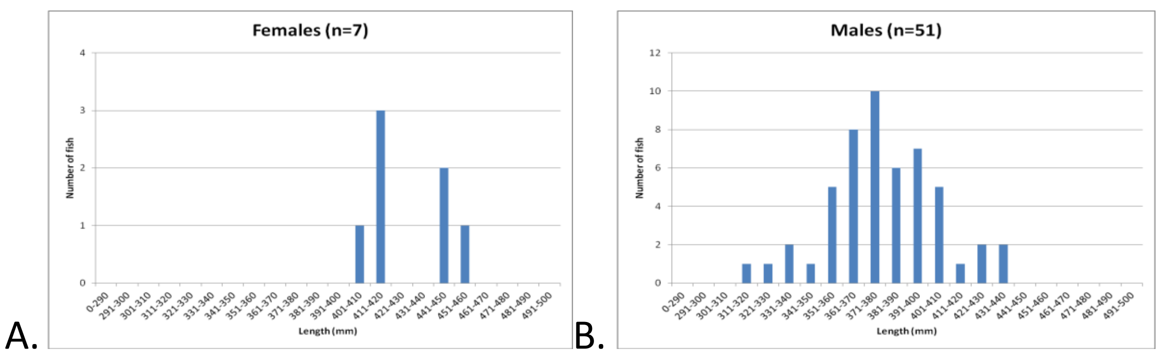


Figure 12. Length frequency distribution for 2012 Savannah River fishery dependent sampling for A. Female and B. Male shad.

c. Estimation of effort:

The 2012 estimated mean catch per angler-hour was 1.0, 2.7, 2.5, and 3.2 for Rediversion Canal (RD), Wilson's Landing, CRTC, and Augusta Dam respectively (Figure 13).

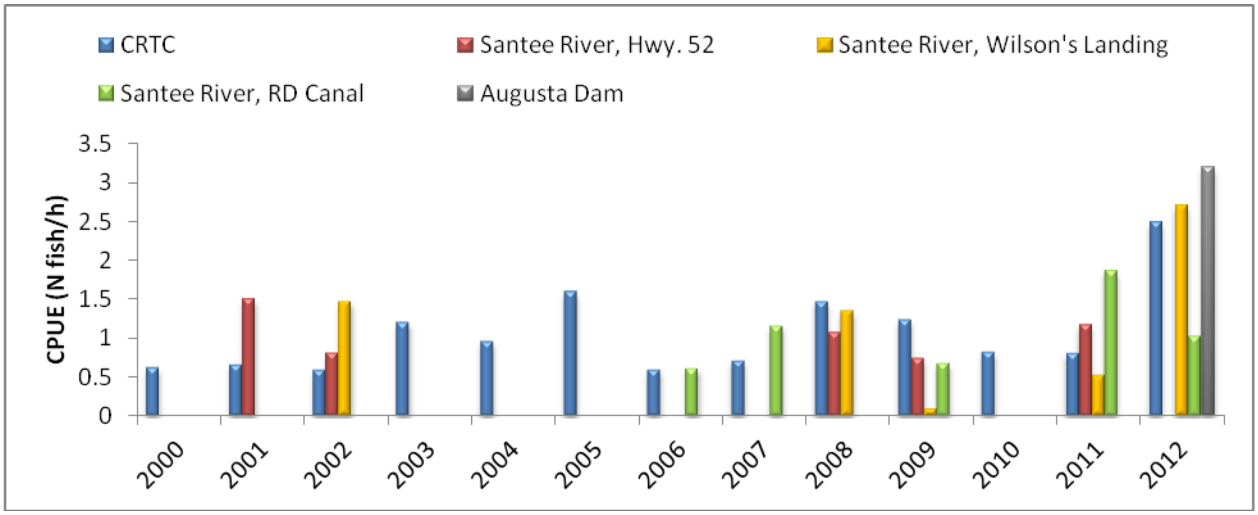


Figure 13. Recreational American shad fishery survey results, 2000 - 2012. Mean CPUE for Cooper River Tailrace Canal (CRTC), bank access survey conducted at the Rediversion Canal (RD), Wilson's Landing near Santee Dam, and the Savannah River at the Dam in Augusta, GA.

3. Characterization of other losses (poaching, hook/release mortality, etc.)

a. Estimate and method of estimation:
No data are available.

b. Estimate of composition (length and/or age):
No data are available.

C. Other losses (passage mortality, male discards, brood stock capture, research losses, etc.)

Although it is likely that male or buck shad are occasionally discarded because of poor market value, no estimate of such losses is available. It is also probable that shad of both sexes are lost or discarded at the boat or dock because of damage from opportunists such as otters, alligators, eels, isopods, crabs, etc. Again the losses from such opportunistic feeding damage have not been quantified or estimated. Only two dams (Pinopolis Dam at the headwaters of the Cooper River and St. Stephen Dam on the Rediversion Canal of the Santee River) in South Carolina afford passage to alosines where mortalities related to upstream passage are likely. The navigational lock used to pass alosines at New Savannah Lock & Dam on the Savannah River would only lead to mortalities if fish were held in the lock too long before release. No mortalities were observed or estimated.

The lock at Pinopolis Dam was functional in 2012, but shad passage numbers were not determined. Although both American and hickory shad are known to be passed at this facility, there is and has been no routine sampling of passed fish for determination of relative passage numbers by species. The expense associated with such a sampling program continues to preclude the discernment of species-specific passage estimates. No mortality associated with upstream passage at this facility was observed or recorded. There have been no estimates of mortality (for upstream or down-stream passage of any species) made at this facility at any time.

Limited lift operations at St. Stephen Dam in 2012 passed 150,082 adult shad (Post 2012). Turbine mortality studies have not been performed for adult shad attempting to leave the Santee-Cooper Lakes via Pinopolis, St. Stephen or Wilson Dams, either before or after spawning. Occasional observations of dead or injured shad are made below dams within the Santee-Cooper system, but such mortalities and injuries have not been quantified. Turbine mortality studies have also not been performed at any of these facilities for out-migrating juvenile shad. However, such juvenile mortalities are believed to be relatively low, i.e. ~30% (Doug Cooke, SCDNR, personal communication).

D. Harvest and losses:

Landings reported through the wholesale dealer system are not typically separated by gear type and mean sizes by gear of capture are not available. However, the only legal commercial gear in most areas is 5 1/2" stretched-mesh gill-nets (either drift or set) and size of landed fish by these gears should be similar.

Table 2. Harvest and Losses for 2012.

Harvest and Losses	Number	Pounds
Commercial Gear (includes drift and set nets)	78,823	299,528
Recreational Gear (hook and line)	9,812	37,286
Fish Passage Mortality	10	38
Discarded Males	0	0
Brood Stock Capture	678	2,576
Research Losses	118	448

E. Protected species: Atlantic sturgeon by-catch estimates:

Both Atlantic and shortnose sturgeon are taken incidentally by shad gill-net fisheries. The catch rate (and potential mortality rate) is undoubtedly highly variable by water area and temporally within a given area.

Sturgeon by-catch was included as part of the mandatory catch and effort reporting system for the commercial shad and herring fisheries in 2000. The statewide reported by-catch of

Atlantic sturgeon from the shad gill-net fishery in 2012 was 205 [none were reported from herring fisheries]. Thirty-eight percent were reported from the Santee River, 32% from the Winyah Bay, 25% from the Waccamaw River, and 5% in the Savannah River. Thirty-five shortnose sturgeon were reported as incidental catches in 2012, 12 from the Santee River 1 from the Winyah Bay, 6 from the Waccamaw River, and 16 from the Savannah River. It should be noted, SCDNR is implementing major changes in the shad fishery (beginning in 2013) to account for and reduce the by-catch of sturgeon.

II. Required fishery independent monitoring

A. Description of requirement as outlined in Amendment 3:
South Carolina is to conduct an annual spawning stock survey including the representative sampling of biological data and is to calculate mortality and/or survival estimates. Such studies may be performed in a single river per year as selected by the State. However, this year, due to growing concerns concerning Atlantic coast shad stocks, American shad sampling took place in the Santee and Waccamaw Rivers. South Carolina is also mandated to conduct JAI surveys and partner with GA in the Savannah River.

B. Brief description of work performed:

Santee River: In 2012 a total of 25 netting trips were conducted between January 25 and April 16. This yielded 25.84 net hours with a CPUE of 4.45 and 2.94 shad per hour of effort for females and males respectfully. SCDNR also conducted a tagging study in the Santee River to estimate the fishing mortality rate for American shad in this system.

Waccamaw River: In 2012 a total of 18 netting trips were conducted between February 2 and April 11. This yielded 55.26 net hours with a CPUE of 4.09 and 2.08 shad per hour of effort for females and males respectfully. SCDNR also conducted a tagging study in the Santee River to estimate the fishing mortality rate for American shad in this system.

Savannah River: As in previous years, sampling of the spawning stock was conducted by GADNR just below the New Savannah Bluff Lock and Dam (NSBL&D) near Augusta, GA. In 2012, a total of 4 sampling trips occurred between March 16 and June 4. Using electro-fishing gear sampling yielded a overall CPUE of 272 adult shad/hour (Table 3).

Table 3. Catch rates for Adult American shad at NSBL&D in 2012.

Date	Effort in seconds	Adult shad collected	CPUE=shad/hr
16-Mar	366	24	235
25-Apr	448	42	338
10-May	300	40	482
4-Jun	497	16	116

C. Results:

1. Juvenile indices:

Due to concerns over declining trends in some rivers, South Carolina initiated surveys in 2008. In an effort to collect juvenile indices and contribution from hatchery stocked fish, the Santee and Edisto Rivers were selected for sampling. Hatchery operations and stocking efforts were initiated on these rivers in 2008 and will continue in future years. Also, due to the growing concerns to prove fishery sustainable rivers, the Great Pee Dee and Savannah Rivers were added to the sampling schedule this year. In past years, bottom trawls, mid-water trawls, and electrofishing gears were selected gear used to capture juvenile shad. Bottom trawl sampling was used in 2008 with little success, so it was not used in 2009. A mid-water trawl rather than electrofishing gear was used in the Edisto River in 2009; however, forty-one sets yielded a total of 1 juvenile shad, so it was discontinued. Electro-fishing gear only was used in 2010 and will be used in future years to maximize catch.

Edisto River: A continuing shad restoration program in conjunction with preparations for coming requirements to prove sustainability of shad fisheries, lead to sampling for juvenile American shad in the Edisto River this year. Electro-fishing gear collected 1107 juvenile shad (Table 4). Results of this sampling are highlighted below

Total combined CPUE
CPUE = 75.78 AMS/HOUR
CPUE = 1.26 AMS/MINUTE
LENGTH RANGE 51mm to 110mm
AVERAGE LENGTH = 76mm

Table 4. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Edisto River, SC

Year	N	Geometric Mean	Variance
2010	601	0.23	0.09
2011	1291	0.79	0.71
2012	1118	0.63	1.22

Great Pee Dee River: As part of the likely requirements for the SC's shad fisheries sustainability plan, the Great Pee Dee River was sampled this year for juvenile American shad. Electro-fishing gear collected 2965 juvenile shad (Table 5). Results of this first year of sampling are as follows:

CPUE = 219.63 AMS/HOUR
CPUE = 3.66 AMS/MINUTE
LENGTH RANGE 39mm to 120mm
AVERAGE LENGTH = 68mm

Table 5. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Great Pee Dee River, SC

Year	N	Geometric Mean	Variance
2011	2254	1.46	3.44
2012	2965	3.44	4.21

Savannah River: As part of requirements for the SC's shad fisheries sustainability plan, the Savannah River was sampled this year for juvenile American shad. Electro-fishing gear collected 1101 juvenile shad (Table 6). Results of this year of sampling are as follows:

CPUE = 67.40 AMS/HOUR
CPUE = 1.12 AMS/MINUTE
LENGTH RANGE 52mm to 116mm
AVERAGE LENGTH = 76mm

Table 6. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Savannah River, SC

Year	N	Geometric Mean	Variance
2011	829	0.56	0.37
2012	1011	0.88	0.32

Santee-Cooper Lakes System: Several areas were selected upstream of dams in the Santee System to sample in hopes of finding juvenile shad. Sampling sites were located in the Congaree, Wateree, Broad, and upper Santee Rivers along with Lake Marion and Moultrie (Table 7).

