Atlantic States Marine Fisheries Commission

Shad & River Herring Management Board

February 7, 2012
10:45 a.m. – 12:45 p.m.
Alexandria, VA

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 *(M. Duval)*	10:45 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from November 10, 2011	10:45 a.m.
3.	Public Comment	10:50 a.m.
4.	Consider approval of Amendment 3 American Shad Sustainable Fishery Plans **Action** • Technical Committee Report *(L. Miller)*	10:55 a.m.
5.	Consider Approval of 2012 American shad bycatch request **Action** • Technical Committee Report *(L. Miller)*	11:05 a.m.
6.	Update on River Herring Bycatch Avoidance Project by the Sustainable Fisheries Coalition, School of Marine Science and Technology and Massachusetts Division of Marine Fisheries collaborative project *(D. Bethoney)*	11:10 a.m.
7.	Review and Discuss NEFMC Draft Amendment 5 *(L. Steele)* **Action**	11:40 a.m.
8.	Review and Discuss MAFMC Draft Amendment 14 Timeline *(K. Taylor)*	12:30 p.m.
9.	Election of Vice-Chair **Action**	12:40 p.m.
10.	Other Business/Adjourn	12:45 p.m.

The meeting will be held at the Crowne Plaza Hotel, 901 North Fairfax Street, Alexandria, Virginia; 703-683-6000

MEETING OVERVIEW

Shad & River Herring Management Board Meeting
February 7, 2012
10:45 a.m. – 12:45 p.m.
Alexandria, VA

Chair: Michelle Duval (NC) Assumed Chairmanship: 02/12	Technical Committee Chair: Larry Miller (USFWS)	Law Enforcement Committee Representative: Bridi/Thumm
Vice Chair: Vacant	Advisory Panel Chair: Pam Lyons Gromen	Previous Board Meeting: November 10, 2011
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 November 10, 2011

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. Shad Sustainable Fishing Plan Review (10:55 – 11:05 a.m.) Action

Background

- The Board approved Amendment 3 (American Shad) at the Winter 2010 Meeting. Under Amendment 3 states and jurisdictions were required to submit a sustainable fishing and recovery plans by August 1, 2011. Fisheries without an approved plan in place (with the exception of catch and release fisheries) are to close by January 1, 2013.
- At the 2011 Annual Meeting the Board approved plans from South Carolina and Florida.
- The following states or jurisdictions submitted fishing/recovery plans for American shad: Georgia, PRFC, Delaware River Cooperative, Massachusetts and New York. The following states or jurisdictions submitted American shad recovery plans: Maryland, Delaware, New Hampshire, DC and Pennsylvania. **(Briefing CD)**.
- The TC met to review the plans in January 2012.

Presentations

- Technical Committee Report by L. Miller

Board actions for consideration at this meeting

- Discuss and Consider Approval of American shad Sustainable FMPs

5. Review and Consider 2012 Shad Bycatch Request (11:05 – 11:10 a.m.) Action

Background

- The Potomac River Fisheries Commission requests an increase in their commercial by-catch allowance of American shad beginning in 2012. The restoration benchmark in the Potomac River, as set in the 2007 American Shad Stock Assessment, was exceeded for the first time in 2011. The request was preliminarily approved at the 2011 Annual Meeting, pending further revisions requested by the Technical Committee **(Briefing CD)**.

Presentations

- Technical Committee Report by L. Miller

Board actions for consideration at this meeting

- Approval of bycatch proposal from PRFC

6. Update on River Herring Bycatch Avoidance Project (11:10 - 11:40 a.m.)

Background

- In order to minimize unintended bycatch of river herring and shad (alosine) in the Atlantic herring and mackerel fisheries the Sustainable Fisheries Coalition (SFC) has partnered with the Massachusetts Division of Marine Fisheries (MA DMF) and the University of Massachusetts Dartmouth School of Marine Science and Technology (SMAST) to develop alosine bycatch avoidance methods. This collaboration seeks to develop (1) a predictive model of where alosines are likely to occur in space and time, (2) a real-time bycatch avoidance intra-fleet communication system, and (3) additional support for port sampling to inform the initiative.

Presentations

- Sustainable Fisheries Coalition, School of Marine Science and Technology and Massachusetts Division of Marine Fisheries collaborative project by D. Bethoney

7. Review and Discuss NEFMC Draft Amendment 5 (11:40 a.m. – 12:30 p.m.) Action

Background

- Amendment 5 management alternatives include options to mitigate and monitor shad and river herring bycatch in the Atlantic herring fishery **(Briefing CD).**
- The New England Fishery Management Council (NEFMC) is on schedule to submit a Draft Environmental Impact Statement to NMFS in late January/early February 2012 and the 45-day public comment period is likely to open in late February 2012.
- The Board will not meet during the public comment period for Amendment 5 if the current schedule holds.
- The most recent version of Amendment 5 is the September 2011 draft. NEFMC staff has indicated that the management measures will not change significantly from the September 2011 version. Accordingly, the Board can select preferred alternatives for ASMFC staff to compile and submit when the public comment period opens.

Presentations

- Draft Amendment 5 by L. Steele

Board actions for consideration at this meeting

- Select preferred alternatives on Draft Amendment 5 **Action**

8. Review and Discuss MAFMC Draft Amendment 14 Timeline (12:30 – 12:40 p.m.)

Background

- The Mid-Atlantic Fisheries Management Council approved a motion to address river herring bycatch in the Amendment 14 to the Mackerel, Squid and Butterfish (MSB) Fisheries at the MAFMC August 2009 Meeting. The Council approved the DEIS for Submission to NMFS with the preferred alternatives at the October 2011 Council Meeting. Public hearings are expected in Spring 2012, with final implementation in 2013.
- It is expected that the public comment period will fall within the ASMFC May 2012 Board meeting.

Presentations

- Update on Draft Amendment 14 timeline by K. Taylor

9. Election of Vice-Chair

10. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

SHAD AND RIVER HERRING MANAGEMENT BOARD

The Langham Hotel
Boston, Massachusetts
November 8, 2011

These minutes are draft and subject to approval by the Shad and River Herring Management Board.
The Board will review the minutes during its next meeting.

TABLE OF CONTENTS

INDEX OF MOTIONS

ATTENDANCE

Board Members

Terry Stockwell, ME, proxy for P. Keliher (AA)
Doug Grout, NH (AA)
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)
David Simpson, CT (AA)
Rep. Craig Miner, CT (LA)
Lance Stewart, CT (GA)
James Gilmore, NY (AA)
Byron Young, NY, proxy for Sen. Johnson (LA)
Pat Augustine, NY (GA)
Pete Himchak, NJ, proxy for D. Chanda (AA)
Tom Fote, NJ (GA)
Adam Nowalsky, NJ, proxy for Asm. Albano (LA)
Leroy Young, PA, proxy for J. Arway (AA)
Loren Lustig, PA (GA)
Rick Cole, DE, proxy for D Saveikis (AA)
Bernie Pankowski, DE, proxy for Sen. Venables (LA)
Roy Miller, DE (GA)
Tom O'Connell, MD (AA)
Russell Dize, MD, proxy for Sen. Colburn (LA)
Bill Goldsborough, MD (GA)
Steven Bowman, VA (AA)
Jack Travelstead, VA, Administrative Proxy
James Kellum, VA, proxy for Sen. Stuart (LA)
Catherine Davenport, VA (GA)
Michelle Duval, NC, proxy for L. Daniel (AA)
Bill Cole, NC (GA)
Ross Self, SC, proxy for R. Boyles (LA)
Malcolm Rhodes, SC (GA), Chair
Spud Woodward, GA (AA)
Aaron Podey, FL, proxy for J. McCawley, FL (AA)
Sen. Thad Altman, FL (LA)
Jaime Geiger, USFWS
A.C. Carpenter, PRFC
Steve Meyers, NMFS

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

Ex-Officio Members

Pam Lyons Gromen, Advisory Panel Chair
Wilson Laney, Technical Committee Chair

Staff

Vince O'Shea
Kate Taylor
Bob Beal
Chris Vonderweidt

Guests

The Shad and River Herring Management Board of the Atlantic States Marine Fisheries Commission convened in the Wilson Ballroom of the Langham Hotel, Boston, Massachusetts, November 10, 2011, and was called to order at 8:45 o'clock a.m. by Chairman Malcolm Rhodes.

CALL TO ORDER

CHAIRMAN MALCOLM RHODES: I'm Malcolm Rhodes. I'm chairman of the Shad and River Herring Management Board. I would like to call the meeting to order.

APPROVAL OF AGENDA

CHAIRMAN MALCOLM RHODES: We had previously sent out agendas and proceedings from our last meeting. Are there any changes to the agenda? Seeing none, any opposition to acceptance? Seeing none, we accept the agenda.

APPROVAL OF PROCEEDINGS

CHAIRMAN MALCOLM RHODES:You also received the minutes from the August 3, 2011, meeting. Were there any changes to that? Seeing none, any opposition to acceptable? Seeing none, we shall move forward.

PUBLIC COMMENT

CHAIRMAN MALCOLM RHODES:This is the time of the meeting where we have a space set aside for public comment for any issues that will not be discussed later. We had a sign-up sheet out front and there were no names that I saw on the sign-up sheet. Is there any comment from the public? Seeing none, we shall move on. The next item on the agenda is the Shad and River Herring Sustainable Fishery Management Plan Review. I'll turn it over to Wilson.

SHAD AND RIVER HERRING SUSTAINABLE FISHERY MANAGEMENT PLAN REVIEW

DR. WILSON LANEY: Mr. Chairman, I'm sitting in for Technical Committee Chairman Larry Miller this morning. With regard to the New York Plan, New York had requested a fishery in the Hudson River. Their target is less than the 25th percentile for young of year alewife and blueback surveys for three consecutive years. The technical committee recommendation is that the board consider approval of the plan.

There are a number of other shad sustainable fishing management plans from South Carolina, Florida, Georgia, Delaware Coopeative, Massachusetts, PRFC, Maryland, D.C, Pennsylvania, Delaware and New Hampshire, and we have received some of these and approved them previously, I believe, have not? We haven't on these.

Some of these we had some concerns with and we have requested additional information. Some of the rest of them we're going to recommend for approval along with New York. One of those is South Carolina. Their proposed regulations would close all the fisheries except for the Pee Dee, Waccamaw, Santee-Cooper, Edisto, Combahee, and Savannah River Fisheries. Their target is 75 percent of the annual mean of the catch-per-unit effort for recent years by river system. The TC recommendation is that the board considers approval of that plan as well as New York.

Florida is requesting status quo. They're using a spawning stock index and the TC recommendation is that board considers approval of that plan as well. There are other plans, again as I said, that were reviewed by the TC and we've requested additional information for those, and those are Georgia, the Delaware Cooperative, Massachusetts and PRFC.

We will be reviewing those plans as they are resubmitted along with Maryland, D.C., Pennsylvania, Delaware and New Hampshire and hope to get those done in the not too distant future, probably during January so that we have some more plans for action at your February board meeting. That's my report, Mr. Chairman.

CHAIRMAN RHODES: Thank you, Wilson. Any questions of Dr. Laney? Mr. Miller.

MR. ROY MILLER: Wilson, I was scanning through these and in the New York proposal for river herring there was something that troubled me that stood out. It was the fairly steady decline in the mean size at age of the river herring. Do you recall, Wilson, anyone on the technical committee noting that did that cause any concern?

DR. LANEY: Yes, we did note that, Roy, and that same change is evident coastwide. It's just something that we're keeping an eye on right now.

MR. MILLER: The only reason I bring it up is for someone to argue about sustainability in the face of that happening does make me concerned. Thank you.

CHAIRMAN RHODES: Any other discussion? Is there a motion for approval? Mr. Augustine.

MR. PATRICK AUGUSTINE: **Mr. Chairman, I move to approve – would name the states in the document?**

MS. KATE TAYLOR: New York, South Carolina and Florida.

MR. AUGUSTINE: New York, South Carolina and Florida be approved by the management board.

CHAIRMAN RHODES: Sustainable Fishery Plan.

MR. AUGUSTINE: Sustainable Fishery Plan; thank you, Mr. Chairman.

CHAIRMAN RHODES: Second by Mr. Adler. Any discussion? All right, the motion is to approve the Florida, South Carolina and New York's sustainable fishery plans. Motion by Mr. Augustine; second by Mr. Adler. Any further discussion? Any opposition? **Seeing none, we will move by consent**. The next order of business is Amendment 2 bycatch discussion by Kate.

MS. TAYLOR: At the technical committee meeting, the technical committee also reviewed what the sustainable fishing plan implement was going to be for 2012. At the last board meeting the board also had a question about what the state regulations would be for federal waters bycatch. The technical committee did compile a report on each state's implementation for Amendment 2 compliance as well as the federal bycatch provisions, what states might have for regulations.

Maine has an approved plan in place. There is a pending bycatch proposal for 2012. New Hampshire has the approved plan in place. Massachusetts had had a moratorium for river herring since 2005. They do have an exception for federally permitted vessels, which are allowed to land up to 5 percent by number of river herring per trip. Rhode Island has had a moratorium since 2006. Connecticut has had a moratorium since 2002. The New York Plan was just approved. New Jersey, there is a moratorium pending approval by the Marine Fisheries Commission and governor's office with a 5 percent bycatch allowance by weight from federally permitted vessels for river herring.

In Delaware the fishery will close in 2012. In Pennsylvania the fishery will close. Maryland will enact regulations for no possession with an exception for river herring originating from waters not under their jurisdiction. The PRFC has regulations prohibiting bycatch that they will be reviewing at their December 2nd meeting.

Virginia will have a no possession allowance of river herring. North Carolina and South Carolina both have had plans approved by this board, and in Florida there is no directed fishery for river herring.

CHAIRMAN RHODES: Any questions? Mr. O'Connell.

MR. THOMAS O'CONNELL: Just for a point of clarification to follow up, Maryland is going to be a no possession unless you have a documented sale from another state that allows harvest.

DR. MICHELLE DUVAL: Mr. Chairman, just to clarify, North Carolina has no possession unless our very limited four-day season is open, when is included in our plan.

MR. A.C. CARPENTER: Mr. Chairman, I expect at our December 2nd meeting the Potomac River Fisheries Commission will have a no possession total closure.

CHAIRMAN RHODES: Thank you for the information. Any further discussion? We will continue moving on. Kate is going to bring us up to speed on where the Mid-Atlantic and New England Council amendments are.

FEDERAL COUNCIL AMENDMENT UPDATES

MS. TAYLOR: First I will be reviewing the New England Fishery Management Council's Amendment 5 to the Atlantic Herring FMP. For those that were at the Atlantic Herring Section meeting on Monday, Lori Steele went into detail on the progress of that amendment. The very abridged version is that management options included in the amendment are covering trip notification, reporting requirements, catch monitoring, access to groundfish closed areas, and, of course, the river herring bycatch. The amendment was approved for finalization and submittal of the Draft EIS to NMFS. Their PRT will be working on finalizing that document.

For the Mid-Atlantic Council, their work on Amendment 14 to the Squid, Mackerel, Butterfish FMP is dealing with shad and river herring bycatch. The board has been briefed on this amendment at the October council meeting. The council voted to

remove options relating to mesh requirements and the requirements for sorting and weighing of dealers, and they added in an option for portside monitoring among a couple of other options that they finalized at that meeting.

The big issue that the board discussed in August was the stock-in-the-fishery designation. There were some questions around the flexibility in the ACL/AM requirements; specifically whether or not shad and river herring, if designated as a stock in the fishery would fall under that as a species there would be given flexibility to.

The FMAT discussion has found that similar plans for anadromous species designated as a stock in the fishery are not really applicable; and additionally discards are not addressed in ASMFC plans so the council would really not be able to defer responsibility to ASMFC in order to cap mortality. Shad and river herring, if designated as a stock in the fishery, would not be given the flexibility in the ACL/AM requirements.

This analysis is supported by NOAA General Counsel. Additionally, I would just like to point out if shad and river herring were designated as a stock in the fishery, council staff has determined that it would most likely not be able to occur within Amendment 14, and it would have to be addressed in a separate amendment.

Right now both the New England Council and the Mid-Atlantic Council have had their draft amendments approved for finalization and submittal of their Draft EIS. At this moment we do not have copies of those amendments. They will be worked on by council staff and their respective PRTs. Potentially we might have copies available prior to the February board meeting, but with the timeline that was included in your briefing material that may not occur.

Public hearings are most likely going to be held during February and March for the two amendments and potentially some overlap in concurrent meetings. Both councils are expecting to approve final management in April 2012 with the amendments effective January 1, 2013. And just to make the board aware, the Mid-Atlantic has sent a letter to the New England Council requesting inclusion of the mortality caps in Amendment 5. The board at the last meeting did send a letter to the council saying that they support inclusion of Alternative Sets 1 through 8 in the Amendment 14 document by the Mid-Atlantic Council, which included a catch cap alternative. Thank you, Mr. Chairman.

CHAIRMAN RHODES: Any questions? I think we have a good idea of where the timeline is. I believe this would be the point that we need to bring back a motion at the last meeting that was brought forward when we were sending a letter in regards to Amendment 14 with support of Alternatives 1 through 8 for the public hearing.

We did not comment upon Alternative Set 9, which was the stock in the fishery. At that point we were hoping to get more input from the councils and for the public input. Mr. Stockwell, you had made the original motion that was postponed to this time. Would you like to bring it up again or should we wait for the document to be released to the public?

MR. TERRY STOCKWELL: Mr. Chairman, I would be comfortable with waiting for the document to be released. The New England Council next week will be reviewing the letter from the Mid-Atlantic Council. I am assuming it will be included as part of Amendment 5, and we will be moving forward with our public hearings, Doug, sometime early this winter; is that correct?

MR. DOUGLAS GROUT: I believe Lori was saying March.

CHAIRMAN RHODES: All right, is any further discussion to that point? Dr. Duval.

DR. DUVAL: Mr. Chairman, I'm comfortable with that as well. I was the one who said that I wanted to see a NOAA General Counsel assessment of the flexibility that would or would not be afforded with the designation of stocks in the fishery. Now that that initial analysis that flexibility would not be allowed and likely a separate amendment would be required in order to move forward with stocks in the fishery, if that was what was chosen, I'm happy waiting until the complete document is put together and there is a little bit further analysis by the staff in terms of if that was chosen, how that would move forward, so I'd rather wait for that. Thank you.

CHAIRMAN RHODES: Thank you. Steve.

MR. STEVE MEYERS: Mr. Chairman, since this is a letter to a council, I, of course, will have to abstain until, of course, within the council process the recommendation goes to the secretary for approval.

MR. JEFF KAELIN: Mr. Chairman, I'm Jeff Kaelin with Lund's Fisheries. The reason why I came to the microphone during this discussion is that one of the key elements of both of these plan amendments we think is the bycatch avoidance program that we have rolled out within the last year at SMAS, similar to what we're doing in the scallop fishery to identify hotspots on the water in real time.

At the last Mid-Atlantic Council meeting, Dave Bethany who works for SMAS, came to the council and made a presentation about that project, which I believe the council members thought was very helpful in understanding how this kind of a project would work. We think it works better than closures would. Anyway, what I'm putting on the table today, Mr. Chairman, is we've tried to figure out how someone from SMAS could come before the board to kind of describe this project, and it looks like perhaps there would be time on your agenda in February to do that.

We have been told that the people from SMAS have to talk to Dr. Miller and the technical committee before they get a chance to come before you, but we've been talking about this for some months, and we'd love to be able to have an opportunity to get them on your agenda for February, Mr. Chairman.

CHAIRMAN RHODES: Great, thank you very much, and we can work with staff to try and make that occur.

MR. KAELIN: Thank you; I think you'd find it interesting.

CHAIRMAN RHODES: All right, so at this point this means we're waiting for the public information document for Amendment 5 and Amendment 14 to go out. Hopefully, they will be released by the February meeting, at which point as a board we can make a comment on it. If it occurs after that point, we're going to have to come up probably at the February meeting with some way to review the document and comment upon it as a management board. That's just this timetable whether it occurs before or after February, but we'll have to discuss that occurrence at the February meeting if the plan has not been released at that point. At this point we were asked to consider bycatch proposals and we're going to go through by state. Bob.

REVIEW AND CONSIDERATION OF 2012 SHAD AND RIVER HERRING BYCATCH PROPOSALS

MR. ROBERT E. BEAL: Real quickly before the board moves away from Amendments 5 and 14, the New England Council is going to be meeting next week, and there is a recommendation from the Mid-Atlantic Council to put catch caps back into the New England Amendment 5 Document. This board has commented to the Mid-Atlantic Council that they're comfortable with river herring bycatch caps going out for public comment. If the New England Council were to ask the commission is there a position on reinserting catch caps into Amendment 5, is there a position of this board that can be conveyed to the New England Council, or what is the position of this board regarding the Mid-Atlantic Council's recommendation?

CHAIRMAN RHODES: Does anyone have any comment? Dr. Duval.

DR. DUVAL: Mr. Chairman, I think if we were supportive of a bycatch mortality cap going out in the Mid-Atlantic Council's document, I don't see why we would not be supportive of the same measure going out for public comment in the New England Council's document.

CHAIRMAN RHODES: That would be my feel that it would be the consistency of this board to like public comment both ways. Mr. Gibson.

MR. GIBSON: Generally I agree with that position, but I would like to know what the technical committee's position is right now on the ability to specify meaningful catch caps from a stock status standpoint?

DR. LANEY: Mark, we really haven't discussed that with any great degree of specificity. I had a conversation with Jason Didden from the Mid-Atlantic Council about that issue last week because we were looking at – well, Jason and I had a general discussion, again absent from the rest of the technical committee, about the problem with river herring catches at sea.

We were talking about area and season closures and doing so in view of the new maps that they have prepared – at least they were new to me – that showed that river herring distribution is rather widespread. It doesn't appear to be; but based on the information they have analyzed, it concentrated to the

extent that some sort of area-over-season closure would be as effective possibly as a cap.

That's the extent of the conversation I've had with the Mid-Atlantic Council staff about that issue. The technical committee hasn't really discussed it as a TC, so that's something we would have to consider I think at our next meeting in January. To answer your question, we haven't discussed it yet.

MR. GROUT: I would like to give the commission sort of an overview of the dilemma that the two councils are dealing with right here. Our scientific bodies and the PDTs are at odds with each other on this issue. We have the Mid-Atlantic Council's PDT saying that area management, which is what the New England Council is proposing, is not feasible and that a catch cap is more feasible.

The New England Council's PDT is telling us that area management is more suitable because we're not at the point where we can do a coast-wide catch cap. Clearly, I think from my personal perspective I don't have a problem with it going out for public comment, but I think we're dealing with opposing scientists right here so it's making it very difficult to come up with something that will be uniform for an industry that's essentially the same industry here. That's sort of an overview of where we're at with this. It's not a clear shot, easy thing to do right now.

DR. LANEY: Thanks, Doug, for that additional explanation. What I might suggest to Kate is maybe at the January meeting of the technical committee if we could get some representation from both of those PDTs to come and discuss it with us, that would be greatly appreciated. Maybe we can sort through it all and come to some sort of a consensus or maybe not, who knows.

At least it seems to me in the interest of furthering the commission's desire to more closely coordinate with both of those councils, that would be a good thing is to get all the scientists together in the same room at least so we can have a thorough discussion of the issue and have everybody on the same page with regard to what data they're looking at and how they're interpreting them.

MR. AUGUSTINE: Mr. Chairman, please recall that the Regional Administrator will have final say so with her department in evaluating either one of those, either the New England and the Mid-Atlantic. I'm sure the way the regional office has worked in the past, Ms. Kurkul's staff has been very diligent in making sure there are a limited number of real problems where it would affect either of the councils.

I think not supporting the Mid-Atlantic by ASMFC would be foolhardy. I think we have supported it along the way. Dr. Duval was very clear on that, and I would support that totally. Secondly, again, let's get the reaction from the public, let's determine what their drive and concerns are from the various sectors' aspects, and then move forward with that result. Please be aware that the Regional Administrator's Office will be very, very clear in what they will accept and what they will allow to happen. Thank you, Mr. Chairman.

CHAIRMAN RHODES: Thank you for that discussion. Mr. O'Shea.

EXECUTIVE DIRECTOR JOHN V. O'SHEA: One of the discussions, for the information of this full board, at the Mid-Atlantic Council the point is made that the work that they're doing, a good part of the provisions is to include the monitoring of the bycatch and try to get a better handle on that.

It's going to take a number of years both for this amendment process to go forward as well as that monitoring, so the issue that the councils are sort of wrestling with – at least the Mid-Atlantic – is do they want an option in there that should there be all this information about – from the technical committees about bycatch information; do they want to retain the management option within the document so should, for example, that information become available that a cap is appropriate, that they have the mechanism to react to that quickly. That's the other part of the debate that's going on here. I'm not recommending one way or the other, but that has been some of response to this concern of lack of ability of the technical committee to resolve this. Thank you.

CHAIRMAN RHODES: I think it's great that we are actually providing a forum where three different bodies are deliberating species of similar concern. In the long run the resource is going to be what we're all aiming at, so it's good that we can hash out a lot of these difficulties and problems early on in development of a plan, so it's a great forum for it.

DR. LANEY: Mr. Chairman, in further response to Roy's question earlier about the size, Roy, I looked in my detailed notes from that meeting, and we did have a discussion of that. I had asked Kathy Hattala from New York whether that annual mean total length decrease was due to the older age classes dropping out of the age structure – and I presume that's your

concern as well – and Kathy responded that was the presumed cause.

I understand your comment about it difficult to maintain sustainability if you're not maintaining that age structure. I think the intent for the states in coming up with these sustainability plans was hopefully to set the mortality targets or the harvest targets, whichever target they choose, low enough to allow that age structure to rebuild, but it's all tied in pursuant to the discussion we just had about the offshore catch.

One thing I'm not sure about – and maybe Kate can help me remember – is whether or not in those monitoring programs they're getting age data on the composition of the river herring bycatch from the ocean. That might shed some additional light on how we're doing in terms of rebuilding that age structure.

I don't know, but that again is another discussion that I think we need to have with the two council PDTs is in addition to what the states are doing in-river; is there any way that – aside from areas or catches, is there any evident distribution of older fish versus younger fish in the ocean because that needs to enter into the discussion as well in terms of trying to rebuild the age structure of the stocks.

CHAIRMAN RHODES: Any further discussion on that point? Seeing none, we have received three requests for some shad and river herring bycatch proposals for 2012 from the state of Maine, the Commonwealth of Virginia and the Potomac River Fisheries Commission. Mr. Stockwell, I'll start with the state of Maine.

MR. STOCKWELL: Mr. Chairman, I will be brief. The state of Maine is requesting a one-year research exemption in order to conduct river herring bycatch experiments with a limited number of floating fish traps and weirs. This experiment was scheduled to have been performed this year and incorporated into our sustainable management plan but was delayed due to funding problems. We have funding in the protocols and are available if so approved for this next year. In the meantime the state of Maine is moving ahead with rulemaking to implement the full provisions of Amendment 2 and we will be in full compliance probably within 90 days.

CHAIRMAN RHODES: Thank you very much, Mr. Stockwell. Wilson, the technical committee reviewed this request?

DR. LANEY: Yes, sir, that is correct, Mr. Chairman. The TC recommends the board consider approval of the proposal for 2012 and allow the harvest of river herring and the final use of the fish, whether to sell those or not to sell, is up to the state.

CHAIRMAN RHODES: Thank you very much. Mr. Travelstead, the Commonwealth of Virginia had a request also.

MR. JACK TRAVELSTEAD: Mr. Chairman, this is Virginia's seventh annual request for a small bycatch fishery up on our spawning grounds, which has previously been approved by the board. There is a comparison of each one of those years in our report. Last year we caught a total of 131 shad. The number of permittees in this process continues to decline for a number of reasons, one which is just simply the aging of the fishermen and they're just moving on to other things. I'll be glad to answer any questions if there are any.

I think the one concern that we have, almost all of these fish that are now taken under this permitted process end up as biological samples at VIMS and are used to monitor the stocks. With the pending moratorium, this may be the last year that we allow this bycatch fishery, but that's going to pose some problems for us because of how else do we collect these biological samples in the face of a total moratorium. It's going to get a little bit more difficult. If you need a motion to approve, I'll be glad to offer one.

CHAIRMAN RHODES: We're going to review all three. Mr. Adler.

MR. WILLIAM A. ADLER: Mr. Chairman, may I go back to Maine just for a minute on their proposal. I'm not against the proposal but it seems to me I remember that unless you had a sustainable plan you were supposed to close the fishery. The wording in your document here says that there is no way you can come up with that type of a result, according to this. I'm not clear as to are you therefore saying that you want to do an experiment for a while instead of a closure; is that what you're doing?

MR. STOCKWELL: I'll be glad to answer your question, Bill. No, the state is moving ahead with full APA rulemaking to close the directed river herring fishing and possession and landing. However, there has been a request from actually six to eight different small floating fish traps and weirs that would like to continue fishing if possible.

Our staff has been working with them on a number of bycatch reduction models and methods that look very promising. We haven't been able to finish the data collection to in fact prove to ourselves that they are doing the job, and so we're proposing for the exemption to allow the research to continue and then come back to the board a year from now and request whether or not to incorporate them into our sustainable management plan.

MR. ADLER: All right, if I may, Mr. Chairman, so therefore the experiment will be to determine whether you can come up with a sustainable fishery plan which would allow you to keep going, right?

MR. STOCKWELL: Correct and let's remember part of our sustainable plan is based around our municipal river fisheries. That part the board has previously approved. This is outside of the purview of the municipal management and would be a handful of floating fish traps and weirs.

DR. LANEY: And just to follow up to, too, is that other states are also interested in the methodology that Maine is using here and whether or not it might be a viable approach to monitoring as well.

MR. THOMAS FOTE: How long do we have to do the experiments to find out if it is sustainable or not, because one of the things I have always worried about in New Jersey is that it would take us two or three years of information to prove – you know, you can't do it with one-year snapshot, so how many years will be able to do it before you prove that the runs are sustainable?

MR. STOCKWELL: We're asking for a one-year exemption. The work is underway at this point. It's simply a matter of monitoring the escape panels that will allow for the passing of the fish. It has shown promise. We haven't been able to document the results, and the intent is to run through next year's fishery, which is in the spring of the year, in order to populate the data to present to the TC for review.

MR. FOTE: Can I follow up"

CHAIRMAN RHODES: Well, just a second. Just to be clear about this, this is actually – to use our southern terminology, this is a BRD experiment and they're going to be catching fully utilized weirs and then ones that have different methods to try and redirect the fish or have escape panels, and so it's looking at the difference – I guess a match set essentially – and see the percent escapement using a bycatch reduction device. Mr. Fote.

MR. FOTE: What do they usually catch as the directed fishery?

MR. STOCKWELL: They direct at mackerel primarily. River herring has been a bycatch that this fishery has every spring. It's a year-round fishery but limited by season. An important part, too, as a bait supply to both recreational and commercial fisheries is an important component of some of our coastal communities, and it's certainly from our perspective well worth the experiment to see whether or not we can sustain this fishery. As Wilson said, it's a bycatch reduction effort that we will happily share with all the other states and jurisdictions on whether it works out or not.

CHAIRMAN RHODES: Thank you very much. Any other questions about that? Otherwise, the technical report on the Virginia Proposal.

DR. LANEY: The TC recommends approval of the request. As Mr. Travelstead said, it is the same request as previous years, and our understanding is the same as his, that it would most likely be the last year requesting this limited bycatch fishery.

CHAIRMAN RHODES: Thank you very much, and, Mr. Carpenter, there was a request by the Potomac River Fisheries Commission, also.

MR. CARPENTER: Could we receive the technical committee's report first and then I'll explain.

DR. LANEY: PRFC was seeking a slight increase in the discard take from one bushel to two bushels to convert dead discards to harvest and eliminate waste. That doesn't sound like a whole lot, I grant you, but the technical committee doesn't feel comfortable recommending expansion of the bycatch allowance in 2012 because the benchmark has been met for only one year.

Aside from that, we did have an extensive discussion about the fact that most of the jurisdictions that are dealing with more than one other jurisdiction have come into us with a plan that rolls all of the information into one, basically, so our concern went beyond just the increase. I'm looking at my detailed notes here. The average had only just gone above the benchmark. It hasn't been above that level consistently at all. The TC felt that it was premature to take management action based on just that one data point.

There is other information that we would like to know in association with the Potomac River fishery;

for example, why the juvenile abundance index is decreasing. Ellen Cosby was the PRFC representative at the meeting. We didn't feel that the information they provided was inadequate; it was just incomplete. We know that, for example, Maryland and Virginia have additional information that could be shared with PRFC to develop a complete picture of the PRFC fishery. That was the biggest reason that we felt uncomfortable acceding to the request.

MR. CARPENTER: We submitted a plan to increase the bycatch because we have met the restored status target that was established in the 2007 stock assessment. If you look at the data – and I'll be glad to pass these around. There is enough for everyone, but there should be enough for at least one per state – there is a graph of the target. It's mostly a pictorial thing. In the 2007 stock assessment we established a restoration target of 31.1 as a CPUE of the pound net catch.

Given that we have a restricted harvest, and it was clear in the 2007 stock assessment document that we would be using a combination of harvest and discard information to determine the comparable number to the 1940's and fifties, if you will look at the green section of that graph that is coming around, we have been approaching this target every year incrementally since 2002, and we have been reporting that increase every year to the point that in 2011 we have actually gone over it.

This is a geometric mean, this is not a simple average, and I'd like to call attention to the fact that in eight of the last nine years the actual number has been well above the target, so we have had steady progress toward this. This is a question of establishing a target and meeting the target. We have met the target.

Some of the questions about the juvenile index, you'll notice that the 2010 index was low; yes, it was, but at the time that we submitted the proposal to the technical committee the 2011 data was not available. That has included on that graph now to show you that both the Maryland index and the District of Columbia index have rebounded in 2011, so I don't that's an issue of major concern.

The long-term average young-of-the-year index for Maryland is still well above what we had seen in the 1960's, so there have been a number of improvements there. With regard to the development of a basin-wide plan, that was submitted in the 2007 stock assessment and reviewed and considered to be sufficient. There were questions raised about the biological data from the brood stock.

We have a number of people dipping fish out of the Potomac for hatchery production to be used in numerous other places. Maryland, Virginia, Pennsylvania, Delaware as well as the Fish and Wildlife Service are all dipping fish out. Part of their permit to take the fish to begin with involves returning 10 percent of the fry that are produced from those fish to the river as part of our continuing stocking efforts. We do collect the biological data from them, and we viewed that information as more a case of needing to be done in the case of a new stock assessment.

We're not asking to do a new stock assessment; we weren't expecting to do a new stock assessment. We were expecting to expand the bycatch fishery.

Our fishery is limited entry so there will be no new additional entrants into the fishery. With that, I will be glad to entertain any questions, but I don't think this was as much a scientific technical committee question. We have met the scientific and technical committee's definition of exceeding the target. I really think that it's a question of trying to change the rules after the rules have been established.

DR. LANEY: Well, just to point out that when the technical committee looked at it, the standard that we used or the calculation that we used is the geometric mean as opposed to the actual index, and the geometric mean had exceeded the target in only the last year. That is good news about the JAI going up. There were other concerns.

I guess the bottom-line concern was after a pretty thorough discussion was that there were additional data that we felt could be employed in the PRFC analysis. The technical committee just wasn't comfortable seeing a doubling of the bycatch based on that one year of having met the target given the risk and uncertainty involved. That's the bottom line.

We definitely don't want to kill off the fishery. Our intent is to restore the fishery. Again, we just had a sufficient number of reservations that we felt additional information and data analysis were needed. We were assured by the Maryland and Virginia folks that were present on the TC that those data were available and they'd be happy to share them with the Potomac River Fisheries Commission.

MR. THOMAS O'CONNELL: Maybe a question for Mr. Carpenter or Mr. Laney; I was informed that the

number of net days has decreased significantly from through the early 2000's to recently from somewhere in the 400 net day range to currently less than a hundred. I'm just curious if it's the prime nets that still remain today; could that have been artificially inflating the geometric mean of the pounds per net day. I'm just trying to see if there was any discussion about that.

DR. LANEY: I don't know that we had that discussion, Tom. I'm not sure that information was presented to us during the meeting. We'd have to go back and look at that.

MR. CARPENTER: I will note that Tom's observation is correct, but this has more to do with the cost of the gear, and it's a declining fishery. There are fewer people fishing fewer nets today than we have had in the past. The nets are still located in the same general area of where they always have been. We have lost the upper river nets, the nets above the 301 Bridge. There is no one fishing up there anymore.

We had done an analysis of their catch versus the lower river catch when we did have both sets of nets going and there was correlation between the two. I think that these nets are as representative today as what was occurring back in the 2000's and very closely associated with those that were being set in the 1940's.

DR. DUVAL: I was just looking at the proposal. A.C., you collect discard information on a weekly basis, it looks like, just the amount of discard as well as why they were discarded?

MR. CARPENTER: Yes, our reporting form, it's a daily logsheet that is submitted on a weekly basis and it does include bycatch information or discard information. They are requested to provide that by the reason it was discarded, season closed, it was either too small or too large, no market for it. We do have some information on that as well and that is submitted weekly.

DR. DUVAL: A followup; I was impressed by that level of discard information personally. I'm not sure how many other states around the table have that level of discard reporting. A.C., it would be your intent that if this were to move forward and that geometric mean fell below the target, you would be able to quickly reinstitute a one-bushel bycatch limit again and go back down to that?

MR. CARPENTER: Yes, that was part of our plan. It was stated in there that if the geometric mean fell below the target, we would automatically revert to the one bushel the following year, so that there is no chance that we'll overfish this fishery. But if you look at the discards and the harvest, I think one of the outcomes of allowing additional harvest is you'll actually get a little bit better estimate of the total combined, because now we'll have additional weight-outs as opposed to estimated discards.

MR. TRAVELSTEAD: Wilson, can you be more specific about the data the technical committee wanted to see from Virginia and Maryland; and are you suggesting that if you got that data, the technical committee could change their opinion on this?

DR. LANEY: Jack, I'm not sure that I have in my notes the specific data that were discussed. There was an indication that Maryland and Virginia had additional data that they were willing to share with the Potomac River. Kate, do you recall exactly what those discussions were?

MS. TAYLOR: No.

DR. LANEY: So, I'd have to go back and ask. The other thing that I did run across that we had discussed was whether or not it might be possible for PRFC to calculate a Z-30 benchmark for the stock, and there was discussion of that. I think the outcome of that was that while the data may be there that would allow them to do that, it wasn't possible for them to do that before this board meeting. That's one other thing that we discussed.

I don't know whether that would make a difference in the technical committee's feelings with regard to the bycatch. I think there was just a lot of concern that with the target having been exceeded in one year, that we just didn't feel comfortable of seeing a potential doubling of the bycatch allowance given the risk and uncertainty associated with one year.

MR. FOTE: This is a shared river system between Virginia, Maryland and Washington, D.C. Really before I'd like to vote to this, I would like to know what their feelings are on this because I guess for the most part you've shut down most of your fisheries on the river. I just would like to know their feeling on this.

CHAIRMAN RHODES: Does either state care to comment at this point? Mr. Grout.

MR. GROUT: Mr. Chair, I have a question for both A.C. and the technical committee. A.C., this is a pound net fishery, correct?

MR. CARPENTER: It is a pound net fishery. In 2004 we did approach the technical committee and were granted the ability to expand the bycatch to our gill net fishery. Again, the primary part of that was the fact that we were encountering some shad as the stock was rebuilding and we were encountering it in the gill net fishery as well.

The gill net bycatch is very minimal, and it is for the fact that our gill net season ends on March 25th. Most of the shad do come up the river after that. If you look at the report that we had, we have not had any discard mortality in the gill net fishery since 2009. In 2011 there was a zero gill net harvest of fish. In 2010 it was 31 pounds; in 2009 it was 209 pounds.

The year before that it was 160 pounds. It's a relatively minor encounter, so it is predominantly the pound net catch. The pound net catch this past year was 2,000 pounds; the year before it was almost 4,000 pounds. The year before that it 19,000 pounds. That gives you an idea of the scale of the two.

MR. GROUT: Of the pound net catch, which is the predominant fishery that you're talking about for doubling the bycatch allowance, are the fish that are discarded out of the pound nets dead or alive or is there some mixture? Do you have any idea of what the mortality rate is on that?

MR. CARPENTER: It is some mixture but I don't have the – we don't ask them about the mortality as part of the discard reporting. I'm assuming that there is a higher release rate in the pound net than there is in the gill net. The gill net is virtually all dead, but there is some possibility of some live being released.

MR. GROUT: And then my question for Wilson was just so I'm clear, there seems to be two concerns that I hear that the technical committee had. One, they're not comfortable with it exceeding the trigger – the restoration benchmark by just one year, so you're looking to see it happen two or three years before the technical committee would be comfortable approving that, that plus you wanted additional information to be brought forward. The specific information; have you relayed that specific information to their technical committee representative so they know exactly what you need for consideration. There are two questions.

DR. LANEY: Yes, Doug, that is correct. The technical committee didn't specify a number of years, but I think it's safe to say that they would be more comfortable with having seen several years in succession where the target was exceeded. And, yes, we did specify to Ellen exactly what we were looking for.

Again, to Tom Fote's point, I think given that it's a multi-jurisdictional stock that's running up the Potomac River, we just wanted to see the whole picture, a comprehensive picture. And then to your previous discussion and your question about the pound net fish, we asked that question. As A.C. pointed out, the bycatch is predominantly from the pound nets, and we did ask if those fish were alive, and Ellen Cosby did indicate to us that – well, she and Harry actually indicated that there are two different methods used for emptying the pound nets.

In those cases where the fishermen are hand-dipping their nets, there is no reason that those fish can't be released alive because they usually are alive. Others apparently use hydraulic gear to dump all the fish on the deck, and the latter method usually results in the death of far more fish, and so the indication was that is where probably a majority of these fish are coming from. Now, as to what proportion of the fishermen were hand-dipping versus hydraulic pumping, that information wasn't provided to us, but it did seem to us – again, taking concern for the stock into account – that there was an opportunity here maybe to release more of these fish alive. If you allow a doubling of the bycatch, then the likelihood is that maybe more of those fish would be retained instead of being released.

MR. GROUT: What I think would be helpful in cases like this where you have a trigger that has been met and the technical committee isn't comfortable with making a positive recommendation on this because it has only been one year, that the technical committee should as a body come to some kind of conclusion under how many years they would be comfortable with, so that a state is aware of what the standard is that they have to meet instead of just saying, well, we're not comfortable with one year. That sort of leaves it open. They could be three, four or five years and don't know it, so it would be helpful if the technical committee, when they make such a recommendation, that they come up with more specifics; we want three years or we want at least two years.

CHAIRMAN RHODES: Thank you. We had had a previous question and, Mr. Travelstead.

MR. TRAVELSTEAD: Mr. Chairman, in response to New Jersey's question, I would say that it is my understanding that the Potomac River Fishery Commission authorized Mr. Carpenter to prepare this proposal and present it to the technical committee and the board for your consideration; but I think in doing so, they also placed great deference on the opinion of the technical committee on whether or not it would stand up for review. That's all I would say at this point.

MR. AUGUSTINE: Mr. Carpenter was very forthright in talking about this mortality rate, and then the question was asked where does the highest mortality seem to occur. It sounded to me as though it was the hydraulic method of removing fish. Our familiarity with the weir fishery, you can literally let them all go unless you leave them in there forever and something drastic happens with water quality changes and that sort of thing.

Is there any way to control the method of hydraulically removing the fish? I don't have a clue as to how many millions or hundreds of pounds that we're talking about of other species such as mackerel at the same time we have the intermix of herring in that. I don't know if Mr. Carpenter can enlighten us on that.

It just seems to me that without further information that the technical committee said maybe A.C. could present in looking at the Maryland data; I would almost move to preliminarily approve their request based on any further information between now and whatever the date is that Mr. Carpenter could present to the technical committee.

We've got the most of the information on the table. We do have bycatch; he wants to go from one bushel to two bushel. We know the method that appears to be killing and creating bycatch and sometimes bycatch is worth the money because here in New York they're worth two or three dollars a piece. I just wonder if Mr. Carpenter might want to address that. Do they have any intention of trying to review more data or gather more data? Does the technical committee really feel they have the wherewithal to change their opinion and their recommendation or is it as it stands now? We are where we are and the Potomac River Group is not going to be approved by them, so I think we have two or three questions that we have to get answered before we move forward. Thank you, Mr. Chairman.

MR. CARPENTER: There have been a lot of questions. With regard to meeting the criteria for one year, let me read some numbers. They were submitted with the plan to the technical committee. The 2011 number was 32; the 2010 was 30.2; the 2009 was 28.1; the 2008 was 23.8; 2007 was 21.3. There has been clear, demonstrated pattern of increasing geometric means increasing every year.

When we are asking the technical committee how long or how many years do you have to be above the target, that is an issue that I think truly has to be set by this board. Either you have a target and you meet it or you have a target that you have to meet for three, four or five years before you can do anything.

There is nothing in the plan that I'm aware of where it says that we have to have three years running, two years running or twelve years running before you can do anything. I don't that that is technical committee decision. The information; if we are going to be asked to go back, I would request that the request for information be put in writing because the technical person that we sent came back with a request for information about the brood stock biological data that they have available, and, yes, we do collect and maintain that.

We do it for the basin-wide and it was done for the 2007 stock assessment; that all of that information was pulled together. We were not prepared to do another complete stock assessment when the target had been established and met. One of the other sources of mortality that we can certainly control is to stop all of the fish-dipping from the hatcheries.

That's a significant number of fish that are taken, and these are ripe fish on the spawning grounds. If controlling mortality is the total picture here, there is an option that I think the commission could consider. I wouldn't recommend it to the commission because we feel that everybody has come to the Potomac to dip fish because there are fish there.

Sharing the wealth has been part of our goal here in providing this brood stock to other areas that need it. We have never argued against it or we have not put any limits on it. We do require them to provide us some basic biological data of their harvest. We have seen in that data returning shad, multiple spawning returns that they're running, so we can provide that information.

It's just that I didn't feel it was necessary or mandated that when you have an established, approved target that you have been on a trajectory for the last ten years restoring the stock, that was necessary. I will leave it at that and see if we can't

come to some conclusion here. I don't want to hold everybody up all day.

DR. LANEY: Well, just one additional point that I again have discovered in my notes here as I'm going through is that the U.S. Fish and Wildlife Service, Maryland Fishery Resources Office, actually provides an annual report on their activities and it contains a lot of information on the American shad removed from the Potomac River, including a catch-per-unit effort index. Larry Miller, who I'm sitting in for today, was going to provide that information to Ellen as well in terms of trying to develop a more comprehensive picture of the Potomac River stock, and hopefully he did so. That was another piece of information that we didn't have available to us when we considered the PRFC request.

MR. CARPENTER: Yes, and we have not gotten that as yet as far as I know; and under the conditions of the permit, I don't think they're actually required until the end of the year to submit that information. But, again, that information up through 2007 was included as part of the 2007 stock assessment. All of that information is there; it is being compiled, but I didn't see a need to have a complete stock assessment. If the plan had said that you need to have a complete stock assessment prior to asking for any additional fish, we could have complied with that. We would have complied with that, but the plan doesn't say that.

MR. AUGUSTINE: Point of information, Mr. Chairman; in response I didn't have an opportunity to respond to what Dr. Laney had said. But based on what Mr. Carpenter has said and what Dr. Laney has said, I think we're in a dead circle here. If the motion is made to accept all three of these, we're going to continue to banter back and forth.

At this moment, before we go any further with further debate, I would move to divide the question and consider that the 2012 shad and river herring bycatch proposals of Maine and Virginia be approved, and that I would make a second motion that we would address consideration of the 2012 shad and river herring bycatch proposal for the Potomac River – but that is the point, Mr. Chairman, at least to deal with the first motion.

MR. BEAL: Well, I think the first problem is you can't make a motion to divide a motion until you have a motion on the floor.

MR. AUGUSTINE: To that point, Mr. Beal, I move –

MR. BEAL: I think, Pat, if you made a motion to approve some subset of these three proposals, that might be a starting point.

MR. AUGUSTINE: That sounds good; it sure got everybody's attention; didn't it? Okay, this will be an original **motion; move to support the Maine and Commonwealth of Virginia proposals for shad and river herring for 2012**.

CHAIRMAN RHODES: Second by Mr. Adler. Any discussion? All right, in favor please signify by raising your right hand; all opposed same sign; null; abstentions. All right, the motion which is move to approve the 2012 Shad and River Herring Bycatch Proposals from Maine and Virginia, made by Mr. Augustine and seconded by Mr. Adler, **passed eighteen** to zero. Now is there a second motion? Mr. Augustine.

MR. AUGUSTINE: **I move that the board preliminarily approve the Potomac River Fisheries Commission Proposal for 2012 Shad and River Herring Bycatch with the understanding that a final review of information supplied by the Potomac River Fisheries Commission meet the requirements of the technical committee.** Please wordsmith if you would like. Thank you.

CHAIRMAN RHODES: And there is a second by Mr. Adler. Mr. White.

MR. R. WHITE: Mr. Chairman, a question to A.C.; I assume this fishery is in the spring?

MR. CARPENTER: It starts in March.

MR. R. WHITE: So, is our February meeting, if it was approved at that point, would that be too late for you to implement?

MR. CARPENTER: The commission meets in December and we'll be setting the rules for 2012 at that time, so I don't see this motion much more than a motion to disapprove the plan.

MR. R. WHITE: If I may, Mr. Chairman, so if there was the ability to pass this in February, you would have no ability to implement it for the March fishery?

MR. CARPENTER: It would require emergency action, and I don't think liberalizing a fishery under our definition of emergency would meet that criteria, so I don't believe that we could get it done for 2012.

MR. O'CONNELL: A question for Mr. Carpenter, and I probably should know the answer because I serve on the Potomac River Fisheries Commission, but what is the possibility that the Potomac River Fisheries Commission at their December meeting could take action pending final action by this board in February; basically set the table, absent another meeting of the Potomac River Fisheries Commission, but giving you the direction to follow through with a regulation if this gets decided upon at the February meeting?

MR. CARPENTER: We have a legal officer who should be answering that, but I think that's something that we could consider, yes, if this were to be approved. I'd like to perfect that motion or amend the motion, if I could, to specify that the requirements of the TC be provided to the commission in writing so that I know exactly what it is that they want and that we would be able to comply with that.

MR. AUGUSTINE: Can we wordsmith it and include that, please, Mr. Chairman.

CHAIRMAN RHODES: So that's accepted as a friendly amendment?

MR. AUGUSTINE: Totally accepted; thank you.

DR. JAIME GEIGER: Mr. Chairman, I'm very comfortable with this amendment and I suggest we call the question. Thank you.

CHAIRMAN RHODES: That being said, do the states need to caucus? Mr. Adler.

MR. ADLER: If I could just ask A.C. a question; A.C., are you comfortable with this, that you can – in fact, this gives you the opportunity to move forward if you get that information; does that help you?

MR. R. WHITE: Mr. Chairman, point of order. I believe there was a friendly amendment proposed to that motion and I don't believe one member can just stop that from going forward.

MR. AUGUSTINE: Mr. Chairman, we agreed to it, both the maker of the motion and the seconder, not as a friendly amendment but as an addition to rather than going through the separate process of amendment, whatever. This is totally appropriate and meets the requirement. It's totally acceptable, Mr. White, and I think it clarifies what we're trying to accomplish here. It gives the Potomac River Commission the latitude to move forward with the information. And in a formal way with a letter in writing, it verifies and validates that we now have a date and time certain.

MR. R. WHITE: So the friendly amendment was accepted, then?

CHAIRMAN RHODES: Correct, by the motioner and the seconder.

MR. ADLER: Mr. Chairman, did A.C. answer my question before Ritchie came in?

MR. CARPENTER: I was waiting for the chairman to recognize me before I answered your question. As I answered Tom, I'll have to talk with our legal officer about a preliminary approval at one meeting subject to action by the ASMFC in February.

I don't know whether this will solve our problem or not, but it seems to be the way that the majority of the people around here believe that we need to progress. The other option is that it will be 2013 before we can do anything.

CHAIRMAN RHODES: The motion before the board right now is move that the board preliminarily approve the PRFC 2012 Shad and River Herring Bycatch Proposal for the PRFC and specify that the requirements of the technical committee be provided to the PRFC in writing for final action at the ASMFC February 2012 meeting. The motion was made by Mr. Augustine and seconded by Mr. Adler. A.C.

MR. CARPENTER: One final thing; we only have a shad bycatch proposal. We have no river herring bycatch, so I don't know whether it's the single species or whether you want to include both in there.

CHAIRMAN RHODES: It should be single; very good, thank you. To read it yet again, the motion before the board is to move that the board preliminarily approve the PRFC 2012 Shad Bycatch Proposal for the PRFC and specify that the requirements of the technical committee be provided to the PRFC in writing for final action at the ASMFC February 2012 meeting. The motion was made by Mr. Augustine and seconded by Mr. Adler. Mr. Grout.

MR. GROUT: Is the board clear that what we're asking for from the TC is requirements for approval of the plan? Requirements is a generic term. Is that clear enough for the technical committee to understand or should we put something specific that says requirements for approval of the plan by the TC.

DR. LANEY: My understanding per comments from yourself and Mr. Carpenter is that the TC will compile a list of what it's looking for from PRFC and submit that in writing back to PRFC, so that it's clearly spelled out what they were looking for when we had the discussion during the TC meeting. I think between my notes and Kate's recollection and the chairman's recollection we can do that.

MR. CARPENTER: I think adding to Wilson's comments here that PRFC will compile the information, resubmit it to the technical committee and will be ready for board action at its February meeting.

DR. LANEY: And also, A.C., those commitments that were made by other TC members to provide information to PRFC during the technical committee meeting need to be followed up on so that you all have that information.

MR. CARPENTER: Yes, we'll get in touch with them.

CHAIRMAN RHODES: All right, that being said, do the states need to caucus? No, all right. All in favor of this motion please signify by raising your right hand; opposed same sign; abstentions; null votes. **All right, the motion passes 17 in favor and none opposed**. We somehow lost a state along the way.

Thank you very much; it was a lively discussion and I think it will bring up some future plans for just interactions with the technical committee and the board specifications on length of time for increasing bycatch, but that is for a future board to discuss. The next item on our agenda deals with a petition to list river herring under the Endangered Species Act. I'm turning this over to Kim Damon-Randall who will be discussing this.

PETITION TO LIST RIVER HERRING UNDER THE ENDANGERED SPECIES ACT

MS. KIM DAMON-RANDALL: I'm going to talk about the petition that NMFS received to list river herring under the Endangered Species Act. I'll just go through the ESA petition process, the ESA definitions, discuss a little bit about the contents of the petition, talk a little bit about the status review process for those of you that aren't familiar with it, discuss our response and next steps, and then talk about some possible outcomes.

Any interested person in the United States can petition the Secretary of Interior or Commerce to list a species under the Endangered Species Act. Upon receiving a petition, the secretary has to respond to that petition within 90 days to the maximum extent practicable as to whether the petition presents substantial, scientific or commercial information indicating that the petition's action may be warranted. The key words there are "may be warranted".

The definition of substantial information is the amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted. There are two outcomes. Once a petition is received, you can publish a negative 90-day finding. That says that the petition and/or information that was readily available in the agency's files at the time of the petition was received does not contain substantial, scientific or commercial information indicating that the petition action may be warranted.

If that's the case, then a notice is published in the Federal Register announcing the negative finding and that's the end of the process. The other outcome is you can have a positive 90-day finding that indicates that the petition and/or information readily available in the agency's files at the time that the petition was received is substantial enough to indicate that the petition action may be warranted.

If that's the case, then you publish a positive 90-day finding in the Federal Register. You can seek information in that notice on that species to help inform the status review, and the species under our process becomes a NMFS candidate species. At the time that you publish a positive finding, a status review or a review of the status of the species is initiated. This includes compiling the best available information on the species, conducting threats assessment or an extinction risk analysis, and submitting a report or information to the agency to make the listing determination.

Within 12 months of the date of receipt of the petition, NMFS must publish a determination as to whether or not listing is warranted. If the listing is warranted, then it's usually in the form of a proposed rule. Just to give you some ESA definitions in case you're not familiar with them, under the ESA a species includes any sub-species of fish or wildlife or plants or any distinct population segment, or DPS, of any species or vertebrate fish or wildlife which interbreeds when mature.

An endangered species is any species which is in danger of extinction throughout all or a significant portion of its range. A threatened species is any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Section 4(a)1 of the ESA states that the secretary shall by regulation promulgated in accordance with Subsection (b) determine whether any species is an endangered species or a threatened species because of any one or more of the following five factors. Those five factors are the present or threatened destruction, modification or curtailment of habitat or range; overutilization for commercial, recreational, scientific or educational purposes; disease or predation; the inadequacy of existing regulatory mechanisms or other natural or manmade factors affecting the species continued existence.

We received the petition on August 5, 2011, from NRDC. The petition requests that we list both alewife and blueback herring or distinct population segments of those species as threatened and designate critical habitat for those species. The petition notes dramatic declines in coast-wide abundance. Fishing-related mortality, water pollution, dams, dredging and global warming were identified as the primary threats to both species.

On November 2, 2011, NMFS published a positive 90-day finding concluding that the petition presents substantial information indicating that the petition action may be warranted, and the citation is there and Kate said that there were copies of the 90-day finding available. The 90-day finding also seeks scientific and commercial information be submitted to the agency by January 3rd for incorporation in the review of the status of the species, and more information is available on the website that is listed up there.

We've had discussions and been coordinating with the Atlantic States Marine Fisheries Commission as we're aware that the stock assessment is ongoing, and that represents a very significant effort on behalf of the ASMFC and the states to compile the available information on the status of the stock.

We recognize that is a very significant effort and contributes greatly to the status review. Our intention is to attend the TC meeting in January to learn about what is in the stock assessment and identify gaps for what we would need for the status review, things like the extinction risk analysis, which isn't obviously part of a stock assessment; Canadian information, and potentially others will be identified, and we will focus our efforts on gathering that information rather than redoing everything that has been done by the stock assessment.

We'll form if necessary focus working groups to work on those gaps to bring people together to gather the best available information on those gaps. Those reports that we produce as a result of those working group meetings will most likely be independently peer reviewed and then used to make the listing determination.

As I said, the status review process is designed to compile the best available scientific and commercial information on the status abundance and trends of both of the species. We have to have to do the five-factor analysis – those are the five factors I mentioned – conduct a threats assessment or extinction risk, which can be quantitative or qualitative depending on the available data; and also consider information on the significant portion of the species range.

Are there areas that those species are DPS once were viable and no longer are viable or self-sustaining? We will also, during the status review process, consider ongoing or plan protective efforts that may affect the species. We'll present available information on elements of habitat that are needed for the survival and recovery. Those can be things like the size of habitat, number of different habitats needed for connectivity.

Also, under the ESA it's important to keep in mind that the economic impacts of a listing cannot be considered. The next steps, as I said we'll be looking at the stock assessment and identifying those gaps where we need to augment the status review. We have to publish a determination as to whether or not listing is warranted within 12 months of receiving the petition, so that has to publish by August 5, 2012.

There are essentially three different outcomes. The first is that we could determine that the species is endangered. If that's the case, then we publish a proposed rule, as I said. There is a 60- to 90-day public comment period, and most often public hearings are held throughout the range of the species. We would have to make a final determination no later than one year after the proposed rule.

If the final rule is that the species is endangered or both species are endangered, then all take is automatically prohibited, and take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to engage in

any of those activities, so it encompasses pretty much anything you could do to those species.

Take from bycatch or incidental catch in directed fisheries would be prohibited unless it's authorized through Section 7 or Section 10 of the Endangered Species Act. NMFS would also have to designate critical habitat at the time of the final listing to the maximum extent prudent and initiate recovery planning for both species.

The other possible outcome is that NMFS could determine that the species is threatened. If that's the case, then the Secretary of Commerce must promulgate protective regulations under Section 4(d) of the Act, so it's often called the 4(d) Rule, and those are deemed to be necessary and advisable for the conservation of the species. Directed take, bycatch, importation and exportation would most likely be prohibited unless they're authorized through Section 7 or 10. Critical habitat would also still need to be designated and recovery planning initiated. The third potential outcome is that NMFS determine that listing is not warranted for either species, and that's the end of the process. Does anyone have any questions?

MR. ADLER: What is the PBR? We've gone through this with whales. One of my questions, however, goes back to when you had the showing of some of the reasons why they might be considered. It had to do with rules but you mentioned predation. What do you mean by that; do you mean that if there are other fish eating this thing, does that constitute that this endangered because of that, because I don't know what we could do about that. Is that part of the thing, if something else is eating it, which they are?

MS. DAMON-RANDALL: Yes, under the ESA we look at the five factors that I mentioned, and disease and predation are one of the factors, and we do look at whether or not predation is occurring at such a level that it threatens the continued existence of the species.

MR. ADLER: So, because striped bass or something are eating these fish, we can't get near them if we go through that process?

MS. DAMON-RANDALL: It would have to be proven that level of predation was not sustainable, and it's often as a result of the species having declined from other factors that level of predation is no longer sustainable.

MR. ADLER: Does this particular determination, rule or whatever have a potential biological removal?

MS. DAMON-RANDALL: No, PBR is under Marine Mammal Protection Act and not the Endangered Species Act.

MR. JAMES GILMORE: Mr. Chairman, I actually have two questions. That was a great presentation because I really understood a lot more about this than I did. The first standard seems to extinction, and that is really a harsh word, I guess. Is there a good definition within ESA in terms of what constitutes extinction, because we have an issue versus a severely reduced stock is not sustaining a fishery versus something that is about to leave the planet. That's Question Number One.

Secondly, if it was listed as endangered, are there standards that sort of lay out a process or some standards for delisting later on if essentially there were actions taken to rebuild the stock. I know in terms of the limited experience I have with this, which is mostly terrestrial things – I mean, once it's listed it's decades before it could even be considered, and that might not work here.

MS. DAMON-RANDALL: Extinction is not defined under the ESA. Generally we're looking at biological extinction so whether or not it's at a level where the threats are so significant that it's not going to be able to continue into the future.

Once those species is listed under the ESA, you have to develop recovery plans, and the recovery plan would identify measures that would be taken if it was listed as endangered to down-list to threatened and then eventually to delist it and take it off the Act. The whole point of ESA is to recover a species to where listing is no longer warranted, so that's how it's done through recovery planning.

MR. ROY MILLER: Mr. Chairman, I'm curious if perhaps Kim or maybe Jaime could answer this particular question. Did the Fish and Wildlife Service and the National Marine Fisheries Service agree that this particular request would be handled by the National Marine Fisheries Service and will the Fish and Wildlife Service be involved in this?

MS. DAMON-RANDALL: We talked about it when we received the petition. We weren't jointly petitioned on this one. It was to NMFS. There is an existing memorandum of understanding that divides the workload between the Fish and Wildlife Service and NMFS. We did talk to the Fish and Wildlife

Service and we shared our draft 90-day finding with them.

They reviewed it and provided comments which were incorporated. We intend to do the same with the listing determination. They are involved. When we have those working group meetings, if we end up having them and they have people that they think would good to have on those working groups, so we definitely have them on those panels.

MR. GROUT: Kim, I had just a brief question because I had read the petition there, and one of the justifications in the petition for potentially listing was that commercial landings had decreased by a certain large factor. Now, in our particular state our commercial landings have – not commercial but our harvest has decreased substantially since the turn of the century, but that has occurred because of regulatory action that we've taken and that you will be collecting information on the regulatory action as well as commercial landings and biological information so that you'll understand why certain things have occurred, I assume; correct?

MS. DAMON-RANDALL: Yes, that's correct.

DR. GEIGER: Kim, thank you for an excellent presentation. To the question, the Fish and Wildlife Service and the National Marine Fisheries Service I think enjoy a very good and very productive, collaborative and interaction on endangered species issues. Again, the Fish and Wildlife Service will continue to support the National Marine Fisheries Service on this issue and to work with them to provide all necessary information. Thank you very much.

DR. LANEY: And to follow upon Dr. Geiger's comments, I'll note that the chairman of the River Herring Stock Assessment Subcommittee is also a Fish and Wildlife Service employee, Dr. John Sweka.

CHAIRMAN RHODES: Pam, would you like to comment upon this AP Chair?

MS. PAM LYONS GROMEN: Mr. Chairman, the AP has not had a chance to get together to discuss this, but certainly would be very interested in looking at the initial finding, looking at the data gaps and providing some information back to the board, so we would appreciate the opportunity to get together and provide some feedback. Thank you.

CHAIRMAN RHODES: All right, thank you for an excellent presentation. I think it brings us all up to speed and gives an idea of where we are. We're currently in 90-day period; and if someone would like to make a motion to recommend that the policy board send a letter offering our services with stock assessment, data gaps, along that line, it would be greatly appreciated so we can make our public comment.

MR. BYRON YOUNG: So moved.

CHAIRMAN RHODES: Mr. Young, would you like to craft the motion?

MR. YOUNG**: Move to recommend that the ISFMP Policy Board craft a letter to the National Marine Fisheries Service indicating that we would provide support and information necessary for the 90-day findings.** Any help in drafting that would be appreciated.

CHAIRMAN RHODES: I saw a second by Mr. McElroy.

MS. DAMON-RANDALL: I wouldn't normally do this, but we actually have made our 90-day finding, so the period between now and January 3rd is the time to submit information and then we have to make our 12-month determination. I don't know if you want to maybe reword that a little bit.

CHAIRMAN RHODES: Okay, so it would be for the status review instead of the 90-day finding. I think it would be move to recommend to the ISFMP Policy Board to craft a letter to the National Marine Fisheries Service providing support and information for the status review for river herring. That would be a motion by Mr. Young and seconded by Mr. McElroy.

MR. ADLER: Mr. Chairman, at what point along this route can we submit our opinion as to whether it should or shouldn't be; does that come after – when can we say, you know, we don't think it deserves this?

MS. DAMON-RANDALL: You can do that now during this comment period. It's not a typical comment period where we're looking for comments on whether or not you support the petitioned action, but you can do that. If we proposed to list the species, then that would definitely be when you would want to submit those comments, and that would be in August, if it happened.

REPRESENTATIVE CRAIG A. MINER: Mr. Chairman, I was listening to Doug Grout's

comments, and I'm thinking that whatever information has been gathered already has been put in different silos and a decision has been made that this somehow reaches a certain threshold. To go back to Doug Grout's comment that there are management decisions that have been made that justify decreases in commercial take or recreational take with those species, it seems like those might actually stack up on the negative side in terms of continued participation in both commercial and recreational fishing. Am I wrong in that?

MS. DAMON-RANDALL: I'm not exactly sure what you mean that they stack up on the negative side.

REPRESENTATIVE MINER: Well, if I understood your presentation correctly, there are thresholds and if the information in the folder is such that species could be considered for endangered species listing, then it must have met certain thresholds. If I understood you correctly, part of the information you looked at was whether or not commercial harvest had fallen below a certain level or was drastically reduced.

If we as a management group made that decision in an effort to maintain a certain population, it almost seems like that is counted – I'll use the words – against continued harvest. Once listing is made – maybe I don't understand this fully, but it seems to me that if this fish gets listed, we'll have a lot of free time on our hands here; because if I understood what you can and can't do, you can't even catch it by accident. I think how we submit our information to you is going to be critical because if we leave any gaps in our information that might lead you to list it, that's where I'm afraid we're headed.

MS. DAMON-RANDALL: It's definitely not counted against you. When we look at the overutilization factor, it's whether or not they're being overutilized to a point that it's driving the species toward extinction. We then also look at the inadequacy of existing regulatory mechanisms. That's how the Act is worded; I'm not making up the inadequacy part. We look at what regulatory mechanisms have been put in place. If those regulatory mechanisms are allowing the species to recover, then that is not driving the species towards extinction. It is not counted against you; it would be counted for you.

REPRESENTATIVE MINER: Thank you, and I meant counted against the species and not us or you. Thank you.

CHAIRMAN RHODES: All right, thank you for the discussion and the information. There is a motion from the board to recommend that the ISFMP Policy Board craft a letter to the National Marine Fisheries Service providing support and information for the status review for river herring. Motion by Mr. Young; seconded by Mr. McElroy. Is there any opposition to the motion? Dr. Daniel.

DR. LOUIS DANIEL: I'm not on this board but I appreciate the opportunity. This could be a big issue for us and I know everybody. It scares me to death to have "providing support" in this motion. I know what it means, but that scares me to death knowing how that could be construed without a lot of explanation. I would strongly suggest you not put the word "support" along with listing river herring in the same motion.

CHAIRMAN RHODES: Well, to the makers of that motion, if we put "technical support", would that solve the concerns that were brought up – "providing technical support and information for the status review of river herring". Representative Peake.

REPRESENTATIVE SARAH K. PEAKE: Mr. Chairman, respectfully, I would just propose taking the word "support" out and say "providing technical information for the status review," because I think support does tend to be a modifier where it implies support of a listing, perhaps, and that's what makes some of us nervous.

My understanding is we are going to be providing them with technical information for their status review, and I think taking the word "support" out that we get the message across that we're going to be providing them with information from the TC but without in any way seeming to endorse it through the wording of the motion.

CHAIRMAN RHODES: Does the maker of the motion and seconder accept the change?

MR. YOUNG: Yes, I accept that.

CHAIRMAN RHODES: All right, the makers accepted the change**. The motion now reads move to recommend that the ISFMP Policy Board craft a letter to the National Marine Fisheries Service providing technical information for the status review for river herring. The motion was made by Mr. Byron Young and seconded by Mr. McElroy.** Is this motion acceptable to the board; any opposition.

MR. MEYERS: Mr. Chairman, I need to abstain.

CHAIRMAN RHODES: **All right, seeing none we will move for acceptance by consensus with an abstention by the National Marine Fisheries Service.** Mr. Adler.

MR. ADLER: I know what we're trying to do here, but the way it words it says "board craft a letter providing technical", or is it the board would craft a letter offering to provide technical information because this letter isn't definitely going to provide the information in that one letter; am I correct?

CHAIRMAN RHODES: I think that is absolutely correct.

MR. ADLER: Now what do we do?

CHAIRMAN RHODES: That being said, Bob.

MR. BEAL: I don't think you necessarily have to go back and change the wording of the motion. If the understanding of the board is that we're going to – you know, the staff will work with the policy board and the executive director to send a letter over making the offer to provide information. I think the record is pretty clear there.

CHAIRMAN RHODES: Thank you very much for all the clarification. That being said, Kate, I think we turn to you for the Fishery Management Plan Review and State Compliance.

FISHERY MANAGEMENT PLAN REVIEW AND STATE COMPLIANCE REPORTS

MS. TAYLOR: Mr. Chairman, I will be brief in my 2010 Shad and River Herring FMP Review. As we are aware, there was a 2007 benchmark assessment for American shad, and we are currently undergoing a river herring assessment, which is scheduled to be reviewed by the management board in May 2012.

State landings in 2010 for American shad were estimated at approximately 555,000 pounds. This is a 12 percent increase from last year. The combined landings from North Carolina and South Carolina accounted for 71 percent of all coast-wide landings. No harvest was reported from Maine, New Hampshire, Rhode Island, New York, Pennsylvania, Maryland, the District of Columbia and Florida.

Under Amendment 1 there is a requirement for the 5 percent bycatch reporting. In 2010 there were 8,546 pounds of American shad reported. This is 1.53 percent of the coast-wide directed harvest. The harvest was reported from Maine, New Jersey and North Carolina. There were two trips in New Jersey that exceeded the 5 percent bycatch limit. However, when combined, the total American shad harvested as a bycatch percentage was only 1.2.

For hickory shad there were reported landings. Rhode Island, Connecticut, New York, Delaware, Maryland, the Commonwealth of Virginia and North Carolina were all states that reported hickory shad commercial landings. In 2010 the commercial landings increased by 17 percent with states landing approximately 128,000 pounds. North Carolina reported 84 percent of the total coast-wide landings.

For river herring commercial landings were reported from Maine, New Hampshire, New York, New Jersey, Delaware, Maryland, PRFC, North Carolina and South Carolina; totaling approximately 2 million pounds, which was a 9 percent increase from previous landings and a continued increase since 2007. The majority of the landings were reported by the state of Maine followed by South Carolina and Virginia.

States are required to report on any stocking efforts, and this was occurring in Maine, Massachusetts, Pennsylvania, Delaware, Maryland, Virginia, D.C., North Carolina with support by the Fish and Wildlife Service. In 2010 there were approximately 21 million shad larvae and fry that were stocked in rivers and approximately 700,000 alewife.

States are also required to report on their Atlantic sturgeon interactions, and in 2010 there were 58 sturgeon interactions reported in various fisheries. States that were reporting these interactions include Rhode Island, New Jersey, Delaware, PRFC, Virginia, North Carolina, South Carolina and Georgia. All of the sturgeon interactions and the disposition of the sturgeons; they were released alive when this happened.

There are three states that were requesting de minimis. This is Maine, New Hampshire and Massachusetts, and it is the recommendation of the plan review team that these states be granted de minimis status for 2012.

CHAIRMAN RHODES: All right, any questions of Kate? Doug.

MR. GROUT: Kate, just a small question; there was a comment under New Hampshire's report that the

PRT provided that said, "The ocean shad bycatch landings were under 5 percent, but the amount was not given." Then the next sentence says, "Table 3 lists zero bycatch, but the report states that there was small amount."

Now, I went back and reviewed the report and I couldn't find where that statement was that there was a small amount of bycatch. In fact, under the bycatch section it says no reported bycatch of shad in federal waters. I would like to see if you help me out in finding out what page had that indication that said there was a small amount.

MS. TAYLOR: Is that in the FMP Review or the PRT Report?

MR. GROUT: It's in the compliance report. It says, "Review of Shad and River Herring Annual Compliance Reports".

MS. TAYLOR: I would have to look through the report to find out exactly where that was.

MR. GROUT: Yes, if you could help us out with that because we couldn't find it.

CHAIRMAN RHODES: All right, any further discussion? Mr. Grout.

MR. GROUT**: I was going to make a motion to approve the plan review with the inclusion of the three states that requested de minimis**. Okay, we accept – I've been told that I need to use the words "move to accept".

CHAIRMAN RHODES: Second by Mr. Adler. Any discussion? All right, there is a motion to accept the 2012 FMP Review and approve de minimis requests from Maine, New Hampshire and Massachusetts. The motion was made by Mr. Grout and seconded by Mr. Adler. Any discussion? Any opposition? **Seeing none, we will approve that** unanimously.

OTHER BUSINESS

Is there any other business to come before the board? I'm going to have one last thing. It has been a pleasure serving for the last two years, but at this point, Dr. Duval, I would love to turn over the chair to you at the next meeting. It's been a very interesting time because we're getting through the second and third amendments and then working with the councils for these fisheries. It has been exciting and an interesting change. It will be very nice to be on that side of the microphone. I have gained a lot more respect for all of you guys when you're up here. Mr. Augustine.

MR. AUGUSTINE: Final comment; Malcolm, you've been a great leader in this process and you have taken us through some pretty rough roads and rocky terrain. We have attacked some pretty serious issues here, and you're to be commended for sticking to the process, moving us forward and being a great leader. Thank you for your service. (Applause)

ADJOURNMENT

CHAIRMAN RHODES: Well, thank all you all. We are adjourned.

(Whereupon, the meeting was adjourned at 10:45 o'clock a.m., November 10, 2011.)

Amendment 3
American Shad Sustainable Fishing Plans
Delaware Cooperative
Potomac River Fisheries Commission
North Carolina
Georgia

Submitted to the
Shad & River Herring Board
February 2012

Delaware River
Sustainable Fishing Plan for American Shad

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 State Division of Fish and Wildlife*

U.S. Fish and Wildlife Service • *National Marine Fisheries Service*

For:

The Atlantic States Marine Fisheries Commission
Shad and River Herring Management Board

December, 2011

Table of Contents

Executive Summary

The Atlantic States Marine Fisheries Commission (ASMFC) has required all states to submit Sustainability Plans for American shad fisheries by Aug 1, 2011 or be forced to close them by January 1, 2013 as per Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring. Within the Delaware River Basin, the Delaware River Basin Fish and Wildlife Management Cooperative (Co-op) is responsible for the management of American shad. The Co-op is seeking sustainability of the Delaware River American shad stock at current levels of recreational and commercial usage. Through extensive data review and analysis, the Co-op has identified several indices for monitoring the Delaware stock with associated benchmarks. The Co-op judge these fisheries as sustainable while avoiding diminishing potential stock reproduction and recruitment as long as indices of stock condition remain within the defined benchmarks.

Currently the Delaware shad stock is considered to be stable, but at low levels. Recent data is suggestive of an increasing trend. Juvenile production (JAI), assessed by seine surveys in both non-tidal and tidal reaches, has varied without trend. Below average production was observed in non-tidal areas from 1998 to 2004, but excellent year classes were observed in both JAI indices in 2005 and 2007. The 2011 JAI was the 7th highest of the tidal reach time series. Measures of relative adult abundance (Smithfield Beach and Lewis haul seine) were suggestive of declining abundance in early 1990s followed by low but stable levels from 1999 to 2009. Recent evidence (2011) has suggested increasing abundance of adults to levels observed in the early 1990s.

The New Jersey Division of Fish and Wildlife (NJDFW), monitors JAI in both the non-tidal and upper estuary reaches, but the non-tidal JAI was discontinued in 2008 as a cost cutting measure. Although the tidal JAI does provide an indication of American shad production within the Delaware River Basin, differences in the two indices indicates that variables such as the timing of the run, water temperatures, etc. may affect the two areas differently in a given year. Concern has been expressed that the correlation between the two JAI indices relies too heavily on occurrences of peak year classes; such that the tidal JAI may not be sensitive to poor year classes observed in the non-tidal reaches. Currently, the Co-op lacks funding to resume sampling for the non-tidal index. Securing funding for this important index is under discussion by Co-op members.

Exploitation of the Delaware shad stock occurs in several fisheries within the Basin. Commercial harvest is permitted by New Jersey and Delaware, generally during the spring spawning migration from late February into May. These fisheries occur in tidal waters of Delaware and New Jersey using anchored or drift gill nets. Landings in the upper estuary are considered to be 100% Delaware shad stock; whereas, landings in the Bay are of mixed stock, with an estimated 39% of Delaware origin. Fishers in New Jersey represent a small directed fishery for American shad; whereas, landings of shad reported to the State of Delaware occur as bycatch from their concurrent striped bass fishery. Trends of combined landings, representative of the Delaware shad stock, have been declining since 1990, with lowest levels

observed in the most recent years (2008-2010). The decline is most likely due to gear changes in DE's striped bass quota driven fishery and the low number of NJ fishers seeking American shad.

In addition to the lower Delaware River and Delaware Bay fisheries, a small haul seine fishery (Lewis haul seine) occurs in the Delaware River, some 15 miles above the fall line at Lambertville, NJ. This fishery exists as an eco-tourism venture with nominal harvest of shad. Trends in this fishery are highly correlated to the Smithfield Beach CPUE time-series.

Historically, a substantial recreational fishery for shad existed in the non-tidal reaches of the Delaware River; however participation in this fishery is declining. The current recreational harvest is unknown. Most shad anglers practice catch-and-release. The mortality associated with catch-and-release of shad in the Delaware River is unknown, but considered to be minimal. The recreational creel limit is currently 3 shad above the Commodore Barry Bridge and 6 shad below the bridge.

In addition to harvest and natural mortality, the Co-op investigated other factors that may also impact the Delaware shad stock. As part of the American shad restoration program for the Schuylkill and Lehigh rivers, the Pennsylvania Fish and Boat Commission (PFBC) estimates the contribution of otolith-marked hatchery shad to the returning adult spawning populations in both rivers. While evidence suggests these fry stockings substantially support the runs in the Schuylkill and Lehigh rivers, the contribution to the mainstem Delaware run above their respective confluences has been minimal. Correlations between the Atlantic Multidecadal Oscillation (AMO) and indices of adult shad relative abundance from the Lewis haul seine fishery suggest a relationship between shad abundance and Atlantic long-term sea surface temperatures; however, there is a disconnect that has occurred since the 1992 that currently is in debate. In addition, a strong inverse correlation has been identified between adult shad abundance in the Delaware River and coastal striped bass abundance. Possible losses from oceanic commercial fisheries principally, as bycatch, have been difficult to evaluate; but, this issue is becoming more of a priority to those agencies responsible for governing offshore fisheries.

The Co-op proposes four benchmarks for sustainability. The benchmarks have been set to respond to any potential decline in stock. Thus all benchmarks are viewed as conservative measures. Failure to meet any of the defined benchmarks will independently cause immediate management action. The severity of the action will be situational and proportional to the number of benchmarks exceeded. No benchmark has tripped its target level for the last two consecutive years. All benchmarks will be reviewed annually after completion of annual ASMFC compliance reports.

- **Non-tidal JAI:** Data for this index is derived from the NJDFW annual fixed station seining (1979-2007) in the non-tidal Delaware River mainstem from Trenton, NJ to Milford, Pa. The benchmark is based on data from 1987-2007. Failure is defined as the occurrence of

three consecutive JAI values below a value of 49.43 (i.e., the 25th percentile of the historical data, where 75% of the values are higher).

- **Tidal JAI:** Data for this index is derived from the NJDFW annual striped bass seining in the upper estuary. The shad benchmark includes only those stations from Trenton to the Delaware Memorial Bridge, and is based on data from 1987 – 2010. Failure is defined as the occurrence of three consecutive JAI values below a value of 2.83 (i.e., the 25th percentile of the historical data, where 75% of the values are higher).

- **Adult CPUE:** This benchmark is based on the annual CPUE (shad/net-ft-hr*10,000) in the PFBC gill net, egg-collection effort at Smithfield Beach. This benchmark was based on the entire dataset (1990-2011), with failure defined as the occurrence of three consecutive CPUE values below a value of 34.79 (i.e., the 25th percentile of the historical data, where 75% of the values are higher).

- **Ratio of Harvest to Smithfield Beach CPUE:** This benchmark is calculated as a ratio of the combined commercial harvest of the Delaware shad stock from the river and bay in pounds divided by relative abundance of adult survivors captured at Smithfield Beach (CPUE). Delaware stock, lower Bay landing are calculated as 39% of the total lower bay landings. The benchmark is based on data from 1990-2010 and failure is defined as the occurrence of three consecutive values above a value of 27.79 (i.e., the 85th percentile of historical data, where 15% of values are higher).

In addition to the above benchmarks, the Co-op identified several other datasets warranting further monitoring as collaborating evidence of the Delaware shad stock trends. The intent was to provide an additional measure of stock performance; however, the Co-op does not propose these as defined benchmarks for management action, given various associated extraneous caveats and assumptions. Auxiliary data sets include: (1) Lewis haul seine adult relative abundance (catch/haul), (2) ratio of harvest to Lewis haul seine relative abundance, (3) commercial effort, (4) harvest of shad from mixed stocks in the Delaware Bay, and (5) commercial exploitation. The Co-op will pursue investigations of assumptions and data needs for these auxiliary datasets.

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 Co-op views this plan having a five-year term beginning with its acceptance by the ASMFC.

Sustainable Fishery Plan for the Delaware River

1. Introduction

In accordance with guidelines provided in Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (ASMFC 2010), the Delaware River Basin Fish and Wildlife Management Cooperative (Co-op) submits the following Sustainable Fishing Plan. It is submitted jointly by the States of Delaware, New Jersey, and New York, and the Commonwealth of Pennsylvania, for management of American shad in waters of the Delaware River Basin (Figure 1).

1.1 Request for fishery

The Co-op desires that the Shad and River Herring Management Board consider this request to approve a Sustainable Fishery Plan for American shad of the Delaware River Basin. This plan includes a request for approval of both recreational and commercial harvest. Accordingly, the Co-op justifies this request based on analysis of historical trends in juvenile and adult relative abundance, and commercial and recreational fishery data.

1.2 Definition of sustainability

Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring defines a sustainable fishery as one that will not diminish potential future stock reproduction and recruitment. The Co-op proposes that reproduction and recruitment in the Delaware River American shad stock be measured by two indices of age zero abundance to be augmented with an index of spawning stock abundance and a ratio of landings to that index of spawning stock abundance. Benchmarks have been proposed for all indices to define levels needed to avoid diminishing potential stock reproduction and recruitment. We will judge fisheries as sustainable as long as indices of stock condition remain within these benchmarks.

2. Current Stock Status

2.1 Previous Assessments

The Delaware River was included in the 1988 and 1998 ASMFC coast-wide stock assessments for American shad (Gibson *et al*. 1988; ASMFC 1998). The 1988 Assessment utilized the Shepherd stock-recruitment model to estimate maximum sustainable yield (MSY) and maximum sustainable fishing rates (F_{msy}). That assessment estimated F_{msy} for the Delaware River to be equal to 0.795 with exploitation at MSY at 0.548. The historical fishing rate for the Delaware stock was estimated to be F = 0.320. The 1998 Assessment utilized the Thompson-Bell yield-per-recruit model to derive an overfishing definition (F_{30}) for American shad. Average fishing mortality from 1992 to 1996 for the Delaware River was estimated at F = 0.17, which

includes out of basin estimates of harvest, and was considered well below the F_{30} value of F = 0.43.

The most recent stock assessment was completed in 2007 (ASFMC 2007). Findings identified more than twenty-five sources of fishery-independent and fishery-dependent data. Clearly, the Delaware River stock of American shad declined through the 1990s and remained at low levels. The cause of the decline was not identified, nor was any explanation postulated for why the stock remained at low levels since the decline. The 2007 assessment concluded that juvenile production remained stable without any apparent trend, and did not appear to be correlated between adult abundance or returning adults in subsequent years (ASMFC 2007). The stock assessment sub-committee was unable to reach consensus on what could be considered the best scientific benchmark(s) from the available datasets (ASMFC 2007).

Substantial monitoring of the American shad population has been accomplished in the Delaware River. Many of the indices analyzed for the ASMFC 2007 stock assessment have continued through 2011.

2.2 Stock Monitoring Programs

2.2.1 Fishery Independent Surveys

Juvenile Abundance Surveys

The New Jersey Division of Fish and Wildlife (NJDFW) conducted juvenile abundance monitoring for American shad in the non-tidal Delaware River from 1979-2007 to provide a juvenile abundance index (JAI) for management purposes. In non-tidal waters, where the majority of spawning takes place, a beach seine monitoring program for juvenile American shad was conducted during August through October at representative stations (Trenton, Byram, Phillipsburg, Delaware Water Gap, and Milford, Pa, Figure 2). Beginning in 1979, only a single station, Byram, was sampled. Other sites were added in later years with the addition of Trenton in 1980, Phillipsburg in 1981, Water Gap in 1983 and Milford, Pa in 1987. Sampling was discontinued at the Byram station in 2002 due to heavy siltation. This station was eliminated from the program since a suitable replacement beach was not located. Because this station is no longer used in the calculation of the index, the entire time-series was recalculated by eliminating this station from the analysis.

In the tidal Delaware River, NJDFW collected data during their annual striped bass recruitment survey from Trenton to Artificial Island during August through October, 1980 – present date. This index was recalculated to eliminate stations in waters of higher salinity where American shad are less likely to be encountered. The actual assessed sampling range is from Trenton to the Delaware Memorial Bridge. In 2010, a quality check was completed on all data sets from the Delaware River resulting in updates to the recruitment indices during the time series.

Both JAIs are reported as geometric means. The non-tidal JAI increased from 1980 to 1984, then fluctuated without trend through 2007, with good year class abundance reported in 1996

and 2007 (Table 1, Figure 2). Closer evaluation reveals an increasing trend from 1980 through the time-series peak in 1996. The JAI decreased from 1996 through 2002 but rebounded until the survey ended in 2007. The geometric mean per haul for the time series was calculated as 83.12. Cohorts with poor recruitment are thought to be due to poor environmental conditions, such as 2002 and 2006. Recent strong year classes in 2005 and 2007, as well as favorable environmental conditions in recent years, are encouraging.

The tidal JAI increased from 1980 to 1988, then varied without an apparent trend excepting a strong peak observed in 1996 (Table 1, Figure 2). The geometric mean per haul for the time series was calculated as 4.85. The preliminary 2011 index (7.99) was the 7th highest of the time series. The tidal JAI has become highly variable in recent years with two very good year classes (2005 and 2007) and two very poor year classes (2006 and 2008). Overall, recent strong year classes in 2003, 2005, 2007 and 2011, as well as favorable environmental conditions in recent years, are encouraging (Table 1, Figure 2).

Both the tidal and non-tidal YOY indices show a significant positive trend through time. The tidal index was regressed on year, and a very highly significant regression was found, ($F = 6.88$, $P = 0.0138$, $R^2 = 19\%$). The slope of the regression was 0.22, meaning that on average, the index increased by 0.22 per year. For the non-tidal index, the regression on year was also highly significant ($F = 9.14$, $P = 0.0056$, $R^2 = 26\%$). The slope was 1.037, meaning the index increased by that amount per year on average. The coefficient of determination (R^2) was not high for either regression, indicating that other (environmental) factors also influenced the variation of the index.

The Delaware non-tidal and tidal indices correlated well (Pearson product-moment $r = 0.793$, $P < 0.001$) from 1994 to 2007, leading to a proposal to discontinue the non-tidal JAI survey as a cost cutting measure. The Technical Committee approved the proposal in January 2008 and the non-tidal JAI survey was therefore eliminated. Although the tidal JAI does provide an indication of American shad production within the Delaware River Basin, differences in the two indices indicates that variables such as the timing of the run, water temperatures, etc. may affect the two areas differently in a given year. For example, the non-tidal JAI was suggestive of a seven year period (1998–2004) when juvenile production was below the long-term mean. During the same time period, the tidal JAI was suggestive of average juvenile production. Concern has been expressed that the correlation between the two JAI indices relies too heavily on occurrences of peak year classes; such that the tidal JAI may not be sensitive to poor year classes observed in the non-tidal reaches. Without a representative index of juvenile production in the non-tidal reaches, prolonged occurrences of poor recruitment in the primary spawning grounds may not be detected. The Co-op is currently attempting to secure funding for re-instituting the non-tidal JAI (Section 6.1.1).

Adult Abundance Indices

The Pennsylvania Fish and Boat Commission (PFBC) annually monitors the relative abundance of returning spawning adult shad in the Delaware River. This effort has and is currently being

accomplished in two separate surveys: a gill net survey at Smithfield Beach (RM 218.0) and an electro-fishing survey at Raubsville (RM 178.5).