Table 7. Sampling locations, # of trips, effort, # shad collected, and CPUE totals for 2012.

Sampling Locations	# of sampling trips	Total pedal time (seconds)	# of AMS captured	CPUE (# of AMS/minute)
BROAD RIVER				
Upstream of Columbia Fishway	6	29781	0	0.00
Downstream of Columbia Fishway	3	12266	0	0.00
	TOTAL FOR BROAD	**42047**	**0**	**0.00**
CONGAREE RIVER				
Bar upstream of HWY 601	18	16200	334	1.24
Bar downstream of HWY 601	18	16200	121	0.45
Congaree/Wateree Confluence	18	16200	240	0.89
	TOTAL FOR CONGAREE	**48600**	**695**	**0.86**
UPPER SANTEE RIVER				
Bar upstream of Trezvants	18	16200	154	0.57
Bar upstream of Week's Landing	18	16200	333	1.23
Bar upstream of Low Falls RR	18	16200	197	0.73
Bar upstream of the Blowout	18	16200	296	1.10
	TOTAL FOR SANTEE	**64800**	**980**	**0.91**
WATEREE RIVER				
2nd Bar upstream of HWY 378	6	5400	54	0.60
1st Bar upstream of HWY 378	6	5400	40	0.44
Bar downstream of HWY 378	6	5400	47	0.52
	TOTAL FOR WATEREE	**16200**	**141**	**0.52**
LAKE MARION				
Harry's Fish Camp	4	7200	124	1.03
Big Water	4	7200	182	1.52
Indian Bluff	4	7200	24	0.20
	TOTAL FOR MARION	**21600**	**330**	**0.92**
DIVERSION CANAL				
Upstream of HWY 45 Bridge	6	5400	2	0.02
	TOTAL FOR DIVERSION	**5400**	**2**	**0.02**
LAKE MOULTRIE				
Bonneau Beach	5	9000	48	0.32
	TOTAL FOR MOULTRIE	**9000**	**48**	**0.32**
	OVERALL 2012 TOTALS	**207647**	**2196**	**0.63**

Table 8. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Broad River, SC

Year	N	Geometric Mean	Variance
2009	37	0.0033	0.005
2010	13	0.0004	0.007
2011	52	0.0030	0.012
2012	0	0	0

Table 9. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Congaree River, SC

Year	N	Geometric Mean	Variance
2009	682	0.15	0.12
2010	720	0.33	0.76
2011	589	0.31	2.55
2012	695	0.34	1.10

Table 10. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Upper Santee River, SC

Year	N	Geometric Mean	Variance
2009	277	0.08	0.15
2010	565	0.15	0.32
2011	676	0.26	1.18
2012	980	0.36	1.63

Table 11. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Wateree River, SC

Year	N	Geometric Mean	Variance
2010	42	0.03	0.04
2011	184	0.41	0.43
2012	141	0.17	0.46

Table 12. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Lake Marion, SC

Year	N	Geometric Mean	Variance
2009	810	0.73	3.79
2010	1405	1.96	9.18
2011	1519	2.16	7.42
2012	330	0.62	0.48

Table 13. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Diversion Canal, SC

Year	N	Geometric Mean	Variance
2011	55	1.03	0.82
2012	2	0.02	0.00

Table 14. Geometric mean catch per minute of juvenile American shad by electro-fishing in the Lake Moultrie, SC

Year	N	Geometric Mean	Variance
2009	9	0.055	0.0008
2010	100	0.80	0.06
2011	101	0.49	0.34
2012	48	0.26	0.04

This is still considered a work in progress, but SC will do everything possible to gather data in order to collect accurate measurements of the juvenile recruitment and hatchery contribution. SCDNR will continue this sampling, in order to collect valuable juvenile shad data and in order to be in compliance with sustainability plan requirements.

2. Spawning stock assessment

a. Length frequency:

Such studies were initiated on a selected single river basis annually beginning in 2000. However, as mentioned above, the Santee and Waccamaw Rivers were selected for such studies in 2012. Fork and total lengths were recorded for all captured shad. Length frequency (fork length – FL) distributions for each rivers female and male American shad are presented below (Figures 14-15). Mean FL for Santee River females (115 fish) was 446 mm (range 395-501 mm). Mean FL for Santee River males (76 fish) was 411 mm (range 330-460 mm). Mean FL for Waccamaw River females (140 fish) was 450 mm (range 381-506 mm). Mean FL for Waccamaw River males (83 fish) was 419 mm (range 338-460 mm).

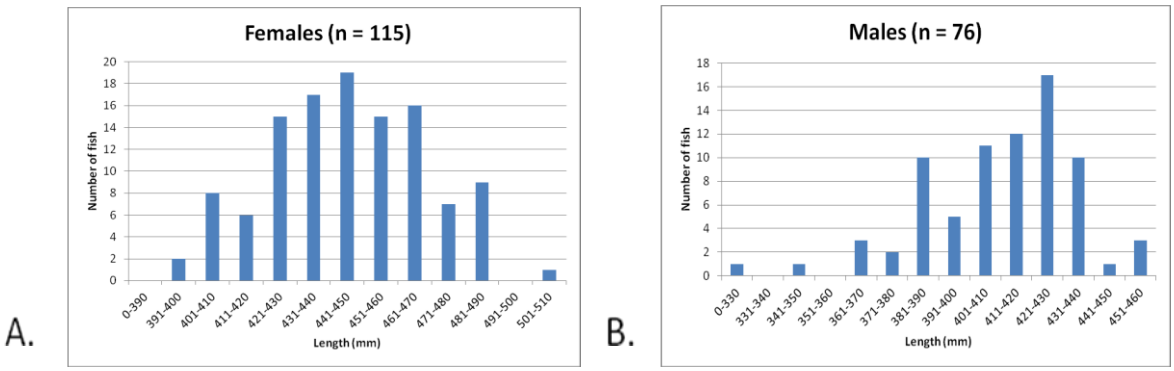


Figure 14. Length frequency distribution for 2011 Santee River fishery independent sampling for A. Female and B. Male shad.

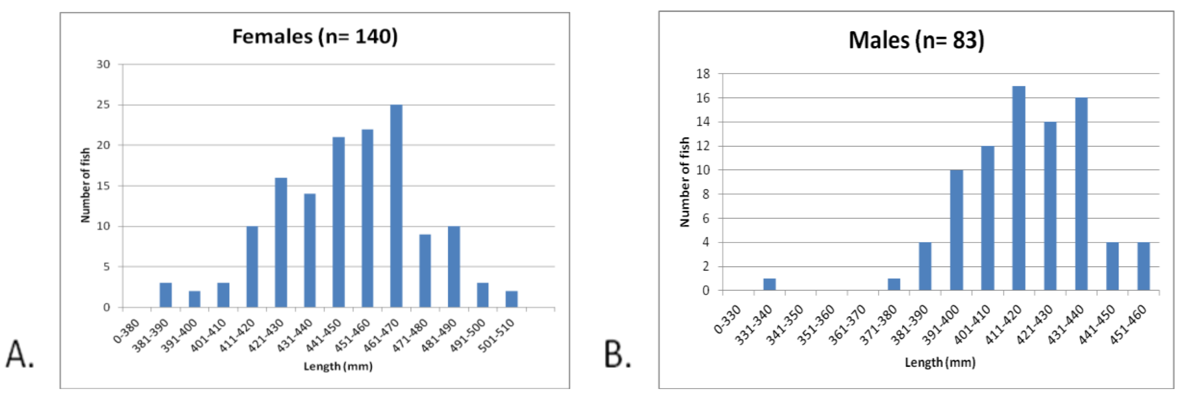


Figure 15. Length frequency distribution for 2011 Waccamaw River fishery independent sampling for A. Female and B. Male shad.

b. Age frequency:
   Such studies were previously performed during 1979-1985. In 2012, biologists did not take scale samples from fish to be tagged from the Santee or Waccamaw Rivers, as such would likely significantly increase both pre and post-tagging mortality rates.

c. Sex:
   Sex composition studies were initiated in 2000 on an annually selected single river basis. The Santee and Waccamaw Rivers were selected for such studies in 2012.

Sampling yielded a sex ratio of 1.51:1 females as compared to males for the Santee River and 3.5:1 for the Waccamaw River. However, the gears used (5” and 5 ½” stretched-mesh drifting gill-nets) were likely selective for females, which were the target of the study primarily aimed at determining the catch rate on female American shad. Male American shad and both sexes of hickory shad are known to escape the commercial gill-net fishery (5 ½” stretched-mesh only), which is the primary source of fishing mortality, at much higher rates than do female American shad.

d. Degree of repeat spawning:
As described above, no scale samples were collected. American shad are thought to be semelparous in SC, so repeat spawning rarely occurs.

3. Annual mortality rate calculation:
In 2012, tagging studies were successful in capturing and tagging 115 female and 76 male shad in the Santee River and 140 female and 83 male shad were tagged in the Waccamaw River. All shad were tagged with dart tags that were imbedded in the pterygiophores supporting the dorsal fin. Each tag was checked for security of attachment, and all shad were checked for active breathing before their release. All tags were international orange in color and each was marked with a legend bearing the tag number, return address, and the word “reward”, specifying an undetermined reward amount. In 2012, 1 tag was returned from the Santee River and 5 were returned from the Waccamaw River. With implementation of Amendment 3 requirements and closing some fisheries in 2013, fishermen are not cooperating (returning tags) because their perception is returned tags=closed fishery. Fishery independent sampling accounted for 118 shad mortalities. These fish (28%) account for all mortalities during sampling months using independent gear. The majority of mortalities occurred due to increasing river temperature near the end of the season.

4. Hatchery evaluation (% wild vs. hatchery juveniles):
As mentioned in an earlier section, hatchery operations and stocking efforts were initiated on the Edisto and Santee Rivers in 2008 and will continue in future years. Edisto River stock enhancement program is a joint effort by SCDNR and Bears Bluff National Fish Hatchery (USFWS). Collections from the Edisto River, using electrofishing gear, yielded a total of 95 adult shad (51 males 44 females). There were a total of 256,304 eggs collected. From these, 3,291 fry were hatched and after marking 2,465 fry were stocked in the system. This is still a work in progress, as this was only the fourth year of attempting shad production for this hatchery. However, if agency priorities lead to continued efforts, production should improve in future years. Efforts to collect juvenile shad in 2012 from the Edisto River to evaluate hatchery contribution yielded 1118 fish. Of these, three shad were identified as hatchery fish, leading to a 0.2% hatchery contribution.

Five hundred and eighty-three brood fish were collected from the Santee River system as part of the Santee Accord stock enhancement study. Adult American shad were captured during their spawning runs from the St. Stephen Fish Lift. A total of 583 fish (318 males and 265 females) were collected for seventeen batches of spawning fish.

Due to complications with the fish lift and the sheer numbers of shad present below the dam, an entire batch of spawners was collected in 15 seconds using only dip nets. Fry were produced, marked with OTC, and stocked after 4-7 days. A total of 1,250,808 fry were stocked in the Broad River and 334,302 fry were stocked on the Wateree River. . Efforts to collect juvenile shad from the Santee Cooper System to evaluate hatchery contribution yielded 2,277 fish. Hatchery contribution for 2012 was 0.8% (Table 15).

Table 15. Hatchery contribution by year for American shad in the Santee Cooper System.