Gill Net Survey

Collections at Smithfield Beach principally focus on capture of brood fish and subsequent strip-spawning to produce fertilized eggs in support of PFBC restoration efforts in the Schuylkill and Lehigh rivers, the largest tributaries to the Delaware River. Gill net gear is used for shad capture and efficiently provides the largest sample for strip-spawning and biological data. Approximately 8 to 18 gill nets (200 feet in length) are set per night with mesh sizes ranging from 4.5 to 6.0 inches (stretch). Nets are anchored on the upstream end and allowed to fish parallel to shore in a concentrated array. Netting/spawning operations typically begin on Mother's Day when river flows are workable and river temperatures reach 16C. The project is performed on Sunday through Thursday evenings and is typically terminated near the end of May or early June when egg viability decreases and/or river temperatures reach 21.1C. Biological data collected include gender, length (total and fork), weight (excluding ovarian weight due to the strip spawning procedures), otolith age, scale age, repeat spawning marks, and hatchery otolith marks.

Catch-per-unit-effort (CPUE) values ranged from 17.1 to 190.1 shad/net-ft-hr*10,000 (Figure 3). Abundance peaked in the early 1990's, declined through the mid 1990's, and remained relatively stable from 1999 to 2009 (mean = 35.1 shad/ net-ft-hr*10,000). In 2009, CPUE was the lowest recorded (17.1 shad/ net-ft-hr*10,000); however, this was most likely impacted by climatic factors. The exceptionally wet spring resulted in higher than average flows, reducing the efficiency of the gill nets. Cold water temperatures delayed and/or marginalized spawning behavior which would also reduce gear efficiency. In the last two years, CPUE increased with the 2011 CPUE estimate (72.0 shad/net-ft-hr*10,000) ranking as the fifth highest since 1990. High flows during the 2011 collections may have adversely impacted CPUE, which could have been higher than measured. Angler catches, as reported on an internet message board (http://woofish.homestead.com/shad.html) were good in 2009, better in 2010, and exceptional in 2011.

Electrofishing Survey

The PFBC historically (1997–2001) monitored returning adult American shad at a fixed station (RM 178.5) in the vicinity of Raubsville, Pa using electro-fishing gear. This survey was re-initiated in 2010 and continues to date. Separate samples were collected on the PA side (west) and the NJ side (east) of the river. The river was sampled four to five times from April to May with one electro-fishing event per week. Sampling events were terminated when 15 American shad were caught or after one hour of electro-fishing, whichever came first. Biological data collected included gender, length (total and fork), total weight, otolith age, scale age, repeat spawning, and hatchery otolith marks.

Preliminary correlations (Pearson product-moment analysis) of this data series to other datasets, i.e., Smithfield Beach gill net and Lewis haul seine CPUE, have demonstrated a strong correlation and excellent potential of the Raubsville electro-fishing survey for utility as a relative index of abundance for adult shad. Therefore, in consensus with other Basin states, PFBC has tentatively agreed to continue the Raubsville sampling and re-evaluate its utility after five consecutive years of data have been collected.

Adult Fish Passage

Many of the Delaware River tributaries historically contained spawning runs of American shad. Unfortunately, with the development of the lock/canal systems in the Lehigh and Schuylkill rivers in the early 1800s, shad became extirpated in these tributaries. Efforts have been undertaken to restore shad in the Lehigh and Schuylkill rivers by installation of fish ladders, stocking of OTC tagged fry, and on-going feasibility studies of dam removal. A considerable time series of fish passage monitoring exists for the Lehigh and Schuylkill rivers, but passage into many other Delaware River tributaries is unknown. Passage of shad into the Lehigh and Schuylkill rivers occurs via fishways outfitted with observation rooms enabling monitoring of passage using and video surveillance equipment. Monitoring occurs 24 hours a day, 7 days a week using time-lapsed photography. Passage is monitored only during the spawning migration, typically from April 1st through July 1st. Shad passage is enumerated by staff review of video tape.

Since 1995, the PFBC has been monitoring shad passage into the Lehigh River from the Delaware River. The Easton Dam (RM 0.0), situated at the confluence of the Lehigh and Delaware rivers, has a vertical slot fishway equipped with observation chamber. Annual passage of shad ranged from 408 to 4,740 total shad (0.11 to 2.28 average shad/hour; Figure 4). Passage of shad through the Easton fishway was not significantly correlated (Pearson product-moment, $P > 0.05$) to either the Smithfield Beach or Raubsville CPUE. This lack of any relationship suggests that the shad run into the Lehigh River is independent of the Delaware River spawning run. Co-op members agreed that Easton fish passage was of no utility in assessing/monitoring the shad population within the Delaware River. No attempt was made to document downriver passage from the Lehigh River back into the Delaware River.

Between 2002 and 2011, the Philadelphia Water Department (PWD) maintained a robust monitoring program on the Schuylkill River, quantifying the resurgence of key migratory species including American shad, assessing the relative health and abundance of both resident and migratory fish, and evaluating the success of restoration activities with fish passage counts at the Fairmount Dam Fishway. A video monitoring program was established in 2003 to assess fish passage at the fishway (Figure 4). The 2010 fish passage season at the Fairmount Fishway was a record-breaking year, with 2,521 American shad ascending the fishway. This number was the highest ever recorded and more than seven times greater than passage numbers prior to the renovations in 2008 (Figure 4). Data from 2004–2010 suggests a similar trend in upstream fish passage between the Lehigh (Easton Dam) and Schuylkill Rivers (Fairmount Dam); but no significant correlation (Pearson product-moment, $P > 0.05$) was found (Figure 4). Since

hatchery contribution is high in both these stocks (96% for the Schuylkill and 74% for the Lehigh), this may be related to annual variations in hatchery production and similar environmental conditions at stocking. The positive trend in both rivers is encouraging. Passage of shad through the Fairmount fishway was not significantly correlated (Pearson product-moment, $P > 0.05$) to Smithfield Beach CPUE.

Comparison of JAI to adult indices

One might expect that juvenile production (i.e., recruitment) would be a function of adult stock size. Figure 5 plots both the non-tidal and tidal JAI indices (i.e., recruitment) against Smithfield Beach relative abundance (a proxy for the spawning stock size). No obvious relationship appears to exist between adult relative abundance and year class strength (juvenile production) (Figure 5). Thus, production of young-of-year shad does not appear to be related to adult stock size. The lack of a correlation most likely is related to environmental influences and sampling variability. Future work is planned to examine the JAI-Adult relationship with multivariate statistics, including the influence of environmental variables.

Shad from the Delaware River Basin have been aged using scales and otoliths. The Co-op initially used all available data, including estimation of ages from scales and otoliths, knowing that there are limitations and controversy attached to ageing techniques which produced the data sets. Exploratory correlations (Pearson product-moment analysis) between adult CPUE , partitioned by age and summed to represent year class contributions to YOY year class production, as measured by the non-tidal JAI, yielded a positive slope, but an insignificant correlation (Pearson product-moment $r = 0.431$, $P > 0.05$; Figure 6). Recent findings have determined that the ageing of scales from Delaware River American shad cannot be substantiated (McBride *et al*. 2005). Otolith ageing has been validated using known age specimens from the Lehigh and Delaware Rivers (Duffy et al., in review). Without confidence in the scale ageing technique (Cating 1953), the frequency of repeat spawning from scale microstructure also cannot be determined with confidence. The Co-op agreed that alternative methods (e.g., otolith ageing) are preferable to assess ages of the Delaware River stock.

2.2.2 Fishery Dependent Data

Commercial fisheries

Exploitation of the Delaware shad stock occurs in several fisheries within the Basin. Commercial harvest is permitted by New Jersey and Delaware, generally during the spring spawning migration from late February into May. These fisheries occur in tidal waters of Delaware and New Jersey using anchored or drift gill nets. Fishers in New Jersey represent a small directed fishery for American shad; whereas, landings of shad reported to the State of Delaware occur as bycatch from their concurrent striped bass fishery.

In addition to the lower Delaware River and Delaware Bay fisheries, a small haul seine fishery (Lewis haul seine) occurs in the Delaware River, some 15 miles above the fall line at Lambertville, NJ.

Total catch, landings, and effort

Lewis haul seine: The Lewis haul seine is the only in-river fishery and is located at Lambertville, NJ (RM 148.7). It dates back to the late 1880's, representing a significant time-series of recorded data with catch-per-unit-effort data documented since 1925. The fishery has evolved from a commercial enterprise to more of an eco-tourism enterprise. To preserve this historical data series the Co-op members support the fishery with a $6,000 grant (2008-2012) to collect CPUE (catch/haul) and biological data from the catch. Contract obligations require the Lewis haul seine to fish for shad a minimum of 33 days within the traditional fishing period (mid-March through June). Required information includes dates fished, number of hauls, and total American shad catch per haul. Gear specifications and deployment were left to the discretion of the operator of the Lewis haul seine to maintain traditional methodology, subject to in-river flow variations.

The exceptionally long time-series of CPUE data from the Lewis haul seine is a good indication of the spawning run strength in the Delaware River. Unfortunately, this may not be an ideal abundance measure since the fishery uses varying nets depending on daily environmental conditions. In addition, natural changes to the river channel in the area of the fishery may be affecting the catchability of American shad. Recent CPUE shows an increasing trend from the 1960's-80's followed by an overall decrease to the mid-2000's (Figure 7).

CPUE from the Smithfield Beach gill net and Lewis haul seine for 1990-2010 exhibit similar trends (Figure 8) and are strongly correlated (Pearson product-moment: $r = 0.866$; $P < 0.001$;Figure 9).

New Jersey commercial fishery: Prior to 1998, the National Marine Fisheries Service (NMFS) estimated American shad landings for the State of New Jersey. In 1999, the NMFS estimates were combined with voluntary logbook data from New Jersey's commercial fishers. These landings data reported by NMFS date from the late 1800s to 2000, while extensive, are thought to be under-reported and considered inaccurate. In 2000, the State of New Jersey instituted limited entry and mandatory reporting for the American shad commercial fishery.

In New Jersey, as of June 20, 2011, there were 86 permits issued (46 commercial and 40 incidental) to allow harvest of American shad. The shad permit allows the holder to fish in any state waters where the commercial harvest of shad is allowed if the permit holder meets all other net requirements for commercial fishing in a particular area. Currently, only 76 of these permits are active, due to attrition, while only 10 fishers landed shad in the Delaware Estuary during 2010.

Since 2000, the data on catch, landings, and effort have been collected via mandatory logbooks through the limited entry program and will continue to be used to assess stock status. Records indicate that the shad fishing season started as early as February 15 and ended as late as May 22. Data collected from the logbooks show that the mesh size in the Delaware Bay fishery ranges from 5 to 6 inch stretch.

Delaware commercial fishery: Delaware has a limited entry system for commercial gill net fishers. In recent years only handful of fishers has reported landings of shad, which is currently a bycatch in the directed 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.

Delaware fishers have explained that they have a small striped bass quota which is often filled quickly. If they then try to fish for shad, striped bass fill their nets. They are difficult to pick out of the nets because of their spines and sharp gill covers, which can cut fishers' hands and the nets are damaged by the bass catch. Striped bass are currently at unprecedented levels of abundance in the River and Bay. Clark and Kahn (2009) reported that catch per trip of striped bass in Delaware's spring gill net fishery increased by 3000% to 6000% between 1987 and 2002-2003, based on at-sea samples of gill net catches. The result of the high abundance of striped bass together with the limited striped bass quota is that fishing for shad is impractical, according to numerous commercial fishers.

The spring striped bass season runs from February 15th through May 31st. Gill nets used in February and May are restricted to drift nets; either anchored or drift nets are allowed during other times. Shad have been landed as early as February, but peak in April. Delaware fishers are required to pull their nets during the first week in May as a conservation measure for weakfish, but very few shad are still in the estuary at that time.

Combined State landings

Recent commercial landings (1985–2010) from the Delaware River and Bay are shown in Figure 10 and Table 2. Landings prior to 1985 are not easily partitioned between bay and river and therefore are not useful for discussions of the Delaware River stock status. State landings are considered very reliable from Delaware since 1985 and New Jersey since 2000. Reported landings for both states are presented for comparison. The harvest areas are delineated as river and bay based on information on the fisheries gathered throughout the years. Delaware River harvest is separated from Delaware Bay harvest at a line drawn from the mouth of the Leipsic River, DE to Gandy's Point, NJ (Figure 11).

Shad harvested in the Delaware River are considered to be 100% Delaware stock while those from the Bay areas are mixed stock and the origin of these fish may vary annually. In 1995, NJDFW initiated American shad tagging in Delaware Bay as part of a cooperative interstate tagging program between New York and New Jersey. Tagging was performed at Reed's Beach located in Cape May County, approximately 10 to 15 miles from ocean waters. American shad

are caught as bycatch in NJ's striped bass tagging program. This program utilizes drifting gill nets during February through May of each year. In recent years, bass have been very abundant in the sampling with few American shad being caught. Over the past five to seven years fewer than 100 shad were caught and tagged annually.

A total of 4,239 American shad were tagged from 1995 to 2011 (Table 3). Through May 2011, there have been 246 American shad returns reported (5.8% of tagged fish). The tag return data indicate that shad taken in this portion of Delaware Bay are of mixed stock origin. Reported recaptures of American shad tagged in Delaware Bay ranged from the Santee River in South Carolina to the St. Lawrence River near Quebec, Canada (Table 4).

The proportion of out-of-basin (non-Delaware River stock) shad present throughout the Bay and River undoubtedly changes annually and most likely decreases as one moves up the Bay and into the River. Analysis completed for the 2007 ASMFC Stock Assessment estimated that 39% of shad caught in lower Delaware Bay were of Delaware River stock origin. Other stocks with significant tag returns included the Hudson River (17%) and Connecticut River (15%).

Delaware stock commercial landings have declined since 1990 for a variety of reasons including a decline in the stock, increased abundance of striped bass, reduced efforts of Delaware fishers and attrition in the New Jersey fishery as fishers retire from the business. Furthermore, 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. A comparison of the commercial landings to gill net CPUE from Smithfield Beach shows a similar trend between the fishery and a measure of escapement from the upper Delaware (Figure 10).

Fishery biological data: size, sex and age composition

Lewis haul seine: Data on age, size and sex composition of shad captured in the Lewis haul seine fishery have been collected intermittently since 1979. Beginning in 2008, reporting of biological data (i.e., total number shad landed, length, sex, and scale samples) was mandatory as part of contractual obligations with the Co-op. Mean fork lengths for both genders show similar changes over time with no apparent overall trend toward an increase or decrease in mean fork length (Figure 12).

New Jersey: Length frequency data (total length) was collected from American shad caught during fishery independent tagging operations by gill net in lower Delaware Bay. However, data are comparable to the commercial fishery since similar gill net mesh sizes are used for this program (Figure 13a). Sex ratios show the fishery is mostly prosecuted for females but there are years when the percentage of males increased (Table 5). The State of New Jersey obtains and will continue to obtain representative samples of the commercial catch to determine gender, size, and otolith samples for age estimation as required under the ASMFC FMP.

Delaware: Length, scales for age determination and weight data by sex was collected from American shad caught by commercial fishers in Delaware Bay from 1999 through 2010, except a few years (Figure 13b). The same data was collected from commercial fishers in the Delaware River beginning in 1997. In the last few years, extremely low landings in Delaware have eliminated this source of data. In 2011, Delaware Division of Fish and Wildlife was aided by the NJDFW in contacting New Jersey commercial fishers to obtain samples from their landings in the River and Upper Bay, and data was collected from several hundred fish.

Recreational Fisheries

The recreational fishery for American shad generally occurs from late March through June of each year. The fishery is concentrated in the non-tidal reach from Trenton, New Jersey (RM 133) to Hancock, New York (RM 330). Typically, the lower non-tidal reach is fished earlier in the season, moving further upriver as waters warm up.

Participation in the recreational shad fishery fluctuates but overall, angler effort has declined from historical levels. Numerous creel surveys have been conducted since the 1960's using various sampling methodology (Marshall 1971; Lupine et al. 1980, 1981; Hoopes *et al.* 1983; Miller and Lupine 1987, 1996; NJDFW 1993, 2001; Volstad e*t al.* 2003; Table 6). Estimates of angler catch and harvest in 2002 (Volstad 2003) were substantially lower than reported by Miller and Lupine (1987, 1996), representing a decline of total catch by 63% and 42% since those surveys in 1986 and 1995, respectively. Similarly, the percent of harvested shad declined from 1986 (49%) to 1995 (20%) and was estimated at 19% in the 2002 survey. Angler catch rates (shad/hr), also varied among the three surveys (0.19 shad/hr, 0.25 shad/hr, 0.13 shad/hr in 1986, 1995, and 2002, respectively) with the lowest catch rate observed during the 2002 study. Inclusion of only those anglers specifically targeting American shad during the 2002 survey however, substantially improved angler catch rate (non-tidal: 0.34 shad/hr; Volstad et al. 2003).

The PFBC, in collaboration with the National Park Service, jointly promotes a voluntary angler diary program (2001 – present) for reporting recreational angler catch (Lorantas and Myers 2003, 2005, 2007; Lorantas et al. 2004; Pierce and Myers 2007). In addition, the reporting of catch is mandatory for all licensed guides operating in the Upper Delaware Scenic Recreational River. Catch rates of shad varied among years (0.01 – 0.11 shad/hr) with the highest rate observed in 2001 thereafter declining to a relatively stable rate after 2003 (Table 6). Harvest of shad by logbook anglers was minimal (0 – 10.9%) in any given year. Anglers reported 496 trips during which anglers landed shad, but anglers harvested one shad/trip from 57 trips (11%), 2 shad/trip from 19 trips (4%), 3 shad/trip from 9 trips (2%), and only 4 trips (0.8%) harvested more than 3 shad/trip.

In-State Bycatch and Discards

There is little information on bycatch or discards of shad in any commercial fisheries within the Delaware Estuary, although it is known that male shad are discarded when they are no longer profitable to commercial fishermen. Some shad (male and female) are also discarded during

the striped bass fishery in Delaware for the same reason. As previously discussed, fishers in the lower Bay area may harvest shad from other river systems but as the fish move further up the Bay, the more likely fishers are to be harvesting Delaware River stock.

The recreational fishery for shad in the Delaware River principally practices catch-and-release (R. Marks, Delaware River Shad Fisherman's Association, personal communication). There have been at least two studies which estimated catch and release mortality in the Susquehanna River (Lukacovic 1998; reference point mileage: Conowingo Dam RM 10) and Hudson River (Millard *et al.* 2003, tidal influenced). These studies estimated catch and release mortality at less than 2 percent. The Co-op considers mortality due to recreational angling to be of minimal impact despite the long migrations necessary for the Delaware River American shad population. It should be noted that the shad in the non-tidal Delaware River experience long migrations and the inherent energy expenditure is presumed to be greater for these shad as compared to those in the previous studies, thus the expected catch and release mortalities may or may not be similar. The tidal influence of the Delaware River terminates near Trenton, NJ at RM 133, therefore the shad must traverse another 207 miles of river without the aid of the tide to assist the shad in its spawning migration.

Impacts of Restoration Stocking

The PFBC has been stocking otolith-marked American shad fry as part of their restoration program for the Delaware River Basin (Table 7). Eggs collected from Delaware River shad have been used in restoration efforts on other rivers, but since 2000, all Delaware River shad fry have been allocated to the Lehigh, and Schuylkill rivers. Occasionally, excess production was stocked back into the Delaware River at Smithfield Beach (2005 – 2008). Since 1985, egg-take operations on the Delaware River have resulted in the use of an average of 765 adult shad brood fish per year. Eggs from these shad are fertilized and transported to the PFBC's Van Dyke Anadromous Research Station where they are hatched, otolith-marked and stocked in areas above dams where fish passage projects are in place or are planned.

The contribution of hatchery-reared fry to the returning population was estimated by interpretation of oxytetracycline daily tagging patterns within the otolith microstructure (Hendricks *et al*. 1991). The total hatchery contribution at Smithfield Beach was low ranging from 0.0 to 7.8% (Table 8) suggesting that hatchery-reared fry are not a significant component of the Smithfield Beach catch. In contrast, electrofishing between Easton and Chain Dams showed that an average of 74% of captures were hatchery fish. At the Fairmount Dam on the Schuylkill River, about 96% of the fish returning to spawn are of hatchery origin. In addition, below the confluence of the Lehigh River with the Delaware River, Hendricks *et al.* (2002) demonstrated the occurrence of hatchery stocked shad in the Raubsville collections. Hatchery origin fish favored the west side of the river, presumably homing to the Lehigh River where they were stocked as fry.

2.3 Other Influences on Stock Abundance

In addition to harvest and natural mortality, other factors can also impact American shad populations. The Co-op has identified several such influences: (1) water pollution block, (2) the Atlantic Multi-decadal Oscillation which correlates with Delaware River stock indicators, (3) striped bass-American shad interaction which shows that American shad commercial harvest in the lower Bay negatively correlates with the recreational catch of striped bass, and (4) potential effects from overfishing and ocean bycatch.

2.3.1 Water Pollution Block

During the late 1800s there was evidence indicating that shad were spawning in the freshwater tidal areas of the mainstem as well as several tributaries of the lower Delaware River. It was presumed that the principal spawning area was located just south of Philadelphia prior to 1900. The prevalence of spawning in tidewater near Burlington was documented by the huge fishery there, as well as the hatchery effort that took place at that location (Gay 1892). During the 1940s and 1950s, heavy organic loading around Philadelphia, Pennsylvania caused severe declines in dissolved oxygen (D.O.). The ensuing "D.O. blocks" made parts of the lower Delaware River uninhabitable for fish during the warmer months of the year (Sykes and Lehman 1957). A remnant of the American shad run in the Delaware River survived by migrating upstream early in the season, when water temperatures were low and flows were high, before the D.O. block set up. These fish, because of their early arrival, migrated far up the Delaware to spawn. Out-migrating juveniles survived by moving downriver late in the season during high flows and low temperatures, thus avoiding the low oxygen waters present around Philadelphia earlier in the fall. Pollution continued to be a major factor until passage of the Federal Clean Water Act in 1972. This Act was instrumental in the elimination of the "pollution block" in the region around Philadelphia (Figure 14). By 1973, the majority of spawning took place above the Delaware Water Gap more than 115 river miles upstream. American shad can now freely pass through this area during the spring spawning run as well as the fall out-migration. Recent observations indicate that shad spawning has returned to the tidal areas of the Delaware.

2.3.2 Atlantic Multidecadal Oscillation (AMO)

North Atlantic sea surface temperatures have been found to exhibit long-duration oscillation for at least the last 150 years (Schlesinger and Ramankutty 1994; Enfield et al 2001). This includes most of the North Atlantic Ocean between the equator and Greenland. Kerr (2000) termed this oscillation the Atlantic Multidecadal Oscillation (AMO) to distinguish it from the atmospheric North Atlantic Oscillation (NAO). Models of the ocean and atmosphere that interact with each other indicate that the AMO cycle involves changes in the south-to-north circulation, including the Gulf Stream current, and overturning of water and heat in the Atlantic Ocean. When the overturning circulation decreases, the North Atlantic temperatures become cooler.

The AMO delineates cool and warm phases that may last for 20-40 years at a time and a difference of about 1°F between extremes. These changes are probably a natural climate oscillation and have been measured for at least 150 years. A positive AMO indicates a warm phase while a negative AMO indicates a cool phase. The AMO is currently in what is considered a warm phase since the mid-1990s (AMO Kaplan SST V2 data is provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd/).

The AMO affects air temperatures and rainfall over much of the North America including the frequency of major droughts in the Midwest and Southwest such as those during the 1930s and the 1950s. Between AMO warm and cool phases, Mississippi River outflow varies by 10% while the inflow to Lake Okeechobee, Florida varies by 40% (Enfield et al 2001). It is also reflected in the frequency of weak tropical storms that mature into severe Atlantic hurricanes, with at least twice as many severe hurricanes during warm phases. In the 20th century, the climate swings of the AMO have alternately camouflaged and exaggerated the effects of global warming, and made attribution of global warming more difficult to ascertain.

In an attempt to determine if there was any evidence of a relationship between the AMO and measures of the American shad stock within the Delaware River Basin, the Co-op first compared the AMO to the Lewis haul seine CPUE (Figure 15). The Lewis haul seine represents the longest catch per unit effort within the Basin. The Co-op analyzed various portions of the AMO dataset but determined the smoothed January to December average was the best fit for final analysis. A five-year moving average was developed for all data to decrease yearly variability. This was a similar methodology as used for the most recent ASMFC weakfish stock assessment which used a 10 year average (ASMFC 2009).

The smoothed Lewis haul seine CPUE index is calculated as a catch per haul with haul data collected back to 1925. From 1925 to 1971, the smoothed Lewis haul seine CPUE averaged less than seven fish per haul except for the brief period during 1961-1965. The Lewis haul seine CPUE increased steadily from 1972 to 1990, similar to the AMO. A quick decline ensued through 1997 with a continued steady decline until 2007. There has been a slight increase in recent years.

No correlation is evident between the Lewis haul seine CPUE and the AMO from 1925 to 1971. As noted earlier, this period also coincided with very poor water quality (i.e., dissolved oxygen pollution block) within the Delaware River. As water quality improved from the 1970s into the 1990s, the American shad population within the Delaware River also improved. From 1972 to 1989, the smoothed Lewis haul seine CPUE correlated well with the smoothed AMO with an R^2 = 0.7986 (Figure 16). This correlation disintegrates during the 1990s suggesting a problem with the stock that is not related to the AMO. The Lewis haul seine to AMO analysis showed a negative correlation for the time period of 1990 to 2010 with an R^2 = 0.7811 (Figure 17).

Additional analysis was conducted between the AMO and the Smithfield Beach CPUE for 1990 to 2010. The first few years of this survey was associated with high catches but declined rapidly

throughout the remainder of the time series until recent years. The Smithfield Beach to AMO analysis showed a negative correlation for the time period of 1990 to 2010 with an $R^2 = 0.7771$ (Figure 18). This corroborates data reported earlier from the Lewis haul seine for the same time period.

In conclusion, this analysis provides evidence that long-term sea surface temperature change may have an impact on abundance of American shad within the Delaware Basin. The Lewis haul seine CPUE correlates well with the AMO during the AMO index's rise in the 1970s and 1980s but there is a disconnect that occurs during the 1990s that currently is unexplainable. Potential sources of the discontinuity include decline in adults due to overharvest; bycatch discards in ocean fisheries; increased predation from striped bass or other species; or other unknown interruption of the spawning runs during this time period.

2.3.3 Striped Bass vs. American shad

To investigate the hypothesis that striped bass have had a negative impact on American shad abundance in the Delaware River, correlation analysis was conducted between the Lewis haul seine index of adult shad abundance and an index of striped bass abundance in Delaware state waters, using the National Marine Fisheries Service's Marine Recreational Fisheries Statistics Survey (MRFSS; Figure 19a). The Lewis haul seine index was used as a proxy of the Delaware shad stock, given its longer timer-series to 1981 when the MRFSS survey was initiated and high correlation with the Smithfield Beach relative abundance index.

The contrast in the abundance of striped bass over this period is particularly large in the Delaware. Abundance was extremely low in the 1980s, but dramatically increased through the 1990s, being declared fully restored in 1998 by the Atlantic States Marine Fisheries Commission. Prior to resurgence in the 1980s, the Delaware River stock was considered extinct by some writers. Clark and Kahn (2009) demonstrated that catch per trip in the Delaware spring gill net fishery in the Delaware Bay and River increased by 3000% to 6000% between 1987 and 2002-2003.

Conversely, trends in American shad abundance, as implied by the Lewis haul seine are essentially the opposite of striped bass population trends. The shad population within the Delaware River, while variable, tended to be at higher levels during the 1980s and early 1990s, prior to record lows observed after 1999. Striped bass total catch per recreational trip for the state of Delaware had a highly significant negative correlation with the Lewis haul seine index (Figure 19b; Pearson's $r = -0.76$, $P << 0.01$).

2.3.4 Overfishing and Ocean Bycatch

Excessive losses to directed fishing and bycatch are often implicated as causative factors in fish stock declines. Directed commercial harvest occurs in spawning rivers on adults and until 2005, in ocean waters. Recreational harvest of American shad generally occurs during spawning migrations. American shad taken while fishing for other species is called bycatch and it can occur in both rivers and the ocean.

We evaluated potential impacts of recent directed in-river commercial harvest of Delaware American shad by comparing losses estimated by the hind cast method discussed in Section 5.2 to relative abundance of the spawning stock as measured by catch per haul (CPH) in the Lewis haul seine fishery. Hind cast estimates were available from 1985 through 2010. For visual comparison, data were normalized by dividing each value by the mean of the time series. Results did not show a spike in harvest followed by a decline in stock size that would have suggested that directed harvest was excessive (Figure 20). In fact, the harvest and the stock index both declined during the time-series and were significantly correlated ($r = 0.66$, $P = 0.0002$). It would appear that in-river directed harvest declined as did the shad population. We did not evaluate impacts of recreational harvest on Delaware River American shad because data were too sparse for meaningful analyses. However, as discussed above, recreational harvest has generally been lower than reported commercial landings and much lower than the hind cast estimates of commercial losses.

Potential impacts of recent directed ocean harvest on American shad are more difficult to identify. Ocean harvest has been poorly quantified. Moreover, limited tagging data suggests that ocean harvest is made up of many Atlantic coast populations. Since the stock of origin is generally not known, it is very difficult to identify losses that are specific to the Delaware River stock. Some sense for relative losses on a coast-wide basis can be obtained from reported landings. The Delaware shad population appeared to decline most precipitously during the early 1990s. Mean annual harvest for states north of North Carolina during the first half of the 1990s was 1,148,893 lbs per year from ocean waters and 413,510 lbs from in river fisheries (ASMFC 2007). Reported annual ocean harvest of American shad from outside the 200 mile limit off of Mid-Atlantic and New England states was 310,000 lbs (Northwest Atlantic Fisheries Organization http://www.nafo.int/about/frames/about.html Catch statistics for ocean waters outside of the EEZ). Recent ASMFC shad assessments have drawn conflicting conclusions about impact of this ocean harvest. ASMFC (1998) concluded that there was no evidence that the ocean harvest was affecting coast-wide stocks. ASMFC (2007) hypothesized that coastal harvest was affecting some stocks including that in the Delaware River. Directed harvest of American shad in state coastal waters has been banned by US Atlantic Coastal states since 2005.

Possible effects of bycatch losses in ocean commercial fisheries on Delaware River American shad are much more difficult to evaluate. Not only are bycatch losses poorly documented, but as with ocean harvest, stock of origin is generally not known. American shad appear to be a rare or poorly reported event in available fisheries observer data obtained by the National Marine Fisheries Service Observer Program. For example, NFSC (2009) reported that only 2,918 kg of American shad were observed during 10,108 observer days on a range of commercial fishing trips in northeastern ocean waters from July 2007 through June 2008. However, 405,881 kg of unidentified herring were landed during this time period which was tentatively identified as shad. NFSC (2011) estimated a mean of 385,000 lbs of American shad were landed in ocean fisheries for squid, mackerel, and butterfish in 1991 through 1995. Becker (2010a and 2010b) reported on monitoring of landings from the commercial Atlantic herring fishery at

processing facilities from Cape May, NJ through Prospect Harbor, ME. From January through December 2010, he examined 46 samples and observed 171 kg of American shad in 58,783 kg of landed bycatch. Most shad observed in these fisheries were immature fish. Few data are available from onboard observers on bycatch of shad in near-shore or estuarine fisheries of the Northeast. Based on reports by fishermen, few American shad have been taken by Northeastern commercial fishermen in recent years (ASMFC 2007, 2008, 2009). However, differentiating among Alosines in commercial catches is questionable. Both Amendment 14 of the Squid, Butterfish Plan, Mid-Atlantic Fishery Management Council and Amendment 5 to the Atlantic herring plan of the New England Fishery Management Council will begin to address bycatch issues in the ocean.

3 Sustainable Fishery Benchmarks

The Co-op proposes a series of relative indices for monitoring trends in the American shad population in the Delaware River. The benchmarks were derived to allow the existing fishery to continue. The benchmarks have been set to respond to any potential decline in stock. Thus all benchmarks are viewed as conservative measures. The benchmark measures for maintaining sustainability are in order of their importance as follows:

1. Non-tidal JAI index
2. Tidal JAI index
3. Smithfield Beach adult CPUE survey
4. Harvest to Smithfield Beach relative abundance ratio

3.1 Juvenile Benchmarks

3.1.1 Non-tidal JAI index

The benchmark was based on data from years 1987-2007 (Table 1, Figure 21) and failure is defined as the occurrence of three consecutive JAI values below a value of 49.43 (i.e., the 25th percentile where 75% of the values are higher). Exceeding the benchmark will trigger management action. The period of 1987 to 2007 was selected because sampling methodology was more consistent, with representative stations throughout the middle and lower reaches of the River.

Sampling to generate this index was discontinued in 2008. Currently, the Co-op is unable to accomplish sampling for this index pending securing funding for field activities (Section 6.1.1).

3.1.2 Tidal JAI index

The benchmark was based on data from years 1987-2010 (Table 1, Figure 22) and failure is defined as the occurrence of three consecutive JAI values below a value of 2.83 (i.e., the 25th percentile where 75% of the values are higher). Exceeding the benchmark will trigger management action. The period of 1987 to 2010 was selected as these encompass the years when sampling methodology and catches of shad were more consistent. The tidal JAI has been

above this target for the past three years. The preliminary 2011 data was not incorporated into the benchmark time period since the JAI may change slightly when data proofing is finalized.

3.2 Adult Benchmarks

3.2.1 Smithfield Beach CPUE Index

This benchmark is based on the annual CPUE (shad/net-ft-hr*10,000) in the PFBC egg-collection effort at Smithfield Beach and represents the entire data series available from 1990 through 2011 (Figure 23, Table 1). Failure is defined as the occurrence of three consecutive CPUE values below a value of 34.79 (i.e., the 25^{th} percentile where 75% of values are higher). Exceeding the benchmark will trigger management action. The 2010 index was above the target and the 2011 CPUE is estimated to be higher than that of 2010.

3.2.2 Ratio of commercial harvest to Smithfield Beach relative abundance index

One of the main concerns of fisheries managers is potential overfishing of a particular species. Determining overfishing or over-exploitation with accuracy is difficult when actual stock numbers are not measured or those estimates are considered not scientifically sound. Obtaining a ratio based on harvest and a measure of a fishery independent CPUE is one way of assessing exploitation trends. No indices of abundance, measured before harvest, exist for the Delaware River American shad stock, therefore we cannot estimate true relative exploitation. In the case of the Delaware shad stock, the Co-op analyzed a ratio of Delaware landings to the Smithfield beach gill net CPUE since 1990.

Acceptable measures of reported commercial harvest within the Delaware Basin have only been available from Delaware since 1985 and New Jersey since 2000. Landings data has been reported since the late 1800s but cannot be verified. Since the Smithfield Beach CPUE has been conducted since 1990, the Co-op agreed to develop a ratio of commercial harvest to CPUE for Smithfield Beach (landings/CPUE, scaled by 100) using the period from 1990-2010. The Co-op also decided to report the estimates combined and in two phases (1990-1999 and 2000-2010) to reflect the more accurate reporting from New Jersey during the 2000-2010 time period. For clarity, the 1990-1999 time period will be called the early period while data from 2000-2010 will be known as the late period.

To develop these estimates, an understanding of American shad migration patterns and fisheries within Delaware Bay must be considered (see Adult monitoring programs above). Based on New Jersey's mark/recapture information, American shad in the lower Bay are of mixed stock origin with returns from Canada to South Carolina. It is estimated that 39% of landings from the lower portion of the Delaware Bay are of Delaware stock origin. The 39% figure was developed from the number of recaptures reported during 1995-2011 within the Delaware Bay and River. This is considered a conservative estimate since some of these recaptures were taken in areas of mixed stock congregations and may have actually been from other stocks. All shad harvested within the tidal Delaware River and upper Bay (Figure 10) are considered to be Delaware stock. Total estimates of Delaware stock harvest were developed by

combining reported Delaware landings (river) plus the reported New Jersey landings (river) and 39% of the combined Delaware (bay) and New Jersey (bay) landings from mixed stock fisheries (Table 2).

The Co-op has agreed to use the ratio of commercial harvest/CPUE from Smithfield Beach as a means to determine if management intervention is warranted to insure stock sustainability. These ratios ranged from 6.78 to 26.69 in the early period and 2.66 to 52.48 in the late period (Table 2; Figure 24). The early time series varied without trend while the late period varied through 2004 but has decreased through recent years. The benchmark was based on data from 1990-2010 (Table 2; Figure 23) and failure is defined as the occurrence of three consecutive values above a value of 27.79 (i.e., the 85th percentile where 15% of the values are higher). Exceeding the benchmark will trigger management action. During the early period, the ratio estimate did not exceed the benchmark. During the late period, the benchmark was exceeded three times (2001, 2003 and 2004). This index is particularly appealing since it is sensitive to changes in both harvest and abundance (CPUE).

It should be noted that this approach to measuring exploitation is conservative. To mimic change in actual exploitation rate, a relative exploitation rate is estimated by dividing landings by some index of stock abundance prior to the fishery. In our case, we are measuring relative abundance after the fishery occurs. That means the denominator is reduced and the relative exploitation index is biased high. The degree of bias is related to the fraction of the original population that is lost to harvest (exploitation rate or u). Bias is relatively low at low levels of exploitation, but increases as exploitation rate increases. For perspective, we created a fictitious population of fish, exploited it at different rates, and calculated actual exploitation rates based on abundance of survivors (our approach) and on abundance of the population prior to harvest (Figure 25). Results suggested low bias when actual exploitation rates were less than u <= 0.10, but dramatically higher bias when u exceeded 0.30.

The American shad stock in the Delaware River is considered stable but at low levels compared to the historic population. Juvenile production has been measured since 1980. The JAI decreased somewhat after 1996 but has increased in recent years. It is unknown why there was a decrease in numbers of returning adult American shad within the Delaware River during the 2000s. One hypothesis is that commercial overfishing within the Delaware Estuary could be hindering stock growth. Results of the harvest to relative abundance ratio analyzed here are not consistent with that hypothesis. The harvest to relative abundance ratio has varied without trend or even decreased in recent years. Furthermore, the Co-op does not believe that the recreational fishery is responsible for the recent downturn in spawning stock, based on low estimated harvest in the most recent creel survey (2002).

4 Proposed Time Frame for achievement

The Co-op proposes that this plan be re-evaluated on a five-year cycle. All datasets will be updated annually for assessing the exceeding of any benchmarks requiring immediate

management action. All sustainability benchmarks will be reviewed annually after completion of annual ASMFC compliance reports.

5 Adaptive management

5.1 Benchmarks

All management actions are subject to the severity of the breach. For instance, if the Smithfield Beach CPUE falls below the benchmark for three consecutive years but the JAI is increasing and appears in no danger of doing the same, the action taken will be less severe than if the JAI was decreasing and in jeopardy of falling below its own benchmark. If both indices were to exceed the benchmarks simultaneously, swift action such as a harvest closure may be justified. The Co-op will review these benchmarks annually to determine if management action is necessary, and if yes, to detail appropriate management based on the options below.

There are many restrictions already in place for the commercial fishery that limit participation. These include limited entry, seasons and gear restrictions throughout the Delaware Bay. The recreational fishery is limited to three fish in most areas and will be so in all waters once this plan is fully enacted. One of the following options regarding breach of the Delaware River benchmarks are based on amending the current regulations.

A) If the non-tidal or tidal JAI benchmark is exceeded:

Option 1: closure of commercial fishery; recreational catch and release only

Option 2: reduce commercial fishery by 50% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 1 fish bag limit

Option 3: reduce commercial fishery by 25% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 2 fish bag limit

B) If the Smithfield Beach adult CPUE benchmark is exceeded:

Option 1: closure of commercial fishery; recreational catch and release only

Option 2: reduce commercial fishery by 50% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 1 fish bag limit

Option 3: reduce commercial fishery by 25% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 2 fish bag limit

C) If both the tidal JAI and Smithfield Beach adult benchmarks are exceeded:

Option 1: closure of commercial fishery; recreational catch and release only

Option 2: reduce commercial fishery by 50% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 1 fish bag limit

D) If the harvest to Smithfield Beach adult CPUE ratio benchmark is exceeded:

Option 1: closure of commercial fishery; recreational catch and release only

Option 2: reduce commercial fishery by 50% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 1 fish bag limit

Option 3: reduce commercial fishery by 25% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 2 fish bag limit

5.2 Auxiliary Data

The Co-op has recognized several datasets that warrant monitoring as collaborating evidence to support the identified sustainability benchmarks: 1) the Lewis haul seine as a fishery dependent index of adult spawning population; 2) the harvest to Lewis haul seine relative abundance ratio; 3) estimates of commercial effort; 4) the harvest of shad from mixed stocks in the Delaware Bay; and 5) commercial exploitation (u) as derived from a scaled up Smithfield Beach relative abundance.

Lewis haul seine: The Lewis haul seine provides a separate index of the returning adult spawning population to the Delaware River (Figure 7). Given the greater uncertainty of catchability in the Lewis haul seine fishery, the Co-op does not desire to overstate sustainability targets with this index. Yet, the observed strong correlation between the Smithfield Beach and Lewis haul seine CPUEs suggest these indices are complementary and can offer two viewpoints on the status of the Delaware River shad population (Figure 8).

Harvest to Lewis haul seine relative abundance ratio: As with the calculation of the harvest/Smithfield Beach relative abundance ratio, the Co-op derived a similar ratio using the Lewis haul seine dataset. While the Lewis haul seine dataset is extensive, the Co-op decided to restrict the ratio estimator to the same time–series (1990-2010) as Smithfield Beach. The ratio was calculated as the landings/CPUE, scaled by 1000. These the estimates were calculated as combined and in two phases (1990-1999 and 2000-2010) to reflect the more accurate reporting from New Jersey during the 2000 to 2010 time period. Estimates of relative exploitation based on the Lewis haul seine relative abundance ranged from 2.33 to 21.42 in the early period and 5.93 to 43.84 in the late period (Table 2; Figure 26).

The Co-op decided to use the harvest to Lewis haul seine CPUE ratio as ancillary data to the four benchmarks due to the inconsistent nature of the Lewis haul seine which implements varying nets pending environmental conditions. There has also been a concern raised regarding possible changes to the channel in the area of the fishery which may have changed catchability

of American shad. If a distinct increase in this ratio occurs over time, technical review will ensue.

Commercial effort: Commercial fishing effort for Delaware is calculated from the mandatory monthly landings data using net yards as the indicator of measure. Net-yards were the yards of net fished on that day the landings occurred. The Delaware CPUE estimate of the Delaware River drift-net fishery was developed to determine a time period when shad catches were typically the greatest. The CPUE from this time period was then used to determine possible trends in stock abundance.

Effort data for New Jersey's commercial fishery is estimated from mandatory logbooks, which started in 2000 and CPUE is presented in pounds per square foot of netting. New Jersey data is partitioned to examine the in-river CPUE as well as the CPUE in mixed stock areas of Delaware Bay.

The overall State of Delaware CPUE has declined since 1992 due to a combination of a decline in adult abundance and major changes to the way Delaware fishers prosecute the fishery (Figure 27). Shad is no longer the target species but are considered bycatch in the striped bass fishery. Few shad are harvested in the fishery since the larger mesh sizes used for striped bass allow escapement. To emphasize the decline of effort on American shad within the Delaware Estuary, the Co-op examined effort data from the State of Delaware, expressed in yards of net fished, from 1990 to 2010 (Figure 28). Effort has decreased dramatically throughout the time series with effort peaking in the bay fishery in 1991 and the river fishery in 1996.

The overall New Jersey commercial fishery CPUE varied without trend throughout the time period with a slight decline in recent years due mainly to a lack of effort and large concentrations of striped bass within the river (Figure 29). New Jersey's river fishery CPUE mimics the overall trend. CPUE within the Bay has actually increased in recent years; however, actual effort is low. Overall effort in New Jersey has decreased more than 30 percent since 2005. The New Jersey river fishery CPUE shows a similar trend to the Delaware River CPUE in recent years (Figure 30).

Delaware Bay landings: Landings in the Delaware Bay present a unique situation. Ongoing tagging studies conducted by the NJDFW in the lower eastern Bay off Reed's Beach, New Jersey, approximately fifteen miles north of Cape May Point (Section 2.2.2) indicate that American shad landings from this portion of Delaware Bay are a mixture of East Coast stocks (Tables 3-4). Shad recaptures have occurred in various locations from South Carolina to Canada, with the majority coming from the Delaware, Hudson and Connecticut Rivers.

The actual landings for the Delaware Bay have declined from a peak of 581,805 pounds in 1990 to a low of 6,730 pounds in 2009 (Figure 31). Landings in 2010 were also low (9,371 lbs). No expansion of the Delaware Bay fishery is expected in the near future, specifically for the 2011 season based on communication with fishers in this area. The main causative factors of the decline include regulatory action (limited entry), attrition in the fisheries, low market value of

shad, increased mesh size (7" stretch mesh) used by Delaware gill netters targeting larger striped bass and increased abundance of striped bass. New Jersey gill netters who target shad complain that their nets catch striped bass in high numbers, yet they are not allowed to land bass; the bass damage their nets and they cut their hands on the spines and gill cover edges. Delaware gill netters report that any attempts to target shad catch large numbers of bass, and if they have already filled their striped bass quota, they cannot land additional striped bass. The overall decrease in coastal stocks of American shad may be an additional factor to the decrease in landings of shad.

There is concern whether the results of the tagging efforts off Reeds Beach are indicative of the mixed stock shad landed by commercial fishers within the Delaware Bay. One theory is that as shad swim north in late winter and early spring, they must navigate across the mouth of Delaware Bay. If they swim slightly too far to the west, which could be made more likely by strong tidal flows into the Bay and warmer water temperatures within the Bay, they will arrive in the Bay just to the west of Cape May. Since tidal exchange with the ocean is occurring, it may take them some time to orient themselves to exit the Bay and continue north along the coast.