	2010			2011			2012		
Water body	**# AMS collected**	**# AMS analyzed**	**% marked**	**# AMS collected**	**# AMS analyzed**	**% marked**	**# AMS collected**	**# AMS analyzed**	**% marked**
Broad River	13	13	7.7%	52	52	9.6%	0	0	0.0%
Congaree River	720	720	4.0%	589	589	1.2%	732	732	1.2%
Wateree River	42	42	4.8%	184	184	0.5%	142	142	0.0%
Santee River	565	565	5.8%	676	676	0.7%	1023	1017	0.8%
Lake Marion	1405	1248	0.6%	1519	1510	0.3%	330	257	0.0%
Diversion Canal	n/a	n/a	n/a	55	55	0.0%	2	2	0.0%
Lake Moultrie	101	101	1.0%	101	101	1.0%*	48	48	0.0%
Totals	**2846**	**2689**	**2.8%**	**3176**	**3167**	**0.7%**	**2277**	**2198**	**0.8%**

*** holdover collected in 2012**

SUSTAINABLE FISHERY MANAGEMENT PLAN (SMFP) FOR HERRING

South Carolina's SMFP was approved by the shad and herring technical committee and board in 2010. The plan closed those fisheries that were not shown to be sustainable, it identified sustainability targets for those fisheries that remain open, and specified actions if those targets were not met. In order to comply with South Carolina's approved SMFP, the South Carolina Department of Natural Resources (SCDNR) made regulatory changes to this fishery in 2012. These changes took effect for the 2012 fishing year.

As specified in the SMFP, SCDNR closed all commercial and blueback herring fisheries in the state, except the Santee-Cooper System and the Pee Dee River.

Santee Cooper System Target: The approved "interim" sustainability benchmark for the Santee Cooper System is u = 0.050. Management action would be taken if the benchmark is exceeded. In 2012, the three year running average for u=.034 therefore the benchmark was not exceeded.

Year	Metric Tons	Harvest Data (Kg)	Number Caught (Lbs/.3)	Passage	Minimum Population	Relative Exploitation	Scalar M-R LCI w/o 1988	3-yr running avg.
1990	1.28	1280	9,408	71,000	80,408	0.12	0.006	
1991	9.83	9830	72,251	400,000	472,251	0.15	0.008	
1992	91.77	91770	674,510	589,000	1,263,510	0.53	0.028	0.014
1993	180.92	180920	1,329,762	345,000	1,674,762	0.79	0.042	0.026
1994	128.91	128910	947,489	298,000	1,245,489	0.76	0.040	0.036
1995	206.89	206890	1,520,642	561,000	2,081,642	0.73	0.038	0.040
1996	265.06	265060	1,948,191	1,452,285	3,400,476	0.57	0.030	0.036
1997	142.24	142240	1,045,464	176,814	1,222,278	0.86	0.045	0.038
1998	179.61	179610	1,320,134	112,466	1,432,600	0.92	0.048	0.041
1999	**120.38**	**120380**	**884,793**	**182,798**	**1,067,591**	**0.83**	**0.043**	**0.045**
2000	**134.83**	**134830**	**991,001**	**695,586**	**1,686,587**	**0.59**	**0.031**	**0.041**
2001	**24.29**	**24290**	**178,532**	**1,862,015**	**2,040,547**	**0.09**	**0.005**	**0.026**
2002	**0**	**0**	**0**	**421,459**	**421,459**	**0.00**	**0.000**	**0.012**
2003	52.25	52250	384,038	86,909	470,947	0.82	0.043	0.016
2004	9	9000	66,150	35,545	101,695	0.65	0.034	0.026
2005	35.04	35040	257,544	175,184	432,728	0.60	0.031	0.036
2006	7.5	7500	55,125	105,129	160,254	0.34	0.018	0.028
2007	50.7	50700	372,645	49,343	421,988	0.88	0.046	0.032
2008	**0**	**0**	**0**	**8,503**	**8,503**	**0.00**	**0.000**	**0.021**
2009	71.6	71600	526,260	438,746	965,006	0.55	0.029	0.025
2010	69.9	69600	511,560	217,750	729,310	0.70	0.037	0.022
2011	37.6	37600	276,360	336,210	612,570	0.45	0.024	0.030
2012	18.9	18900	138,915	37,117	176,032	0.79	0.041	0.034

Pee Dee River: The approved sustainability benchmark for the Pee Dee River is a three year running average of harvest less than 500kg. Management action would be taken if the benchmark is exceeded. In 2012, the three year running average for kilograms of herring is 450; therefore the benchmark was not exceeded.

Year	kg	3-yr running avg.
1998	2	
1999	15	
2000	323	113
2001	432	257
2002	140	298
2003	244	272
2004	1	128
2005	193	146
2006	19	71
2007	267	160
2008	600	295
2009	465	444
2010	386	484
2011	343	398
2012	622	450

PART 2 - RIVER (BLUEBACK) HERRING – 2012 FISHING YEAR

I. Harvest and losses

A. Commercial fishery

1. Characterization of fishery (seasons, caps, gears, regulations)

a. Seasons:

The open blueback herring season in South Carolina varies by water area, and there is no commercial fishing activity for herring in the Ashley, Edisto, Combahee, Coosawhatchie, and Savannah River (above Hwy 301) or in State territorial Atlantic Ocean waters. The open season is 15 February - 15 April in the Pee Dee River and 15 February - 1 May in the Santee River. The open commercial season for the Rediversion Canal of Santee River and the Tailrace Canal of Cooper River is 1 March - 30 April of each year. There is no closed season for the commercial take of herring in the Santee-Cooper Lakes with legal gears in open areas.

b. Caps:

There are caps in effect for the allowable daily take of herring (including the allowable by-catch) for the net fisheries in the Tailrace Canal of the Cooper River (10 US bushels per boat), the Santee-Cooper Lakes (250 pounds per boat), and the Rediversion Canal (10 US bushels per boat). There are no other caps or quotas in effect for commercial herring fisheries in South Carolina.

c. Gears:

The approved commercial gears are anchored (set or stationary) and drift gill-nets in all open riverine waters seaward of dams, with the exceptions of open portions of the Santee and Cooper River where other gears are allowed. Circular drop-nets up to six feet in diameter, lift-nets and cast-nets are the only gears allowed in the upper Tailrace Canal of the Cooper River and in the open portions of the Rediversion Canal of the Santee River. Lift-nets, cast-nets, and hook & line may be used within the Santee-Cooper Lakes and cast-nets and/or hook & line are legal gear in other inland reservoirs. Legal minimum mesh size for gill-nets is 2 1/2" stretched mesh in all State waters open to such gear. The length of any gill-net may not exceed one half of the width of the waterway where it is fished. Gill-nets may not be fished within 200 yards of any previously deployed net. Regulatory changes implemented in 2001 restricted net lengths to a maximum of 200 yards in freshwaters and 300 yards in inland marine waters.

d. Regulations:

There is a weekly 84-hour lift period in effect for all waters within the Pee Dee River during the 15 February through 15 April open gill-netting season. The use of nets (cast and hoop/drop) in the Tailrace Canal is allowed only from sunrise until 10:00 PM, but all week during the 1 March through 30 April open season. Fishing with nets (cast and hoop/drop) in the Rediversion Canal is allowed during the 1 March through 30 April open season from 7:00 PM - 12:00 midnight EST or 8:00 PM – 12:00 PM EDT, with no lift period. Portions of several rivers are closed to commercial gear. Boats used to transport commercial gear must have an identification decal. Gill-nets are licensed by length at $10 per 100 yards or fraction thereof. In order to sell their catch, fishermen must possess a $25 individual commercial license to sell to a licensed wholesale dealer. If fishermen sell to anyone other than a licensed wholesale dealer, they must possess a $100 wholesale dealer license themselves. Each drop, dip or cast-net used for commercial purposes requires a $10 license. All previously listed license fees are for State residents. Nonresident license fees are $300 and $500 for the individual commercial license and a wholesale dealer license, respectively.

Beginning with the 1998 commercial herring netting seasons, all licensed fishermen are required to report their daily catch and effort to the South Carolina Department of Natural Resources (SCDNR).

2. Characterization of directed harvest for blueback herring

   a. Landings and methods of estimation:
   Several types of "herring" fisheries occur within South Carolina. These fisheries can be separated by area of operation and by targeted catch and the disposition thereof. Over the past decade or more, traditional gill-net fisheries have been restricted primarily to the rivers of the Winyah Bay watershed. Riverine gill-nets accounted for 1,812 pounds of recorded herring landings in 2012, 100% of which were taken in the Pee Dee River. Despite only limited observations from this fishery, the take is presumed to be largely adult blueback herring. Most of these landings are consumed locally by fishers or sold as bait.

   The vast majority of herring landed in the State over the past several decades have been taken in cast/drop net fisheries immediately below Pinopolis Dam on the Cooper River (particularly prior to 1986) and below St. Stephen Dam on the Santee Rediversion Canal. A haul seine fishery operated below Wilson Dam on the Santee River prior to completion of the Santee Rediversion project in 1986. Increased water levels and flows have largely prevented the operation of this fishery since rediversion.

   The WFFD of the SCDNR monitors the Santee River Rediversion or Wilson's landing (depending on turbine discharge) and Cooper River cast-net/drop-net fisheries and records estimated landings from these fisheries through routine sub-sampling and surveys at the landings used for off-loading and transport of the catch. Landings data, while helpful showing trends in abundance, should be examined based on discharge. **It should also be noted landings can significantly fluctuate year to year depending on river flow below hydroelectric facilities. In certain low flow years, little to no attractant current is present for herring resulting in lower fishing effort and reduced overall landings which may not accurately reflect abundance.**

   Landings from creel surveys for 2012 were 18.9 metric tons (41,667 lbs.), approximately 126,297 fish for the Santee River Rediversion fishery. The permit and mandatory reporting system also covers these fisheries, and monthly harvest reports are submitted to the Marine Resources Division of the SCDNR. The mandatory catch and effort reporting system garnered landings of blueback herring for both the Santee River and Cooper River fisheries in 2012 of 91,907 and 30,329 pounds, respectively. The greater of the landings estimates for these two fisheries are presented in Table 18. These fisheries target adult, pre-spawning blueback herring, which are marketed for both bait and for human consumption, particularly the roe.

   Catches within the Santee-Cooper Lakes (where passage is provided for adult blueback herring and hickory and American shad) may include a mixture of adults and juveniles of these and other Clupeids. The Savannah River impoundments are not equipped with fish passage devices, but blueback herring populations are landlocked within these reservoirs as a result of forage-fish stockings taken from the Santee-Cooper Lakes. Catches in the Savannah River reservoirs are also likely a mixed bag, but would not include American or hickory shad. “Shad” and “herring” landed in these above-dam areas are generally sold (or used personally) as live, or fresh dead, bait for striped or hybrid striped bass and catfishes. Such landings reported for 2012 are included in Table 18 as “herring” landings. However, landings have not been used to produce numbers of fish landed since the size and species composition are poorly known. Total reported “herring” landings for 2012 were 163,076 pounds (Table 18). Numbers of adult blueback herring landed were estimated by dividing pounds landed by the mean weight of an adult herring (0.3 pounds). Numbers of individuals taken were not estimated for those fisheries with landings of mixed species and size composition. Effort data are not included since such data are poorly represented in most reports, particularly relative to duration of fishing activity per day. The SCDNR is working to improve the scope and reliability of licensee data. The wholesale dealer reporting system does not generally produce herring landings. Herrings can be sold as bait to licensed bait dealers but, those dealers are not required to report what they buy.

b. Catch composition

i. Age frequency:

No age data were collected prior to 2008; however due to growing concerns, SCDNR began collecting scale samples in 2009 and will continue for subsequent years. Scale samples were taken from random samples while conducting recreational creel surveys. Age data were collected for the Santee, Cooper, and Savannah Rivers in 2012.

NOTE: All blueback herring scale samples were aged by another state agency following the Cating method. This is part of an ongoing partnership with MD DNR.

Santee River

In 2012, scale samples were taken from a random sample of 45 herring (1 female and 44 males) from the blueback herring fishery in the Santee River (Figure 16). Mean age for females was 7.0 years. The mean age for males was 4.5 years, with the range between 3-6 years old.