In an effort to determine stock composition, Delaware and New Jersey provided samples for a Hudson River Foundation genetic study in 2009 and 2010. These fish were caught in several locations within Delaware Bay, including Delaware commercial landings from the western side of the Bay, and from New Jersey landings off Reeds Beach and the Maurice River Cove area. Stock composition will be determined based on microsatellite nuclear DNA. The analysis should be completed during the winter of 2012 (J. Waldman pers. comm.). Until this analysis is completed, the extent of stock mixing in commercial landings will be unclear.

The Co-op is sensitive to the potential impacts on East Coast shad stocks should there be any increase in exploitation, especially as these stocks recover. The Co-op will continue to annually monitor landings in the lower Delaware Bay to ensure any significant increase in harvest results in immediate increased regulatory control for keeping exploitation at current levels to protect other East coast stocks. However, pending outcomes of the genetic analysis for defining the extent of the mixed stock composition of commercial landings, a plan will be developed to constrain expansion of this fishery. Although a specific benchmark has not been developed at this time, it is anticipated Co-op members will develop a more comprehensive approach once the additional information is available. Current regulations include limited entry and gear restrictions, which have limited access to the fishery and limited harvest to individual fishers. However, the Co-op will work to define specific management actions such as gear restrictions, mesh size restrictions, closed areas, closed seasons or individual quotas which can be implemented if landings exceed a threshold level.

Discussion points and analysis for consideration within the timeframe of this plan will include:

- A more detailed analysis of existing tagging data to determine migration patterns of recaptured fish within season. This may allow the Co-op to develop closed seasons when non-Delaware Basin stocks are more prevalent.

- A more thorough analysis of mixed stock landings and effort will be undertaken including exact areas of the Bay where landings occur. The Co-op can also estimate harvest levels of stocks based on recapture percentages, as demonstrated in Table 9.
- NJ and DE management staff will consult with the fishing industry and State Management Councils to determine appropriate benchmarks for the commercial mixed stock fishery. This will be completed within three years, reviewed by the Co-op and the finalized benchmark(s) incorporated into this plan.
- Funding is needed to support a more robust tagging program in the Delaware Bay for determination of the mixed stock component of Delaware Bay landings. Consideration may be given to expanding tagging to the DE side of the Bay for complementing efforts in NJ waters to determine if stock percentages are the same throughout the Bay. Portions of the Bay fishery are prosecuted further up the Bay than where the NJ tag program is conducted.

Exploitation: This section presents work done towards the goal of estimating the exploitation rate from the commercial fishery conducted in New Jersey and Delaware. In order to evaluate the impact of the fishery and possibly move in the future toward biological reference points, estimates of exploitation rate and the instantaneous fishing mortality rate are needed. Estimation of one will allow conversion to the other. In previous decades, the Co-op supported two general methods of estimating the number of shad in the River every spring: tag-recapture methods 1976-1977; 1979-1983; 1992 (Schaefer Estimation, 1976–1992, NJDFW 1993, 2001) and hydroacoustic methods, alternative estimates 1995-1996; 2000-2007 (Barnes-Williams Environmental Consultants 1992, 1995, 1996, 1998, 1999, 2000, 2001; P.A.C.E. Environmental Services 2002, 2003, 2004, 2005). Our current best estimate of relative abundance is the Smithfield Beach index of catch per unit effort, which began in 1990. Prior to 1990, we have the Lewis haul seine catch per haul index. A plot of these two indices for 1990-2010 shows similar trends (Figures 8-9). The correlation between these two indices is highly significant (Pearson product-moment: $r = 0.866$; $P < 0.001$). This suggests that we can consider the Lewis haul seine index to be a proxy for the Smithfield Beach index prior to 1990.

If we plot the Lewis haul seine index with the Schaffer tag-recapture estimates, we see another very tight correlation (Spearman's Rank; $r_S = 0.83$, $n = 17$, $P < 0.01$) (Figure 32). This suggests that both the Lewis haul seine index and the Schaffer estimates are tracking the stock size fairly well, since the correlation of the two is extremely high, and the probability that the match is due to chance alone is very small. Yet estimation of population size in prior years using hydroacoustic methodology (alternative estimates), do not appear correlated with the Smithfield Beach index except for the last four years (Figure 33).

Estimation of the American shad run size requires the scaling up of the observed relative index. Given the tight correlation between the Lewis haul seine and Smithfield beach indices and the uncertainty of shad catchability in the Lewis haul seine, the Co-op decided to initially focus on Smithfield Beach index. The Smithfield Beach relative index was scaled to an estimate of absolute abundance using a scalar (Schaefer estimate)/ (Smithfield index) derived from Schaffer estimates. Only a single year, 1992, was a Schaeffer estimate conducted concurrently with the

Smithfield Beach index. This scalar was then multiplied by all Smithfield Beach index values to get absolute population estimates for all years (Figure 34). These run size estimates were in very close agreement with the run size estimates from the hydroacoustic estimates (alternative estimates) during the last four years (2004-2007).

Estimation of the commercial exploitation rate and the instantaneous fishing mortality exerted by the combined New Jersey and Delaware fisheries can now be calculated based on the run size estimates. Corrections to the commercial harvest were required to estimate landings prior to the implementation of mandatory reporting by New Jersey (2000). Previous landings were developed by the National Marine Fisheries Service, but that agency did not seem to have good estimates from the River and Upper Delaware Bay, where much of the New Jersey fishery occurred. We used the ratio of New Jersey river landings to the bay landings in Delaware for the period 2000-2003, after the New Jersey mandatory reporting went into effect, but before Delaware shad landings declined due to a shift to larger mesh nets that catch few shad. The average of this ratio for the four years was then applied to the period before 2000 by multiplying the Delaware Bay landings by this ratio, producing a higher set of New Jersey landings for this period (Figure 35). The resulting estimates of annual instantaneous fishing mortality average F = 0.15 from 1990 to 2010, and have declined in recent years. A value of F = 0.15 is a low rate of fishing mortality (Figure 36). Exploitation of the total Delaware stock was estimated to vary between 1.3% and 28.5%, during the time period with a long-term average of 13.7% (Figure 37). It should be noted that this mortality rate only applies to in-river fisheries and does not account for mortality caused by the historical directed ocean fishery or the historic and current ocean bycatch losses.

6 Future Monitoring Programs

6.1 Fishery Independent

6.1.1 Juvenile abundance indices

The tidal beach seine program conducted by NJDFW will continue, given its importance to their striped bass monitoring requirements.

The Co-op would like to reinstitute the upper river non-tidal JAI index that was discontinued in 2008 by the NJDFW. A look at the period of 1999 to 2005 lends emphasis to the Co-op's concerns over lack of juvenile abundance sampling within the non-tidal section of the Delaware River. During that period, two year classes were considered to be below the sustainability benchmark while five others were at or slightly higher than the benchmark. During that same period, the tidal JAI was below its benchmark only once and well above it for the majority of those years. The consensus of the Co-op is that it is critical to renew the non-tidal survey as part of this sustainability plan, given the perceived variability of juvenile production within the entire Basin.

The Co-op is discussing possible options to re-initiate the non-tidal JAI. In the spirit of moving forward with the Delaware River Basin Sustainability Plan, the Co-op proposes retaining the non-tidal JAI benchmark as discussed above with the caveat of its use pending secured funding.

6.1.2 Adult stock monitoring

Spawning stock

The two fishery independent surveys at Smithfield Beach (gill net survey) and at Raubsville (electro-fishing) will continue for, at minimum, the next five years. The objective is to obtain biological data on the spawning stock as well as a relative abundance.

Total mortality

Due to the uncertainty associated with ageing of shad scales and otoliths, confidence in ageing is low. The Co-op will not use mortality estimates as targets for managing the Delaware River shad stock. However, scale and otoliths will continue to be collected and the Co-op will re-evaluate the use of mortality estimates as shad ageing techniques improve.

Upriver and downriver passage efficiencies

Access into tributary waters from the Delaware River mainstem is problematic. The two largest tributaries to the Delaware River Basin, the Lehigh River (RM 186) and Schuylkill River (RM 92.5), have several low head dams with various fishway designs. Furthermore, the Delaware Canal along Pennsylvania from Easton, Pa to Bristol, Pa and the Delaware & Raritan Canal from Bulls Island, NJ to Trenton, NJ restrict access to some tributaries in Pennsylvania and New Jersey; whereas other tributaries (e.g., Tohickon Creek, Cooks Creek and Frya Run in Pennsylvania) retain their direct connection to the Delaware River mainstem.

The PFBC, with the support from PA Department of Conservation and Natural Resources and the City of Easton, has received a grant from American Rivers/NOAA Community Grant Program to fund a feasibility study for improving fish passage at the two lowermost dams on the Lehigh River (i.e., Easton (RM 0.0) and Chain (RM 3.0) dams). This proposal was fully funded ($75,000 from Am. Rivers; and an additional $75,000 non-federal matched fund from Palmerton Resource Damage Settlement) in the spring of 2011. The PFBC anticipates the study's findings to provide future guidance on its shad restoration program in the Lehigh River. The study is expected to be completed no later than end of summer 2013.

Hatchery evaluation

Otoliths of all hatchery-reared American shad larvae stocked by PFBC into the Delaware River Basin are marked with tetracycline to distinguish hatchery-reared shad from wild, naturally-produced shad (Hendricks *et al*. 1991). Since 1987, larvae were marked with unique tagging patterns accomplished by multiple marks produced by immersions 3 or 4 days apart. Determinations of origin are interpreted from the presence of florescent tagging patterns in the otolith microstructure. Hatchery contribution is determined for specimens collected in the

Schuylkill and Lehigh rivers above the first dam and in the Delaware River at Smithfield Beach and Raubsville. The proportion of hatchery fish present in juvenile or adult population will continue to be monitored as per ASMFC Amendment 3.

6.2 Fishery Dependent

6.2.1 Commercial fishery

The States of Delaware and New Jersey will conduct fishery dependent surveys as required by ASMFC Amendment 3.

6.2.2 Recreational fishery

Comprehensive angler use and harvest surveys are monetarily prohibitive. As an alternative, the Co-op intends to utilize the PFBC/NPS angler logbook survey as a measure of recreational angling on the Delaware River stock. To provide a more comprehensive understanding of angler catches the Co-op has solicited the Delaware River Shad Fisherman's Association (DRSFA) to participate in the logbook survey. The DRSFA organization represents the single largest sportsmen's group dedicated to fishing for American shad in the Basin states.

Angler information will also be gathered from a long standing annual American shad harvest tournament. The "Forks of the Delaware Tournament" is located in Easton Pa., lasts for multiple days in mid-May, and traditionally draws sizable angler participation. Unfortunately, historical information from this tournament is sporadic. To improve data gathering, the PFBC requires a special activities permit for any tournament with participation over ten anglers. A condition for this permit is the mandatory reporting of tournament catch. Tournament directors are required to electronically submit catch information (total number of participating anglers, total hours fished, total number of fishes checked in by species, total number of fishes released) for the tournament, but not on a per angler basis.

The Marine Recreational Information Program (MRIP) will be reviewed for pertinent angler catch data for the Delaware River Basin. However this program does not extend to anglers above head-of-tide, where the shad fishery is principally focused.

7.0 Fishery Management Program

7.1 Commercial Fishery

Delaware: The State of Delaware has no regulations that have been specifically adopted to reduce or restrict the landings of American shad in the Delaware Estuary. However, there are regulations that apply to the commercial fishery in general that limit commercial fishing. As described above, existing regulation affecting the striped bass fishery will remain the same, such as limited entry, limitations on the amount of gear and annual mandatory commercial catch reports. Area and gear restriction will remain the same (Table 10).

New Jersey: New Jersey waters are open to gill netting for the majority of the year but the current directed commercial fishery for American shad occurs primarily during March through April of each year depending on environmental conditions. New Jersey regulations are listed in Table 10. Limited entry is in place; permits are not gear specific. All permits are currently non-transferable except to immediate family members.

Pennsylvania and New York: Both Pennsylvania and New York do not permit the commercial harvest of American shad within the Delaware River Basin.

7.2 Recreational fishery

Above the Commodore Barry Bridge (82.9 km downstream from the head-of-tide in Trenton), both, New Jersey and Pennsylvania currently have an American shad creel limit of three shad per day. Below the Commodore Barry Bridge, the six shad/day limit still applies, but very little recreational fishing for shad occurs in this tidal zone. In the joint New York/ Pennsylvania reaches of the upper Delaware River, the creel limit is three per day. The State of Delaware continues with a ten fish/day, combined American and hickory shad, with no size limit or closed season. Little effort is expended by recreational anglers for American shad in Delaware waters.

The Lehigh and Schuylkill rivers represent the two largest tributaries to the Delaware River, draining 3,529.7 km^2 and 4,951.2 km^2, respectively. Both of these tributaries in their entirety are contained within Pennsylvania, under the stewardship of the Pennsylvania Fish and Boat Commission. The Lehigh River is managed under the Lehigh River Fisheries Management Plan adopted in May 2007 (Arnold and Pierce 2007; http://www.fishandboat.com/LehighRiverPlan.htm). Current regulations allow for a one shad daily creel, no minimum size in both rivers, including all their respective tributaries, starting at the Easton Dam (RM 0.0) on the Lehigh River and Interstate 95 Bridge on the Schuylkill River (RM 0.5). Both rivers are stocked with hatchery reared fry annually to support PFBC's restoration efforts, with a goal of generating self-sustaining spawning populations. Given PFBC's ongoing restoration program for these rivers, by definition, the American shad populations within the Lehigh and Schuylkill rivers are considered recovering stocks. As such, the PFBC intends to modify current regulations to reflect recreational catch and release only and prohibit any commercial harvest by Jan 1, 2013 for the Lehigh and Schuylkill basins. The Lehigh River Management Plan has been submitted to the ASMFC in fulfillment of the required Implementation (Recovery) Plan.

7.3 Bycatch and Discards

New Jersey and DE will require data on bycatch and discard in commercial fisheries in state waters in their mandatory reports. In the recreational fishery many anglers are practicing catch-and-release, there are no plans to regulate this other than with creel limits which are already in place.

8.0 Literature Cited

Arnold, D.A. and D.J. Pierce. 2007. Lehigh River Fisheries Management Plan. Bureau of Fisheries, Division of Fisheries Management. Pennsylvania Fish and Boat Commission. 450 Bellefonte, PA 16823.

ASMFC (Atlantic States Marine Fisheries Commission). 1998. American Shad Stock Assessment. ASMFC, Peer Review Report, Washington, D.C.

ASMFC (Atlantic States Marine Fisheries Commission). 2007. American shad stock assessment report for peer review. Washington, D.C.

ASMFC (Atlantic States Marine Fisheries Commission) 2008. Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for shad and river herring (Alosa spp.) 2009. Atlantic States Marine Fisheries Commission. Washington, DC, USA.

ASMFC (Atlantic States Marine Fisheries Commission). 2009. Weakfish Stock Assessment Report. Peer Review Report, Washington, D.C.

ASMFC (Atlantic States Marine Fisheries Commission) 2009. Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for shad and river herring (Alosa spp.) 2009. Atlantic States Marine Fisheries Commission. Washington, DC, USA.

ASMFC (Atlantic States Marine Fisheries Commission). 2010. Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). Atlantic States Marine Fisheries Commission Shad and River Herring Plan Development Team. 158p.

Barnes-Williams Environmental Consultants, Inc., 1992. 1992 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

Barnes-Williams Environmental Consultants, Inc., 1995. 1995 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

Barnes-Williams Environmental Consultants, Inc., 1996. 1996 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

Barnes-Williams Environmental Consultants, Inc., 1998. 1998 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

Barnes-Williams Environmental Consultants, Inc., 1999. 1999 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

Barnes-Williams Environmental Consultants, Inc., 2000. 2000 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

Barnes-Williams Environmental Consultants, Inc., 2001. 2001 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

Becker 2010a, J. 2010a. Estimates of American shad and river herring bycatch in the winter ocean fishery for sea herring and mackerel in the New York Bight. Semit-Annual Compliance Report to the New York State Department of Environmental Conservation, New Paltz, NY.

Becker 2010b. Estimates of American shad and river herring bycatch in the winter ocean fishery for sea herring and mackerel in the New York Bight. Annual Report for 15 March 2010 to 31 December 2010 to the New York State Department of Environmental Conservation, New Paltz, NY

Cating, J. P. 1953. Determining age of American shad from their scales. U.S. Fish Wildlife Service, Fishery Bulletin 54(85): 187-199.

Clark, J. H. and D. M. Kahn. 2009. Amount and disposition of striped bass discarded in Delaware's spring striped bass gill-net fishery during 2002 and 2003: effects of regulations and fishing strategies. North American Journal of Fisheries Management 29: 576-585

Duffy, W.J., McBride, R.S., Hendricks, M.L., and K. Oliveira. *In review*. Otolith age validation and growth estimation from oxytetracycline-marked and recaptured American shad Alosa sapidissima.

Enfield, D.B., A.M. Mestas-Nunez, and P.J. Trimble. 2001. The Atlantic multidecadal oscillation and its relation to rainfall and river flows in the continental US. Geophys Res Letters 28(10): 2077- 2080

Gay, J. 1892. The shad streams of Pennsylvania. In Report of the State Commissioners of Fisheries for the years 1889-90-91. Harrisburg, Pennsylvania.

Gibson, M.R., V.A. Crecco, and D.L. Stang. 1988. Stock assessment of American shad from selected Atlantic coastal rivers. Atlantic States Marine Fisheries Commission, Special Report 15, Washington, D.C.

Hendricks, M.L., T.R. Bender, Jr. and V.A. Mudrak. 1991. Multiple marking of American shad otoliths with tetracycline antibiotics. North American Journal of Fisheries Management 11:212-219.

Hendricks, M.L., R.L. Hoopes and D.A. Arnold. 2002. Homing of Hatchery reared American Shad to the Lehigh River, a tributary to the Delaware River. North American Journal of Fisheries Management 22:243-248.

Hoopes, R. L., R. A. Lahr, C. W. Billingsley. 1983. Angler use and fish harvest from the upper Delaware River during 1982. Pennsylvania Fish & Boat Commission. 450 Robinson Lane, Bellefonte, PA 18623.

Kaplan SST V2 data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd/

Kerr R.A. 2000. A North Atlantic climate pacemaker for the centuries. Sci. 288 (5473): 1984-1985.

Lorantas, R. M. and J. L. Myers. 2003. Delaware River and Estuary Angler Log 2001 Summary. Pennsylvania Fish & Boat Commission, 450 Robinson Lane, Bellefonte, PA 18623.

Lorantas, R. M., D. P. Kristine, J. L. Myers. 2004. Delaware River and Estuary Angler Log 2004. Pennsylvania Fish & Boat Commission, 450 Robinson Lane, Bellefonte, PA 18623.

Lorantas, R. M. and J. L. Myers. 2005. Delaware River and Estuary Angler Log 2003. Pennsylvania Fish & Boat Commission, 450 Robinson Lane, Bellefonte, PA 18623.

Lorantas, R. M. and J. L. Myers. 2007. Delaware River and Estuary Angler Log 2004. Pennsylvania Fish & Boat Commission, 450 Robinson Lane, Bellefonte, PA 18623.

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 21 Annapolis, Maryland.

Lupine, A.J., J. Buchanan, J. Gall and C. Weilandics, 1980. Delaware River Fisheries Research Project F-38-R-2. 1980 Delaware River American Shad Population Estimate. NJDFW Miscellaneous Report No. 43

Lupine, A.J., C. Weilandics, and J. Gall. 1981. Delaware River Fisheries Research Project F-38-R-3. 1981 Delaware River American Shad Population Estimate. NJDFW Miscellaneous Report No. 45

Marshall, R. W., 1971. Shad creel census. Unpublished Data. Pennsylvania Fish & Boat Commission, 450 Robinson Lane, Bellefonte, PA 18623.

McBride, R.S.,M.L. Hendricks, and J.E. Olney. 2005. Testing the validity of Cating's (1953) method of age determination of American shad using scales. Fisheries 30(10):10-18.

Millard, M.J., J. Mohler, A. Kahnle, K. Hattala, W. Keller, A, Cosman. 2003. Mortality Associated With Catch and Release of Angling of Striped Bass and American Shad in the Hudson River. U.S. Fish and Wildlife Service Northeast Fishery center. Lamar, PA 16848.

Miller, J.P. New Jersey Division of Fish and A.J. Lupine. 1987. Angler utilization and economic survey of the American shad fishery in the Wildlife. 1993. Delaware River. Fisheries Research Project F-48-R-7, Job I-1, Delaware River American Shad Fishermen's Association. Hellertown, PA. 26p.

Miller, A. and A. Lupine. 1996. Creel survey New Jersey Division of the Fish and Wildlife. 2001. Delaware River American shad recreational fishery. Shad Angler Logbook Survey. 2000 Survey Data with the Delaware River Shad Fishermen's Association. Hellertown, PA. 32p.

New Jersey Division of Fish and Wildlife. 1993. Delaware River Fisheries Research Project F-48-R-7, Job I-1, Delaware River American Shad Population Estimate.

New Jersey Division of Fish and Wildlife. 2001. Delaware River American Shad Angler Logbook Survey. 2000 Survey Data with the Delaware River Shad Fishermen's Association.

NFSC (Northeast Fisheries Science Center). 2009. Standardized bycatch reporting methodology, annual discard report 2009, section 1. Northeast Fisheries Science Center, National Marine Fisheries Service, Woods Hole, MA.

NFSC (Northeast Fisheries Science Center). 2011. Part I - preliminary analyses for Amendment 14 to the Atlantic Mackerel, Squid and Butterfish Fishery Management Plan., Prepared by the Northeast Fisheries Science Center for the Mid-Atlantic Fishery Management Council, Dover, DE.

P.A.C.E. Environmental Services. 2002. 2002 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

P.A.C.E. Environmental Services. 2003. 2003 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

P.A.C.E. Environmental Services. 2004. 2004 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

P.A.C.E. Environmental Services. 2005. 2005 American Shad Spawning Migration Hydroacoustic Monitoring Study at the Interstate 202 Toll Bridge on the Delaware River at Lambertville, New Jersey.

Pierce, D.J. and J.L. Myers. 2007. Delaware River and Estuary Angler Log 2005 & 2006. Pennsylvania Fish & Boat Commission, 450 Robinson Lane, Bellefonte, PA 18623.

Schlesinger,M.E., and N. Ramankutty. 1994. An oscillation in the global climate system of period 65-70 years. Nature 367: 723- 726.

Sykes, J.E. and B.A. Lehman. 1957. Past and present Delaware River shad fishery and considerations for its future. I.S. Fish and Wildlife Service, Research Report 46:25. Washington, D.C.

Volstad, J.H., W. Richkus, J. Miller, A. Lupine, and J. Dew. 2003. The Delaware River Creel Survey 2002. Pennsylvania Fish and Boat Commission, Versar Inc. Columbia, Maryland.

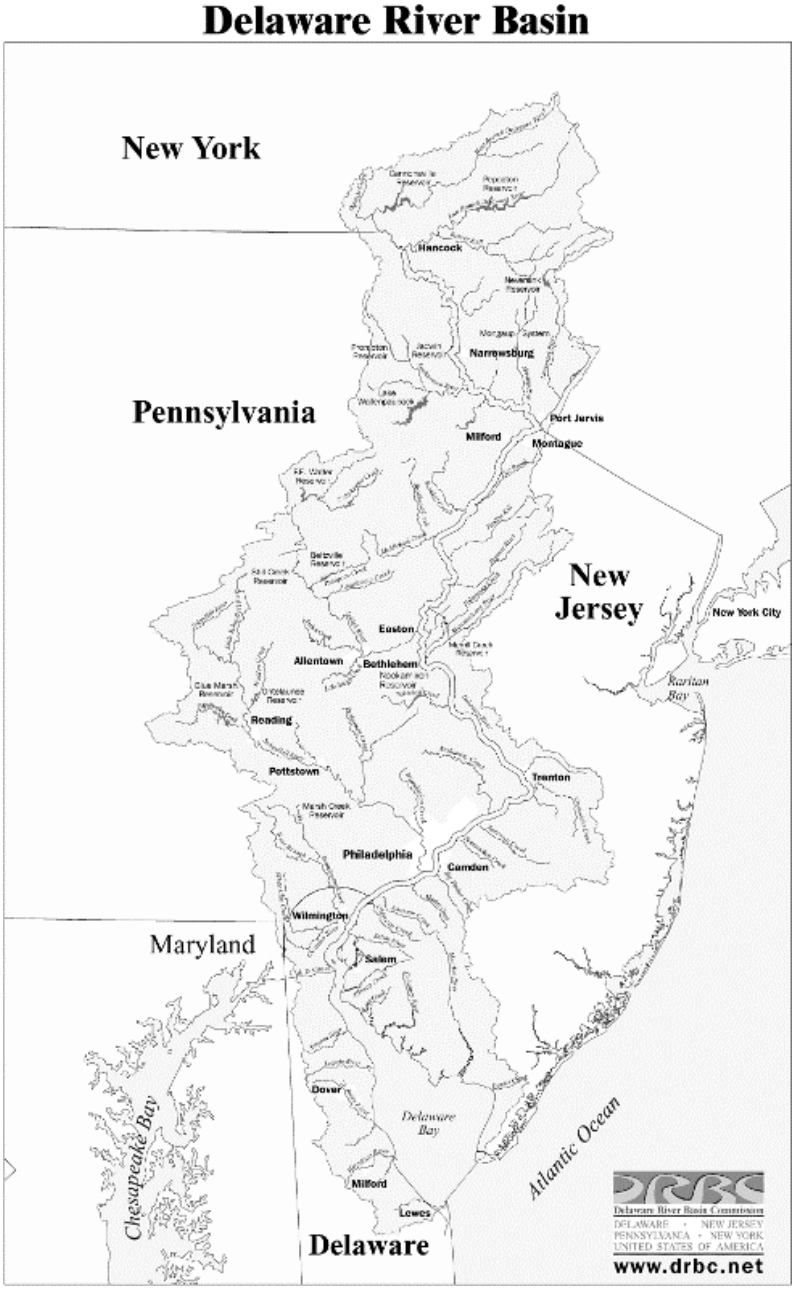


Figure 1. The Delaware River watershed.

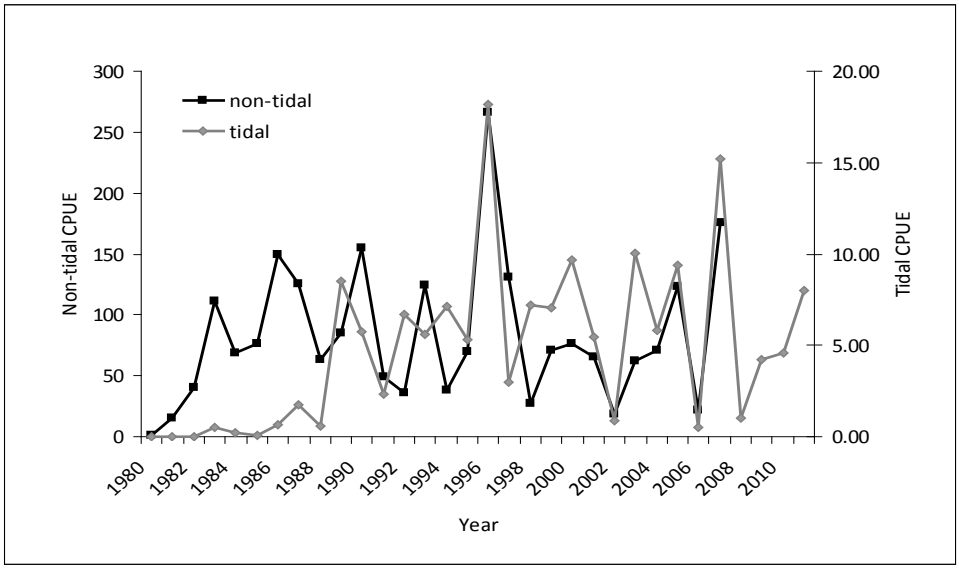


Figure 2. Non-tidal and tidal Delaware River American shad JAI (Geometric mean): 1980 – 2011. Data for 2011 is preliminary.

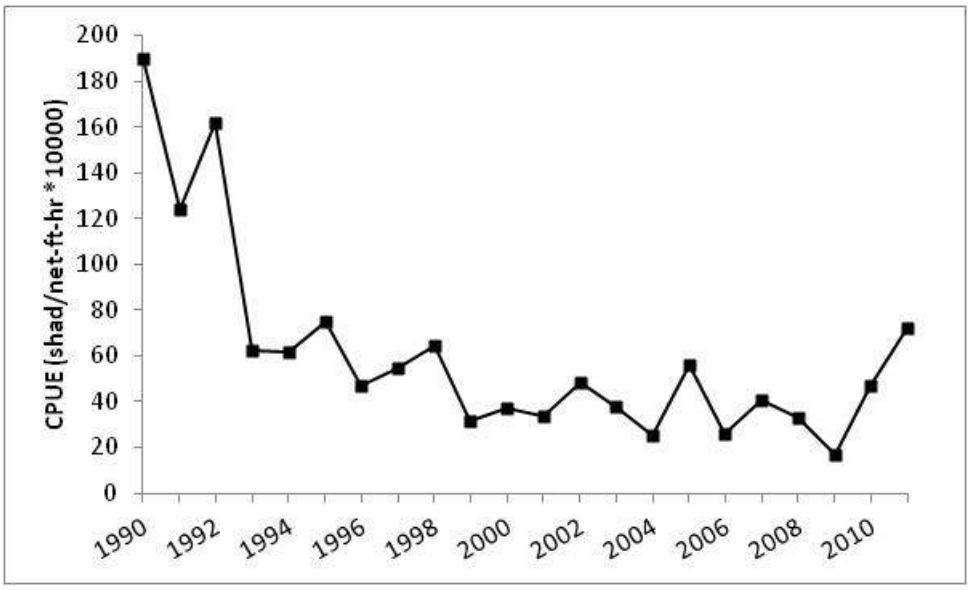


Figure 3. CPUE for American shad collected from the Delaware River at Smithfield Beach (RM 218) by gill net (shad/net-ft-hr * 10,000).

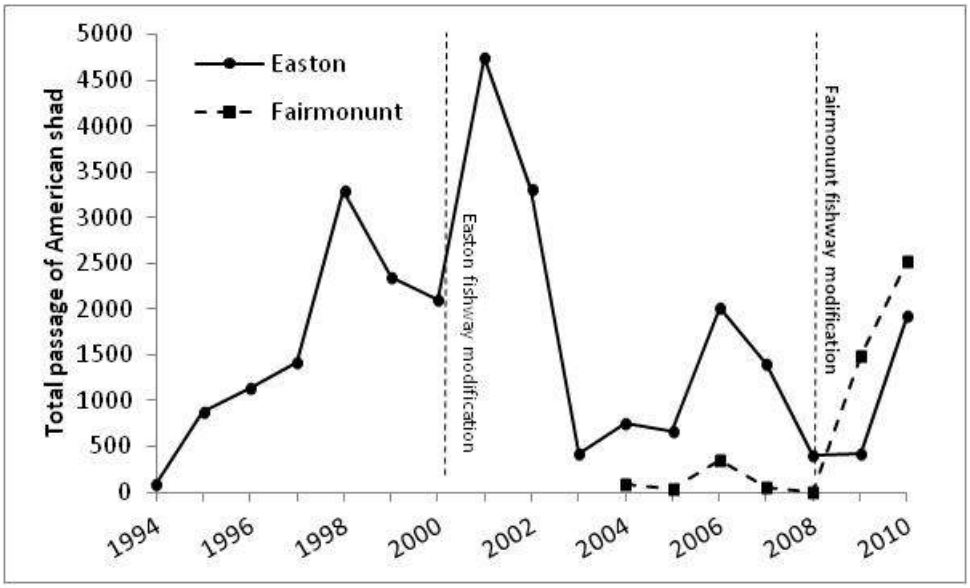


Figure 4. Upstream fish passage trends for the Lehigh (Easton Dam) and Schuylkill (Fairmount Dam) rivers.

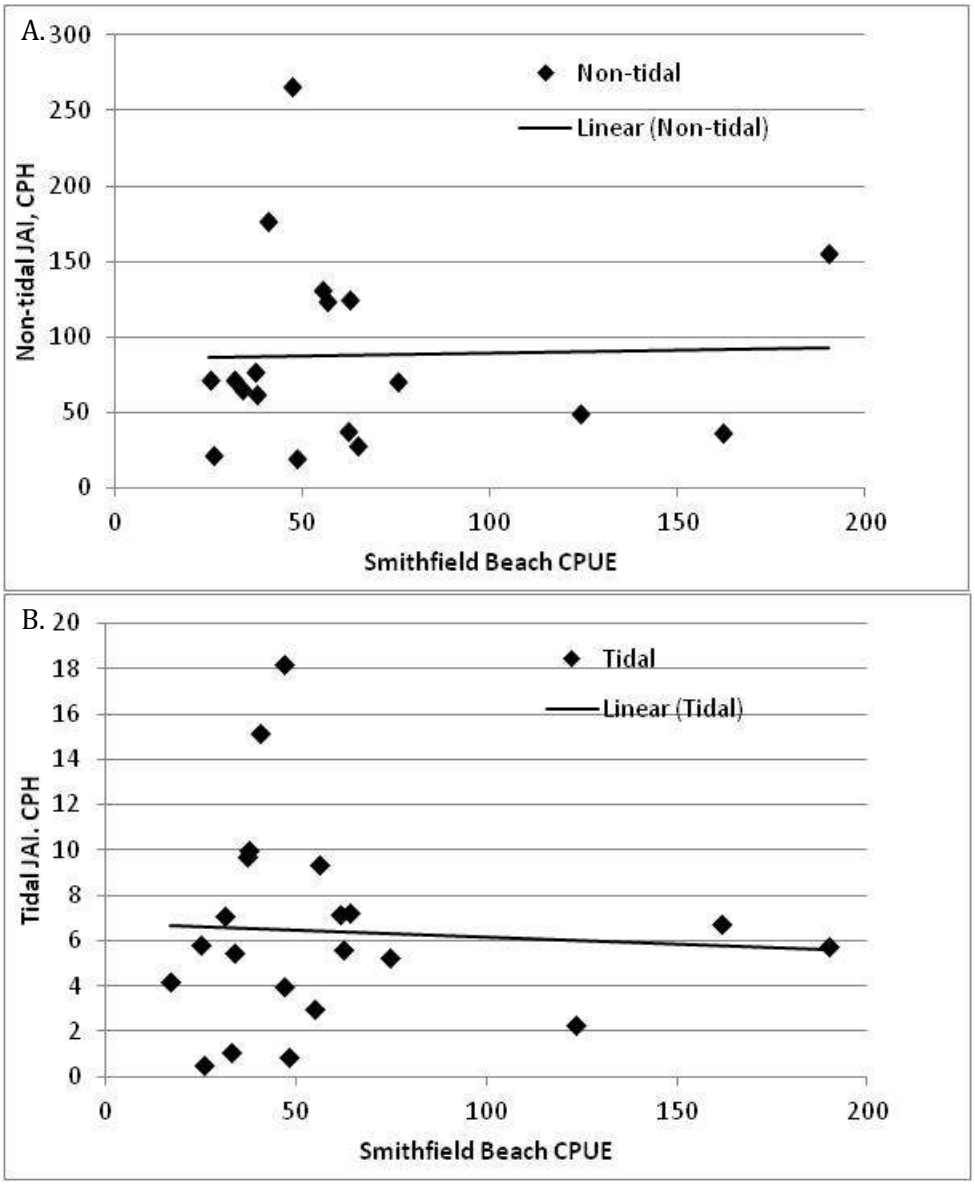


Figure 5. Scatter plots of the non-tidal (A) and tidal (B) JAIs to adult relative abundance as indexed at Smithfield Beach.

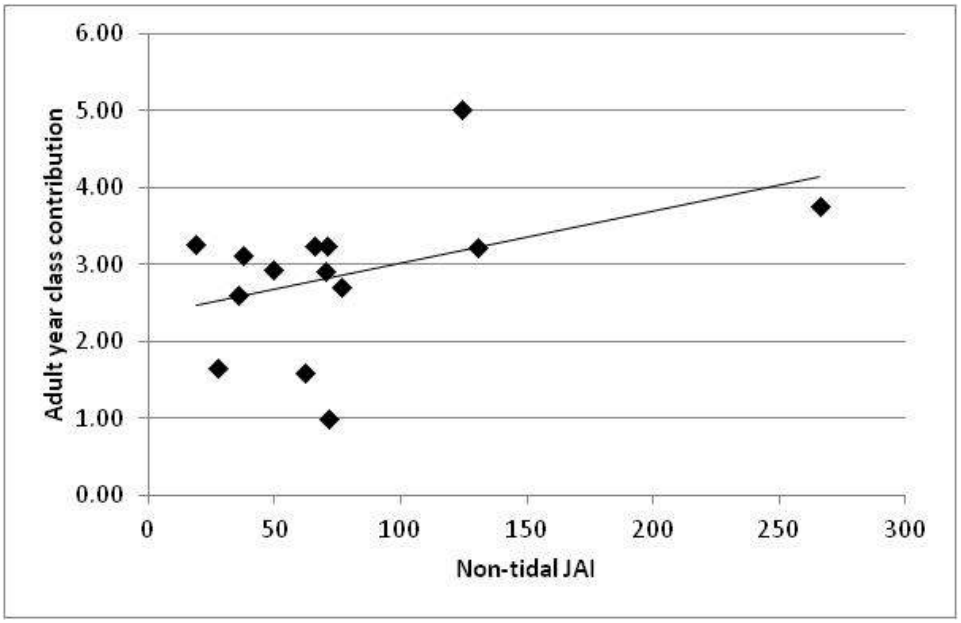


Figure 6. Correlation between spawning adult year class CPUE partitioned by year class contributions at Smithfield Beach to non-tidal JAI index.

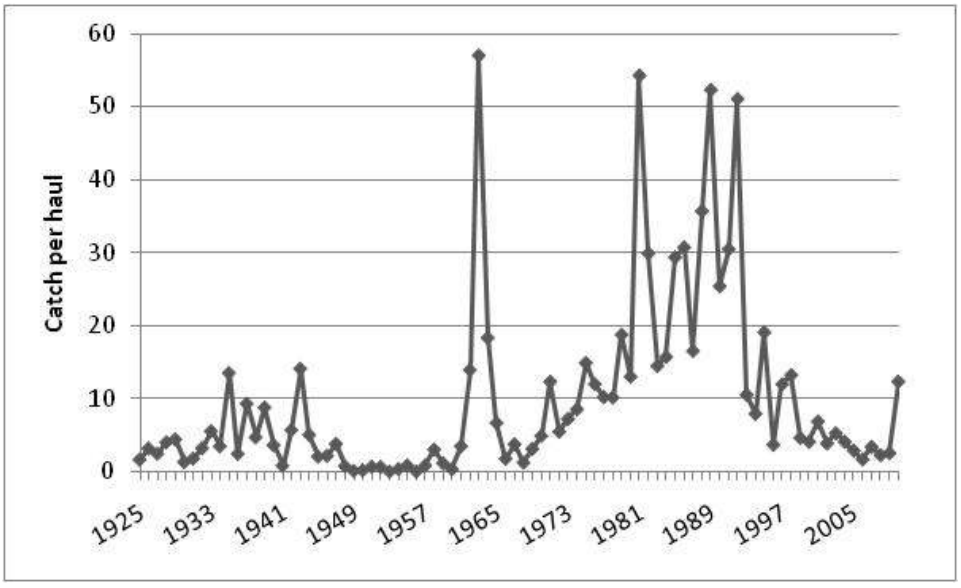


Figure 7. Lewis haul seine CPUE (shad/haul), 1925-2010.

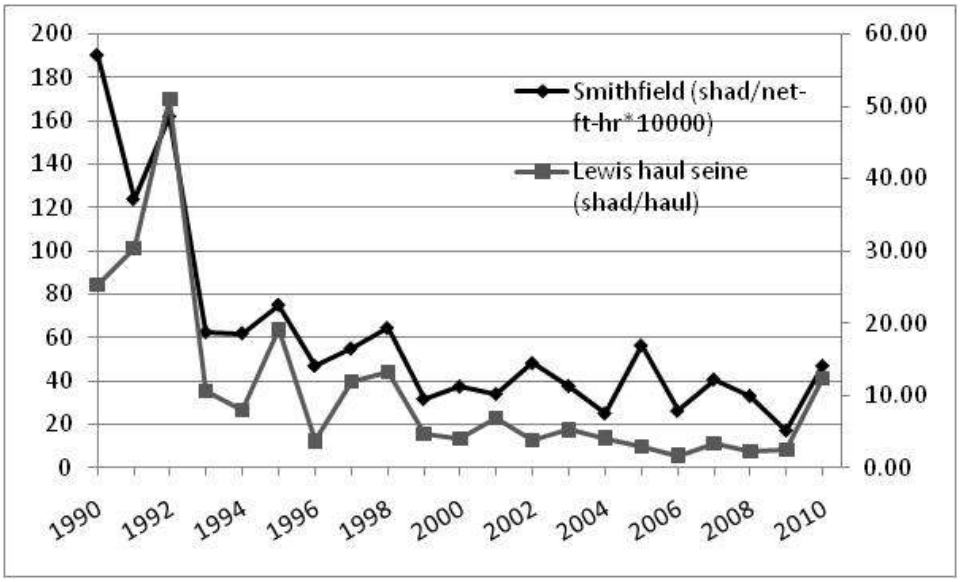


Figure 8. Trends in relative abundance as estimated from Smithfield Beach and Lewis haul seine, 1990-2010.

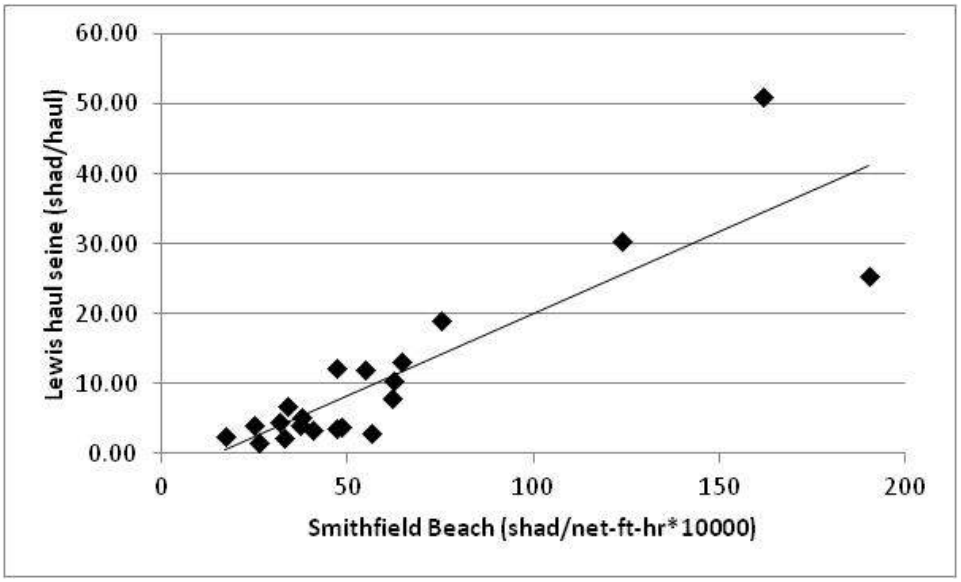


Figure 9. Correlation between Smithfield Beach and Lewis haul seine, 1990-2010.

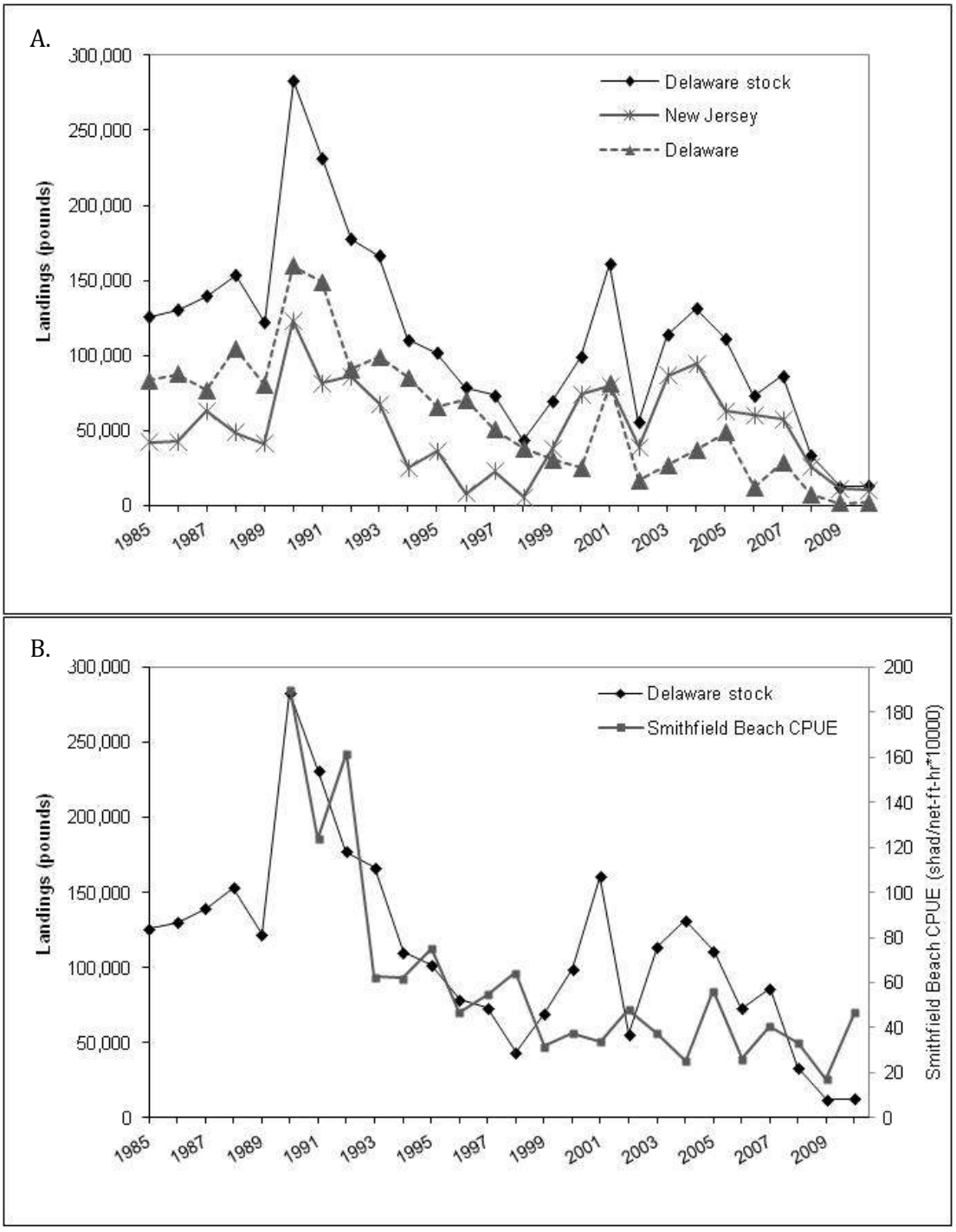


Figure 10. Commercial landings of American shad from New Jersey, Delaware and the combined Delaware stock (A); and the Delaware stock to Smithfield Beach CPUE (B).