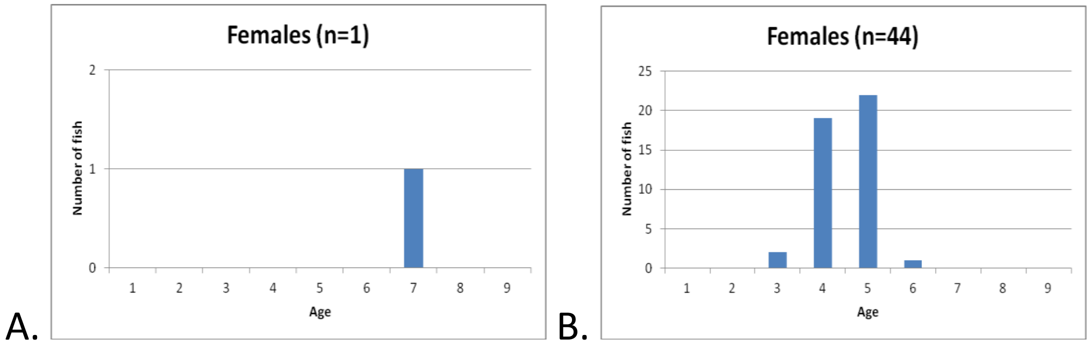


Figure 16. Age frequency distribution for 2012 Santee River fishery dependent sampling for A. Female and B. Male herring.

ii. Length frequency:

In 2012, length data were recorded from random samples while monitoring the commercial fishery.

Santee River

Fork length (FL), total length, and weight were determined for a random sample of 45 herring (1 females and 44 males) from the commercial fishery (Figure 17). Results for 2012 are presented for females and males in the figure below. Mean FL for females was 292 mm. The FL for males was 232 mm, with a range of 190-277 mm.

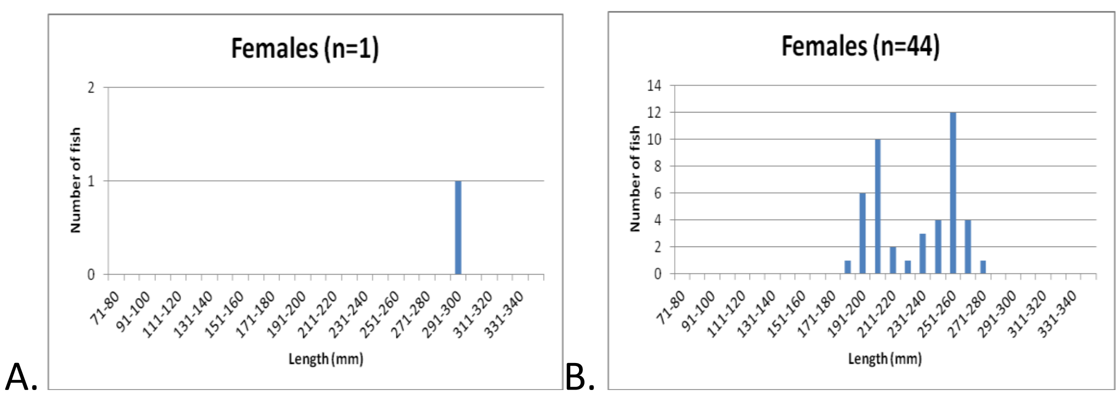


Figure 17. Length frequency distribution for 2012 Santee River-Wilson fishery dependent sampling for A. Female and B. Male shad.

iii. Sex ratio:

The observed sex ratio for the sampled Santee River Rediversion Canal fishery was 2% female and 98% male (Post, 2012).

iv. Degree of repeat spawning (estimated from scale data):

SCDNR collected scale samples for ageing purposes in 2012, but due to staff shortages, few samples were collected. However, of the 45 samples, 9 were determined, by MD DNR to be repeat spawners.

c. Estimation of effort:
Effort estimates for the Santee River Rediversion Canal fishery were made by catch per unit of effort (catch per man day and per man hour; CPMD, CPMH) estimates were made from access point surveys directed at periods of maximum effort, but overall estimates of effort were not made. Effort for this fishery totaled 147 trips, 255 man-days, or 604 man-hours.

3. Characterization of other losses (poaching, by-catch, etc.)
   a. Estimate and method of estimation:
      No such estimates are available.

   b. Estimate of composition (length and/or age):
      No such estimates are available.

B. Recreational fishery

1. Characterization of fishery (seasons, caps, gears, regulations):
   a. Seasons:
      There is no closed season for the recreational take of herring with legal gears.

   b. Caps:
      The daily catch limit for the recreational/non-commercial take of herring is one US bushel per person.

   c. Gears:
      Hook & line and cast-nets are the only legal recreational gears. Hook & line fisheries for shad take herring as a by-catch. There is some undetermined amount of directed effort for herring by fishermen using weighted treble hooks for "snatching" below dams where the fish are concentrated.

   d. Regulations:
      Fishermen taking herring recreationally must possess the appropriate recreational fishing license for fresh or marine waters. Sanctuary lines are established and posted below major dams in the State where strong and rapidly changing flow rates create potential danger to fishermen and watercraft. Herring caught for recreational purposes may not be sold. There are no further regulations in effect for the recreational take of herring.

2. Characterization of directed harvest

   a. Landings and methods of estimation:
      Data are collected as part of the shad census. There were 85 blueback herring recorded in the shad creel survey from the Cooper River Tailrace Canal (CRTC).

b. Catch composition

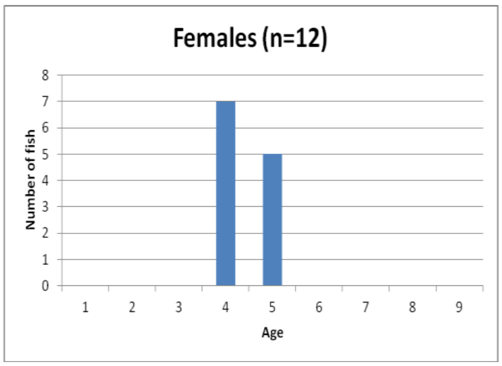
i. Age frequency:

In 2012, scales were taken from random samples from the Cooper River Tailrace Canal (CRTC) fishery.

Cooper River Tailrace Canal (CRTC)

Scale samples were taken from random samples 25 herring (12 females and 13 males) while conducting recreational creel surveys (Figure 18). Mean age for females was 4.42 years, with the range between 4-5 years old. The mean age for males was 4.46 years, with the range between 3-5 years old.

A.



B.

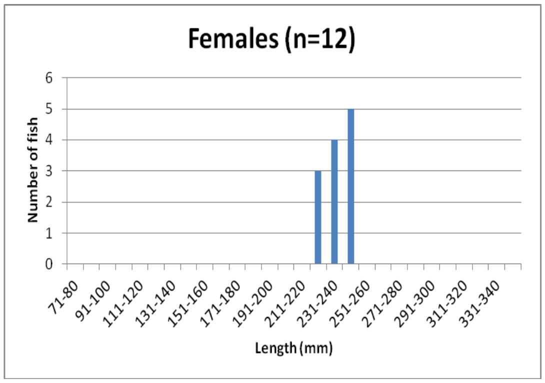
Figure 18. Age frequency distribution for 2012 CRTC fishery dependent sampling for A. Female and B. Male herring.

ii. Length frequency

Mean fork length are determined for samples taken from recreational shad fishery in the Cooper River where blueback herring are caught, but not usually targeted (Figure 19).

Cooper River Tailrace Canal (CRTC)

Length and weight were determined for a random sample of 25 herring (12 females and 13 males) from the recreational hook and line fishery (Figure 11). Mean length for females was 238 mm, with the range 227--250 mm. Mean length for males was 222 mm, with a range of 191-241 mm.

A. 

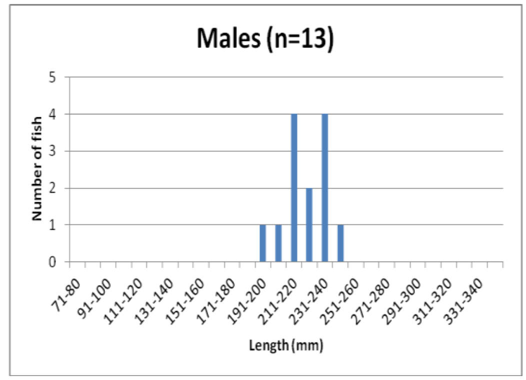
B. 

Figure 19. Length frequency distribution for 2012 CRTC fishery dependent sampling for A. Female and B. Male shad.

c. Estimation of effort:
No estimates are available.

3. Characterization of other losses (poaching, hook/release mortality, etc.)

a. Estimate and method of estimation:
No estimates are available.

b. Estimate of composition (length and/or age):
No estimates are available.

C. Other losses (passage mortality, male discards, brood stock capture, research losses, etc.):
Although it is likely that male or buck herring are occasionally discarded because of poor market value, no estimates of such losses are available. It is also probable that herring of both sexes are lost or discarded at the boat or dock because of damage from opportunists such as otters, alligators, eels, turtles, cormorants, etc. Again the losses from such opportunistic feeding damage have not been quantified or estimated. However, as many as 20,000 cormorants can be observed feeding on herring at the St. Stephen Dam during March and April. (Personal communication Jarrett Gibbons SCDNR) Only two dams (Pinopolis Dam at the headwaters of the Cooper River and St. Stephen Dam on the Rediversion Canal of the Santee River) in South Carolina afford passage to alosines where mortalities related to upstream passage are likely. The navigational lock used to pass alosines at New Savannah Lock & Dam on the Savannah River would only lead to mortalities if fish were held in the lock too long before release. Mortality observations have not been made at New Savannah Lock & Dam on the Savannah River, nor have such observations been made for Pinopolis Dam. There have been no estimates of mortality (for upstream or down-stream passage of any species) made at this facility at any time. However, mortalities related to passage procedures are believed to be minimal.

D. Harvest and losses - including all above estimates in numbers and weight (pounds) of fish and mean weight per fish for each gear type (Table 16).

E. Protected species

I. Atlantic sturgeon by-catch estimates:
No by-catch estimates are available for either Atlantic or shortnose sturgeon relative to herring fisheries. Sturgeon by-catch in these fisheries is expected to be very low. **Sturgeon by-catch was included as part of the mandatory catch and effort reporting system for the commercial herring fishery beginning in 2000**. No by-catch of sturgeons was reported for these fisheries in 2012.

II. Required fishery independent monitoring:

A. Description of requirement as outlined in Amendment 2:
Beginning with the implementation of Amendment 2 South Carolina is to conduct an annual spawning stock survey including the representative sampling of biological data and is to calculate mortality and/or survival estimates. Such studies may be performed in a single river per year as selected by the State. South Carolina initiated fishery-independent sampling program in the Santee River beginning in 2008. However, due to staff shortages and other priorities, such as juvenile shad monitoring, fishery independent monitoring did not occur in 2010, but did occur in 2012.

B. Brief description of work performed:
In 2012 a total of 4 netting trips were conducted between March 13 and April 5. This yielded 8.39 net hours with a CPUE of 2.26 for blueback herring (CPUE Females=2.26 and CPUE Males=0.00).

C. Results:

1. Juvenile indices:
It was determined by the shad and river herring technical committee, that SCDNR would not be required to conduct juvenile sampling in the Santee River. Fish passage and exploitation data indicate no juvenile recruitment bottleneck in this river.

2. Spawning stock assessment
a. Length frequency:
Such studies were initiated on a selected single river basis annually beginning in 2008. As mentioned above, the Santee River was selected for such studies. Fork and total lengths were recorded for all captured herring (Figure 20). Mean FL for Santee River females (19 fish) was 251 mm (range 237-270 mm). No males were captured.

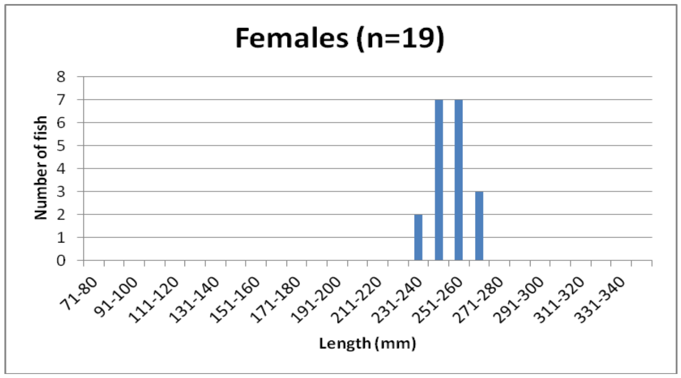


Figure 20. Length frequency for fishery independent catches from the Santee River in 2012.

b. Age frequency:
   Such studies were previously performed during 1979-1985. Biologists did not take scale samples in 2012 from fish to be tagged from the Santee River, as such would likely significantly increase both pre and post-tagging mortality rates.

c. Sex:
   Sex composition studies were initiated in 2008 on an annually selected single river basis. The Santee River was selected for such studies in 2012. Sex ratio could not be determined due to lack of males captured.

d. Degree of repeat spawning:
   No scale samples were collected.

3. Annual mortality rate calculation:
   In 2012, captured herring were not tagged. SCDNR will attempt to tag herring in subsequent years.

Table 16. Summary of 2012 South Carolina Shad Laws by Water or Fishery Area

A. Winyah Bay and Tributaries (includes Waccamaw, Great Pee Dee, Little Pee Dee, Lynches, Black and Sampit Rivers)

1) Pee Dee River and tributaries above Hwy. 701, Waccamaw River and tributaries above entrance of Big Bull Creek, and Black River above Co. Rd. 179

Open Season	Feb. 1 - Apr. 30
Weekly Open Period	Mon. Noon - Sat. Noon
Special Provisions	None
Gear Restrictions	As specified in general provisions
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

2) Remainder of Winyah Bay system including Big Bull Creek and Sampit River

Open Season	Feb. 1 – Apr. 15
Weekly Open Period	Mon. Noon - Sat. Noon
Special Provisions	Drift gill-nets measuring not more 300 yards in length may be used between the Waccamaw River mouth and Butler Island
Gear Restrictions	As specified in general provisions
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

B. Santee River

1) Rediversion Canal

Open Season	None - hook & line only
Hook & Line Gear	No season; 20-fish aggregate creel limit for American and hickory shad

2) Wilson Dam seaward to Hwy. 52

Open Season	None - hook & line only
Hook & Line Gear	No season; 20-fish aggregate creel limit for American and hickory shad

3) Hwy. 52 bridge seaward to Hwy. 41 bridge

Open Season	Feb. 1 - Apr. 30
Weekly Open Period	Tues. & Thurs., 7:00 AM - 7:00 PM
Gear Restrictions	None
Hook & Line Gear	No season; 20-fish aggregate creel limit for American and hickory shad

4) Hwy. 41 bridge seaward

Open Season	Feb. 1 – Mar. 31
Weekly Open Period	Mon. Noon - Sat. Noon
Gear Restrictions	None
Hook & Line Gear	No season; 20-fish aggregate creel limit for American and hickory shad

C. Charleston Harbor; Wando, Cooper & Ashley Rivers

1) Tailrace Canal from Wadboo Ck. to Pinopolis Dam

Open Season	None - hook & line only
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

2) Cooper River from Wadboo Ck. to Hwy. 17

Open Season	None - hook & line only
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

3) Ashley River to confluence with Popper Dam Ck. entrance

Open Season	Feb. 1 - Mar. 31
Weekly Open Period	Wed. Noon - Sat. Noon
Gear Restrictions	Drift gill-nets only
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

4) Remainder of Charleston Harbor system

Open Season	Feb. 1 - Mar. 31
Weekly Open Period	Wed. Noon - Sat. Noon
Gear Restrictions	Drift gill-nets only
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

D. Edisto River

1) Above U.S. Hwy. 17 bridge

Open Season	Jan. 15 - Apr. 15
Weekly Open Period	Tues. Noon - Sat. Noon
Gear Restrictions	5.5" minimum stretched mesh except minimum 4.5" allowed above Hwy. 15 (beginning in 2003, 5” minimum)
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

2) Seaward of U.S. Hwy. 17

Open Season	Jan. 15 - Mar. 31
Weekly Open Period	Wed. Noon - Fri. Midnight
Special Provisions	None
Gear Restrictions	None
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

E. Ashepoo River

1) Above U.S. Hwy. 17 bridge

Open Season	Feb. 1 - Mar. 31
Weekly Open Period	Fri. Noon - Sat. Noon
Gear Restrictions	None
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

2) Seaward of U.S. Hwy. 17

Open Season	Feb. 1 - Mar. 31
Weekly Open Period	Fri. Noon - Sat. Noon
Gear Restrictions	None
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

F. Combahee River

1) All tributaries and distributaries

Open Season	None
Weekly Open Period	None
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

2) Main river, including main stems of Salkehatchie Rivers

Open Season	Jan. 15 - Mar. 31
Weekly Open Period	Set Nets: Tues. Noon – Thurs. Noon Drift Nets: Mon. Noon - Sat. Noon
Gear Restrictions	None
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

G. Coosawhatchie River and all tributaries and distributaries

Open Season	None
Weekly Open Period	None
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

H. Savannah River within South Carolina jurisdiction

1) Above (inland of) U.S. Hwy. I-95 bridge

Open Season	Jan. 1 - Apr. 15
Weekly Open Period	Wed. 7:00 AM - Sat. 7:00 PM
Special Provisions	No open season from confluence of Spirit Creek to New Savannah Bluff Lock & Dam; all tributaries closed
Gear Restrictions	None
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

2) Main river seaward of U.S. Hwy. I-95 bridge

Open Season	Jan. 1 - Mar. 31
Weekly Open Period	Wed. 7:00 AM – Sat. 7:00 PM
Special Provisions	Nets prohibited in Savannah's Back River & north channel downriver from New Savannah Cut
Gear Restrictions	None
Hook & Line Gear	No season; 10-fish aggregate creel for American and hickory shad

J. Lake Moultrie, Lake Marion, Diversion Canal, Intake Canal of Rediversion Canal and all tributaries and distributaries thereto

Open Season	None
Weekly Open Period	None
Gear Restrictions	Cast net, lift net, and hook & line only
Special Provisions	Daily limit of 250 pounds of herring and shad combined for cast and lift nets
Hook & Line Gear	No season; 10-fish aggregate creel for American and Hickory shad

K. General provisions

1) Gill-net marking/identification

a) All inland saltwaters	20" minimum diameter international orange buoys on each end of all nets; one such buoy must bear name and license number of owner; nets longer than 100 yards must have international orange buoy at least 10" in diameter along float line every 300 ft. Individual nets may not exceed 300 yards in length.
b) All freshwaters	6" minimum diameter international orange buoys on each end of all nets; one such buoy must bear name and license number of owner; nets longer than 100 yards must have international orange buoy at least 6" in diameter along float line every 300 ft. Individual nets may not exceed 200 yards in length.

2) Fishing gill-nets near the mouth or confluence of tributaries

a) All waters	No net may be used within 75 ft. of the confluence of any tributary.

Table 17. South Carolina Annual Landings for American Shad as Reported to NMFS since 1979 (sexes combined).

Year	Riverine		Ocean - Intercept		Total
	Pounds [2]	% Total	Pounds	% Total	
1979	113,563	57.6	83,508	42.4	197,071
1980	117,205	43.3	153,348	56.7	270,553
1981	296,860	66.5	149,552	33.5	446,412
1982	153,342	38.5	245,086	61.5	398,428
1983	125,826	38.0	205,522	62.0	331,348
1984	176,159	32.8	360,203	67.2	536,362
1985	231,523	62.7	137,555	37.3	369,078
1986	257,635	53.5	224,020	46.5	481,655
1987	126,890	26.1	359,617	73.9	486,507
1988	111,145	30.1	258,397	69.9	369,542
1989	118,575	34.2	228,237	65.8	346,812
1990	63,732	28.3	161,374	71.7	225,106
1991	101,489	41.3	144,252	58.7	245,741
1992	135,940	55.5	109,106	44.5	245,046
1993	49,685	43.3	64,936	56.7	114,621
1994	50,250	41.1	71,909	58.9	122,159
1995	153,283	53.7	132,321	46.3	285,604
1996	320,629	61.6	199,593	38.4	520,222
1997	229,961	67.0	113,315	33.0	343,277

Table 17. South Carolina Annual Landings for American Shad as Reported to NMFS since 1979 (sexes combined). (continued)

Year	Riverine		Ocean - Intercept		Total
	Pounds [2]	% Total	Pounds	% Total	
1998 [1]	356,236	84.1	67,486	15.9	423,722
1999 [1]	204,425	91.4	19,329	8.6	223,754
2000 [1]	443,768	83.3	88,938	16.7	532,706
2001 [1]	215,198	69.9	92,465	30.1	307,663
2002 [1]	453,085	84.3	84,421	15.7	537,506
2003 [1]	354,389	90.5	37,087	9.5	391,476
2004 [1]	336,496	88.0	45,941	12.0	382,437
2005[1]	167,221	100.0	0	0	167,513
2006[1]	185,492	100.0	0	0	185,492
2007[1]	227,211	100.0	0	0	227,211
2008[1]	334,626	100.0	0	0	334,626
2009[1]	228,467	100.0	0	0	228,467
2010[1]	298,609	100.0	0	0	298,609
2011[1]	377,907	100.0	0	0	377,907
2012[1]	339,876	100.0	0	0	339,876

[1] **1998 through 2011 landings include recorded losses of adult shad from fish passage mortality (38 pounds in 2012) and from research activities by state and private groups. All of these additional "landings" were from riverine areas.**

[2] **Fish are usually reported in pounds by wholesale dealers. Statewide means are 2.5 and 4.0 pounds each for males and females, respectively.**

Table 18. South Carolina Reported Commercial Blueback Herring Landings by Area for 2012.

Water Area	Landings Report Source	Source of Landings	Blueback Herring – Sexes Combined		
			~ Number	~ Pounds	% Statewide
Winyah Bay system	Licensee Reports	Gill-nets	6,066	2,002	<1
Santee River	Licensee Reports & WFFD of SCDNR	Cast/Drop Nets	126,297	41,678	26
		Fish Lift Losses	24	8	<1
		Total Take	126,321	41,686	26
Cooper River/ Tailrace Canal	Licensee Reports & WFFD of SCDNR	Cast/Drop Nets	19,162	6,323	4
Santee-Cooper Lakes (Marion Moultrie & Murray)	Licensee Reports	Cast/Drop Nets	48,692	16,068	10
Savannah River & Lakes	Licensee Reports	Cast/Drop Nets	293,929	96,997	59
Statewide Total	**All Sources**	**All Sources**	**494,170**	**163,076**	**100**

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Georgia's 2012 Annual State Report for Shad and River Herring to the Atlantic States Marine Fisheries Commission - June 2013

I. Harvest and Losses

A. Commercial fishery

1. Characterization of fishery

The commercial shad (American and hickory) season is open each year from January 1 to March 31. Each week, the Savannah River is open to commercial fishing from Tuesday through Friday below the I-95 bridge and Wednesday through Saturday above the bridge with an upper boundary at the US Hwy 301 bridge. The Ogeechee River is open below the GA Hwy 204 bridge to drift nets only on Friday of each week. The Altamaha River is open Monday through Friday below the saltwater demarcation line and Tuesday through Saturday with an upper boundary at the US Hwy 1 bridge. The Satilla and St. Marys rivers are closed to commercial fishing. Set gill nets and drift gill nets with mesh sizes of at least 4 ½ inches (stretch mesh) are legal gears for shad fishing.

2. Characterization of directed harvest for all alosines

a. Landings and method of estimation

In Georgia, dealers are required to report commercial harvest of shad. The Coastal Resources Division (CRD) of the Georgia Department of Natural Resources receives dealer reports. In 2012, less than three dealers reported shad landings. Therefore, the commercial landings data is confidential and not included in this report.

b. Catch composition

In 2012, less than three dealers reported shad landings. Therefore, the commercial catch composition data is confidential and not included in this report.

c. Estimation of Effort

In 2012, less than three dealers reported shad landings. Therefore, the commercial effort data is confidential and not included in this report.

3. Characterization of other losses

Since commercial shrimpers are required to use Bycatch Reduction Devices in their nets, shad are rarely caught in commercial shrimp trawling off the Georgia coast. In 2012, ACFCMA bycatch observers did not report any shad being taken from shrimp trawls. This is the only commercial fishery in Georgia to which shad are vulnerable.

B. Recreational fishery

1. Characterization of fishery

There is an eight fish per angler per day creel limit on shad (combination of American and/or hickory). Shad are only targeted recreationally in Georgia at the New Savannah Bluff lock and dam on the Savannah River and in the Ogeechee River. There are no directed recreational fisheries on other rivers within the state. Shad are occasionally caught as bycatch by anglers in the Altamaha River, but this is very rare.