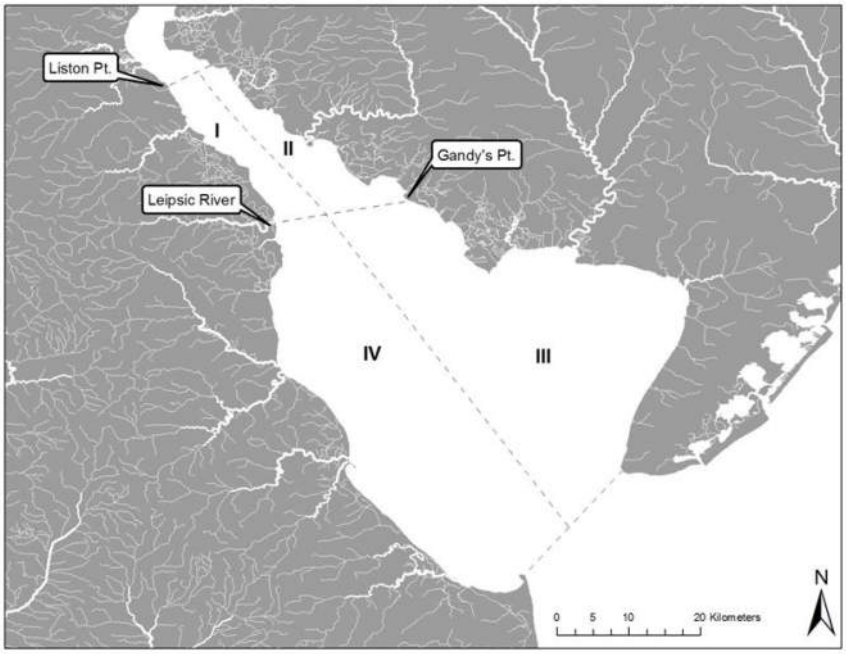


Figure 11. Map of illustrating general regions of commercial landings for River (I and II) and Bay (II and IV) reporting.

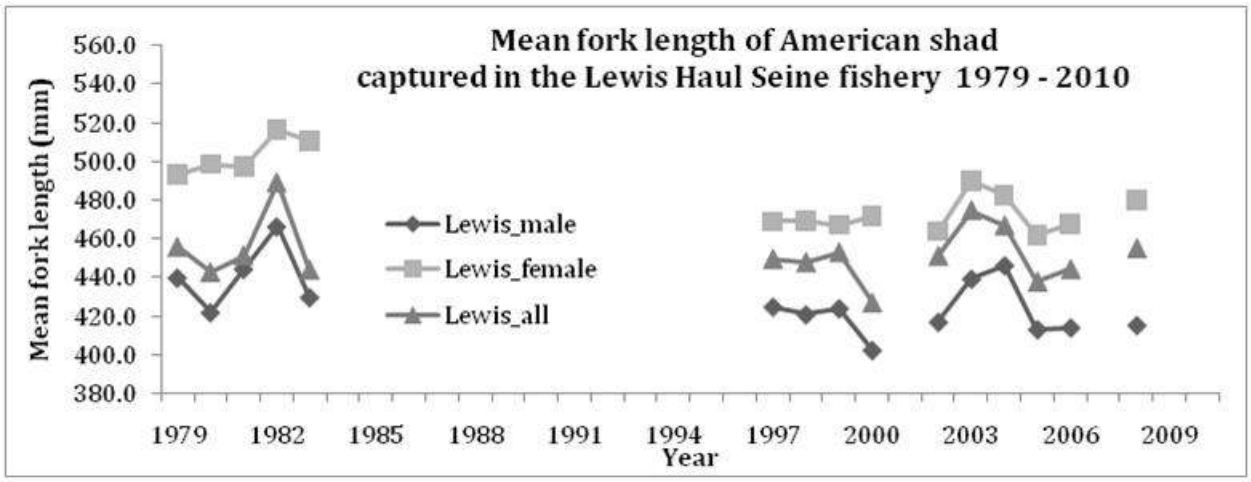


Figure 12. Mean fork length of male and female American shad captured in the Lewis haul seine fishery between 1997 and 2010.

A.

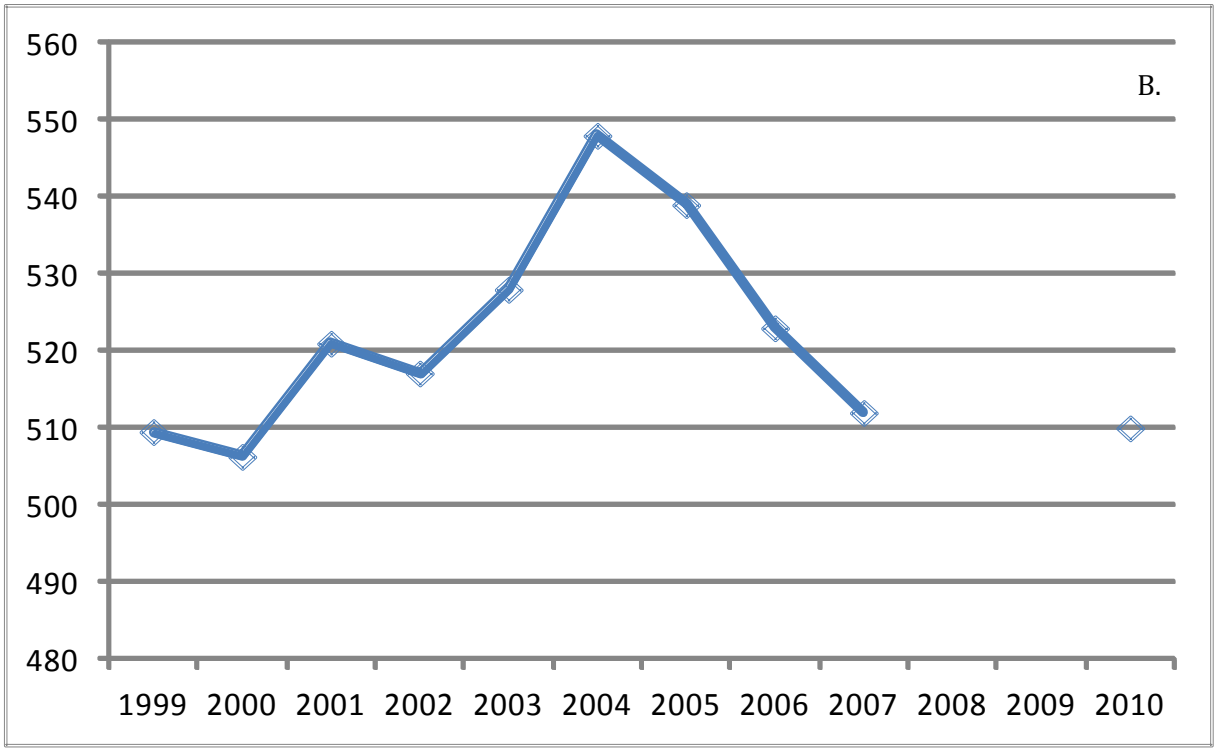


Figure 13. Length frequency of shad from A) New Jersey's Delaware Bay fisheries independent sampling at Reed's Point for American shad using gill net similar to commercial mesh sizes, length frequencies (sexes combined): 1997-2010; and B) State of Delaware commercial fishers American shad mean lengths from all locations sampled in the Delaware River and Bay, sexes combined, 1999-2010. No samples were obtained by Delaware in 2008 and 2009.

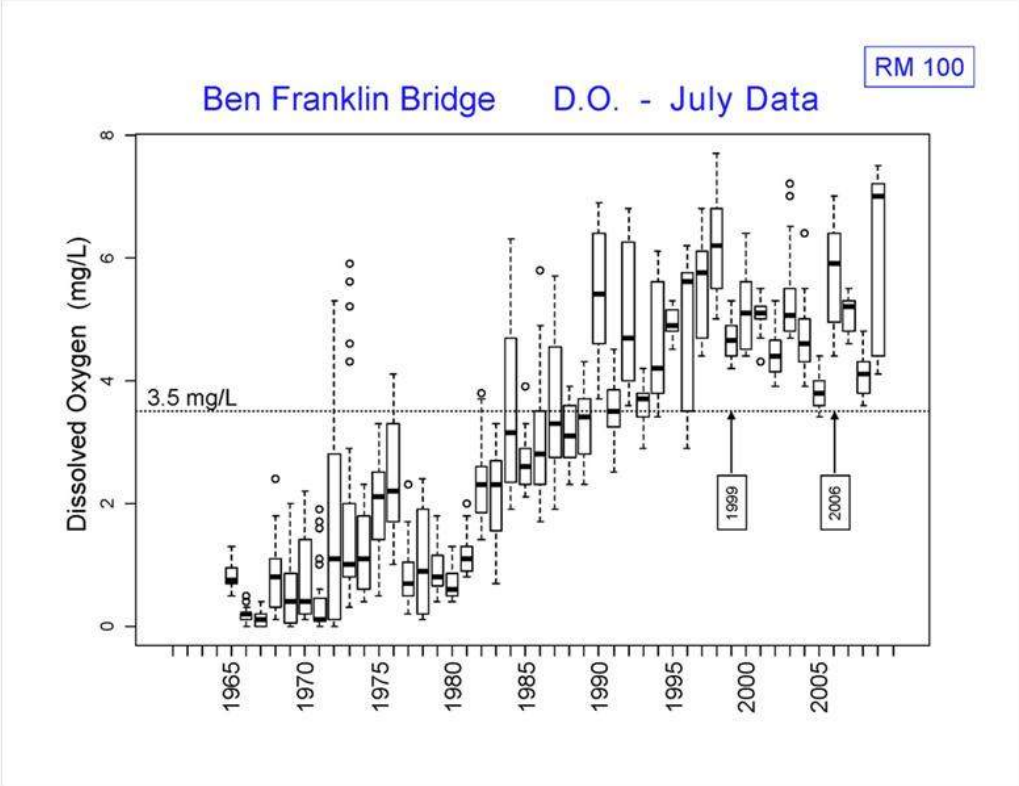


Figure 14. Box and whisker plot of dissolved oxygen concentrations during July, 1965-2009 at the Ben Franklin Bridge (RM 100). Data and graph provided by the Delaware River Basin Commission (DRBC).

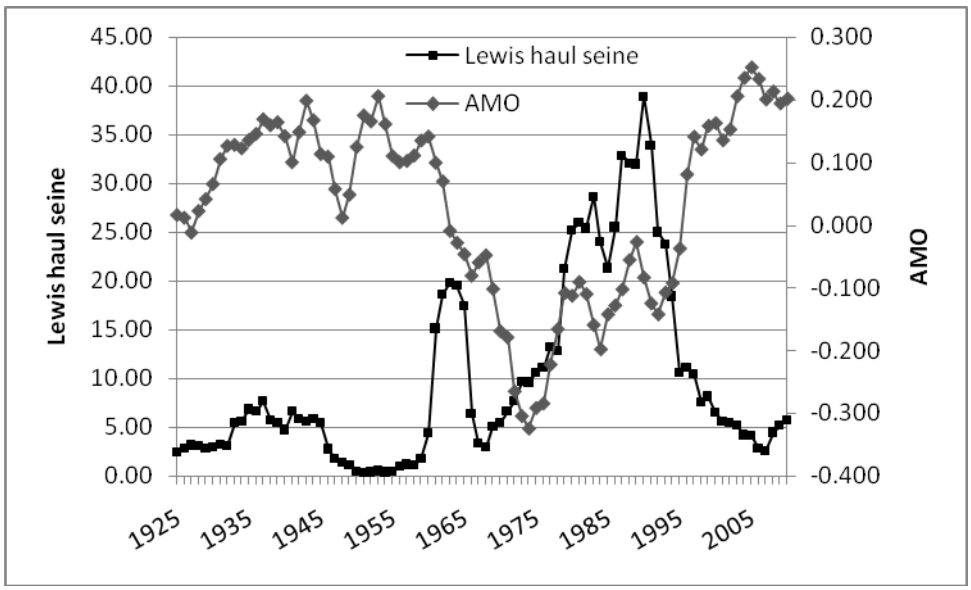


Figure 15. Five-year smoothed Atlantic Multidecadal Oscillation (AMO) compared to five-year smoothed Lewis haul seine CPUE: 1925 - 2010.

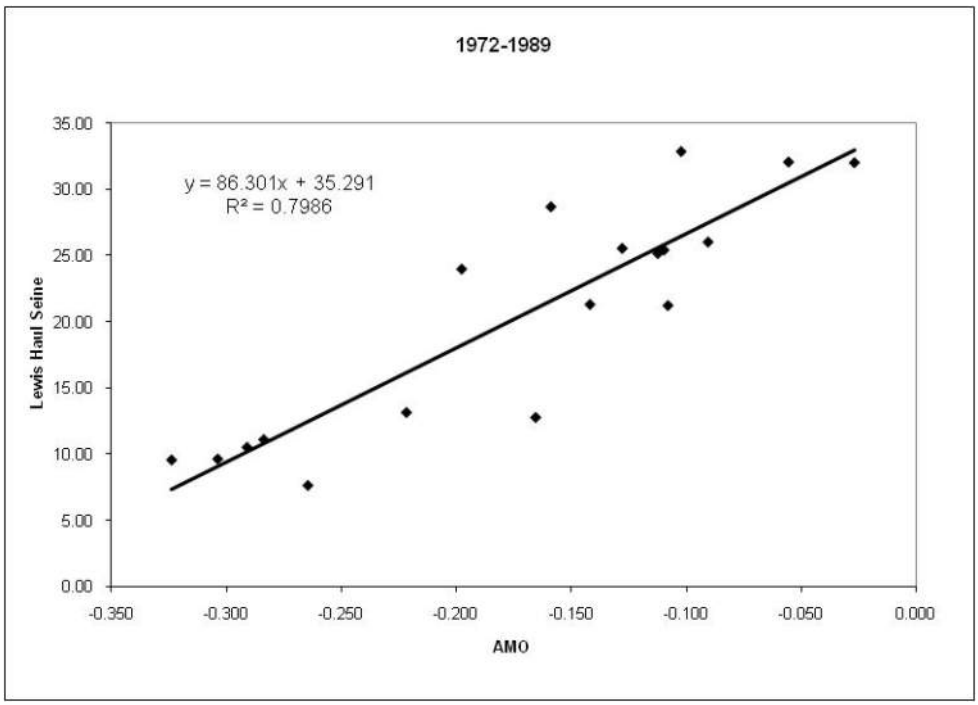


Figure 16. Scatter plot of the five-year smoothed Atlantic Multidecadal Oscillation (AMO) compared to five-year smoothed Lewis haul seine CPUE: 1972 - 1989.

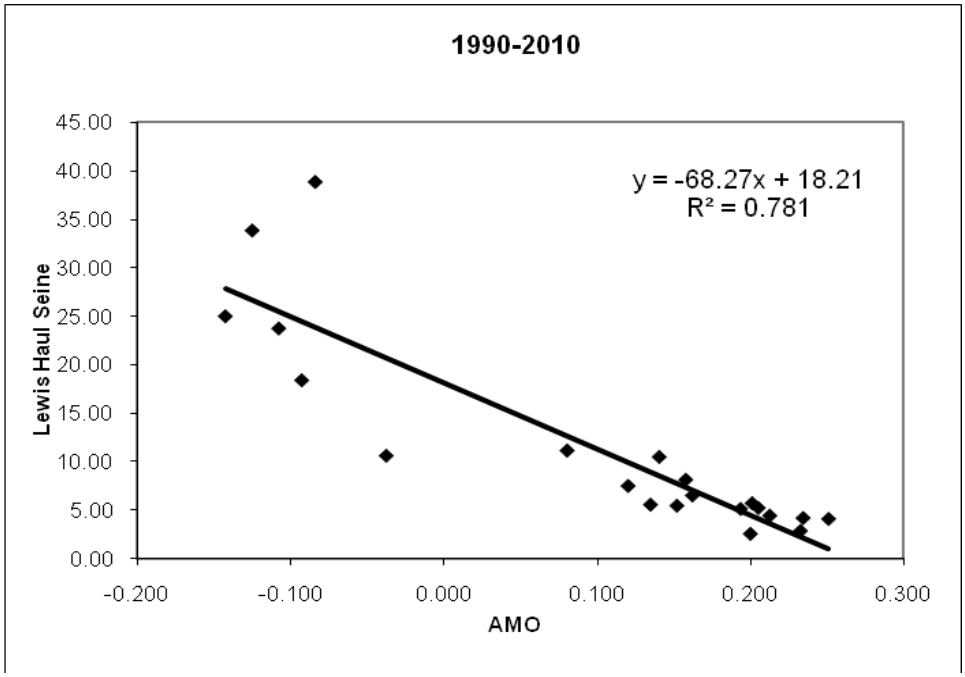


Figure 17. Scatter plot of the five-year smoothed Atlantic Multidecadal Oscillation (AMO) compared to five-year smoothed Lewis haul seine CPUE: 1990 - 2010.

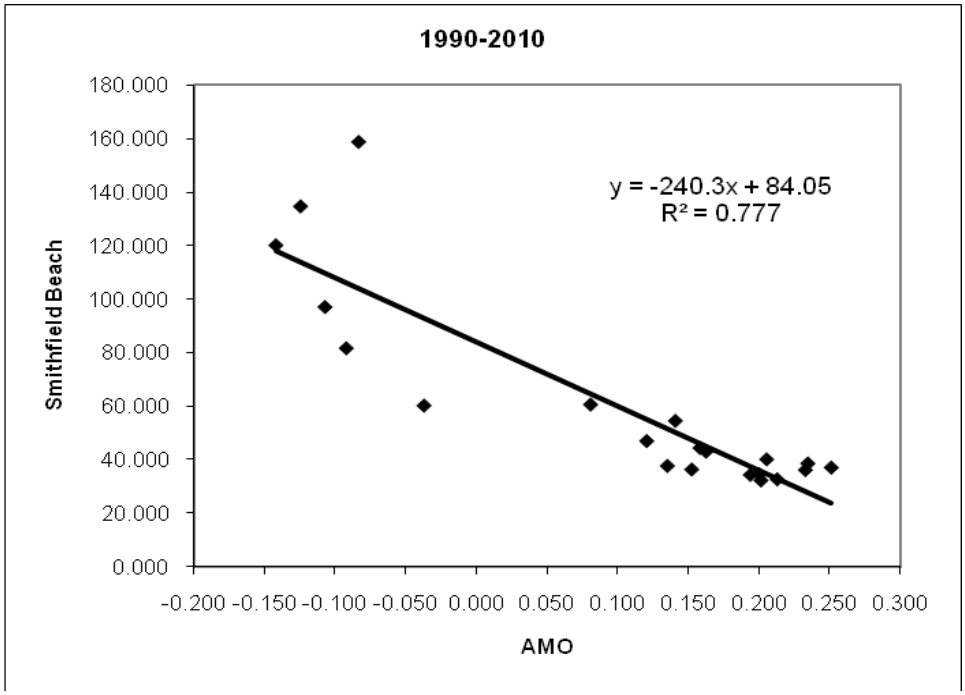


Figure 18. Scatter plot of the five-year smoothed Atlantic Multidecadal Oscillation (AMO) compared to five-year smoothed Smithfield Beach CPUE: 1990 - 2010.

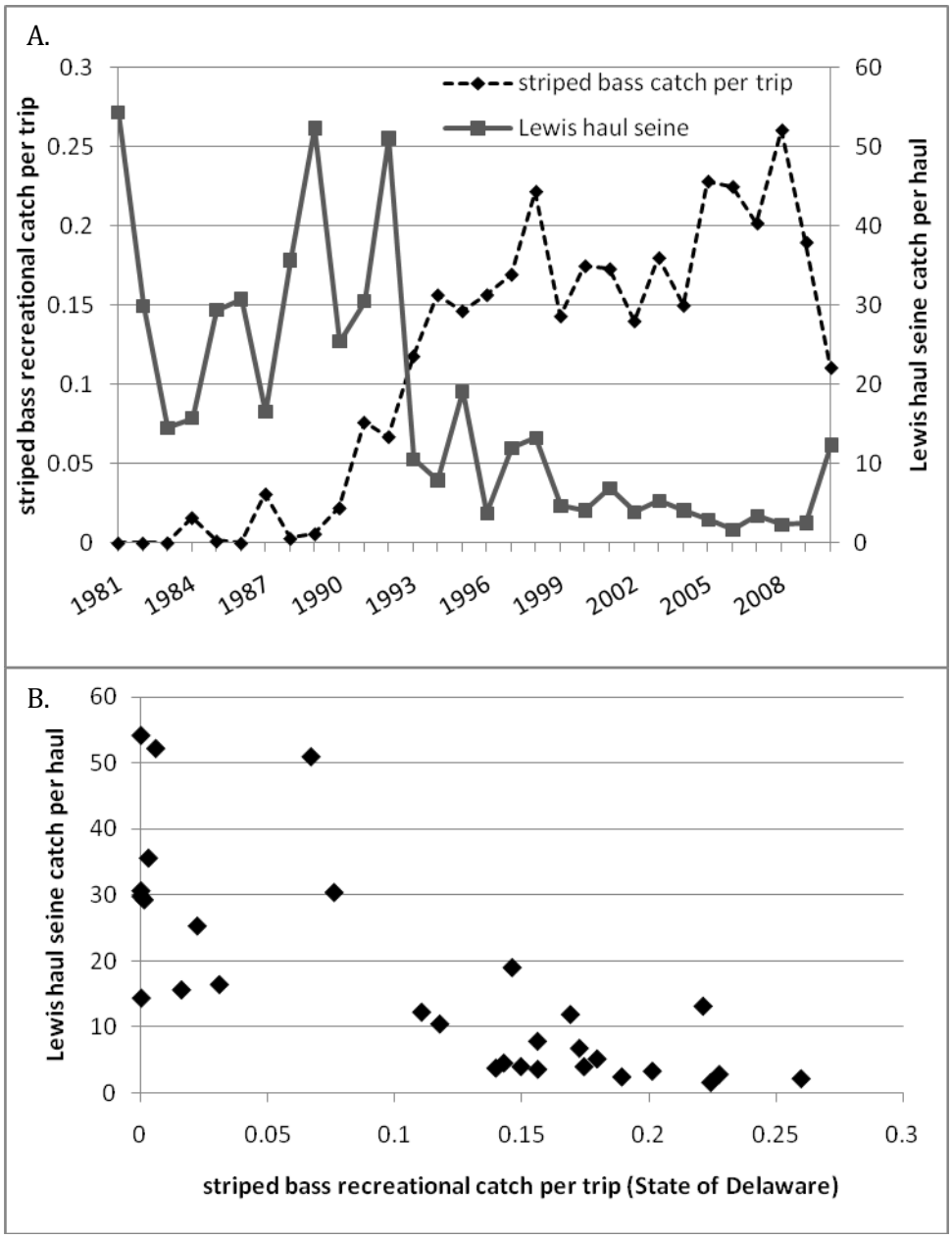


Figure 19. Adult shad abundance as estimated by the Lewis haul seine catch-per-haul from 1981 through 2010 plotted with an index of striped bass relative abundance in Delaware waters (MRFSS recreational total catch per trip; A) and associated scatter plot. (B)

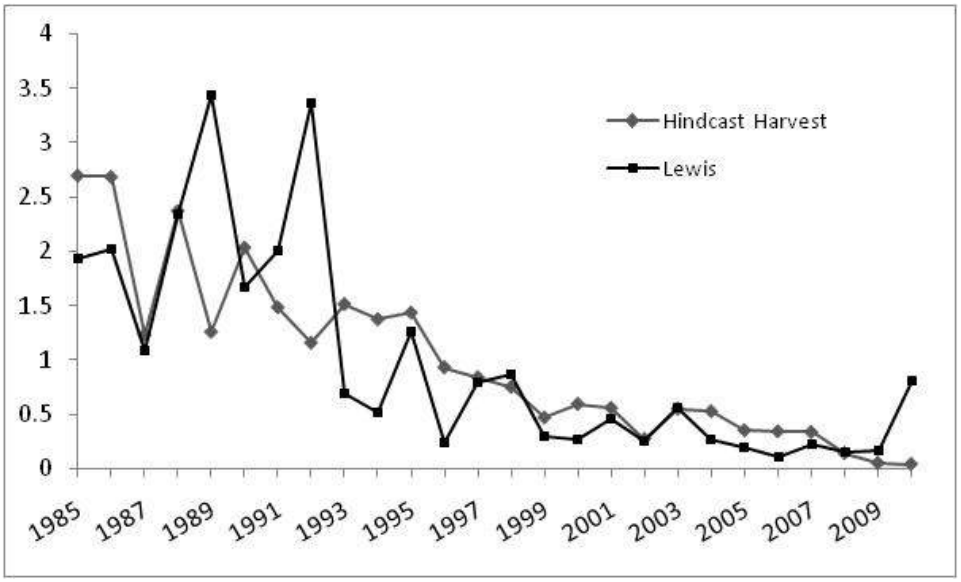


Figure 20. Normalized estimated harvest in numbers of American shad from the Delaware stock and relative abundance of surviving mature American shad in the Lewis haul seine fishery at Lambertville, NJ.

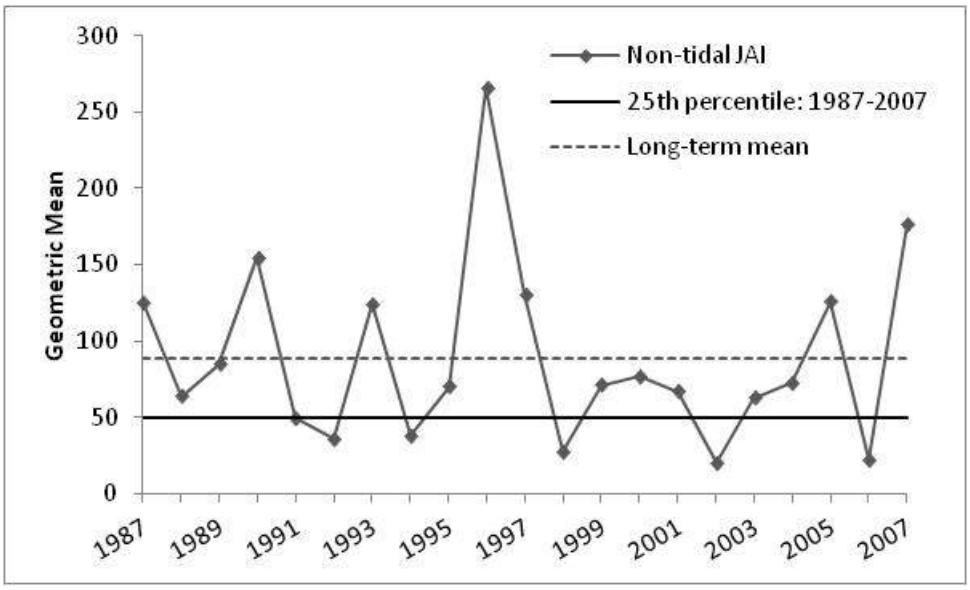


Figure 21. The Delaware River non-tidal American shad JAI with 25th percentile benchmark: 1987 – 2007.

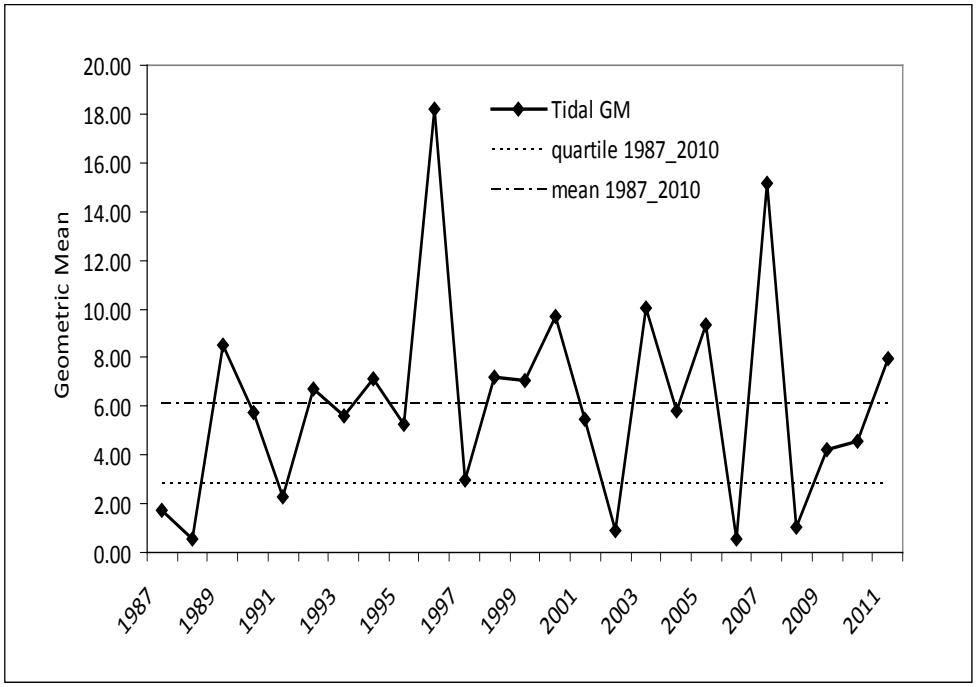


Figure 22. The Delaware River tidal American shad JAI with 25th percentile benchmark: 1987 – 2011. The geometric mean JAI for 2011 was not included in the benchmark calculation and is considered preliminary.

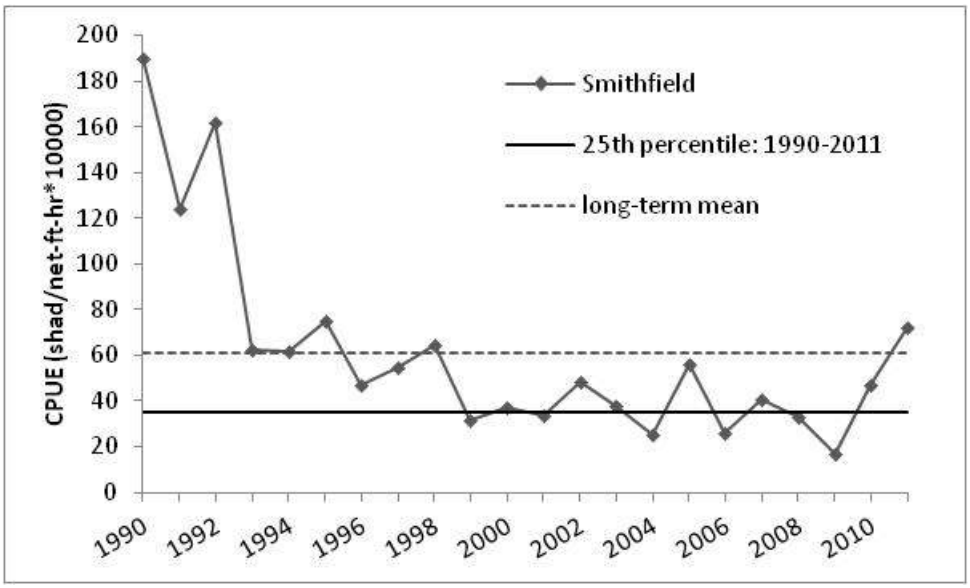


Figure 23. The Delaware River spawning adult American shad index at Smithfield Beach (RM 218) with 25th percentile benchmark: 1990 – 2011.

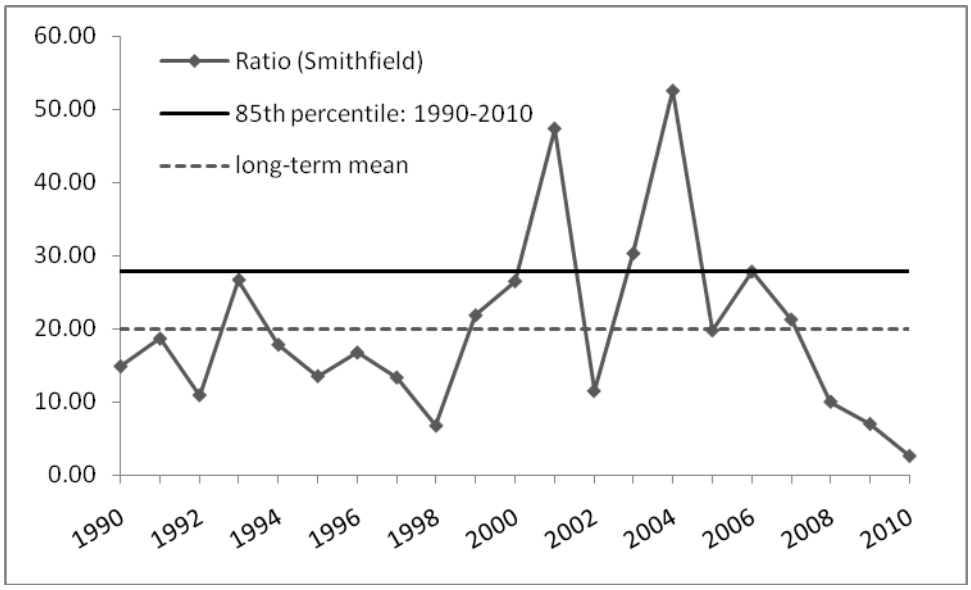


Figure 24. Ratio of harvest to Smithfield Beach relative abundance with 85th percentile benchmark: 1990-2010.

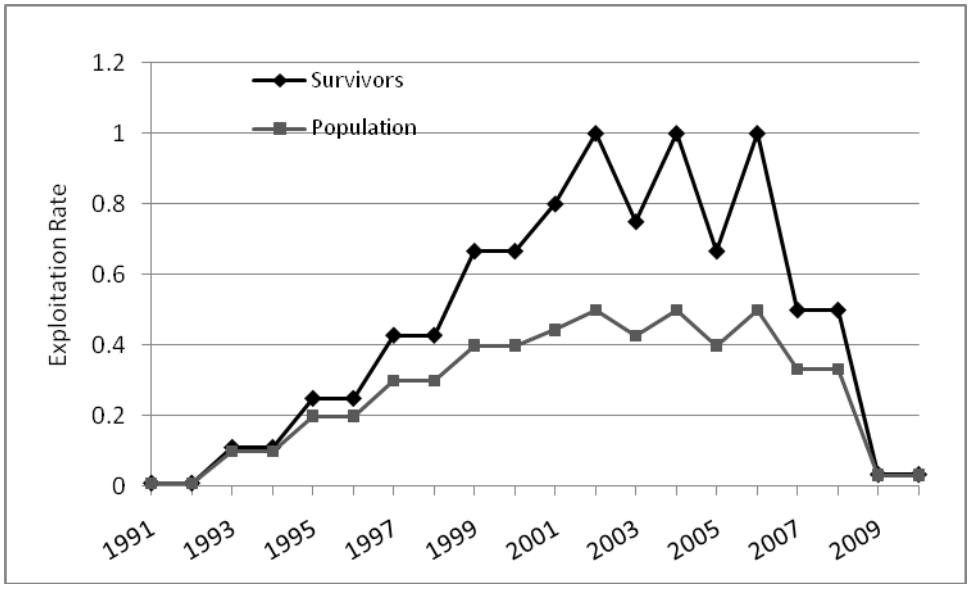


Figure 25. Comparison of exploitation rates based on the population prior to harvest (pop) and on survivors following harvest (survivors).

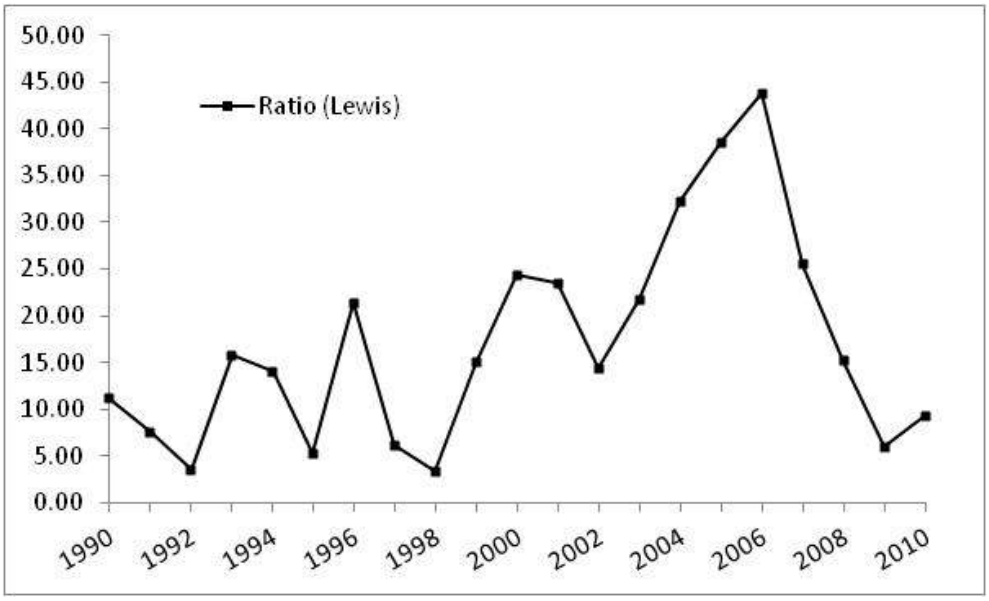


Figure 26. Ratio of harvest to Lewis haul seine relative abundance.

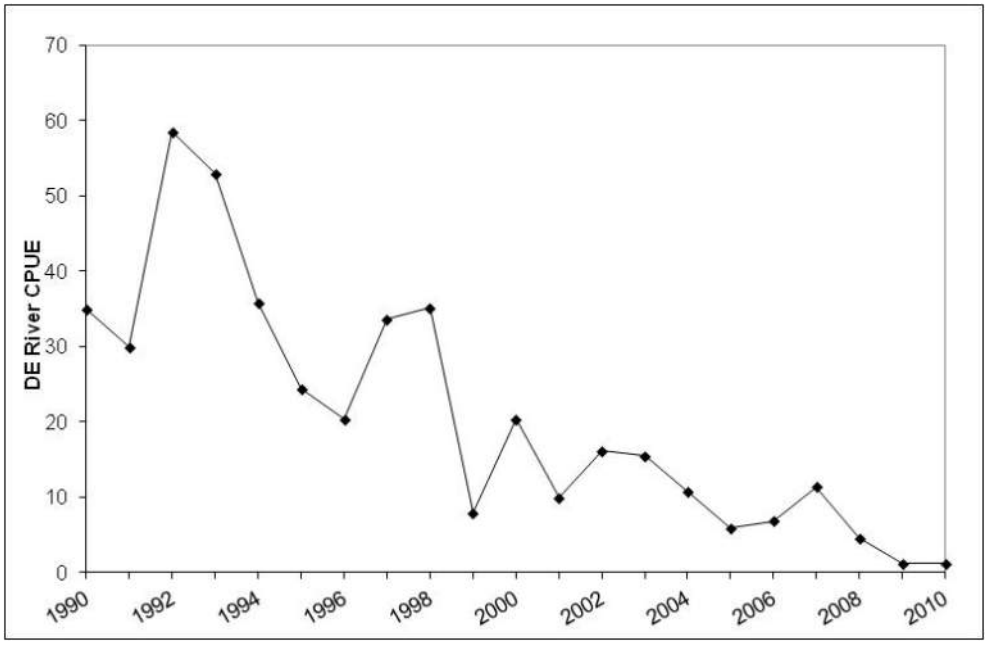


Figure 27. State of Delaware commercial American shad CPUE for the Delaware River.

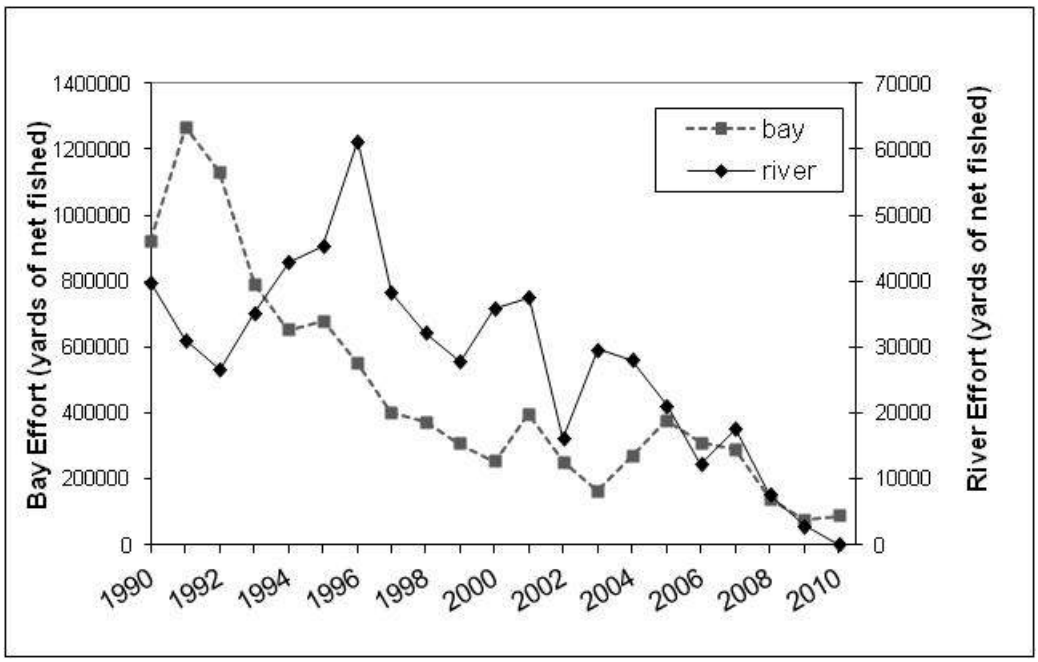


Figure 28. State of Delaware **c**ommercial fishery effort in yards of net fished for the Delaware River and Bay (1990-2010).

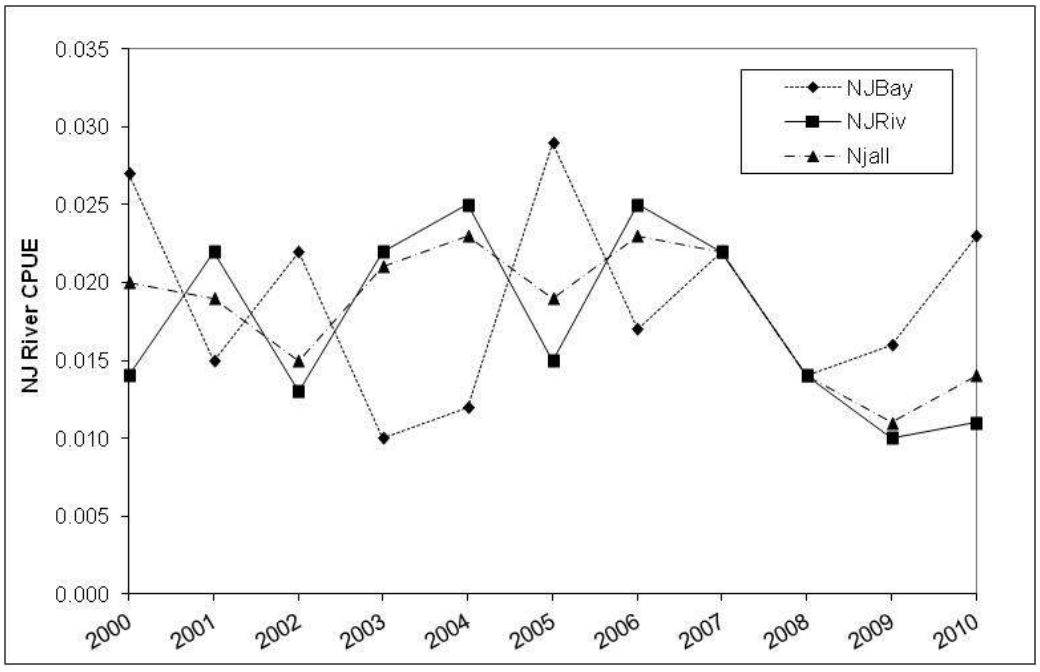


Figure 29. New Jersey commercial American shad CPUE from 2000-2010.