2. Characterization of directed harvest

a. Landings and method of estimation

Georgia did not conduct any creel surveys in 2012.

b. Catch composition

Data on age and length frequency are not available for 2012.

c. Estimation of effort

Estimation of recreational effort is not available for 2012.

3. Characterization of other losses

The only commercial fishery in Georgia to which shad are vulnerable is the shrimp trawl fishery. Since commercial shrimpers are required to use Bycatch Reduction Devices in their nets, shad are rarely caught in commercial shrimp trawling off the Georgia coast. This is the only commercial fishery in Georgia to which shad are vulnerable.

C. Other losses

The Altamaha, Ogeechee, Satilla, and St. Marys rivers are free-flowing, so losses through pump-back turbines or fish passageways are not of concern. For reasons stated above, shad are rarely caught in the shrimp trawl fishery and no losses were reported in 2012.

D. Harvest and losses

In 2012, less than three dealers reported shad landings. Therefore, the commercial harvest and loss data is confidential and not included in this report.

E. Protected species

Atlantic and shortnose sturgeon are caught in gill nets. In drift nets, essentially 100% of the sturgeon can be released unharmed. During 15 field days of tagging adult shad in 2012, 24 Atlantic and 9 shortnose sturgeon were captured in drift gill nets. All sturgeon were released unharmed.

II. Required fishery independent monitoring

A. Description of requirements

Spawning stock surveys and representative sampling for biological data for American shad are required for the Altamaha, Ogeechee, and Savannah rivers. Juvenile abundance surveys are also required on these same rivers.

B. Description of work

The population of adult American shad was estimated in the Altamaha River using mark-recapture techniques via gill netting. Exploitation was estimated from tag returns. Average weights were calculated and partitioned by sex to calculate average weight of shad in the Altamaha River. Adult spawning stock surveys were conducted via electrofishing on the Ogeechee and Savannah rivers. Juvenile seine surveys were completed on the Altamaha, Ogeechee, and Savannah rivers in 2012.

C. Results

1. Juvenile indices

Juvenile sampling efforts were initiated in 2010 and are becoming standardized as appropriate sampling sites are identified. During 2012, juvenile alosines were collected by utilizing a 50’ bag seine with 1/4” mesh on the Altamaha, Ogeechee, and Savannah rivers during the months of July-September.

A total of 1,289 juvenile American shad (variance=1094.8) were collected in 48 seine hauls from 6 sampling sites on the Altamaha River. The overall geometric mean was 13.91shad/haul. In addition, 116 juvenile blueback herring (variance=9.1) were collected for a geometric mean of 1.79 blueback herring/haul. No hickory shad were captured.

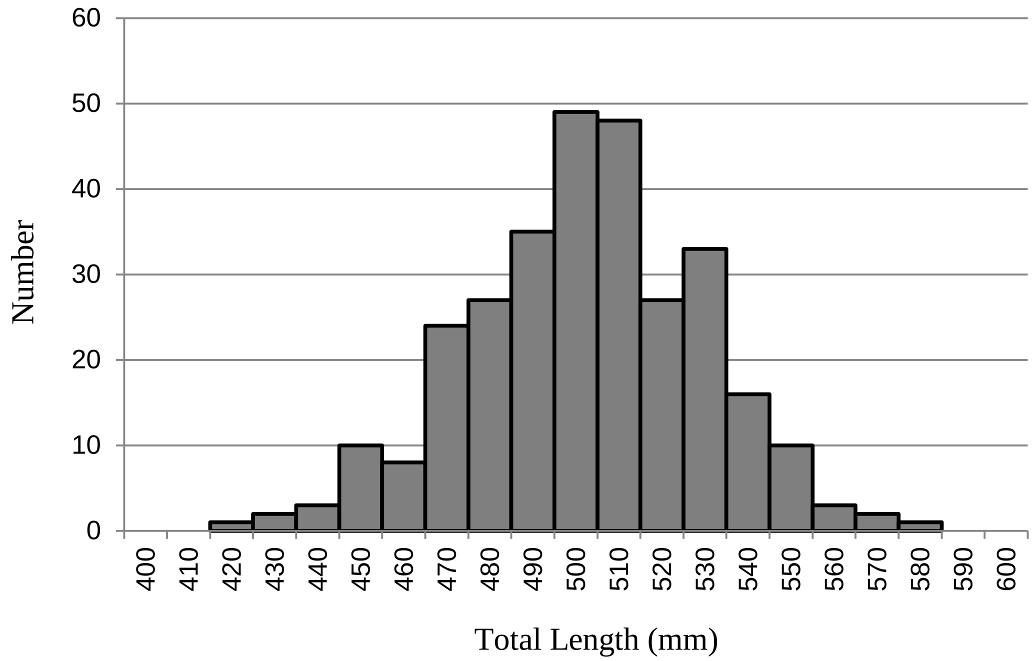
Ogeechee River juvenile sampling efforts comprised 18 seine hauls over 7 sites, which resulted in the capture of 227 juvenile American shad (variance=476.8) and produced a geometric mean of 4.45 shad/haul. No blueback herring or hickory shad were captured.

Savannah River juvenile sampling efforts comprised 36 seine hauls over 6 sites, which resulted in the capture of 1102 juvenile American shad (variance=823.7) and produced a geometric mean of 14.7 shad/haul. In addition, 96 juvenile blueback herring (variance=95.5) were collected for a geometric mean of 1.48 blueback herring/haul. No hickory shad were captured.

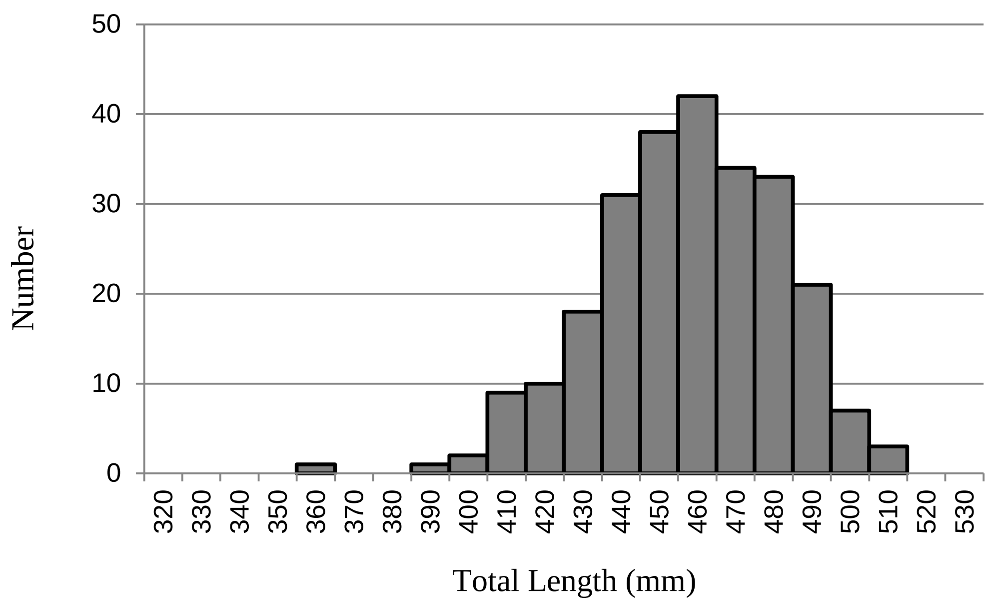
2. Spawning stock assessment

a. Length Frequency

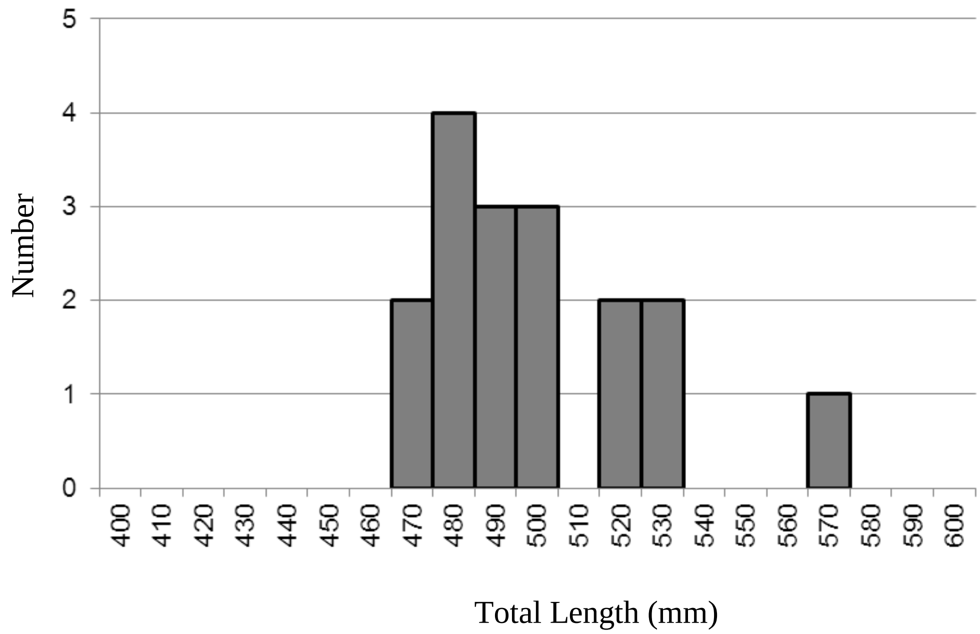
Length frequency of female American shad captured from the Altamaha River during 2012 adult monitoring efforts (N=299).



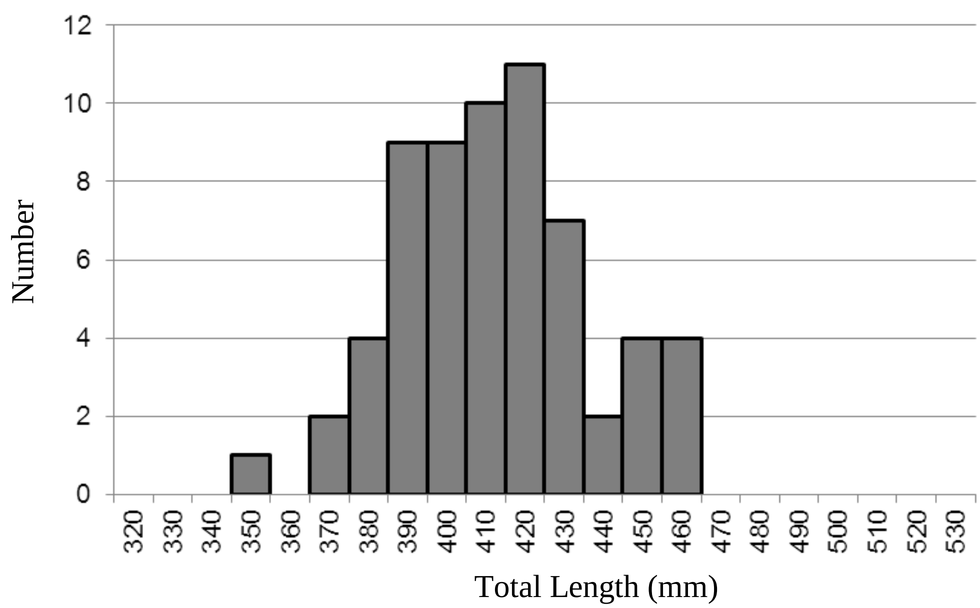
Length frequency of male American shad captured from the Altamaha River during 2012 adult monitoring efforts (N=250).