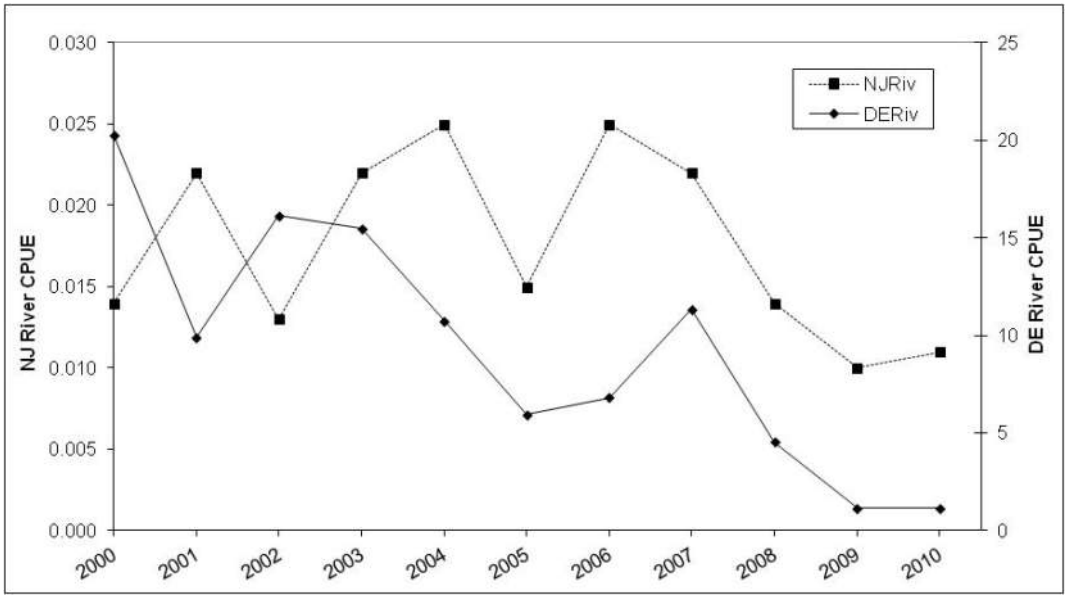


Figure 30. New Jersey and Delaware trends in commercial American shad CPUE from 2000-2010.

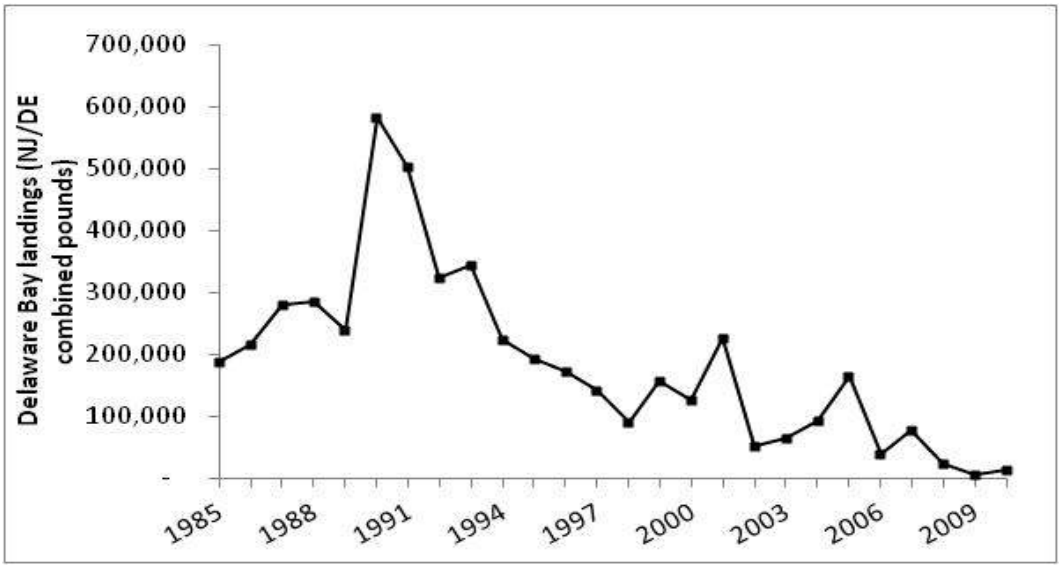


Figure 31. Combined Delaware Bay landings (pounds) of the mixed stock from New Jersey and Delaware, 1985 – 2010.

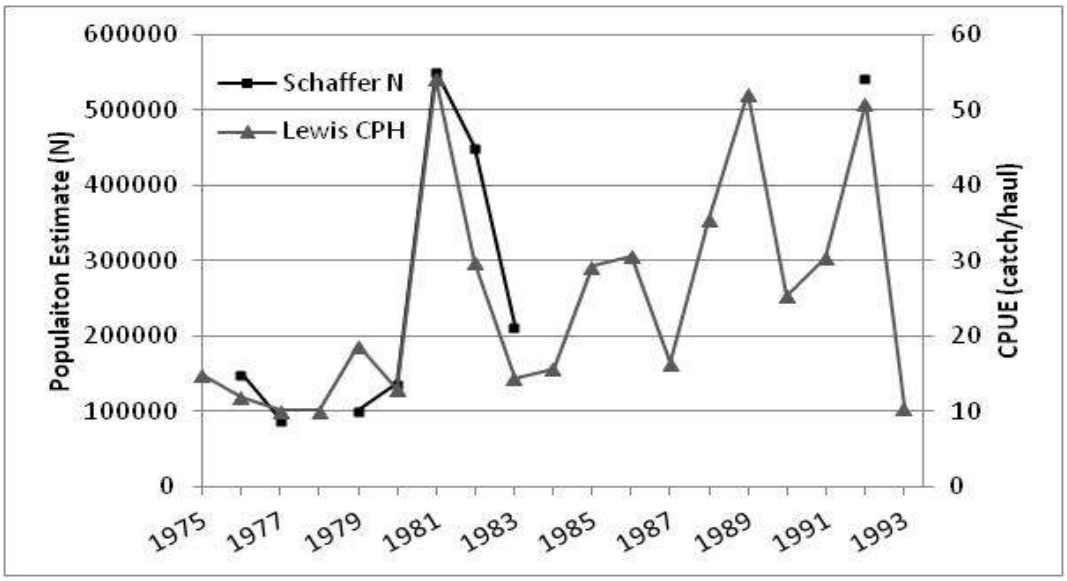


Figure 32. Schaefer tag-recapture estimates of stock size and the Lewis haul seine index of relative abundance, 1976 – 1992.

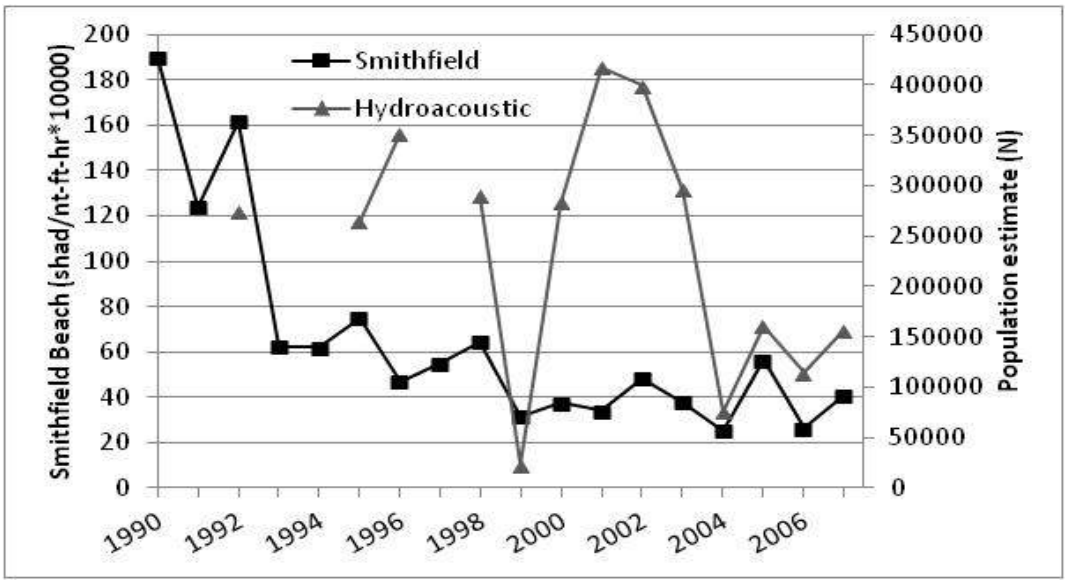


Figure 33. Estimates of absolute abundance from the hydroacoustic (alternate method) and the Smithfield Beach relative abundance.

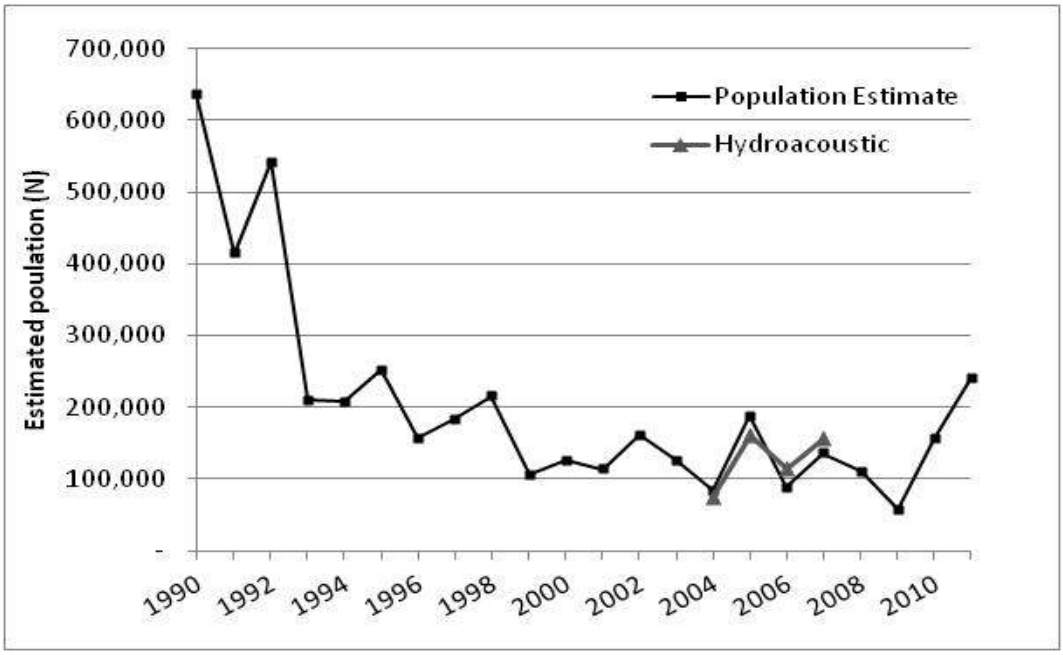


Figure 34. Absolute run size estimates for 1990 – 2011 based on the Smithfield Beach index as scaled up by use of the 1992 Schaefer estimate of run size. Estimates of run size from the hydroacoustic alternative method are also plotted for 2004-2007.

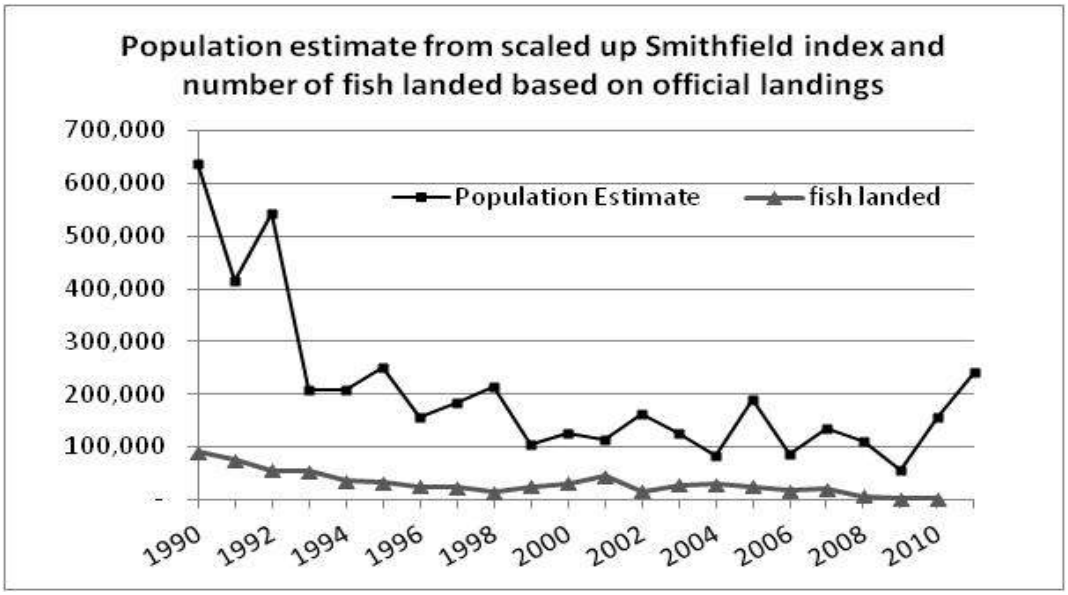


Figure 35. Landings in numbers of shad landed plotted with the run size estimated from the scaled up Smithfield Beach index.

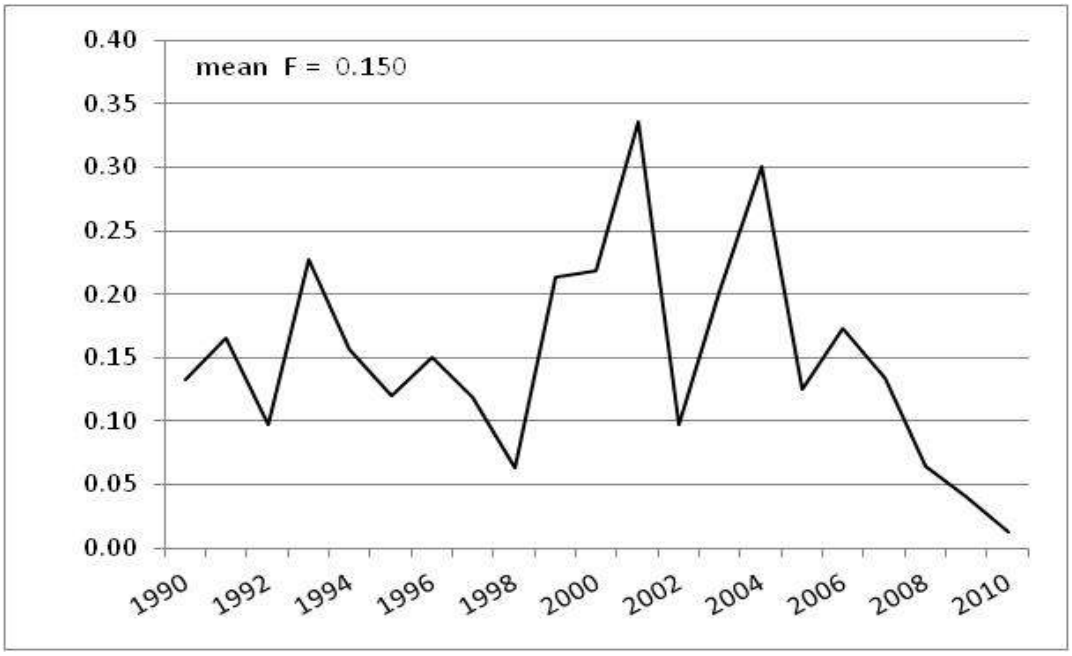


Figure 36. The time series of estimated instantaneous fishing mortality from the combined commercial fisheries of New Jersey and Delaware for the period 1990-2010.

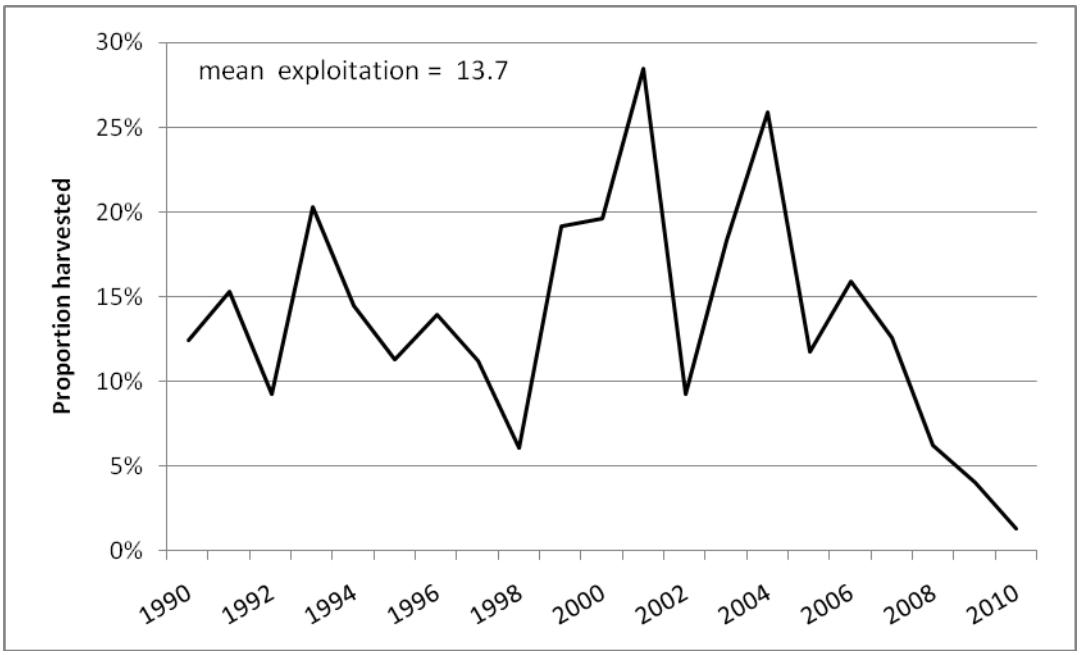


Figure 37. Estimation of the percentage of exploitation of the Delaware stock by commercial fishers as derived from the scaled Smithfield Beach relative abundance index, 1990-2009.

Table 1. Abundance indices for Delaware River American shad.

	Juvenile Indices		Adult Indices	
Year	Upper Non-tidal	Lower Tidal	Smithfield Beach CPUE	Lewis haul seine CPUE
1925				1.62
1926				3.18
1927				2.43
1928				4.00
1929				4.39
1930				1.30
1931				1.77
1932				3.20
1933				5.54
1934				3.45
1935				13.47
1936				2.43
1937				9.29
1938				4.68
1939				8.77
1940				3.59
1941				0.80
1942				5.68
1943				14.07
1944				5.02
1945				2.05
1946				2.15
1947				3.79
1948				0.73
1949				0.09
1950				0.18
1951				0.66
1952				0.63
1953				0.00
1954				0.35
1955				0.84
1956				0.00
1957				0.83
1958				3.00
1959				1.13
1960				0.32
1961				3.46
1962				13.89

	Juvenile Indices		Adult Indices	
Year	Upper Non-tidal	Lower Tidal	Smithfield Beach CPUE	Lewis haul seine CPUE
1963				56.90
1964				18.29
1965				6.65
1966				1.75
1967				3.74
1968				1.22
1969				3.10
1970				4.88
1971				12.30
1972				5.44
1973				7.19
1974				8.51
1975				14.85
1976				11.95
1977				10.18
1978				10.13
1979				18.72
1980	1.15	0		12.97
1981	15.8	0		54.17
1982	40.62	0		29.83
1983	111.19	0.49		14.44
1984	68.87	0.25		15.68
1985	76.09	0.08		29.30
1986	149.12	0.67		30.67
1987	125.39	1.71		16.49
1988	63.74	0.56		35.62
1989	84.73	8.49		52.20
1990	154.74	5.72	190.09	25.35
1991	49.43	2.29	123.72	30.42
1992	35.86	6.72	161.84	50.96
1993	124.41	5.61	62.44	10.52
1994	37.85	7.14	61.93	7.90
1995	70.14	5.28	75.00	19.05
1996	265.95	18.21	46.88	3.67
1997	130.4	3.01	54.89	11.96
1998	27.46	7.21	64.34	13.20
1999	71.13	7.07	31.60	4.60
2000	76.57	9.69	37.36	4.07
2001	65.5	5.45	33.94	6.84
2002	18.9	0.89	48.14	3.85

	Juvenile Indices		Adult Indices	
Year	Upper Non-tidal	Lower Tidal	Smithfield Beach CPUE	Lewis haul seine CPUE
2003	61.9	10.01	37.59	5.23
2004	71.3	5.81	24.99	4.07
2005	123.7	9.38	56.28	2.89
2006	21.8	0.53	26.17	1.66
2007	175.9	15.17	40.57	3.38
2008	-	1.05	33.01	2.24
2009	-	4.21	17.07	2.57
2010	-	4.58	46.88	12.31
2011	-	7.99	72.00	
Long-term Mean	88.78	6.07	61.22	
Benchmark quartile	49.43	2.83	34.79	
Period used	1987-2007	1987-2010	1990-2011	

Table 2. Commercial landings of American shad in the Delaware River Basin and estimates of the ratio of the combined Delaware stock harvest to Smithfield Beach and Lewis haul seine relative abundance. Light shading = early period; dark shading = late period.

	River			Bay			Delaware Stock			Smithfield	Lewis
	NJ	DE	Comb	NJ	DE	Comb	NJ	DE	Comb	Ratio	Ratio
1975			0	5,611		5,611	2,188	0	2,188		
1976			0	18,780		18,780	7,324	0	7,324		
1977			0	29,578		29,578	11,535	0	11,535		
1978			0	31,438		31,438	12,261	0	12,261		
1979			0	17,499		17,499	6,825	0	6,825		
1980	25,000		25,000	50,600		50,600	44,734	0	44,734		
1981	30,000		30,000	67,600		67,600	56,364	0	56,364		
1982	1,100		1,100	132,900		132,900	52,931	0	52,931		
1983	4,300		4,300	49,300		49,300	23,527	0	23,527		
1984	7,400		7,400	41,900		41,900	23,741	0	23,741		
1985	23,100	29,297	52,397	48,900	139,186	188,086	42,171	83,580	125,751		4.29
1986	17,700	28,622	46,322	63,900	150,889	214,789	42,621	87,469	130,090		4.24
1987	20,200	10,265	30,465	109,400	169,954	279,354	62,866	76,547	139,413		8.46
1988	17,300	24,413	41,713	80,700	204,889	285,589	48,773	104,320	153,093		4.30
1989	16,800	12,249	29,049	62,500	175,538	238,038	41,175	80,709	121,884		2.33
1990	40,364	15,798	56,162	212,749	369,056	581,805	123,336	159,730	283,066	14.89	11.17
1991	23,092	11,715	34,807	150,209	352,670	502,879	81,674	149,256	230,930	18.67	7.59
1992	41,765	9,247	51,012	114,035	209,757	323,792	86,239	91,052	177,291	10.95	3.48
1993	19,552	13,008	32,560	123,428	220,395	343,823	67,689	98,962	166,651	26.69	15.85
1994	9,066	14,347	23,413	41,305	181,793	223,098	25,175	85,246	110,421	17.83	13.98
1995	11,811	14,293	26,104	61,621	132,030	193,651	35,843	65,785	101,628	13.55	5.34
1996	1,100	10,095	11,195	17,563	155,140	172,703	7,950	70,600	78,549	16.76	21.42
1997	9,250	8,473	17,723	34,549	108,043	142,592	22,724	50,610	73,334	13.36	6.13
1998	75	8,047	8,122	14,180	76,766	90,946	5,605	37,986	43,591	6.78	3.30
1999	5,670	2,055	7,725	83,036	74,129	157,165	38,054	30,965	69,019	21.84	14.99
2000	43,299	6,867	50,166	78,132	47,010	125,142	73,770	25,201	98,971	26.49	24.34
2001	69,098	3,677	72,775	27,040	198,152	225,192	79,644	80,956	160,600	47.32	23.47
2002	32,746	2,510	35,256	15,671	36,200	51,871	38,858	16,628	55,486	11.53	14.43

2003	84,198	4,748	88,946	6,322	57,628	63,950	86,664	27,223	113,887	30.30	21.77
2004	92,073	3,015	95,088	5,385	87,078	92,463	94,173	36,975	131,149	52.48	32.19
2005	46,543	677	47,220	41,441	122,933	164,374	62,705	48,621	111,326	19.78	38.54
2006	56,847	576	57,423	9,307	29,949	39,256	60,477	12,256	72,733	27.80	43.84
2007	53,818	1,816	55,634	9,010	69,622	78,632	57,332	28,969	86,300	21.27	25.53
2008	23,877	260	24,137	5,157	18,073	23,230	25,888	7,308	33,197	10.06	15.20
2009	9,589	97	9,686	3,381	3,349	6,730	10,908	1,403	12,311	7.02	5.93
2010	8,699	121	8,820	4,499	4,872	9,371	10,454	2,021	12,475	2.66	9.34

Table 3. American shad tag returns, by year, from fish tagged in Delaware Bay: 1995-2011.

Year	No. Tag	Recaptures
1995	107	10
1996	294	14
1997	508	36
1998	554	38
1999	753	46
2000	425	32
2001	663	35
2002	274	15
2003	170	7
2004	51	0
2005	220	9
2006	71	2
2007	42	1
2008	0	0
2009	11	1
2010	85	3
2011	11	0
Total	4,239	246

Table 4. American shad tag returns, by area, from fish tagged in Delaware Bay: 1995-2011.

Recapture Area	Number	Proportion
Delaware River	69	28.1%
Hudson	43	17.5%
Connecticut	38	15.5%
NJ Ocean	38	15.5%
Delaware Bay	30	12.2%
Ches/Susq	8	3.3%
Ocean DE - NC	7	2.9%
Ocean NY - RI	5	2.0%
Canada	5	2.0%
Pawcatuck	1	0.4%
Cape Fear	1	0.4%
Santee	1	0.4%
Total	246	

Table 5. Sex composition of New Jersey's commercial gill net shad landings: 1996–2010.

	Delaware Bay		Coastal	
Year	% female	% male	% female	% male
1996	-	-	84.1	15.9
1997	-	-	82.8	17.2
1998	-	-	81.4	18.6
1999	82.6	17.4	81.9	18.1
2000	86	14	69	31
2001	83.8	16.2	70.8	29.2
2002	69.4	30.6	71.4	28.6
2003	80.3	19.7	61	39
2004	77.9	22.1	71.3	28.7
2005	73.9	26.1	98.9	1
2006	79.5	20.5	73.3	26.7
2007	80.6	19.4	96.6	3.6
2008	77.5	22.5	91.7	8.3
2009	80.4	19.6	84	16
2010	67.2	32.8	75.5	24.5
AVG	**78.3**	**21.7**	**79.6**	**20.4**

Table 6. Recreational catch in the Delaware River by various investigators. Upper Delaware River: the non-tidal reach upriver of Port Jervis, New York (RM 253.6); non-tidal: above head-of-tide at Trenton, New Jersey (RM 133.4); tidal: below head-of-tide; and Delaware River: boundary waters of Eastern Pennsylvania.

Year	River reach	No. anglers	Total catch	Total Harvest	Catch rate (shad/hr)
		Marshall (1971)			
1971	Non-tidal		25,204		
		Lupine et al (1980)			
1980			7,386		0.47
		Lupine et al (1981)			
1981			12,767		0.67
		Hoopes et al. (1983)			
1982	Upper Del. River		37,323	31,725	
		Miller and Lupine (1988)			
1986	Non-tidal	65,690	56,320	27,471	0.19
		NJDEP (1993)			
1992			46,780	5,146	1.10
		Miller and Lupine (1996)			
1995	Non-tidal		83,141	16,628	0.25
		NJDFW (2001)			
2000					0.77
		Volstad et al. (2003)			
2002	Non-tidal		34,091	6,312	0.13
2002	Tidal		1,190	315	0.008
		PFBC/NPS Angler Diary			
2001	Del. R.	62	1,375	81	0.11
2002	Del. R.	52	708	67	0.06
2003	Del. R.	50	345	24	0.03
2004	Del. R.	45	330	36	0.03
2005	Del. R.	42	330	12	0.03
2006	Del. R.	35	35	0	0.01
2007	Del. R.	41	359	16	0.05
2008	Del. R.	33	207	14	0.02

Table 7. Number of American shad larvae stocked in the Delaware River Basin.

Year	**Delaware**	**Schuylkill**	**Lehigh**
1985		251,980	600,000
1986		246,400	549,880
1987		194,575	490,730
1988			340,400
1989		316,810	833,170
1990		285,100	2,087,700
1991		75,000	793,000
1992		3,000	353,000
1993			789,600
1994			642,200
1995			1,044,000
1996			993,000
1997			1,247,000
1998			948,000
1999		410,000	501,000
2000		535,990	447,390
2001		490,901	675,625
2002		2,000	85,025
2003		1,000,448	783,013
2004		421,583	366,414
2005	169,802	545,459	668,792
2006	52,782	253,729	293,083
2007	47,587	540,655	281,884
2008	158,151	486,774	696,785
2009		161,938	210,584
2010		380,000	347,522
Total	428,322	6,602,341	17,068,797

Table 8. Hatchery contribution for adult American shad collected from the Delaware River (Smithfield Beach and Raubsville), the Lehigh River and the Schuylkill River.

	Percent exhibiting hatchery mark							
	Delaware River							
	Smithfield Beach		Raubsville		Lehigh River		Schuylkill River	
Year	%	N	%	N	%	N	%	N
1997	0%	88	-	-	-	-	-	-
1998	4%	234	-	-	-	-	-	-
1999	0%	208	5%	150	91%	104	-	-
2000	3%	330	11%	129	91%	99	-	-
2001	4%	198	8%	144	92%	103	-	-
2002	1%	378	1%	109	89%	99	-	-
2003	8%	245	-	-	-	-	100%	25
2004	1%	414	-	-	80%	60	90%	21
2005	1%	776	-	-	62%	13	92%	25
2006	1%	350	-	-	73%	55	100%	19
2007	3%	746	-	-	58%	40	91%	23
2008	1%	667	-	-	51%	41	100%	28
2009	1%	367	-	-	63%	27	96%	25
2010	0%	470	-	-	67%	96	100%	25
Mean	2%		6%		74%		96%	

Table 9. Total number of mixed stock American shad landed from Delaware Bay from 2008-2010, the average number landed annually, the proportion of tag-recaptures recovered in various rivers, and the numbers of shad from each spawning stock, on average, landed in Delaware Bay.

Year	Total Number of shad landed	
2008	4,718	
2009	1,367	
2010	1,903	
average	2,663	
Spawning stock	Proportion of recaptures	Number per spawning stock
Delaware	0.39	1,038.52
Hudson	0.175	466.00
Connecticut	0.155	412.74
Che/Sus	0.033	87.87
Pawcatuck	0.004	10.65

Table 10. New Jersey and Delaware regulations for the harvest of American shad (current as of 2010) in the Delaware River and Bay.

State	Season	Gear Limits	Mandatory reporting	Other Restrictions
NJ: Delaware Bay & River	Gill nets: Feb 1-Dec 15	-2.75" min. stretch mesh Feb 1-Feb 29; * 3.25" min. stretch Mar 1-Dec 15 (*special permit required) -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'		
DE: Delaware Bay & River	See gear limits	- Del River: Jan 1-May 31 no fixed gill nets - Del River: Not more thatn 200 ft gill net Jun to Dec - Striped bass spawning area closed to all gillnets Apr 1 to May 31 - Del Bay No fixed gill nets May 10 to Sep 30	Yes	

Potomac River Fisheries Commission's

American Shad Fishing / Recovery Plan

Submitted to the
Atlantic States Marine Fisheries Commission

January 10, 2012

1. Sustainable Fishery Plan

In accordance with the guidelines provided in Amendment 3 to the Interstate Fishery Management Plan (IFMP) for Shad and River Herring, the Potomac River Fisheries Commission (PRFC) submits the following Sustainable Fishery Plan.

1a. Request for Fishery

The PRFC requests that the Shad and River Herring Management Board consider this request to continue a limited commercial by-catch allowance of American shad in the portion of the Potomac River under PRFC jurisdiction (Figure 1). Accordingly, the PRFC justifies this request based on the fact that the Board accepted the 2007 Shad Stock Assessment which established a benchmark goal for American shad recovery in the Potomac River and required the PRFC to continue monitoring the pound net fishery's by-catch allowance of American shad, including discards. The Stock Assessment stated "to continue stock rebuilding, there should be no new expansion of the fishery until the benchmark is reached". The benchmark goal identified in the 2007 Stock Assessment was approved as a restoration target and was exceeded in 2011.

1b. Definition of Sustainability

Amendment 3 to the IFMP for Shad and River Herring defines a sustainable fishery as one that will not diminish potential future stock reproduction and recruitment. The PRFC proposes to continue with the mandatory daily harvest reporting program with the fishermen on the Potomac River, in which they record daily harvest, effort and discard data. The continuation of this data collection enhances the long term data set that the PRFC maintains, updates and utilizes to monitor the progress of the American shad stock rebuilding and recovery in the Potomac River. The long-term American shad juvenile abundance index (JAI) for the Potomac River is provided by Maryland Department of Natural Resources (MD DNR) and will continue on an annual basis.

1c. Summary of current stock status

The Potomac River has been closed to the commercial and recreational directed harvest of American shad since March 1, 1982. The only allowable commercial 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. Starting in 1996, the pound net by-catch provision 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 shad by-catch for the gill net fishery was approved by the ASMFC Shad and River Herring Technical Committee and Board, and established by the PRFC. In the Potomac River, all directed commercial, recreational and charter boat fisheries for American shad remain closed.

1d. Benchmark goals and objectives or restoration goals/targets

In the 2007 ASMFC Shad Stock Assessment, a benchmark for American shad in the Potomac River was defined as the geometric mean (GM) CPUE of pound net landings reported in Walburg and Sykes (1957) for the years 1944 to 1952, or 31.1 pounds per net-day. It was concluded in the assessment that among Chesapeake Bay stocks of American shad, the Potomac River population showed the most promising signs of recovery. The gill net index, the pound net index, and the JAI depicted strongly increasing trends in relative abundance. To continue stock rebuilding in the Potomac River, it was recommended that there should be no new expansion of the fishery until the benchmark goal is reached, and that this requires continued monitoring of the pound net fishery, including discards.

The ASMFC Shad and River Herring Management Board accepted the 2007 Shad Stock Assessment Report, which included the Potomac River benchmark. This benchmark goal of 31.1 became the restoration target for the Potomac River and was approved by the ASMFC Shad and River Herring Technical Committee (Figure 2).

We have been steadily approaching this restoration target over time (Table 2). The GM was calculated for CPUEs of total pound net data (catch + discards) for the years 1999 – 2011, and for the first time the GM exceeded the benchmark goal and restoration target with a value of 32.0 pounds per net-day. The GM has increased every year since 2002, so achieving the target in 2011 was not unexpected. The PRFC has reported this information in their annual compliance report every year.

1e. Proposed time frame for achievement

The benchmark goal identified in the 2007 Stock Assessment and approved as a restoration target was exceeded in 2011.

1f. Discussion of management measure(s) to be taken if sustainable target is not achieved within indicated timeframe

The target was achieved in 2011. The PRFC will continue monitoring the total pound net CPUE data as well as the MD DNR survey data.

2. Stock Monitoring Programs

2a. Fishery Independent

Since 1995, American shad have been taken from the Potomac River as brood stock for hatchery production by the Interstate Commission on the Potomac River Basin (ICPRB), under special collection permits issued by the PRFC (Table 3). The ICPRB participated in the Potomac Restoration Stocking Program for American shad from 1995 – 2002, at which time recovery was considered sufficient for natural reproduction. In 2003, restoration stocking of the Rappahannock River started using Potomac River origin eggs through a partnership between ICPRB, the Virginia Department of Game and Inland Fisheries (VDGIF), and the U. S. Fish & Wildlife Service (USFWS) Harrison Lake National Fish Hatchery. Stocking of the Potomac River continues, but now as "replacement stocking" to account for the Potomac shad sacrificed for another river system. Since 1995, the ICPRB has released nearly 22 million fry into the Potomac. The Maryland Department of Natural Resources (MD DNR) (since 2001), VDGIF (2003 - 2009) and the USFWS (since 2004) have also collected American shad for brood stock under special collection permits issued by this Commission. The MD DNR began replacement stocking in 2007, and has released about 600,000 fry into the Anacostia River, a tributary of the Potomac River in Washington D.C. The VDGIF reported a total of 4,668,448 fry and the USFWS reported 188,000 fry stocked in the Potomac River as mitigation for egg collections. The Potomac River has been the egg source for all of Maryland's shad restoration projects, Virginia's shad restoration program in the Rappahannock River, as well as the Susquehanna River (MD/PA) and some of Delaware's rivers since 2002.

The ICPRB kept 890 American shad (approximately 2,519 lbs.) from the Potomac River in 2010 (Table 3). The MD DNR collected 1,203 American shad (approximately 3,404 lbs.) from the Potomac River in 2010 (Table 4) and analyzed the egg collections (Figure 4). The USFWS collected 2,151 American shad (approximately 6,087 lbs.) from the Potomac River in 2010 (Table 6). No American shad were removed from the Potomac River by VDGIF in 2010 for brood stocking. The total 2010 brood stock removals from the Potomac River amounted to 4,244 American shad or approximately 12,010 pounds (average weight of 2.83 lbs.). Summaries of MD DNR (Table 5) and USFWS (Table 6) brood stock collection activities are provided. The ICPRB, MD DNR, and USFWS were permitted again in 2011 to collect American shad as brood stock for hatchery production and stocking efforts.

i. Juvenile abundance indices

Maryland is required to provide an American shad juvenile index for the Potomac River and several other river systems throughout its portion of the Chesapeake Bay. The annual juvenile abundance survey has been conducted since 1954, with American shad data collected 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. The American shad juvenile index for the Potomac River is derived from the Maryland DNR state wide annual young of the year survey as geometric mean CPUEs (Figure 3). The 2011 value of 1.99 was significantly higher than the 2010 value of 1.05. http://www.dnr.state.md.us/fisheries/juvindex/index.html

ii. Adult stock monitoring

Maryland DNR has conducted a Striped Bass Spawning Stock Survey since 1985, using multi-panel drift gill nets in the Potomac River. Since 1997, adult American shad that were incidentally caught were processed to obtain length, sex and age (scale samples) and repeat spawning determination (Figure 5).

Data was collected on age, size and sex composition for some of the American shad collected for brood stock (Tables 7 – 12). These fish were processed by Michael Hendricks in Pennsylvania.

2b. Fishery Dependent

i. Commercial Fishery

The non-directed Potomac River pound net by-catch harvest in 2011 consisted of 2,419 pounds of American shad (Table 1). The PRFC's mandatory commercial daily harvest reporting system is the source of these data, collecting harvest as well as discards or released fish. The 2011 discards/released by-catch of American shad in excess of the daily landing limit from pound nets was 2,465 pounds. The 2011 harvest data was combined with 2011 discard data to identify the total catch of 4,884 pounds. There were no reports of American shad harvest or discards from any other gear types in 2011.

Pound net effort is expressed as "pound net fishing day" which is one net fished one time. During 2011, one hundred pound nets were licensed in the Potomac River; however most of them were not set during the early spring months (the shad run). The pound net fishery is a 'limited entry' fishery capped at 100 licenses (each net is licensed separately). Effort included 77 pound net fishing days for the American shad by-catch harvest.

New regulation effective January 1, 2011 – 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. This regulation will have a beneficial impact on the release of river herring, but will not be effective in the release of adult shad. These fish cull panels were being used for by-catch reduction by some pound netters on a voluntary basis prior to 2011; they are now mandatory.

ii. Recreational Fishery

The Potomac River, under PRFC jurisdiction, recreational and charter boat fisheries for American shad remained closed in 2011 and 2012. The American shad fishery has been closed since 1982 in this portion of the Potomac River. We are unaware of any historical or current recreational activity within the PRFC's jurisdiction. A historical recreational fishery existed in the D.C. portion of the Potomac River, but that fishery is now closed.