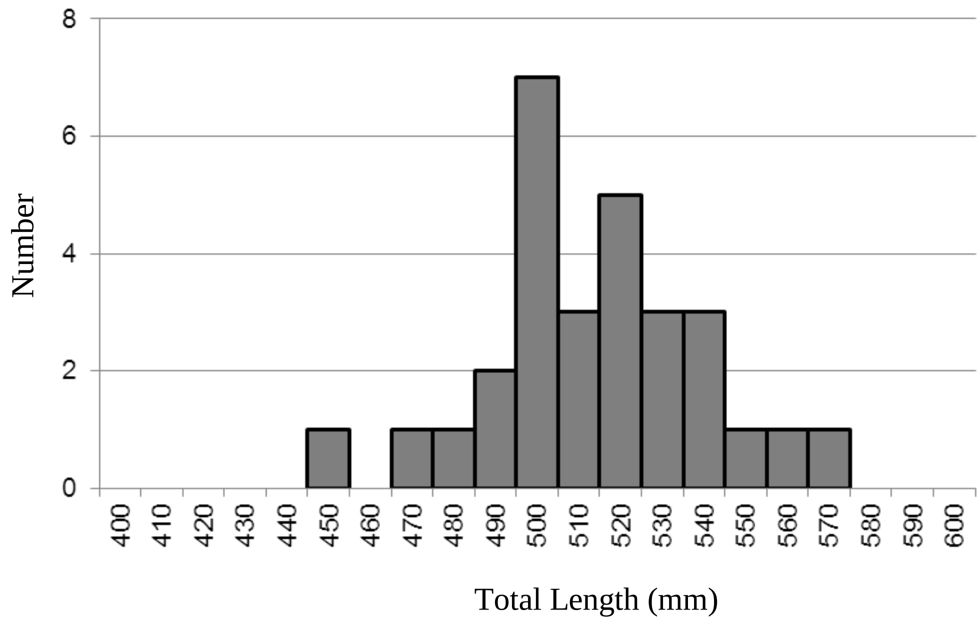
Length frequency of female American shad captured from the Ogeechee River during 2012 adult monitoring efforts (N=17).



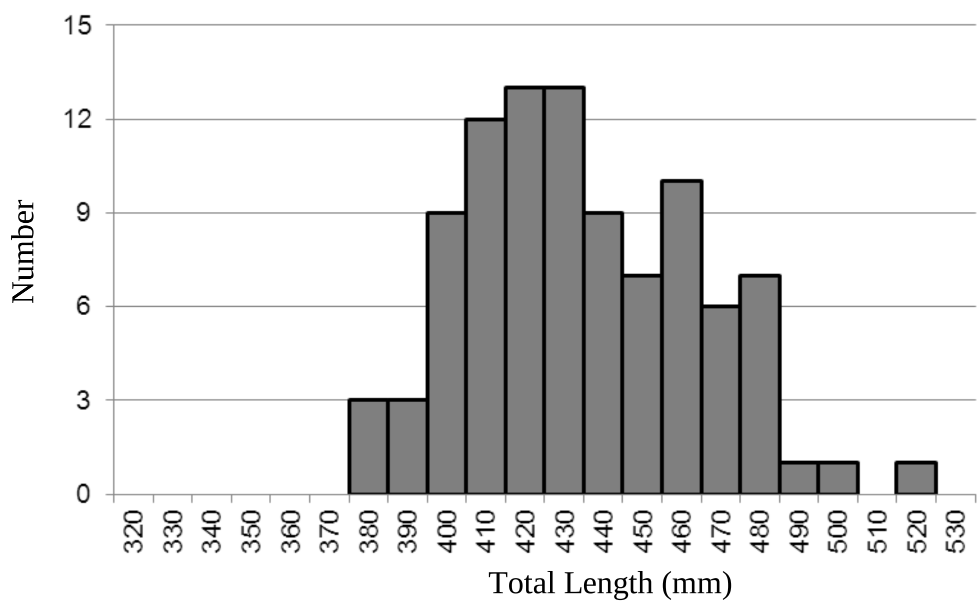
Length frequency of male American shad captured from the Ogeechee River during 2012 adult monitoring efforts (N=63).



Length frequency of female American shad captured from the Savannah River during 2012 adult monitoring efforts (N=29).



Length frequency of male American shad captured from the Savannah River during 2012 adult monitoring efforts (N=95).



b. Catch composition

Age and length of female American shad captured from the Altamaha River during 2012 adult monitoring efforts (N=100).

Age	Number	% Frequency	Size Range (mm Total Length)	Average Wt. (g)
4	11	11	432-485	1126 (3 fish)
5	32	32	425-545	1325 (11 fish)
6	50	50	482-596	1529 (26 fish)
7	7	7	511-570	

Age and length of male American shad captured from the Altamaha River during 2012 adult monitoring efforts (N=92).

Age	Number	% Frequency	Size Range (mm Total Length)	Average Wt. (g)
3	1	1	368	
4	31	34	394-477	760 (2 fish)
5	45	49	425-498	897 (5 fish)
6	14	15	469-565	975 (1 fish)
7	1	1	473	

Age and length of female American shad captured from the Ogeechee River during 2012 adult monitoring efforts (N=17).

Age	Number	% Frequency	Size Range (mm Total Length)	Average Wt. (g)
4	3	18	455-475	1059 (3 fish)
5	11	65	480-521	1114 (11 fish)
6	3	18	520-539	1589 (3 fish)

Age and length of male American shad captured from the Ogeechee River during 2012 adult monitoring efforts (N=42).

Age	Number	% Frequency	Size Range (mm Fork Length)	Average Wt. (g)
3	11	26	360-416	485 (11 fish)
4	23	55	370-439	644 (23 fish)
5	8	19	429-490	772 (8 fish)

Age and length of female American shad captured from the Savannah River during 2012 adult monitoring efforts (N=8).

Age	Number	% Frequency	Size Range (mm Fork Length)	Average Wt. (g)
4	1	13	450	720 (1 fish)
5	3	38	476-500	1110 (3 fish)
6	4	50	505-537	1390 (4 fish)

Age and length of male American shad captured from the Savannah River during 2012 adult monitoring efforts (N=8).

Age	Number	% Frequency	Size Range (mm Fork Length)	Average Wt. (g)
3	1	13	409	380 (1 fish)
4	4	50	412-434	620 (4 fish)
5	2	25	455-475	620 (2 fish)
6	1	13	481	900 (1 fish)

c. Population Estimate

The population of American shad in the Altamaha River in 2012 was 313,427 shad (a 12% increase from 2011). The sex ratio of American shad males to females was 1:2.06.

d. Electrofishing Catch Per Unit Effort

In 2012, Savannah River American shad electrofishing catch rate were 272.3 fish/hr. This was approximately a 1% increase from the catch rate of 269.5 fish/hr observed in 2011.

On the Ogeechee River, adult American shad were captured via electrofishing at a rate of 22.4 fish/hr in 2012. This was approximately 47% increase from the catch rate of 11.8 fish/hr observed in 2011.

3. Annual mortality rate calculation

Exploitation rate (μ) of both sexes combined was 0.11 in 2012. The average weight of a shad caught in the Altamaha River in 2012 was 3.12 lbs/fish. Natural Mortality (M) is not estimated for any of Georgia's river systems since the total actual mortality rate (A) is 100% (no repeat spawning).

4. Hatchery evaluation

Georgia did not have a hatchery program for stocking shad in any of Georgia's rivers during 2012.

Florida’s Annual State Report on Shad and River Herring Monitoring in 2012

Submitted to the Atlantic States Marine Fisheries Commission Shad and River Herring Technical Committee

Prepared by
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July 01, 2013

Introduction

Declining landings of American shad during the twentieth century led to the passage of the Atlantic States Marine Fisheries Commission's (ASMFC) Fishery Management Plan (FMP) for Alosa species in 1985. This report is written in the format requested by the ASFMC to satisfy Florida's compliance requirement with the most current amendment to the FMP.

Florida's St. Johns River is the only river within the state with a notable spawning population of American shad (Alosa sapidissima). Although this species is also found in the St. Marys River, along the Georgia-Florida border, this report only addresses a single stock, that of the St. Johns River, Florida.

I. Harvest and losses

A. Commercial fishery

1. Characterization of the fishery

No commercial fishery exists for American shad or river herring in Florida. In-river gill netting was restricted to nets with stretched mesh sizes of ≥ 6 inches, through a series of regulations between 1992-1995. The coastal fishery was restricted by tending and soak time regulations that were enacted gradually from 1992-1994, and in 1995 gill netting in inshore waters became prohibited by a Constitutional Amendment (s. 16, Art. X of the State Constitution) that eliminated entangling nets from state waters and restricted the use of other nets to less than 500 ft^2 within 1 mile of the Atlantic coast and in inland waters. Subsequently, effective January 1997, the Florida Marine Fisheries Commission made hook and line fishing the only allowable gear to fish for any Alosa species (Chapter 46-52.001 [2], Florida Administrative Code [FAC]). Sales of Alosa species are not prohibited, but they must observe the above regulations (see also "B. Recreational fishery").

2. Characterization of directed harvest for all Alosa species

Commercial fishing effort estimations are based on data reported to Florida's Marine Fisheries Information System (MFIS). Since 1986, Florida law requires wholesale transactions of marine organisms landed within the state to be reported to the MFIS. Annual landings were grouped as a fishing year (July-June) because Alosa species spawn in Florida between November and May. There is essentially no commercial fishery for Alosa species in Florida since 1996 when the net limitation amendment was enacted (Table 1).

3. Characterization of other losses (poaching, bycatch, etc.)

There are no records of poaching or bycatch mortalities.

B. Recreational fishery

1. Characterization of the fishery

An in-river recreational fishery continues on the St. Johns River. Effective January 1997, hook and line fishing is the only allowable gear to fish for any Alosa species (Chapter 46-52.001 [2], FAC) and the possession of more than an aggregate of 10 American, hickory, or Alabama shad is unlawful (Chapter 46-52.001 [3], FAC). A saltwater fishing license is also required of most anglers to fish for Alosa species in Florida.

2. Characterization of the directed harvest

An access point creel was introduced in 2011 (Table 1) and will continue annually as funds allow. The access point creel covers the old creel area (Mullet Lake Creel Area) via two boat ramps and an upstream area (Puzzle Lake Creel Area) via one boat ramp. These ramps are the primary access points to the river sections in which shad fishing occurs. Canvassing anglers on the water indicated that greater than 95% of shad fishing effort originated at these ramps. Total estimated shad-directed effort for both areas combined was 5417 angler hours with a total fished-for catch of 5108 fish and a total catch of 8013. Most of the estimated non-directed catch of 2905 fish occurred as incidental catch in the black crappie fishery. Total estimated harvest from the recreational fishery was 232 fish. Of those 177 were taken in the directed shad fishery and 55 were harvested as by-catch.

Table 1. Results of the 2012 January 1 to March 24 access point creel survey for American shad. Mullet Lake Creel Area consists of interviews from the Cameron Wight and Mullet Lake Park boat ramps and captures fishing effort between river kilometer 285 and 298 that were sampled in a previous roving creel. Puzzle Lake Creel Area consists of interviews from C.S. Lee boat ramp primarily describing the fishery between Lake Harney and Puzzle Lake. Period 1 = 1-January to 28-January-2011. Period 2 = 29-January to 25-February-2011. Period 3 = 28-February to 24-March-2011. Effort is angler hours. Success is shad caught per hour by anglers targeting American shad.

Mullet Lake Creel Area

	Effort			Catch		Fished For Catch		Harvest		Success		
Period	N	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	N	Estimate	S.E.
1	7	631	269	1528	768	796	414	16	13	8	1.39	0.44
2	7	1003	513	839	319	378	231	114	102	6	0.37	0.10
3	7	0	0	24	15	0	0	0	0			
Total	21	1635	579	2390	831	1174	474	131	103	14	0.95	0.29

Puzzle Lake Creel Area

	Effort			Catch		Fished For Catch		Harvest		Success		
Period	N	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	N	Estimate	S.E.
1	7	1301	523	2784	1446	1564	889	73	48	31	1.49	0.35
2	7	2020	182	1986	692	1616	615	29	26	46	0.78	0.22
3	7	462	95	854	371	754	349	0	0	6	1.51	0.55
Total	21	3782	562	5623	1646	3934	1136	101	50	83	1.10	0.18

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3. Characterization of other losses (poaching, hook/release mortality, etc.)

There are no records of poaching. Hook and release mortality is unknown.

C. Other losses

There are no records of other losses such as that from dams or impingement screens. One hundred and forty seven American shad were sacrificed for otolith removal.

D. Total quantified losses*

	Harvest and Losses				
Source	Number Females	Number Males	Average Weight Females (kg)	Average Weight Males (kg)	Total Weight Killed (kg)
Biological Sampling/Otoliths - Electrofishing	56	54	0.91	0.64	105
Recreational Harvest	232		1.2		278
Totals	288	54	1.14	0.64	355

*Females collected for otolith removal are taken throughout the season and reflect females in various stages of spawning related weight loss. Therefore they are lighter than the females taken in the recreational fishery which generally harvests only robust females.

E. Protected species / Atlantic sturgeon bycatch estimates

No netting is allowed for shad, so no sturgeon bycatch is expected.

II. Required fishery independent monitoring

A. Description of requirement as outlined in Amendment 3

Required monitoring of American shad on the St. Johns River includes annual spawning stock survey and representative sampling for biological data and a juvenile abundance index.

B. Brief description of work performed

A bow mounted push net was used to measure the relative abundance of juvenile *Alosa* during the spring and summer of 2012. Two representative habitats downstream from the spawning grounds were sampled. These were a river reach of the nursery zone, river kilometer (rkm) 210 to 260, and a tidal freshwater estuarine zone, rkm 125 to 165. The river reach was sampled bi-weekly from early April through May. The estuarine reach was sampled once in May and bi-weekly in June and July. Each sample trip consisted of 12 five-minute tows at randomly selected stations with three samples in each 10 kilometers within the 40 kilometer reach.

During the 2012 season, personnel completed 9 days of electrofishing between January and March (3 in January, 3 in February, 2 in March, and 2 in April) on the spawning grounds of the St. Johns to measure relative abundance, size, and sex ratio. Reaches sampled included the historical recreational creel area and two upstream stretches. Transects were selected at random by river kilometer within a reach of river and 10 transects were sampled in a sampling day with 10 minutes of electrofishing effort in each transect. *Alosa* were measured (TL and FL), weighed (g), sexed, and released. Up to five of each sex per centimeter group were sacrificed for otolith removal (N =110). Otoliths were read whole under a dissecting microscope.

From 2003 to 2005 adult CPUE sampling occurred December through May. From 2006 through 2011 adult CPUE sampling occurred January through April. December, April, and May sampling added zero data to catch rate calculations that was not reflective of run size but instead was a result of sampling occurring before and after the main spawning run. From 2012 going forward sampling will be standardized to occur bi-weekly from January through March in the main index area and during two peak season (to occur between January 20 and March 10) trips in the supplemental area. Means for the years 2003 through 2011 have been recalculated herein and in the summary excel spreadsheet to include only January through March data.

C. Results

1. Juvenile indices

The geometric mean catch per tow of American shad and blueback herring is summarized by month in Table 2. The relative abundance of American dropped to near zero in the upstream reach by May and peaked in May in the tidal freshwater sample zone. Downstream migration appears to have been rapid in spite of low river discharge during the spring/early summer. Sampling will begin earlier in the tidal freshwater zone in years subsequent to 2012.

2. Spawning stock assessment

Electrofishing in 2012 provided collections for size, sex, and CPUE. Repeat spawning does not occur in Florida populations of A. sapidissima and is not measured.

A total of 819 American shad was collected in 2019 during CPUE monitoring. This included 572 males (302 – 503 mm TL), 247 females (364 – 531 mm TL) (Figure 1). The geometric mean CPUE from river kilometer 314-358 was 5.83 American shad per 10-minute transect which ranked 5th in the record dating to 2003 (Figure 2). The CPUE from river kilometer 276 to 298 was 2.26 and was the highest during the survey period for that reach. Male American shad ranged in age from two to six and age 4 was most common. Females ranged from age three to seven with age 4 being dominant. A greater proportion of males than females were three years old (Figure 3). Hickory shad and blueback herring were present but not abundant (Table 3).

3. Annual mortality rate calculation

Data are not available to estimate mortality.

4. Hatchery evaluation

There are no hatcheries culturing or releasing *Alosa* in Florida.

III. Planned Management For the 2012 Calendar Year

Regulations are unchanged from 2012 in 2013 and changes are not planned. The annual spawning stock survey was continued and a representative sample has been sacrificed for otolith based aging. Bi-weekly sampling for JAI will occur from April through July in the primary index reach and from May through July in a tidal freshwater reach. An access point creel survey has been used to estimate recreational fishing effort, catch rate, and harvest. Harvest remains small.

Table 1. Annual commercial landings in pounds of *Alosa* in Florida. Landings are presumably all American shad, but reporting did not distinguish between American and hickory shad. Data is restricted to reporting from Nassau, Duval, and St. Johns counties (all coastal), and Putnam county (inland). A fishing year (July-June) is used because the spawning run begins as early as November and continues for several months. Data source: Florida Marine Fisheries Information System. **Landings beyond 2005-2006 continue to be zero.**

FISHING YEAR	OCEAN LANDINGS	TOTAL LANDINGS
1986-1987	142,026	155,430
1987-1988	266,251	266,374
1988-1989	164,839	165,112
1989-1990	169,881	289,293
1990-1991	58,810	71,592
1991-1992	49,633	49,798
1992-1993	24,503	24,503
1993-1994	24,930	24,968
1994-1995	26,791	26,886
1995-1996	3,650	3,650
1996-1997	54	54
1997-1998	18	18
1998-1999	480	480
1999-2000	800	800
2000-2001	0	0
2001-2002	0	0
2002-2003	0	0
2003-2004	0	0
2004-2005	0	0
2005-2006	0	0

Table 2. Geometric mean catch per tow by month of juvenile *Alosa sapidissima* and *Alosa aestivalis* collected in 2012 in the two index areas.

River Kilometer 210-260

Month	*A. sap.*	SD	*A. aes.*	SD
Apr	9.02	1.28	1.6	0.92
May	0.44	0.78	0.47	0.65

River Kilometer 125-165

Month	*A. sap.*	SD	*A. aes.*	SD
May	11.7	2.13	1.2	0.94
Jun	3.67	1.64	1.18	2.06
Jul	0.77	0.92	0.56	1.32

Table 3. Total number of adult shad caught per month during the fisheries-independent electrofishing survey in 2012, ASAP = *Alosa sapidissima*, AMED = *Alosa mediocris*, AAES = *Alosa aestivalis*. Number of 10-minute transects per month in parentheses.

Month (number of transects)	ASAP	AMED	AAES
January 2011 (30)	260	8	4
February 2011(30)	396	6	8
March 2011 (30)	163	1	1
Total (90)	819	7	14

Figure 1. Length frequency histogram (TL) of American shad collected by electrofishing from the St. Johns River, FL during winter-spring 2012

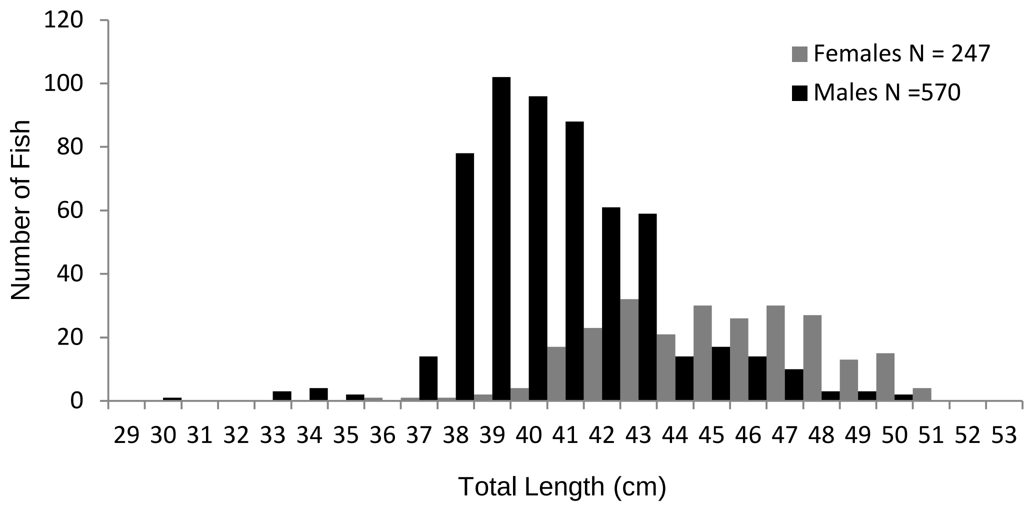

Figure 2. Annual geometric mean electrofishing catch per transect of American shad from the St. Johns River, Florida spawning stock survey. Each transect consisted of 10 minutes of electrofishing effort within a randomly selected 1km portion of the river. **As of 2010 the primary survey segment of the river is between river kilometer (rkm) 314 and 358 and sampling reach from rkm 278 to 298 was reduced to 20 peak-season transects.

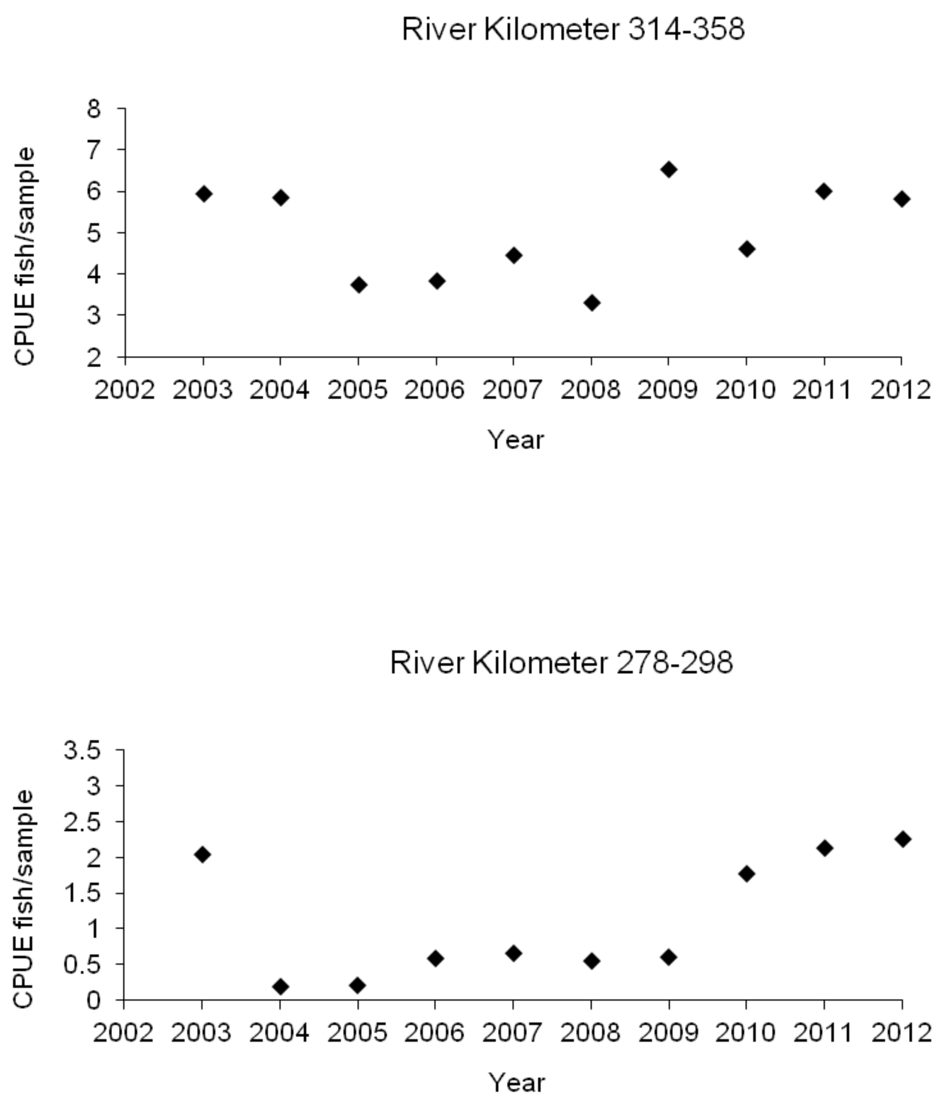

Figure 3. Estimated age percent composition of female and male American shad from the St. Johns River in 2012.