Figure 1. Potomac River – PRFC jurisdiction is the main stem of the Potomac River downstream of Washington, DC

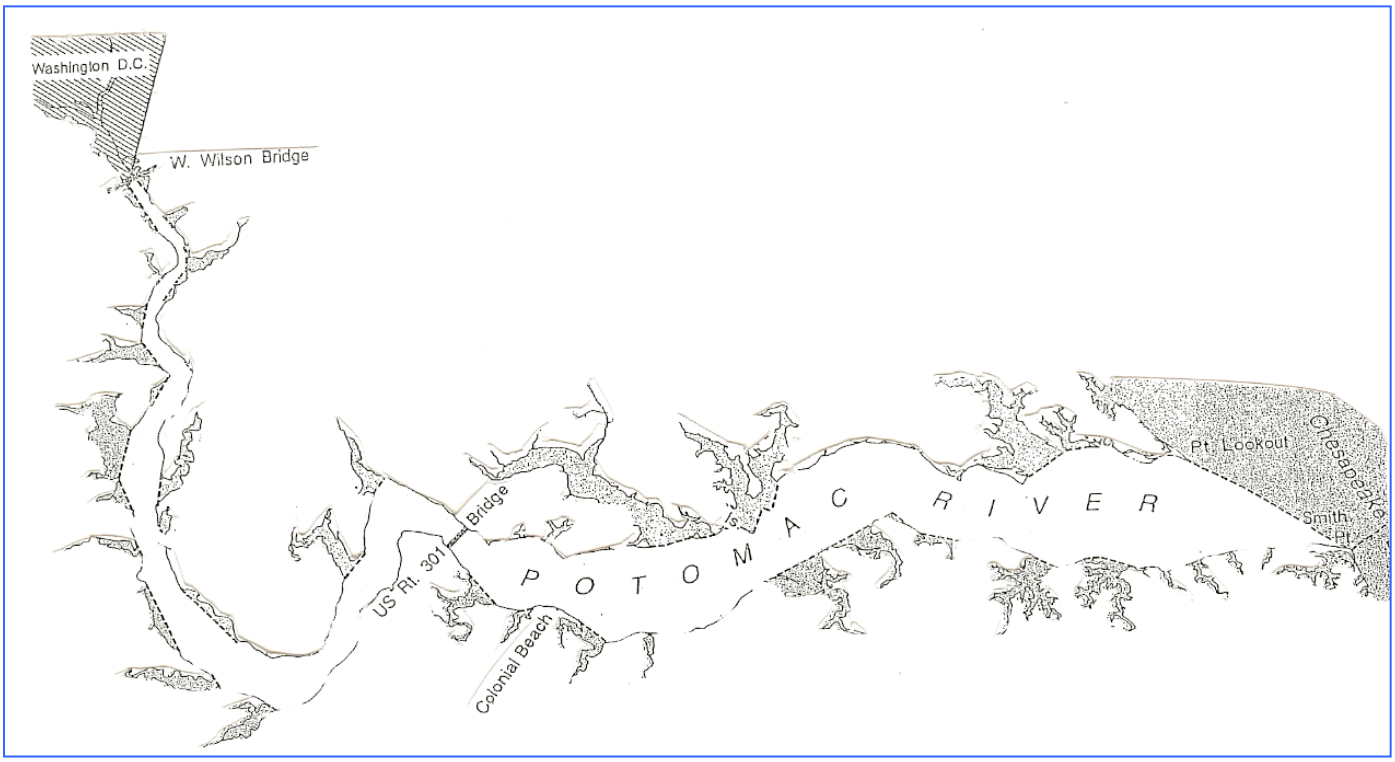


Figure 2

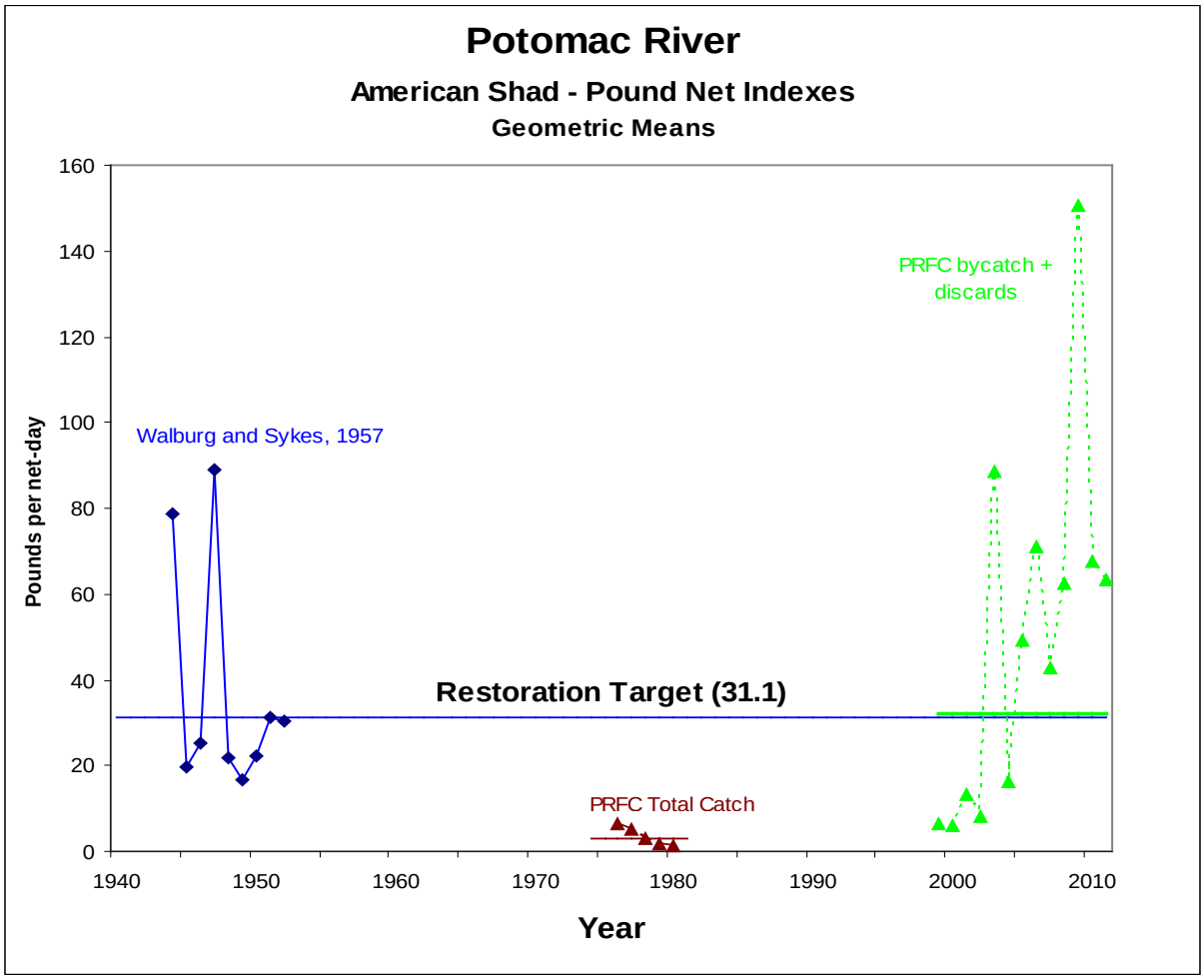


Figure 3

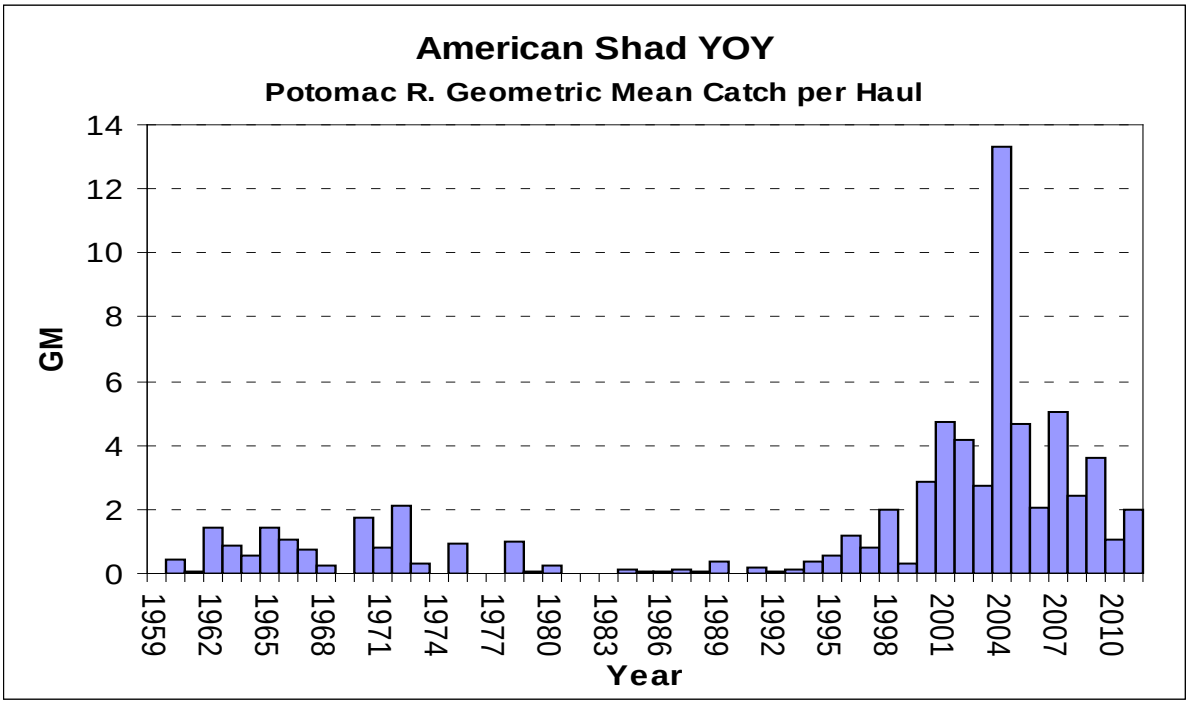


Figure 4

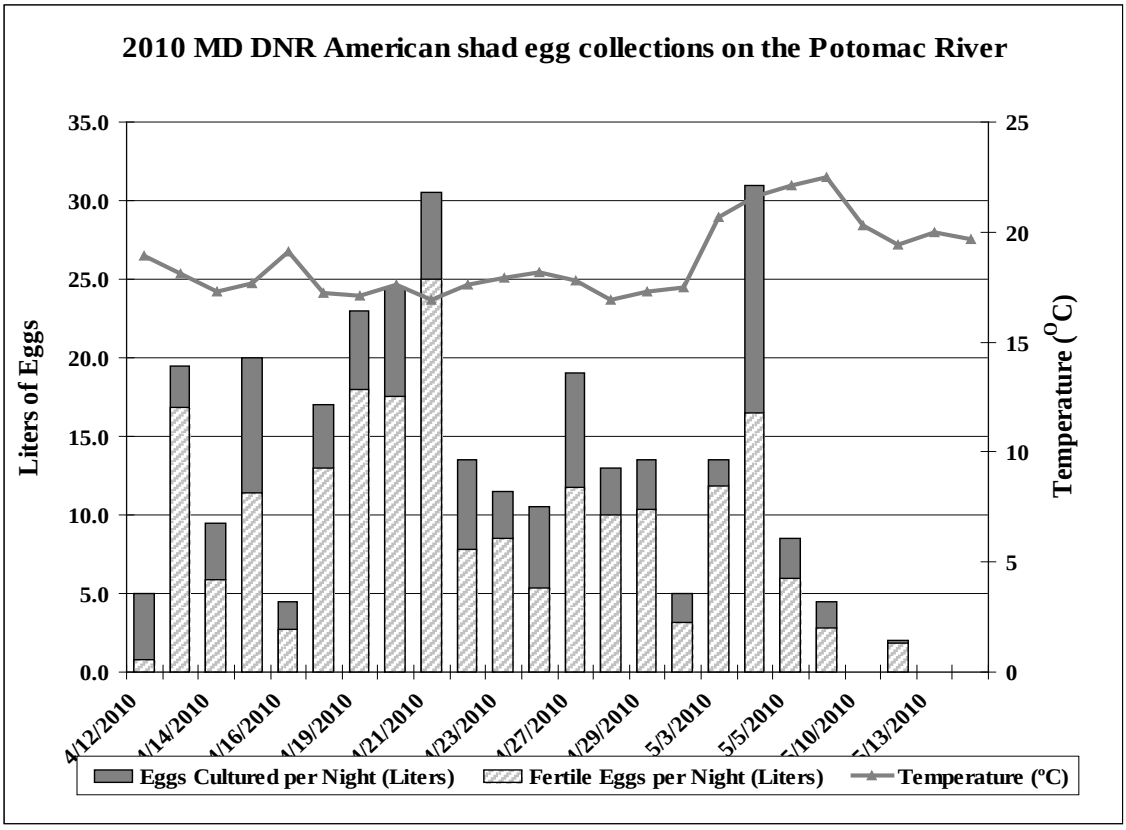


Figure 5

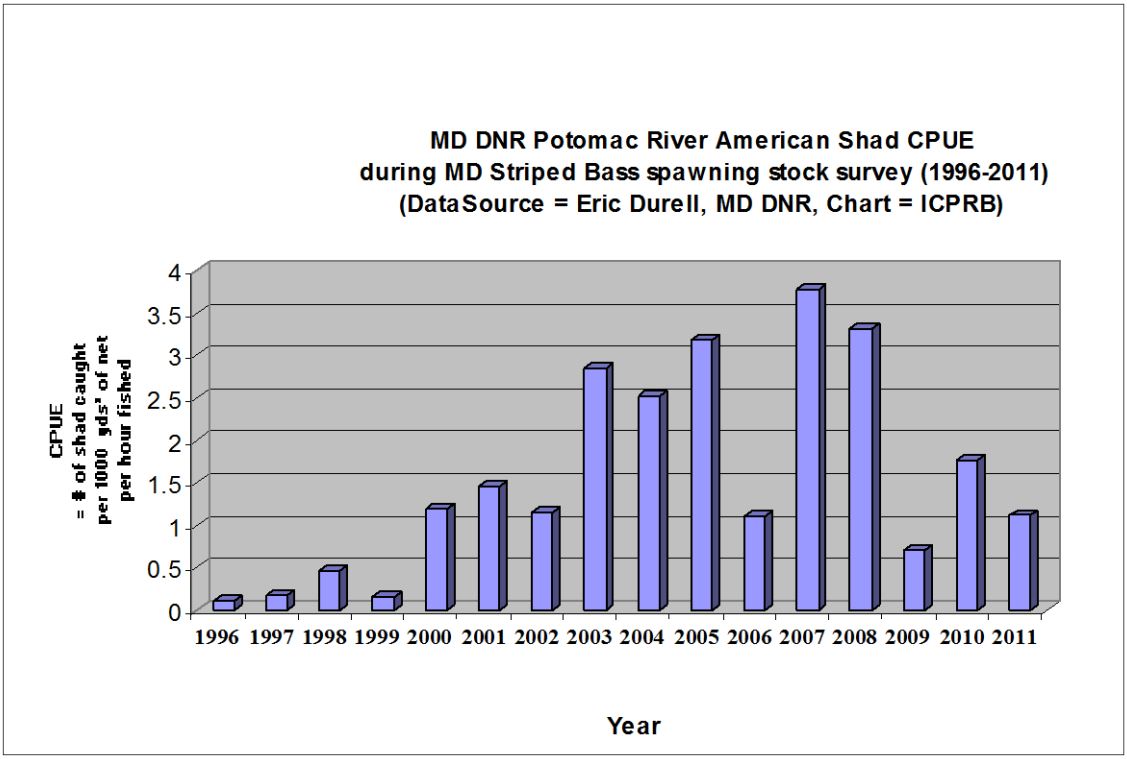


Table 1

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	0	2,015	450					2,465

Table 2

Geometric Mean (GM) of Pound Net CPUE Data												
Time Series	44-52	76-80	99-02	99-03	99-04	99-05	99-06	99-07	99-08	99-09	99-10	99-11
GM	**31.1**	3.0	8.1	13.1	13.6	16.3	19.6	21.3	23.8	28.1	30.2	**32.0**

Table 3. Interstate Commission on the Potomac River Basin (ICPRB) Summary of the Number of American Shad Used, Eggs Collected, Fry Released, and CPUE of Shad Used for Project Period 1995-2011, Including Estimates of Shad Returns

	1995	1996	1997	1998	1999	2000	2001	2002	2003**	2004	2005	2006	2007	2008	2009	2010	2011	Totals
# Ripe females	135	166	245	105	119	373	338	245	240	387	246	316	441	349	183	379	244	4,328
# Green Females	78	51	92	50	44	93	135	141	120	127	49	72	93	150	48	226	122	1,643
# Spent Females	3	1	0	8	10	9	27	25	15	27	2	11	118	43	29	31	31	361
# Males	78	157	207	153	116	282	235	247	240	435	209	283	397	191	102	460	235	3,925
# Total Shad (Used)	294	375	544	316	289	757	735	658	615	976	506	682	1049	733	333	890	409	9,675
# Total Shad (Captured)								1801	1494	1852	1101	1010	1858	903	444	1096	789	11,904
# Shad Released								1143	879	896	595	328	809	170	111	206	380	5,517
# Eggs Collected x 1000	2,405	4,353	5,744	2,626	2,594	6,383	6,565	5,943	5,327	5,773	8,129	NA***	NA	NA	NA	NA	NA	NA
# Collections/# nets set	11per22	11per22	12pe 24	14/28	15/30	11per22	16/32	18/36	10per16	14/25	13/25	16/32	17/34	16/31	16/32	16/32	17/35	224/430
CPUE (# Shad Used/net-set)	13.4	17	22.7	11.3	9.6	34.4	22.9	18.3	35.9	39	20.2	21.3	30.9	23.6	10.4	27.8	11.7	Avg. 21.9
CPUE (Total # shad/net-set)								50	93.4	74.1	44	31.6	54.6	29.1	13.9	34.3	22.5	Avg. 44.7
# Eggs/Ripe-female	17,800	26,200	23,400	25,000	24,400	17,100	19,400	24,260	22,195	14,917	24,783	NA	NA	NA	NA	NA	NA	NA
# Fry stocked Pot. R.(x 1000)	1,175	1,989	1,535	1,589	1,304	3,176	3,336	1,531	200	400	919	1,158	728	884	528	510	488	21,451
# Fry stocked Rapp. R.(x 1000)									1,200	3,100	3,400	6,265	4,453	4,832	2,718	3,943	4,116	34,027
Total # Fry Stocked (x 1000)	1,175	1,989	1,535	1,589	1,304	3,176	3,336	1,531	1,400	3,500	4,319	7,423	5,181	5,716	3,246	4,453	4,604	55,478
# Fry Stocked per Each Shad Collected	4,000	5,300	2,800	5,000	4,500	4,200	4,500	2,326	2,435	3,586	5,690	NA	NA	NA	NA	NA	NA	NA
Est. # of Shad Returning*	3,487	5,902	4,555	4,715	3,869	9,424	9,674	4,444	4,060	10,150	11,300	22,027	15,430	16,961	9,632	13,215	14,080	152,845
Est. # Shad Returning per Each Shad Collected	11.9	15.7	8.4	14.9	13.4	12.4	13.5	6	5.9	10.6	14.9	NA	NA	NA	NA	NA	NA	NA

* Monitoring at the Conowingo Dam fish lifts (Hendricks 2000) found, on average, that it takes 337 hatchery fry stocked in the Susquehanna River to get one returning adult shad. Subsequent results have modified that number slightly, but the one shad returning per 337 stocked fry ratio has been used since 2001 as an assumed Potomac return rate to provide a constant estimate.

** The Potomac Restoration Stocking Program for American shad was conducted 1995 - 2002, at which time recovery was considered sufficient for natural reproduction. In 2003, restoration stocking of the Rappahannock River using Potomac River origin eggs was started through a partnership between ICPRB, VDGIF, and the USFWS's Harrison Lake National Fish Hatchery.Stocking of the Potomac River continues, but now as "replacement stocking" to account for the Potomac shad sacrificed for another river system.

*** Not applicable (NA) is used after 2005 because these values could no longer be derived. Starting in 2006, we switched from using one boat to two-three boats for our collections. Since 2005, shad from all boats are pooled together during the collection process, and it became too difficult to separate or accurately estimate egg or fry totals for each individual boat contribution.

Note - CPUE is calculated by two methods in this project. The first CPUE (Shad used/net-set) is based on the number of shad used for egg collections and re-stocking of the Potomac and, starting in 2003, the Rappahannock. It does not include shad which were netted but released, i.e. the green females, spent females no longer spawning, or surplus males (we kept a 1:1 ratio of males to females). Starting in 2002, all shad netted were counted and a second CPUE (total shad netted/net-set) has been calculated, this time using all shad brought to the boat, even those released.

Table 4. 2010 Maryland Department of Natural Resources - American shad collection data from the Potomac River

Date	Temp (ºC)	Males	Ripe	Green	Spent	Total shad	Liters of eggs	Liters good eggs per night	Egg viability	Eggs/liter	# of fertile eggs per liter
4/12/2010	18.9	4	10	23	0	37	5.0	0.8	0.155	40,700	6,300
4/13/2010	18.1	39	40	32	0	111	19.5	16.8	0.862	34,900	30,084
4/14/2010	17.3	32	20	17	0	69	9.5	5.9	0.618	33,800	20,899
4/15/2010	17.7	27	40	24	0	91	20.0	11.4	0.570	34,900	19,900
4/16/2010	19.1	8	10	17	0	35	4.5	2.7	0.601	35,600	21,399
4/18/2010	17.2	28	34	41	0	103	17.0	13.0	0.763	40,500	30,902
4/19/2010	17.1	10	33	18	4	65	23.0	18.0	0.783	37,300	29,198
4/20/2010	17.6	31	34	42	6	113	24.5	17.5	0.716	35,200	25,200
4/21/2010	16.9	50	57	12	5	124	30.5	25.0	0.820	37,800	31,000
4/22/2010	17.6	72	31	0	5	108	13.5	7.8	0.581	43,400	25,198
4/23/2010	17.9	42	12	9	7	70	11.5	8.5	0.740	33,800	24,998
4/25/2010	18.2	10	30	26	9	75	10.5	5.4	0.513	40,900	20,998
4/27/2010	17.8	20	36	1	3	60	19.0	11.8	0.620	39,200	24,300
4/28/2010	16.9	24	24	3	7	58	13.0	10.0	0.766	36,600	28,043
4/29/2010	17.3	59	28	0	2	89	13.5	10.3	0.765	40,000	30,600
4/30/2010	17.5	38	11	2	11	62	5.0	3.1	0.624	37,200	23,202
5/3/2010	20.7	3	28	2	4	37	13.5	11.8	0.875	39,100	34,201
5/4/2010	21.6	41	75	13	20	149	31.0	16.5	0.532	42,700	22,699
5/5/2010	22.1	25	23	4	19	71	8.5	6.0	0.706	46,900	33,102
5/6/2010	22.5	27	18	2	8	55	4.5	2.8	0.625	42,900	26,800
5/10/2010	20.3	2	0	0	17	19	0.0	0.0	0.000	0	0
5/12/2010	19.4	3	0	0	3	6	2.0	1.8	0.923	22,200	20,499
5/13/2010	20	6	4	0	6	16	0.0	0.0	0.000	0	0
5/17/2010	19.7	3	1	0	14	18	0.0	0.0	0.000	0	0
		604	599	288	150	1641	299.0				

Table 4 continued. 2010 Maryland Department of Natural Resources - American shad collection data from the Potomac River

Date	Total # of Eggs	Total fertile eggs	Moon Visability %	Lunar Phase	# of nets used	feet of net used	Sq. ft. of net fished per night	
4/12/2010	203,500	31,502	6	Waning	4	1200	23700	0.001561
4/13/2010	680,550	586,634	2	Waning	4	1200	23700	0.004684
4/14/2010	321,100	198,536	0		4	1200	23700	0.002911
4/15/2010	698,000	398,000	0		4	1200	23700	0.003840
4/16/2010	160,200	96,296	1	Waxing	4	1200	23700	0.001477
4/18/2010	688,500	525,326	12	Waxing	4	1200	23700	0.004346
4/19/2010	857,900	671,564	20	Waxing	5	1500	29700	0.002189
4/20/2010	862,400	617,392	29	Waxing	5	1500	29700	0.003805
4/21/2010	1,152,900	945,493	40	Waxing	5	1500	29700	0.004175
4/22/2010	585,900	340,174	51	Waxing	5	1500	29700	0.003636
4/23/2010	388,700	287,483	62	Waxing	5	1500	29400	0.002381
4/25/2010	429,450	220,480	83	Waxing	5	1500	29400	0.002551
4/27/2010	744,800	461,702	96	Waxing	5	1500	29400	0.002041
4/28/2010	475,800	364,558	99	Full	4	1200	23400	0.002479
4/29/2010	540,000	413,100	99	Full	5	1500	29400	0.003027
4/30/2010	186,000	116,008	97	Waning	3	900	17400	0.003563
5/3/2010	527,850	461,710	79	Waning	3	900	17400	0.002126
5/4/2010	1,323,700	703,679	71	Waning	5	1500	28800	0.005174
5/5/2010	398,650	281,367	62	Waning	5	1500	28200	0.002518
5/6/2010	193,050	120,598	52	Waning	5	1500	28800	0.001910
5/10/2010	0	0	17	Waning	3	900	16800	0.001131
5/12/2010	44,400	40,999	5	Waning	3	900	16800	0.000357
5/13/2010	0	0	1	Waning	3	900	16800	0.000952
5/17/2010	0	0	9	Waxing	3	900	16800	0.001071
	11,463,350	7,882,600						

Table 5. Summary of American Shad Collected from the Potomac River by MD DNR and Eggs Obtained

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Totals
# Ripe Females	298	568	458	231	561	472	567	401	425	599	4,580
# Green Females		205	351	276	446	314	438	405	277	288	3,000
# Spent Females		147	60	183	192	98	178	141	144	150	1,293
# Males	143	1083	490	286	385	223	213	476	467	604	4,370
Total Shad	441	2,003	1,359	976	1,584	1,107	1,396	1,423	1,313	1,641	13,243
Liters of Eggs	101.8	309.6	222.6	137.5	246.0	249.0	294.7	213.5	205.5	299.0	2,279
Total # of Eggs	3,906,375	11,501,975	8,337,225	5,742,950	9,514,400	9,350,900	10,222,090	7,918,150	7,557,855	11,463,350	85,515,270
Total Fertile Eggs	1,687,629	5,898,446	3,260,799	3,268,708	4,466,611	3,207,860	3,508,795	3,921,239	4,554,483	7,882,600	41,657,170
# Re-stocked Fry							200,000	200,000	200,000		600,000

Table 6. Summary of American Shad Collected in the Potomac River by the USFWS

	2004	2005	2006*	2007*	2008*	2009*	2010*	Totals
# Females Caught			673	1,110	1,291	451	955	4,480
# Males Caught			117	272	284	510	1,196	2,379
Ripe Females	50			515	501	451		1,517
Ripe Males	39			271	284	510		1,104
# Shad Released	125		395	596	790	787	614	3,307
Total Shad Kept	89		382	786	785	771	2,151	4,964
Total Shad Caught	214	296	777	1,382	1,575	1,558	2,765	8,567
Avg. CPUE (shad/hr/ft^2)			0.001	0.002				0
Volume(L) of Eggs			99.3	183.9	194.4	138.0		616
# of Eggs			4,511,426	7,488,716	8,503,709	6,380,784		26,884,635
Viable Eggs			2,003,222	2,875,455	3,491,069	1,885,500		10,255,246
Viability (%)			44.40	42.00	41.10	30.00		158
# Fry Re-stocked					188,000			188,000

* Scales & otoliths taken on 5% of fish

Table 7. 2006 POTOMAC RIVER OTOLITH AND SCALE AGING - from Mike Hendricks

LF by sex

Count of LG		
SEX	LG	Total
f	425	2
	450	19
	475	46
	500	79
	525	45
	550	19
	575	4
f Count		214
m	350	2
	375	1
	400	1
	425	5
	450	9
	475	13
	500	20
	525	7
	550	1
m Count		59
(blank)	(blank)	
	450	1
(blank) Count		1
Grand Total		274

Mean TL

Average of (mm)	
SEX	Total
f	512.3224299
m	485.6779661
(blank)	469
Grand Total	506.4270073

Count of (mm)	
SEX	Total
f	214
m	59
(blank)	1
Grand Total	274

StdDev of (mm)	
SEX	Total
f	29.37907917
m	39.70687454
(blank)	#DIV/0!
Grand Total	33.67214478

Age frequency (otoliths)

Count of Site		
SEX	AGE2	Total
f	4	3
	5	13
	6	11
	7	2
	9	1
	m	1
	(blank)	183
f Total		214
m	4	1
	5	4
	6	4
	7	1
	(blank)	49
m Total		59
(blank)	5	1
	(blank)	6
(blank) Total		7
Grand Total		280

Age frequency (scales)

Count of Site		
SEX	Age	Total
f	3	1
	4	8
	5	16
	6	15
	7	3
	8	1
	not pressed	166
	regen	3
	(blank)	1
f Total		214
m	4	4
	5	7
	6	5
	not pressed	42
	(blank)	1
m Total		59
(blank)	5	3
	6	1
	7	1
	not pressed	1
	(blank)	1
(blank) Total		7
Grand Total		280

Sex Ratio

Count of ALT #	
SEX	Total
f	214
m	59
(blank)	7
Grand Total	280

Mean Weight

Weight

Average of (Kg)	
SEX	Total
f	1.530751174
m	1.213474576
(blank)	1.25
Grand Total	1.461153846

Count of (Kg)	
SEX	Total
f	214
m	59
(blank)	1
Grand Total	274

Mean Weight

Weight

StdDev of (Kg)	
SEX	Total
f	0.25805952
m	0.283871411
(blank)	#DIV/0!
Grand Total	0.293855967

Table 7 Continued. 2006 POTOMAC RIVER OTOLITH AND SCALE AGING

scale age& repeats

Count of Site			
SEX	Age	repeats	Total
f	3	0	1
	3 Total		1
	4	0	6
		1	2
	4 Total		8
	5	0	8
		1	5
		2	3
	5 Total		16
	6	0	3
		1	4
		2	6
		3	2
	6 Total		15
	7	2	1
		3	2
	7 Total		3
	8	3	1
	8 Total		1
	not pressed	(blank)	166
	not pressed Total		166
	regen	1	1
		(blank)	2
	regen Total		3
	(blank)	(blank)	1
	(blank) Total		1
f Total			214
m	4	0	2
		1	2
	4 Total		4
	5	0	1
		1	2
		2	4
	5 Total		7
	6	2	3
		3	2
	6 Total		5
	not pressed	(blank)	42
	not pressed Total		42
	(blank)	(blank)	1
	(blank) Total		1
m Total			59
(blank)	5	1	3
	5 Total		3
	6	2	1
	6 Total		1
	7	3	1
	7 Total		1
	not pressed	(blank)	1
	not pressed Total		1
	(blank)	(blank)	1
	(blank) Total		1
(blank) Total			7
Grand Total			280

otolith age& repeats

Count of Site			
SEX	AGE2	repeats	Total
f	4	0	2
		1	1
	4 Total		3
	5	0	8
		1	2
		2	1
		(blank)	2
	5 Total		13
	6	0	4
		1	4
		2	2
		(blank)	1
	6 Total		11
	7	2	1
		3	1
	7 Total		2
	9	2	1
	9 Total		1
	m	3	1
	m Total		1
	(blank)	0	4
		1	5
		2	5
		3	3
		(blank)	166
	(blank) Total		183
f Total			214
m	4	1	1
	4 Total		1
	5	1	2
		2	2
	5 Total		4
	6	1	1
		2	2
		3	1
	6 Total		4
	7	3	1
	7 Total		1
	(blank)	0	3
		2	3
		(blank)	43
	(blank) Total		49
m Total			59
(blank)	5	(blank)	1
	5 Total		1
	(blank)	1	3
		2	1
		3	1
		(blank)	1
	(blank) Total		6
(blank) Total			7
Grand Total			280

Table 8. 2007 POTOMAC RIVER OTOLITH AND SCALE AGING - from Mike Hendricks

Sex Ratio

Count of SEX	
SEX	Total
F	19
M	21
(blank)	
Grand Total	40

mean FL

Average of (mm)2	
SEX	Total
F	450.8421053
M	418.7142857
(blank)	
Grand Total	433.975

age frequency (scales)

Count of Age		
SEX	Age	Total
F	5	8
	6	9
	(blank)	
F Total		17
M	4	4
	5	6
	6	9
	(blank)	
M Total		19
(blank)	5	1
	6	1
	(blank)	
(blank) Total		2
Grand Total		38

mean wt.

Average of (Kg)	
SEX	Total
F	1472
M	1185
(blank)	
Grand Total	1322

StdDev of (mm)2	
SEX	Total
F	19.96458853
M	28.82211453
(blank)	
Grand Total	29.56304649

StdDev of (Kg)	
SEX	Total
F	244
M	213
(blank)	
Grand Total	268

Count of (mm)2	
SEX	Total
F	19
M	21
(blank)	
Grand Total	40

age frequency (otoliths)

Count of AGE2		
SEX	AGE2	Total
F	5	3
	6	6
	7	1
	(blank)	
F Total		10
M	4	1
	5	4
	6	8
	8	1
	(blank)	
M Total		14
(blank)	5	1
	6	2
	7	1
(blank) Total		4
Grand Total		28

Count of (Kg)	
SEX	Total
F	19
M	21
(blank)	
Grand Total	40

Table 8 Continued. 2007 POTOMAC RIVER OTOLITH AND SCALE AGING

scale age & repeats

Count of repeats			
SEX	Age	repeats	Total
F	5	0	2
		1	5
		2	1
	5 Total		8
	6	0	5
		1	3
		2	1
	6 Total		9
	(blank)	(blank)	
	(blank) Total		
F Total			17
M	4	0	1
		1	3
	4 Total		4
	5	0	3
		1	3
	5 Total		6
	6	0	1
		1	2
		2	4
		3	2
	6 Total		9
	(blank)	(blank)	
	(blank) Total		
M Total			19
(blank)	5	0	1
	5 Total		1
	6	0	1
	6 Total		1
	(blank)	(blank)	
	(blank) Total		
(blank) Total			2
Grand Total			38

otolith age & repeats

Count of repeats			
SEX	AGE2	repeats	Total
F	5	0	1
		1	2
	5 Total		3
	6	0	3
		1	2
		(blank)	
	6 Total		5
	7	1	1
	7 Total		1
	(blank)	0	3
		1	3
		2	2
		(blank)	
	(blank) Total		8
F Total			17
M	4	1	1
	4 Total		1
	5	0	1
		1	3
	5 Total		4
	6	0	3
		1	1
		2	3
		3	1
	6 Total		8
	8	1	1
	8 Total		1
	(blank)	0	1
		1	2
		2	1
		3	1
		(blank)	
	(blank) Total		5
M Total			19
(blank)	5	0	1
	5 Total		1
	6	0	1
		(blank)	
	6 Total		1
	7	(blank)	
	7 Total		
(blank) Total			2
Grand Total			38

Table 9. 2008 POTOMAC RIVER OTOLITH AND SCALE AGING - from Mike Hendricks

sex ratio

Count of SEX	
SEX	Total
F	18
M	17
na	2
(blank)	
Grand Total	37

mean weight

Average of (Kg)	
SEX	Total
F	1.66666667
M	1.30882353
na	#DIV/0!
(blank)	
Grand Total	1.49285714

StdDev of (Kg)	
SEX	Total
F	0.17149859
M	0.20784256
na	#DIV/0!
(blank)	
Grand Total	0.26069558

Count of (Kg)	
SEX	Total
F	18
M	17
na	2
(blank)	
Grand Total	37

mean FL

Average of (mm)2	
SEX	Total
F	508.7777778
M	463
na	#DIV/0!
(blank)	
Grand Total	486.5428571

StdDev of (mm)2	
SEX	Total
F	25.30183801
M	23.26209363
na	#DIV/0!
(blank)	
Grand Total	33.37077169

Count of (mm)2	
SEX	Total
F	18
M	17
na	0
(blank)	
Grand Total	35

age frequency (scales)

Count of Age		
SEX	Age	Total
F	4	2
	5	6
	6	5
	7	3
	8	1
	regen	1
F Total		18
M	4	2
	5	9
	6	3
	7	1
	regen	1
	(blank)	
M Total		16
na	na	2
na Total		2
(blank)	5	1
	(blank)	
(blank) Total		1
Grand Total		37

age frequency (otoliths)

Count of AGE2		
SEX	AGE2	Total
F	4	1
	5	2
	6	6
	7	2
	(blank)	
F Total		11
M	4	3
	5	4
	6	3
	(blank)	
M Total		10
na	5	1
	7	1
na Total		2
(blank)	4	1
	5	1
	6	1
(blank) Total		3
Grand Total		26

Table 9 continued. 2008 POTOMAC RIVER OTOLITH AND SCALE AGING - from Mike Hendricks

scale age & repeats

Count of repeats			
SEX	Age	repeats	Total
F	4	0	1
		1	1
	4 Total		2
	5	0	1
		1	4
		2	1
	5 Total		6
	6	1	2
		2	3
	6 Total		5
	7	1	2
		2	1
	7 Total		3
	8	2	1
	8 Total		1
	regen	(blank)	
	regen Total		
F Total			17
M	4	0	1
		1	1
	4 Total		2
	5	0	1
		1	7
		2	1
	5 Total		9
	6	0	1
		2	1
		3	1
	6 Total		3
	7	2	1
	7 Total		1
	regen	(blank)	
	regen Total		
	(blank)	(blank)	
	(blank) Total		
M Total			15
na	na	na	2
	na Total		2
na Total			2
(blank)	5	1	1
	5 Total		1
	(blank)	(blank)	
	(blank) Total		
(blank) Total			1
Grand Total			35

otolith age & repeats

Count of repeats			
SEX	AGE2	repeats	Total
F	4	1	1
	4 Total		1
	5	0	1
		1	1
	5 Total		2
	6	1	3
		2	3
	6 Total		6
	7	1	1
		2	1
	7 Total		2
	(blank)	0	1
		1	3
		2	2
		(blank)	
	(blank) Total		6
F Total			17
M	4	0	1
		1	1
		(blank)	
	4 Total		2
	5	0	1
		1	3
	5 Total		4
	6	0	1
		2	1
		3	1
	6 Total		3
	(blank)	1	4
		2	2
		(blank)	
	(blank) Total		6
M Total			15
na	5	na	1
	5 Total		1
	7	na	1
	7 Total		1
na Total			2
(blank)	4	(blank)	
	4 Total		
	5	1	1
	5 Total		1
	6	(blank)	
	6 Total		
(blank) Total			1
Grand Total			35

Table 10. 2009 POTOMAC RIVER OTOLITH AND SCALE AGING - from Mike Hendricks

Scale age frequency

Count of Age	
Age	Total
4	2
5	9
6	7
7	2
??	1
no scales	6
regenerated	3
(blank)	
Grand Total	30

Otolith age frequency

Count of AGE2	
AGE2	Total
4	3
5	12
6	12
7	3
(blank)	
Grand Total	30

scale age & repeats

Count of Rpts		
Age	Rpts	Total
4	1	2
4 Total		2
5	1	4
	2	4
	(blank)	
5 Total		8
6	1	5
	2	2
6 Total		7
7	1	1
	2	1
7 Total		2
??	1	1
?? Total		1
no scales	(blank)	
no scales Total		
regenerated	(blank)	
regenerated Total		
(blank)	(blank)	
(blank) Total		
Grand Total		20

otolith age & repeats

Count of Rpts		
AGE2	Rpts	Total
4	1	1
	2	1
	(blank)	
4 Total		2
5	1	5
	2	2
	(blank)	
5 Total		7
6	1	6
	2	3
	(blank)	
6 Total		9
7	1	1
	2	1
	(blank)	
7 Total		2
(blank)	(blank)	
(blank) Total		
Grand Total		20

Table 11. 2010 POTOMAC RIVER OTOLITH AND SCALE AGING - from Mike Hendricks

Sex Ratio

Count of Sex	
Sex	Total
F	42
M	39
(blank)	
Grand Total	81

Mean Weight

Average of W (g)	
Sex	Total
F	1502
M	1054
(blank)	
Grand Total	1286

Age frequency (scales)

Count of Age		
Sex	Age	Total
F	3	1
	4	2
	5	12
	6	14
	7	8
	9	2
	no scales	3
F Total		42
M	3	1
	4	4
	5	19
	6	12
	7	1
	regenerated	2
M Total		39
(blank)	no scales	1
(blank) Total		1
Grand Total		82

Mean FL

Average of FL	
Sex	Total
F	447
M	410
(blank)	
Grand Total	429

StdDev of W (g)	
Sex	Total
F	481
M	264
(blank)	
Grand Total	450

StdDev of FL	
Sex	Total
F	31.5
M	27
(blank)	
Grand Total	34.5

Count of W (g)	
Sex	Total
F	42
M	39
(blank)	
Grand Total	81

Count of FL	
Sex	Total
F	42
M	39
(blank)	
Grand Total	81

Age frequency (otoliths)

Count of AGE2		
Sex	AGE2	Total
F	3	1
	4	2
	5	14
	6	16
	7	7
	8	2
F Total		42
M	3	1
	4	5
	5	19
	6	11
	8	1
	crystalline	2
M Total		39
(blank)	7	1
(blank) Total		1
Grand Total		82

Table 11 continued. 2010 POTOMAC RIVER OTOLITH AND SCALE AGING

scale age& repeats

Count of spawner			
Sex	Age	spawner	Total
F	3	(blank)	
	3 Total		
	4	(blank)	
	4 Total		
	5	1	4
		(blank)	
	5 Total		4
	6	1	10
		2	2
		(blank)	
	6 Total		12
	7	1	2
		2	1
		3	4
		(blank)	
	7 Total		7
	9	6	2
	9 Total		2
	no scales	(blank)	
	no scales Total		
F Total			25
M	3	(blank)	
	3 Total		
	4	1	1
		2	1
		(blank)	
	4 Total		2
	5	1	5
		2	6
		(blank)	
	5 Total		11
	6	1	3
		2	7
		3	1
		(blank)	
	6 Total		11
	7	3	1
	7 Total		1
	regenerated	(blank)	
	regenerated Total		
M Total			25
(blank)	no scales	(blank)	
	no scales Total		
(blank) Total			
Grand Total			50

otolith age& repeats

Count of spawner			
Sex	AGE2	spawner	Total
F	3	(blank)	
	3 Total		
	4	2	1
		(blank)	
	4 Total		1
	5	1	5
		(blank)	
	5 Total		5
	6	1	7
		2	2
		3	1
		(blank)	
	6 Total		10
	7	1	4
		3	3
	7 Total		7
	8	6	2
	8 Total		2
F Total			25
M	3	(blank)	
	3 Total		
	4	1	2
		2	1
		(blank)	
	4 Total		3
	5	1	4
		2	8
		(blank)	
	5 Total		12
	6	1	3
		2	4
		3	2
		(blank)	
	6 Total		9
	8	(blank)	
	8 Total		
	crystalline	2	1
		(blank)	
	crystalline Total		1
M Total			25
(blank)	7	(blank)	
	7 Total		
(blank) Total			
Grand Total			50

Table 12. 2011 POTOMAC RIVER OTOLITH AND SCALE AGING - from Mike Hendricks

Sex Ratio

Count of Sex	
Sex	Total
could not read label on head	6
F	25
M	18
Grand Total	49

Mean Weight

Average of W (g)	
Sex	Total
could not read label on head	
F	1254.4
M	972.222222
Grand Total	1136.27907

StdDev of W (g)	
Sex	Total
could not read label on head	
F	249.701155
M	148.346001
Grand Total	253.724853

Count of W (g)	
Sex	Total
could not read label on head	
F	25
M	18
Grand Total	43

Mean TL

Average of TL	
Sex	Total
could not read label on head	
F	494.8
M	447.6666667
Grand Total	475.0697674

StdDev of TL	
Sex	Total
could not read label on head	
F	27.48029597
M	73.05356616
Grand Total	56.08216564

Count of TL	
Sex	Total
could not read label on head	
F	25
M	18
Grand Total	43

Table 12 continued. 2011 POTOMAC RIVER OTOLITH AND SCALE AGING

LF by sex

Count of Grp		
Sex	Grp	Total
could not read label on head	(blank)	
could not read label on head Total		
F	450	8
	475	7
	500	6
	525	3
	550	1
F Total		25
M	425	2
	450	10
	475	4
	525	1
	(blank)	
M Total		17
Grand Total		42

Age frequency (scales)

Count of Age		
Sex	Age	Total
could not read label on head	(blank)	
could not read label on head Total		
F	3	1
	4	2
	5	12
	6	7
	pressed scales are from 2 diff. fish	1
	regen	2
F Total		25
M	3	1
	4	3
	5	10
	6	4
M Total		18
Grand Total		43

Age frequency (otoliths)

Count of AGE2		
Sex	AGE2	Total
could not read label on head	5	2
	6	4
could not read label on head Total		6
F	4	2
	5	9
	6	7
	7	1
	cryst.	1
	(blank)	
F Total		20
M	4	3
	5	10
	6	3
	cryst.	1
	(blank)	
M Total		17
Grand Total		43

Table 12 continued. 2011 POTOMAC RIVER OTOLITH AND SCALE AGING

scale age& repeats

Count of spawner			
Sex	Age	spawner	Total
could not read label on head	(blank)	(blank)	
	(blank) Total		
could not read label on head Total			
F	3	(blank)	
	3 Total		
	4	(blank)	
	4 Total		
	5	1	2
		2	3
		(blank)	
	5 Total		5
	6	1	2
		2	4
		(blank)	
	6 Total		6
	pressed scales are from 2 diff. fish	(blank)	
	pressed scales are from 2 diff. fish Total		
	regen	(blank)	
	regen Total		
F Total			11
M	3	(blank)	
	3 Total		
	4	1	2
		(blank)	
	4 Total		2
	5	1	7
		2	1
		(blank)	
	5 Total		8
	6	1	1
		2	3
	6 Total		4
M Total			14
Grand Total			25

otolith age& repeats

Count of spawner			
Sex	AGE2	spawner	Total
could not read label on head	5	(blank)	
	5 Total		
	6	(blank)	
	6 Total		
could not read label on head Total			
F	4	(blank)	
	4 Total		
	5	1	1
		2	3
		(blank)	
	5 Total		4
	6	1	2
		2	3
		(blank)	
	6 Total		5
	7	(blank)	
	7 Total		
	cryst.	2	1
	cryst. Total		1
	(blank)	1	1
		(blank)	
	(blank) Total		1
F Total			11
M	4	1	2
		(blank)	
	4 Total		2
	5	1	6
		2	1
		(blank)	
	5 Total		7
	6	1	1
		2	2
	6 Total		3
	cryst.	1	1
	cryst. Total		1
	(blank)	2	1
	(blank) Total		1
M Total			14
Grand Total			25

North Carolina American Shad Sustainable Fishery Plan

Prepared by

North Carolina Division of Marine Fisheries
and
North Carolina Wildlife Resources Commission

December 2011

INTRODUCTION

American shad (*Alosa sapidissima*) are currently managed under Amendment 3 to the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan for Shad and River Herring. Amendment 3 requires all states and jurisdictions without an approved sustainable fishery plan to close their fisheries (with the exception of catch and release fisheries) for American shad by January 1, 2013 (ASMFC 2010). A sustainable fishery is defined in Amendment 3 as one that "demonstrates their stock could support a commercial and/or recreational fishery that will not diminish future stock reproduction and recruitment". The purpose of this plan is to identify and implement sustainable management measures that will allow for maintenance and rebuilding of American shad populations in North Carolina.

The most recent stock assessment of American shad stated that populations in the Albemarle Sound and Roanoke River are stable and low, whereas a determination of stock status could not definitively be assigned for the Tar-Pamlico, Neuse and Cape Fear rivers due to limited information (ASMFC 2007a). It should be noted that areas south of Albemarle Sound form a zone where stocks transition from iteroparity to semelparity, which can also impact the ability to determine stock status.

Sustainable fishery parameters are being submitted for consideration for the following areas: Albemarle Sound/Roanoke River, Tar-Pamlico River, Neuse River, and Cape Fear River.

EXISTING MANAGEMENT

American shad are jointly managed by the North Carolina Marine Fisheries Commission (MFC) and the North Carolina Wildlife Resources Commission (WRC). The Division of Marine Fisheries (DMF) implements MFC rules for American shad in the Atlantic Ocean as well as the Coastal and Joint waters of North Carolina, while the WRC manages American shad in the state's recreational fishery in Inland Waters. The known extent of American shad in North Carolina river systems is shown in Figure 1.

Seasonal Restrictions

From the 1950s to 1965, a January 1 through May 1 commercial season existed in Coastal Waters, while a January 1 through June 1 season existed in Inland Waters throughout the state. From 1966 through 1994, no seasonal restrictions existed for the commercial fishery. Since 1995, a commercial season of January 1 through April 15 has been in place in Coastal and Joint waters although the fishery is rarely opened prior to February 1 each year. Implementation of this seasonal restriction greatly reduced harvest, as historically a large portion of the commercial American shad harvest occurred after April 15 and into May.

Commercial Gear Restrictions

Beginning in 1988, western Albemarle Sound (also referred to as Batchelor Bay) has been closed to the use of gill nets from February through mid-November. While the purpose of the closure is striped bass (*Morone saxatilis*) conservation, this measure has also afforded protection for American shad. From 1988 through 1990, limits of 1,000 to 2,000 yards were implemented for 5.25-inch stretched mesh and larger gill nets in Albemarle Sound, and nets could only be set 5 days per week. Again, these measures were implemented for striped bass conservation, but it is likely they had positive impacts on American shad.

Since 1998, commercial restrictions in Albemarle Sound have been consistent and include a prohibition on the use of gill nets with a mesh size of 3.5–5.0 inches stretched mesh and a limit of 1,000 yards on the use of 5.25-inch stretched mesh during the open shad season (generally mid-February through April 15). When the season closes, these nets are removed from the water. The Albemarle Sound is the only system for which mesh size restrictions and yardage limits exist during the shad season. There is a statewide rule limiting the amount of 5.0-inch and greater mesh set in internal coastal waters to no more than 3,000 yards per vessel. However, this rule has been suspended in the majority of internal coastal waters as a result of sea turtle conservation measures that allow no more than 2,000 yards per vessel of 4.0–6.5-inch gill net (applies north of the NC Highway 58 bridge; south of the bridge a 1,000-yard limit applies).

Additionally, in certain sections of the Tar-Pamlico and Neuse rivers, gill nets with a mesh size less than five inches must be attended at all times.

Finally, interim management measures implemented in November 2011 for spotted seatrout (*Cynoscion nebulosus*) conservation make it unlawful to use gill nets in Joint Waters on weekends. These measures will reduce American shad harvest since they will likely remain in effect throughout the spring 2012 fishing season.

Recreational Restrictions

Prior to 1995, no recreational restrictions existed. Beginning in 1995, it became unlawful to take American shad and hickory shad (*Alosa mediocris*) by any method except hook-and-line from April 15–December 31 in Coastal Waters. Additionally, from 1995 through 1998, there was a recreational season during January 1 through April 14. Beginning in 1999, it became unlawful to possess more than 10 American shad and hickory shad in the aggregate in both Coastal and Inland Waters. In 2010, the WRC implemented a 1-fish American shad limit within the 10-fish aggregate creel limit for American and hickory shad in the Inland Waters of the Roanoke River. A similar rule implementing a 1-fish limit for American shad in the Inland Waters of the Neuse River will become effective in August 2012 and applicable to the spring 2012 fishing season.

REQUEST FOR FISHERIES

A sustainable fishery is defined in Amendment 3 as one that demonstrates shad stocks could support a commercial and/or recreational fishery that will not diminish future stock reproduction and recruitment. A suite of potential sustainability parameters were considered for North Carolina and it was decided to develop sustainability parameters for each river system based on relative abundance and relative fishing mortality rate. Relative abundance was calculated using available fisheries-independent survey data that were considered appropriate for measuring the abundance of American shad and were expressed in terms of catch-per-unit-effort (CPUE). The standard deviations of the annual CPUE index values were also calculated to demonstrate the variability of these values. Environmental conditions on the spawning grounds, especially flow rates, are a major source of the variability associated with these indices.

Relative fishing mortality rate is calculated by dividing catch by a fisheries-independent index of relative abundance. Imprecision in the survey index can cause estimates of relative *F* to be noisy. The noise can be dampened by using an average of the survey index over adjacent years in place of point estimates in the denominator. Here, relative *F* was computed by dividing commercial landings by a centered 3-year average of a survey index. Note that relative *F* in the first and last year of the time series will be based on only two years of data. In each system, the survey data used in the calculations of relative *F* were subset to reflect conditions in the commercial fishery.

Indices of relative abundance and estimates of relative *F* were calculated for each system using available data. The objective was to select a minimum of one abundance index and one series of relative *F* estimates to serve as sustainability parameters in each system. Where multiple data sources were available in a system to calculate relative abundance or relative *F*, a tiered approach was taken to select the most appropriate data source for deriving the sustainability parameter. Sources of data that were not considered reflective of conditions in the system of interest were eliminated from consideration. Data sources that were available for a minimum of ten years were preferred. Also, data sources associated with extreme variability or a large amount of imprecision were not considered reliable for deriving sustainability parameters. Finally, sustainability parameters based on the female segment of the stock were preferred because the commercial fishery targets roe shad; roe landings can account for as much as 90% of the total American shad landings in a year.

The sustainability parameters evaluated and selected are described below for each system. The selected sustainability parameters will be reported in annual compliance reports and any management actions will

be noted. Potential management actions are included in a separate section to eliminate repetition within each of the river system sections, although any action or suite of actions could be specific to and independent of each system.

Albemarle Sound

Stock Status

The 2007 ASMFC stock assessment stated that American shad stocks in the Albemarle Sound and Roanoke River were low but stable and suggested a benchmark total mortality rate (Z_{30}) of 1.01 (ASMFC 2007b). Annual estimates of Z from the assessment indicate that values have fluctuated around the benchmark since 2000.

Commercial Fisheries

The Albemarle Sound area has traditionally accounted for the largest proportion of the state's commercial harvest (Figure 2). The 2010 American shad landings in North Carolina totaled 233,267 pounds, and the Albemarle Sound area accounted for 79.3% of those landings. Landings from gill nets comprised 97.3% of the overall harvest.

Recreational Fisheries

A recreational fishery for striped bass and hickory shad has existed on the Roanoke River for many years, with little effort, catch or harvest of American shad in annual creel surveys. However, creel surveys conducted by the WRC have traditionally focused on striped bass effort and harvest; therefore, estimates of American shad harvest could be inherently biased. The spring 2006 Roanoke River creel report estimated a directed harvest of 103 American shad and release of 541 fish (McCargo et al. 2007). As noted in the previous section, a 1-fish limit on American shad within the aggregate 10-fish creel for American and hickory shad became effective July 1, 2008 on the Roanoke River. This regulation was implemented to provide additional protection for American shad on the Roanoke River and to complement restoration and stocking efforts (see "Future Considerations" section,).

Sustainability Parameters

Data used in the development of sustainability parameters include independent gill net survey (IGNS) data collected by DMF, electrofishing data collected on the spawning grounds by WRC, and commercial landings data collected through the DMF Trip Ticket Program (see the "Stock Monitoring Programs" section for complete descriptions of these surveys).

Although DMF has conducted a fixed-station alosine seine survey since 1972 for calculation of a juvenile abundance index (JAI), the survey was specifically developed for river herring and is not a reliable indicator of shad juvenile abundance. Further analysis determined that the survey lacked the persistence needed to provide an unbiased index of abundance. For these reasons, the JAI is not being used as a sustainability parameter even though this information is updated annually in compliance reports.

The following sustainability parameters and thresholds were evaluated for the Albemarle Sound area:

Female CPUE (DMF IGNS): The female CPUE index based on the DMF IGNS was calculated as the number of fish per haul using data collected during January through May (Figure 3).

- Time series: 2000–2010. Although the IGNS has been conducted since 1991, use of the 2000–2010 time series will allow for more consistent comparison with the female CPUE index from the Roanoke River electrofishing survey, which has been conducted annually since 2000.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater).

Female CPUE (WRC electrofishing survey): The female CPUE index based on the WRC electrofishing survey was calculated as the number of fish per minute (Figure 3). Data from the 2000 electrofishing survey were unavailable for analysis due to database construction but will be included when parameters are updated for the annual compliance report.

- Time series: 2001–2010.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater).

Female Relative F (DMF IGNS): Female relative *F* based on the DMF IGNS was calculated using commercial gill net landings of roes in Albemarle Sound (February through April) and a female index derived from data collected in the 5.0, 5.5 and 6.0-inch mesh sizes of the IGNS (February through April; Figure 4). The February through April timeframe was used to reflect the period during which the commercial fishery is prosecuted. The mesh sizes selected most accurately reflect those used by the commercial fleet.

- Time series: 2000–2010. See description of time series for female CPUE based on the DMF IGNS.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

Female Relative F (WRC electrofishing survey): Female relative *F* based on the WRC electrofishing survey was calculated using commercial landings of roes by all gear types in Albemarle Sound and the female CPUE index from the Roanoke River electrofishing survey (Figure 5). Because the survey occurs during the months of March through May, landings data from only those months were used in the calculations. As noted above, data from the 2000 electrofishing survey were unavailable for analysis.

- Time series: 2001–2010.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

Total Relative F (DMF IGNS): Total relative *F* based on the DMF IGNS was calculated the same way that female relative *F* based on the DMF IGNS was calculated except that all sexes were included (male, female, unknown) in computing relative abundance, and commercial landings included both bucks and roes (Figure 6).

- Time series: 1998–2010. This time period was chosen because commercial regulations in the Albemarle Sound have been consistent during these years.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

The sustainability parameters selected for Albemarle Sound were female CPUE based on the IGNS, female CPUE based on the electrofishing survey and female relative *F* based on the IGNS. Relative *F* based on the IGNS was chosen over relative *F* based on the electrofishing survey because the electrofishing survey is limited to the Roanoke River and so was not considered representative of Albemarle Sound as a whole. The majority of the commercial fishery occurs in Albemarle Sound and because a reliable IGNS exists for this area, use of relative *F* based on the IGNS rather than the electrofishing index was determined to be a more appropriate sustainability parameter. Exceeding the threshold for any of the selected parameters will trigger management action (see "Potential Management Measures").

The IGNS index of female relative abundance for Albemarle Sound showed little variation over time (Figure 3). This index has been above the threshold during the most recent five years of the time series (2005–2010). The female abundance index derived from the electrofishing survey was above the

threshold throughout most of the time series (Figure 3). This index demonstrated an increase from 2006 to 2008 but decreased in 2009 and dropped below the threshold in 2010.

Estimates of female relative *F* derived from the IGNS also varied with time and exceeded the threshold in 2010 (Figure 4). Relative *F* estimates for female American shad derived from the electrofishing survey demonstrated a decline from 2003 to 2008 followed by a slight increase through 2010 (Figure 5). Trends in total relative *F* derived from the IGNS (Figure 6) were similar to trends in female relative *F* derived from the same survey (Figure 4).

Future Considerations

Since 1998, American shad fry have been stocked in the Roanoke River downstream of Kerr (US Army Corps of Engineers), Gaston (Dominion Power) and Roanoke Rapids (Dominion Power) reservoirs at Weldon, NC as well as upstream of these reservoirs at Altavista and Clover Landing, VA. These stocking activities serve as migratory obstruction mitigation required by Federal Energy Regulatory Commission (FERC) relicensing of the Gaston and Roanoke Rapids hydropower dams. This restoration effort is coordinated by a Diadromous Fish Restoration Technical Advisory Committee (DFRTAC; includes representatives from U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), Virginia Department of Game and Inland Fisheries (VDGIF), WRC, DMF and Dominion Power) and has a target of two annual population estimates of 20,000 adult American shad present below the base of the Roanoke Rapids Dam. The two population estimates do not have to occur in consecutive years. The target was developed based on a combination of $1/10^{th}$ of the projected run size (using the 50 shad per acre rule of thumb for riverine habitat between the dam and the river mouth (St. Pierre 1979)) and very limited historic landings information.

The contribution of these enhancement efforts to the overall population in the Albemarle Sound system, as well as the potential impact of fishery removals on these efforts, are issues that need to be resolved for possible inclusion in future revisions to this plan. Additional efforts in the Albemarle region include prioritization of roadway culvert replacements. DMF is pursuing a grant opportunity to restore river herring habitat through removal of priority culverts within the region. While this is specifically focused on river herring habitat, there may likely be benefits to shad habitat as well should the grant be awarded.

With regard to the Roanoke River creel survey, additional effort will be made in the future to target locations closer to the spawning grounds near Gaston, where there may be a higher encounter rate of American shad by anglers. This creel survey occurs annually, and collection of effort data related to American shad is somewhat dependent on location. Also, existing methods do not capture effort, harvest and catch from bank anglers although efforts are underway to do so in upcoming surveys.

Finally, DMF just completed a research prioritization process for all managed species. A top priority was expansion of existing surveys to meet the need for more accurate JAIs for species of importance. Depending on funding and staff resources, expansion of the alosine seine survey may be able to meet this need.

Tar-Pamlico River

Stock Status

Stock status could not be determined for the Tar-Pamlico River based on the 2007 ASFMC stock assessment (ASMFC 2007b). There were no definitive trends in abundance, although it was noted that the electrofishing CPUE for the Tar River was higher than in other North Carolina rivers since 2000. A total mortality benchmark (Z_{30}) of 1.01 was suggested.

Commercial Fisheries

Commercial landings of American shad have declined significantly since the mid-1980s and have remained low and variable without trend since 1994 (Figure 2). Almost all harvest occurs in gill nets. There has been sporadic harvest by pound nets over the years.

Recreational Fisheries

A recreational fishery does exist, and estimates of angler effort and catch are calculated through the use of a creel survey that rotates among the Tar, Neuse, and Cape Fear rivers. The most recent creel survey on the Tar River was conducted in 2005 and determined recreational harvest to be 1,212 American shad out of a total estimated catch of 7,575 American and hickory shad combined (Homan et al. 2006). The recreational creel limit is 10 American and hickory shad in the aggregate. While DMF has recently expanded creel surveys further upstream in the central region (Pamlico Sound area) of the state, estimates of harvest are highly variable and inherently have a large error associated with them, similar to creel surveys conducted by WRC in Inland Waters.

Sustainability Parameters

Data used in the development of sustainability parameters for the Tar-Pamlico system include electrofishing data collected by WRC and commercial landings data collected through the DMF Trip Ticket Program (see the "Stock Monitoring Programs" section for complete descriptions of these surveys). There is no directed JAI survey for the Tar-Pamlico system. An IGNS has been conducted consistently in the Neuse, Pamlico, and Pungo river tributaries of Pamlico Sound since 2004, but the survey has an average annual catch of only 24 American shad in the Tar-Pamlico River. American shad captured in this IGNS are not sexed; therefore, an independent estimate of female relative abundance could not be calculated from this survey.

The following sustainability parameters and thresholds were evaluated for the Tar-Pamlico River system:

Female CPUE (WRC electrofishing survey): The female CPUE index based on the WRC electrofishing survey was calculated as the number of fish per minute (Figure 7).

- Time series: 2000–2010. The electrofishing survey has been conducted annually since 2000 on the Tar River.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater).

Female Relative F (WRC electrofishing survey): Female relative *F* based on the WRC electrofishing survey was calculated using commercial landings of roes by all gear types from the Pamlico River and the female CPUE index from the Tar River electrofishing survey (Figure 8). Because the electrofishing survey primarily occurs during March through April, only commercial landings from those months were used in the calculations.

- Time series: 2000–2010. The electrofishing survey has been conducted on the Tar River annually during these years.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

Total Relative F (DMF IGNS): Total relative *F* based on the DMF IGNS was calculated using commercial gill net landings (February through April) from the Pamlico River and an abundance index derived from data collected in the 4.5, 5.0, 5.5, 6.0, and 6.5-inch mesh sizes of the IGNS in the Pamlico River (February through April; Figure 9). Because the IGNS occurs during February through April in the Pamlico River, only commercial landings from those months were used in the calculations. The mesh sizes selected most accurately reflect those used by the commercial fleet in this system.

- Time series: 2004–2010. This time period reflects the years that the IGNS has been conducted in the Pamlico Sound and its tributary rivers (Neuse, Pamlico).
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

The sustainability parameters selected for the Tar-Pamlico River were the female CPUE index and female relative *F*, both derived from the WRC electrofishing survey. Although the IGNS is generally considered to be more representative of conditions in the commercial shad fishery, there are currently only 7 years of data available from the IGNS in the Pamlico River while 11 years are currently available from the Tar River electrofishing survey. Exceeding the threshold for any of the selected parameters will trigger management action (see "Potential Management Measures").

Female relative abundance of American shad derived from the electrofishing survey in the Tar River was above the threshold in most years of the time series (Figure 7). The index fell just below the threshold in 2009 but increased to a level slightly above the threshold in 2010. Estimates of relative *F* for female American shad derived from the electrofishing survey were below the threshold during 2000 to 2006 (Figure 8). These estimates of female relative *F* exceeded the threshold in three of the four most recent years, including the last two years (2009, 2010). The estimates of total relative *F* based on the IGNS were variable over time but were generally similar to the female relative *F* estimates derived from the electrofishing survey (Figure 9).

Future Considerations

There is potential to improve upstream passage in this system. The WRC, FWS and the Pamlico-Tar River Foundation have engaged in conversations with the Rocky Mount Mills Dam owner and hydroelectric operator. In addition to interest in providing American shad access to potential spawning habitat upstream of Rocky Mount Mills Dam, concern exists that periodic downward spikes in flow below Rocky Mount Mills Dam compromise the quality of existing spawning habitat.

With regard to creel surveys, DMF and WRC have engaged in a cooperative effort to improve the frequency and design of surveys on the Tar and Neuse rivers beginning in spring 2012. Creel surveys will occur annually and include increased coverage on both rivers, which should improve estimates of recreational harvest. These efforts will continue for at least the next five years.

As noted previously, DMF recently completed a research prioritization exercise for all managed species. One of the top priorities was expansion of existing surveys to provide accurate JAIs for all commercially and recreationally important species. Depending on future funding and protected resources concerns, expansion of the IGNS in the rivers may be able to serve this need.

Neuse River

Status of Stocks

Stock status could not be determined for the Neuse River based on the 2007 ASFMC stock assessment (ASMFC 2007b). There were no definitive trends in abundance over the most recent five to ten years of the assessment. A total mortality benchmark (Z_{30}) of 1.01 was suggested (ASMFC 2007a).

Commercial Fisheries

Commercial landings of American shad have declined since 1972. There have been several peaks throughout the time series, but landings have remained low and variable without trend since the early 2000s (Figure 2). Harvest occurs almost entirely from gill nets. There have been minimal contributions from pound nets over the years.

Recreational Fisheries

Estimates of angler effort and catch are calculated through the rotating creel survey noted in previous systems. A confounding factor in the creel survey is that American and hickory shad co-occur in the Neuse and responses to creel clerks indicated only that anglers were fishing for "shad". The most recent survey occurred in 2003. An estimated 318 American shad were caught during the month of April, 274 of which were harvested (Rundle et al. 2004). A 1-fish limit on American shad within the aggregate 10-fish recreational creel limit for American and hickory shad has been proposed for the Inland Waters of the Neuse River. Unlike the 1-fish limit for American shad on the Roanoke River, this measure is being implemented in response to recent declines in electrofishing indices and creel data and will become effective in 2012.

Sustainability Parameters

Data used in the development of sustainability parameters for the Neuse River system include electrofishing data collected by WRC and commercial landings data collected through the DMF Trip Ticket Program (see the "Stock Monitoring Programs" section for complete descriptions of these surveys). There is no directed JAI survey for the Neuse River. As noted previously, there is an IGNS in the tributaries of Pamlico Sound. However, the IGNS for the Neuse River area of the survey has an average annual catch of only 17 American shad. Because American shad captured by this IGNS are not sexed, an independent estimate of female relative abundance could not be calculated from this survey.

The following sustainability parameters and thresholds were evaluated for the Neuse River system:

Female CPUE (WRC electrofishing survey): The female CPUE index based on the WRC electrofishing survey was calculated as the number of fish per minute (Figure 10).

- Time series: 2000–2010. The electrofishing survey has been conducted consistently since 2000 on the Neuse River.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater).

Female Relative F (WRC electrofishing survey): Female relative *F* based on the WRC electrofishing survey was calculated using commercial landings of roes by all gear types from the Neuse River and the female CPUE index from the Neuse River electrofishing survey (Figure 11). Because the electrofishing survey primarily occurs during March through April, only commercial landings from those months were used in the calculations.

- Time series: 2000–2010. This time period reflects the years the electrofishing survey has been conducted on the Neuse River.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

Total Relative F (DMF IGNS): Total relative *F* based on the DMF IGNS was calculated using commercial gill net landings (February through April) from the Neuse River and an index derived from data collected in the 4.5, 5.0, 5.5, 6.0, and 6.5-inch mesh sizes of the IGNS (February through April) in the Neuse River (Figure 12). Because the IGNS in the Neuse River occurs during February through April, only commercial landings from those months were used in the calculations. The mesh sizes selected most accurately reflect those used by the commercial fleet.

- Time series: 2004–2010. This time period reflects the years that the IGNS has been conducted in the Pamlico Sound and its tributary rivers (Neuse, Pamlico).
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

The sustainability parameters selected for the Neuse River were the female CPUE index and female relative *F*, both derived from the WRC electrofishing survey. Although the IGNS is generally considered to be more representative of conditions in the commercial shad fishery, there are currently only 7 years of data are available from the IGNS in the Neuse River while 11 years are currently available from the Neuse River electrofishing survey. Exceeding the threshold for any of the selected parameters will trigger management action (see "Potential Management Measures").

The electrofishing index of relative abundance for female American shad in the Neuse River has been variable and remained above the threshold throughout most of the time series, but did fall below the threshold in 2010 (Figure 10). Relative *F* estimates for female shad derived from the electrofishing survey have been variable but were below the threshold from 2008 to 2010 (Figure 11). The estimates of total relative *F* based on the IGNS demonstrate a similar trend to female relative *F* estimates derived from the electrofishing survey during 2007 through 2010 (Figure 12).

Future Considerations

Lack of adequate flow during the spring spawning season is a major concern on the Neuse River. The largest dam on this river is the Falls Lake Dam, which forms the drinking water supply for the city of Raleigh and other municipalities. While flow regimes have been negotiated on the Roanoke River for spawning and ecological needs, similar considerations do not formally exist on the Neuse River. The variability in timing and strength of flows can impact restoration efforts, particularly spawning success and subsequent recruitment (e.g., there may be sufficient numbers of spawning adults but flows are insufficient for successful spawning activity or downstream transport of larvae and juveniles to favorable nursery habitat). Periodically limited stream flow and associated navigability issues also impact the ability to conduct electrofishing surveys.

As noted in the previous section, a more frequent creel survey rotation as well as efforts by DMF to expand creel surveys upstream should hopefully provide improvements in future recreational effort and catch/harvest estimates. Similarly, a representative JAI for American shad may be a future possibility depending on resources available to expand or reconfigure existing independent surveys.

Cape Fear River

Stock Status

Similar to the Tar-Pamlico and Neuse rivers, the stock status on the Cape Fear River is unknown, although a total mortality benchmark (Z_{30}) of 1.01 was recommended in the latest assessment (ASMFC 2007a, 2007b). Of all the river systems in North Carolina, the Cape Fear is likely to have the highest proportion of fish that are semelparous.

Commercial Fishery

Commercial landings have displayed several cyclical peaks since 1972, although each successive peak has been slightly lower than the previous. Landings have been somewhat low throughout the 2000s. As with the other river systems, the vast majority of landings are from gill nets. There has been very little harvest from other gears.

Recreational Fishery

The rotating creel survey used in the river systems took place during the spring of 2011 on the Cape Fear River, from mid-March through mid-May. Estimates of total catch and harvest were 22,312 and 14,888 American shad respectively. The creel limit remains at 10 American and hickory shad in the aggregate.

Sustainability Parameters

Data used in the development of sustainability parameters for the Cape Fear system include electrofishing data collected by WRC and commercial landings data collected through the DMF Trip Ticket Program

(see the "Stock Monitoring Programs" section for complete descriptions of these surveys). There is no directed JAI survey for the Cape Fear River. While there was an IGNS from 2003–2007, it was a fixed-station survey rather than a stratified random design and was therefore not used in any sustainability parameter calculations.

The following sustainability parameters and thresholds were evaluated for the Cape Fear River system:

Female CPUE (WRC electrofishing survey): The female CPUE index based on the WRC electrofishing survey was calculated as the number of fish per minute (Figure 13).

- Time series: 2000–2010. The electrofishing survey has been conducted annually since 2000 on the Cape Fear River.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater).

Female Relative F (WRC electrofishing survey): Female relative *F* based on the WRC electrofishing survey was calculated using commercial landings of roes by all gear types from the Cape Fear River and the female index from the WRC Cape Fear River electrofishing survey (Figure 14). Because the electrofishing survey primarily occurs during March through May, only commercial landings from those months were used in the calculations.

- Time series: 2000–2010. This time period reflects the years the electrofishing survey has been conducted on the Cape Fear River.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

Total Relative F (WRC electrofishing survey): Total relative *F* based on the WRC electrofishing survey was calculated using commercial landings by all gear types from the Cape Fear River and an index of total abundance from the WRC Cape Fear electrofishing survey (Figure 15). Because the electrofishing survey is conducted during March through May, only commercial landings from those months were used in the calculations.

- Time series: 2000–2010. The electrofishing survey has been conducted annually on the Cape Fear River since 2000.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater).

The sustainability parameters selected for the Cape Fear River were the female CPUE index and female relative *F*, both derived from the WRC electrofishing survey. Although the IGNS is generally considered to be more representative of conditions in the commercial shad fishery, the IGNS conducted on the Cape Fear River consisted of a fixed-station design and data are currently available for a limited number of years (2003–2007); therefore, it was not considered appropriate for developing abundance indices or calculating relative *F* estimates. Exceeding the threshold for any of the selected parameters will trigger management action (see "Potential Management Measures").

Relative abundance of female American shad in the Cape Fear River has been low since 2004 as compared to the early 2000s, based on the electrofishing survey (Figure 13). The index values have remained near the threshold since 2004 and were below the threshold in 2009 and 2010. Estimates of female relative *F* gradually increased from the beginning of the time series in 2000 to a peak in 2007 (Figure 14). These estimates then decreased in 2008 and increased to levels above the threshold in 2009 and 2010. Total relative *F* estimates show a nearly identical pattern (Figure 15).

Future Considerations

The Cape Fear River is currently the site of a major reconstruction effort for fish passage (Lock and Dam #1 rock arch ramp). This is scheduled for completion by the 2013 spawning season. Based on the construction efforts and changing conditions, DMF and WRC recommend a two-year review of the 75th percentile threshold for female relative *F*. Calculation of this parameter is likely to be heavily influenced by drought, floods, and changes in fish passage and may require revision sooner than other systems. Restoration efforts may also influence electrofishing catch rates because fish passage may improve with completion of the rock arch ramp.

Potential Management Measures

The environmental circumstances under which a sustainability threshold may be reached can vary among systems. Therefore, different management measures may be used for each system in addressing the triggers. A suite of potential measures to be implemented is presented here and may be used singly or in conjunction with one another:

- Restrictions on length of season to reduce effort (e.g., March 1–April 15)—not to extend beyond the estuarine striped bass quotas being filled (avoids waste of striped bass and shad)
- Trip limits (this may result in discards)
- Reduce allowable amount of yards (the 1,000-yard limit in Albemarle Sound could be considered in other areas)
- Area/season closure (e.g., area closure at mouth of Roanoke River from February–mid-November since 1988)
- Only allow fishing certain days of the week (lift days)
- Creel reduction—complement WRC rules in the Roanoke and Neuse Rivers in Coastal Waters
- Commercial harvest quota (although possible, this could be difficult to implement given existing resources)
- If two years of sustainability parameters exceeding thresholds are observed, a suite of management measures could be proactively developed and presented to Finfish and Regional Advisory Committees

Proposed Management Measures for 2013

As noted in the "Commercial Gear Restrictions" section, management measures implemented in November 2011 for spotted seatrout conservation (prohibition on the use of gill nets in Joint Waters on weekends) are likely to reduce commercial harvest of American shad during the upcoming 2012 fishing season. The following management measures are proposed to be effective January 1, 2013:

- Commercial season of March 1, 2013 through April 15, 2013
- Recreational creel limits of 1-fish for American shad in the Joint and Coastal Waters of the Roanoke and Neuse rivers to complement the WRC 1-fish limit in the Inland Waters of these rivers

While none of the selected sustainability parameters for any of the river systems have exceeded the triggers for management, the above measures are considered prudent given the results of the 2007 stock assessment as they pertain to North Carolina. Future changes to creel limits for American shad in the Inland Waters of the other river systems will also be complemented by DMF for Joint and Coastal Waters.

Although harvest is an obvious potential contributor to population declines, significant habitat degradation has also occurred in all of the river systems. It is unlikely that American shad populations in

North Carolina will recover and expand without considerable resources being dedicated to habitat restoration for this species. Our management goals, however, are intended to sustain population levels as additional habitat is protected or improved through aquatic habitat conservation measures and increased passage opportunities of American shad beyond impediments that block migration to historic spawning grounds.

Ancillary Information

The focus on female indices for the sustainability parameters in all systems is based on the conclusion that changes in female abundance combined with impacts from various environmental parameters could prove challenging to stock improvement given that the commercial fishery targets roe shad. Major fluctuations in female abundance could potentially impact future recruitment and landings. The use of sex ratios as a sustainability parameter was considered, but it was determined that the sex ratios from both the IGNS (in the Albemarle system and potentially the other systems) and the electrofishing surveys were more suitable for use as long-term trends rather than short-term (i.e., three year) indicators of stock health due to the impact of environmental variability on the data. The intent of the agencies is to monitor the sex ratios from each of the surveys for trends and use this information to help inform future management.

The use of repeat spawning data was also considered as a potential sustainability parameter. However, inconsistencies in determination of repeat spawning marks made it difficult to set a target or threshold. Because repeat spawning continues to be tracked annually as part of the required monitoring program, it will also be used as ancillary information for determining future management. Should greater confidence in repeat spawning data be attained in the future, they may be considered for developing a formal sustainability parameter.

Finally, while sustainability parameters will be updated annually in compliance reports, DMF and WRC will conduct a review of this plan once every five years as new data and information become available and may elect to change or update sustainability parameters at that time.

STOCK MONITORING PROGRAMS

The following descriptions represent the entirety of stock monitoring programs used to assess the health of American shad in North Carolina. All programs are included in annual compliance reports and as noted in the program descriptions, specific details can be found in past compliance reports.

Fishery-Independent Monitoring

Juvenile Abundance

A juvenile abundance index is calculated for Albemarle Sound area using data from the alosine seine survey that has been conducted annually since 1972. Eleven core seine stations are sampled monthly in the western Albemarle Sound area during June–October of each year. During September, thirteen additional seine samples are taken to determine distribution and annual variations of alosines in the nursery area. All stations are sampled with an 18.5-m (60-ft) bag seine. Relative abundance data are collected for blueback herring, alewife, American shad and hickory shad from the 11 core stations.

Samples are sorted by species and 30 randomly selected individuals of each alosine species present are measured. Other species present are also noted. Water temperature, salinity, and other environmental characteristics are counted, measured, and recorded. As noted previously, this survey was designed specifically for blueback herring and is not considered a reliable indicator of juvenile American shad abundance.

No juvenile abundance indices exist for the Tar-Pamlico, Neuse and Cape Fear river systems.

Adult Stock Monitoring

Spawning Area Survey

An annual spawning stock survey and representative sampling for biological data is required from Albemarle Sound and its tributaries, Tar-Pamlico, Neuse, and Cape Fear rivers for American shad. Sampling in these areas was initiated in 2000.

WRC personnel collect American shad from the Roanoke, Tar, Neuse and Cape Fear systems annually during March–May. A boat-mounted electrofishing unit (Smith-Root 7.5 GPP) is used (1 or 2 dip netters) to capture fish during daylight hours and electrofishing times are recorded. To minimize size selection during sampling, shad are picked up as they are encountered regardless of size. Relative abundance of each year-class is indexed by CPUE expressed as the number of fish captured per hour of electrofishing. American shad broodstock collections are not included in calculations of CPUE. Size, age and sex data are collected for all captured fish.

Independent Gill Net Survey (IGNS)

Since 1991, DMF has been conducting an independent gill net survey throughout the Albemarle Sound area. The survey was designed for striped bass data collection and occurs November through May each year. However, American shad are captured during the survey and size, age and sex data are collected. Forty-yard segments of gill net from 2.5- through 7.0-inch stretched mesh, in half-inch increments, as well as 8.0, and 10.0-inch stretched mesh are utilized. The sound is divided into zones and grids and random sites are selected within these areas. Lines of float and sink nets are set in both shallow and deep strata if they are present in the grid.

The IGNS in the Pamlico Sound area (including Pamlico, Pungo and Neuse rivers) began in 2000. The survey runs from February through mid-December and utilizes a slightly different methodology than that conducted in the Albemarle Sound. Thirty-yard segments of gill net are used, ranging from 3.0-inch stretched mesh through 6.5-inch stretched mesh in half-inch increments. Similar to the Albemarle Sound, each set of nets is fished in both shallow and deep strata, and sites are selected at random from within a set of zones and grids.

An IGNS was conducted in the Cape Fear River from 2003–2007 but used a fixed-station design rather than a stratified random design.

Size, Age and Sex Determination

Spawning Area Survey

Sex is determined for each captured fish by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs. Each fish is measured for total length in millimeters. Scales are removed from the left side of each fish between the lateral line and the dorsal fin. To estimate age, scales are examined at 33X magnification on a microfiche reader and annuli are counted. Spawning marks are recorded separately. Shad that cannot be aged are assigned ages based on the gender specific age-length key developed for each river and included in CPUE and size-distribution analyses. Beginning in 2011, American shad will be aged using otoliths. Up to 10 fish per 10-mm size bin (by sex) will be sacrificed for otolith extraction.

Independent Gill Net Survey

Each fish is measured for fork length and total length. Sex is determined only for fish captured in the Albemarle Sound IGNS. Each fish is sexed by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs. Scales are collected from the left side of each fish between the lateral line and the dorsal fin. Scales are prepared and aged according to the DMF/WRC American Shad Ageing Guidelines.

Total Mortality Estimates

Survival estimates are calculated using the Robson and Chapman (1961) method. Robson and Chapman showed that estimates of annual rates of survival can be made from the catch curve of a single season if the population is exposed to unbiased fishing gear beyond the age of recruitment and if year-class strength and survival rate remain constant from year to year. Annual mortality rates are calculated based on observed samples of individuals at age. Only age groups that are fully recruited to the gear are included in the calculations and the resulting estimates only apply to the fully recruited individuals.

Hatchery Evaluation

Roanoke River American Shad Restoration Project

American shad fry reared at the FWS Edenton National Fish Hatchery and at the WRC Watha State Fish Hatchery have been stocked annually into the Roanoke River since 1998. This restoration project was initiated by the WRC 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). The project has since evolved into a cooperatively managed restoration partnership (see earlier text in the Albemarle Sound section under "Future Considerations") as required by FERC relicensing of the Gaston and Roanoke Rapids hydropower projects.

Initial attempts in 1998 at field collection and fertilization of American shad eggs met with limited success. In 1999, both hatcheries began developing hormone injection/tank spawning techniques in efforts to increase fry production. Also in 1999, WRC began coordination of marking fry with oxytetracycline (OTC) marking and stocking activities with the ad hoc interstate OTC Marking Task Force.

Following protocols of other states involved in American shad restoration efforts, brood stock for fry production are obtained from nearby rivers having adequate shad stocks. American shad brood fish are collected by electrofishing from the Tar, Neuse, Cape Fear, and Roanoke rivers. Upon collection, brood fish are placed in circular tanks with oxygen and continuously circulating water onboard the electrofishing boats and are then transferred to large circular, trailer-mounted tanks for transport to the hatcheries. In 2009, for the first time, no brood fish were injected with hormone (LHRHa or sGnRHa pellets) upon arrival at the hatcheries and prior to being transferred to circular spawning tanks. In 2011, broodstock endemic to the system intended for fry stockings were utilized for production. Broodstock will be genotyped for future genetic analysis of returning adults to identify hatchery contribution.

For additional detail and information regarding OTC marking, please refer to the 2009 North Carolina Shad and River Herring Compliance Report.

Evaluation of Hatchery Contribution

Since 2000, the annual contribution of returning adult American shad to the Roanoke River spawning stock collected in independent sampling gears has ranged between 0% and 3.1%. Because Roanoke River American shad return to the spawning grounds 3 to 6 years after hatching or stocking, recent American shad fry stockings since 2007 are likely still at-large. The WRC will continue stocking and recovery efforts of the Roanoke River American shad restoration program to assess the contribution of hatchery-origin American shad. Please see previous compliance reports for data (e.g., number of fry stocked, number of hatchery origin fish recovered) and additional details regarding hatchery contribution.

Fishery-Dependent Monitoring

Commercial Fishery

Total Catch, Landings and Effort

American shad landings data are collected through the North Carolina Trip Ticket Program. The number of participants by gear utilized and the total number of positive trips can be determined. For the Albemarle Sound area, the following assumptions are made: (1) trips landing over 100 pounds of shad are considered directed trips, and (2) the maximum yardage used in directed trips is 1,000 yards. The total yardage for each area is determined by multiplying the number of participants by the maximum yardage per area. The catch-per-yard (CPY) is determined by dividing the number of pounds harvested by the total yardage estimate of gill nets fished and multiplied by 1,000 yards. This will result in the pounds landed per 1,000 yards. Catch estimates for other areas are determined similarly.

Size, Age and Sex Composition of Catch

Commercial landings from all four systems (Albemarle Sound, Tar-Pamlico River, Neuse River and Cape Fear River) are sampled to obtain size, age, sex and repeat spawning information. A target of 200 samples from each system has been in place since 1999. For specific information regarding exact number of samples collected per area, please see previous compliance reports.

Recreational Fishery

Total Catch, Landings and Effort

The North Carolina Fisheries Reform Act of 1997 required the MFC to establish limits on recreational use of commercial fishing gear. An individual holding a Recreational Commercial Gear License (RCGL) is allowed to use limited amounts of specified commercial gear to catch seafood for personal consumption or recreational purposes. The holder of the RCGL must comply with the recreational size and creel limits, and RCGL catch cannot be sold. During 2002, DMF began a RCGL survey to estimate the harvest by these license holders. The survey was discontinued in 2009 due to budget reductions.

In the Coastal, Joint, and Inland Waters of North Carolina the American shad and hickory shad hook-and-line creel limits are 10 fish per person per day in the aggregate. In the Inland Waters of the Roanoke River—effective July 1, 2008—the limit for American shad was reduced to one fish per person per day. In the Inland Waters of the Neuse River, the limit for American shad will be reduced to one fish per person per day effective August 1, 2012.

An annual creel survey occurs on the Roanoke River each year. The survey targets striped bass catch and effort but also collects information on American shad and other species. A rotating creel survey occurs on the Tar, Neuse and Cape Fear rivers. For specific information regarding catch and harvest of American shad, please see previous compliance reports.

Bycatch and Discards

Bycatch and discard information are not currently collected on commercial trip tickets. The only mechanism that exists to capture commercial bycatch and discards of American shad in other fisheries is an observer program conducted by DMF to monitor sea turtle interactions in gill nets. Because there are very few encounters with sea turtles in the areas and times of year where and when directed American shad fishing occurs (i.e., western Albemarle Sound and the rivers), these areas have little observer coverage. However, current gill net restrictions in the Albemarle Sound and tributaries allows for the use of floating gill net webbing only during the open shad season. Once the shad season closes, the gill net webbing used to target shad is removed from the water.

The creel surveys conducted by the WRC in Inland Waters do capture discard and release information of non-target species. Please see previous compliance reports for this information.

REFERENCES

ASMFC (Atlantic States Marine Fisheries Commission). 2007a. Terms of Reference and Advisory Report for the American Shad Stock Assessment Peer Review. ASMFC, Stock Assessment Report No. 07-01, Washington, D.C. 31 p.

ASMFC 2007b. Status of American shad stocks in North Carolina. Pages 251–382 *In*: American shad stock assessment report for peer review—volume III. ASMFC, Stock Assessment Report No. 07-01 (Suppl.), Washington, D.C. 546 p.

ASMFC. 2010. Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). ASMFC, Washington, D.C. 158 p.

Homan, J. M., R. D. Barwick, and K. R. Rundle. 2006. Tar-Pamlico River basin sport fishery creel survey, 2004–2005. Status of American shad stocks in North Carolina Wildlife Resources Commission, Federal Aid in Fish Restoration, Project F-22. Final Report, Raleigh.

McCargo, J. W., K. J. Dockendorf, and C. D. Thomas. 2007. Roanoke River recreational angling survey, 2005-2006. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22. Final Report, Raleigh.

Rundle, K. R., T. Waters, and R. D. Barwick. 2004. Neuse River Basin sport fishery creel survey, 2002–2003. North Carolina Wildlife Resources Commission, Federal Aid in Fish Restoration, Project F-22. Final Report, Raleigh.

St. Pierre, R. 1979. Historical review of the American shad and river herring fisheries of the Susquehanna River. Reference document, Susquehanna River Anadromous Fish Restoration Committee, Harrisburg, PA. Revised 1981. 40p.

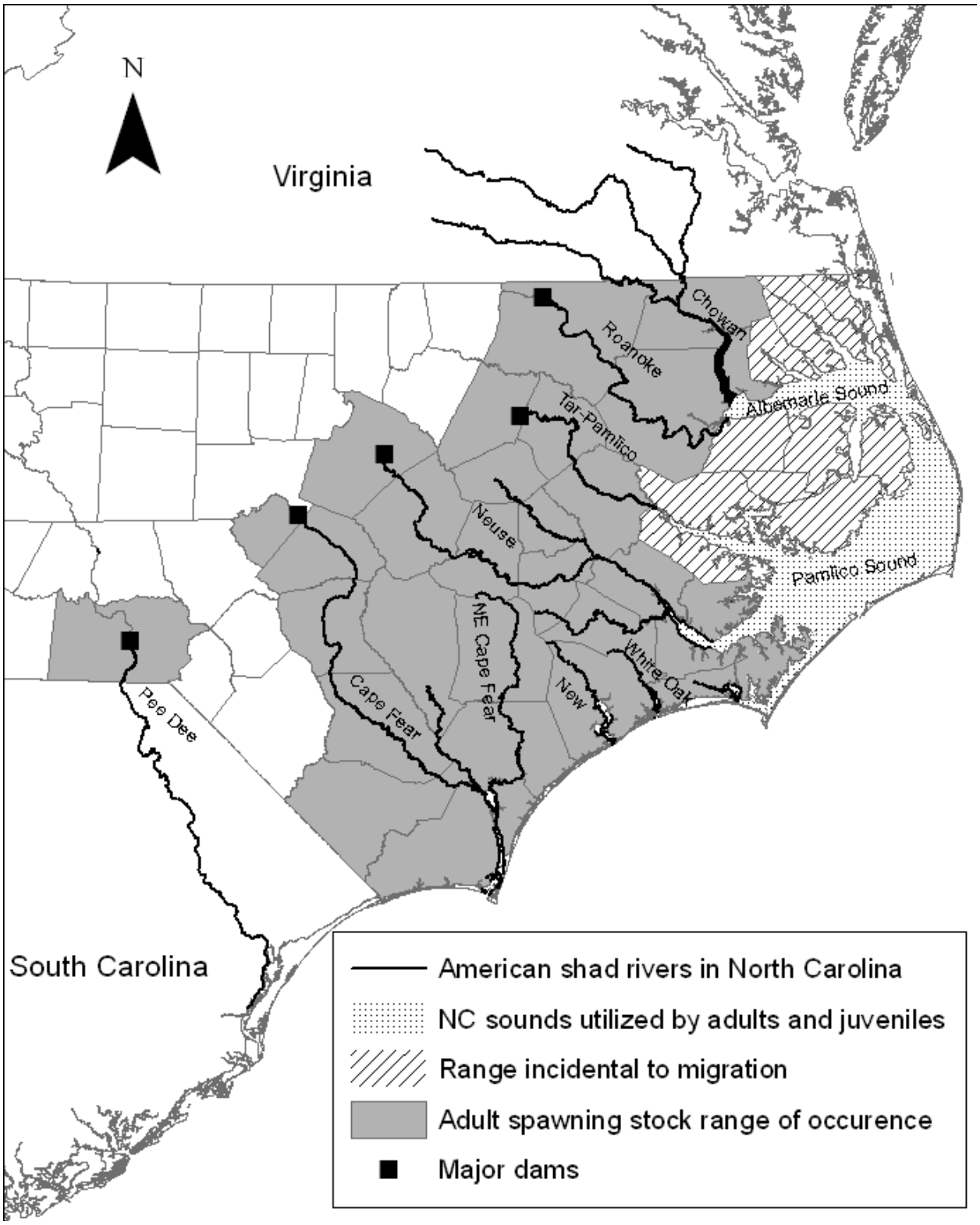


Figure 1. North Carolina river systems depicting the extent of American shad occurrence and habitat use.

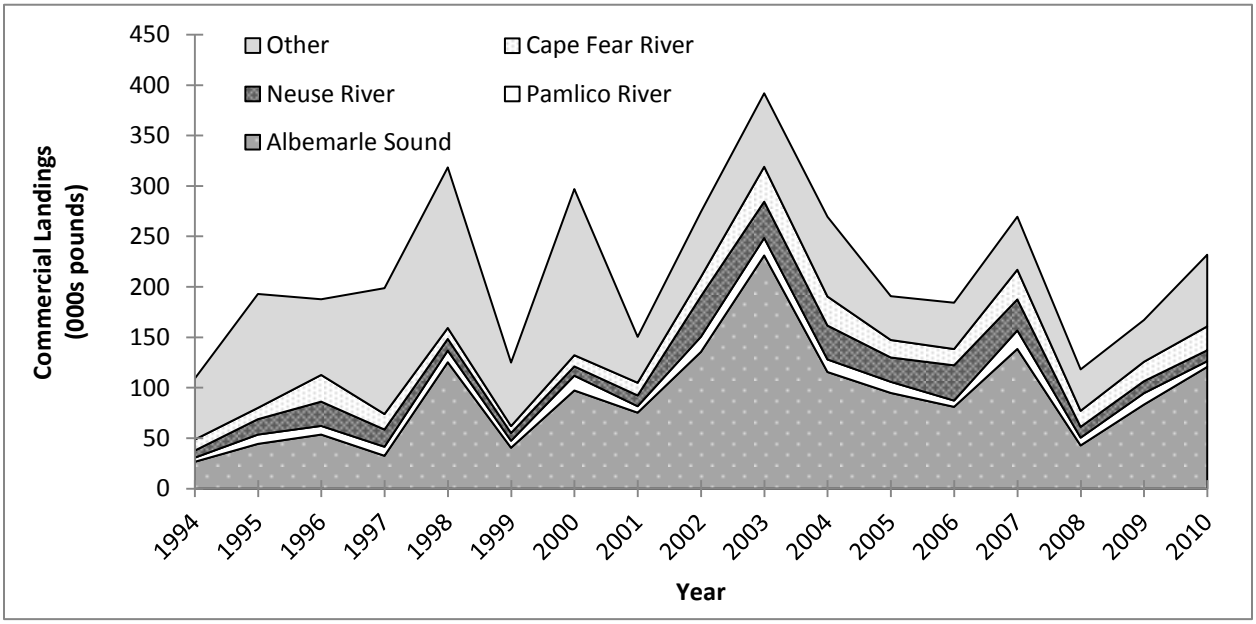


Figure 2. Commercial landings of American shad in North Carolina by water body, 1994–2010.

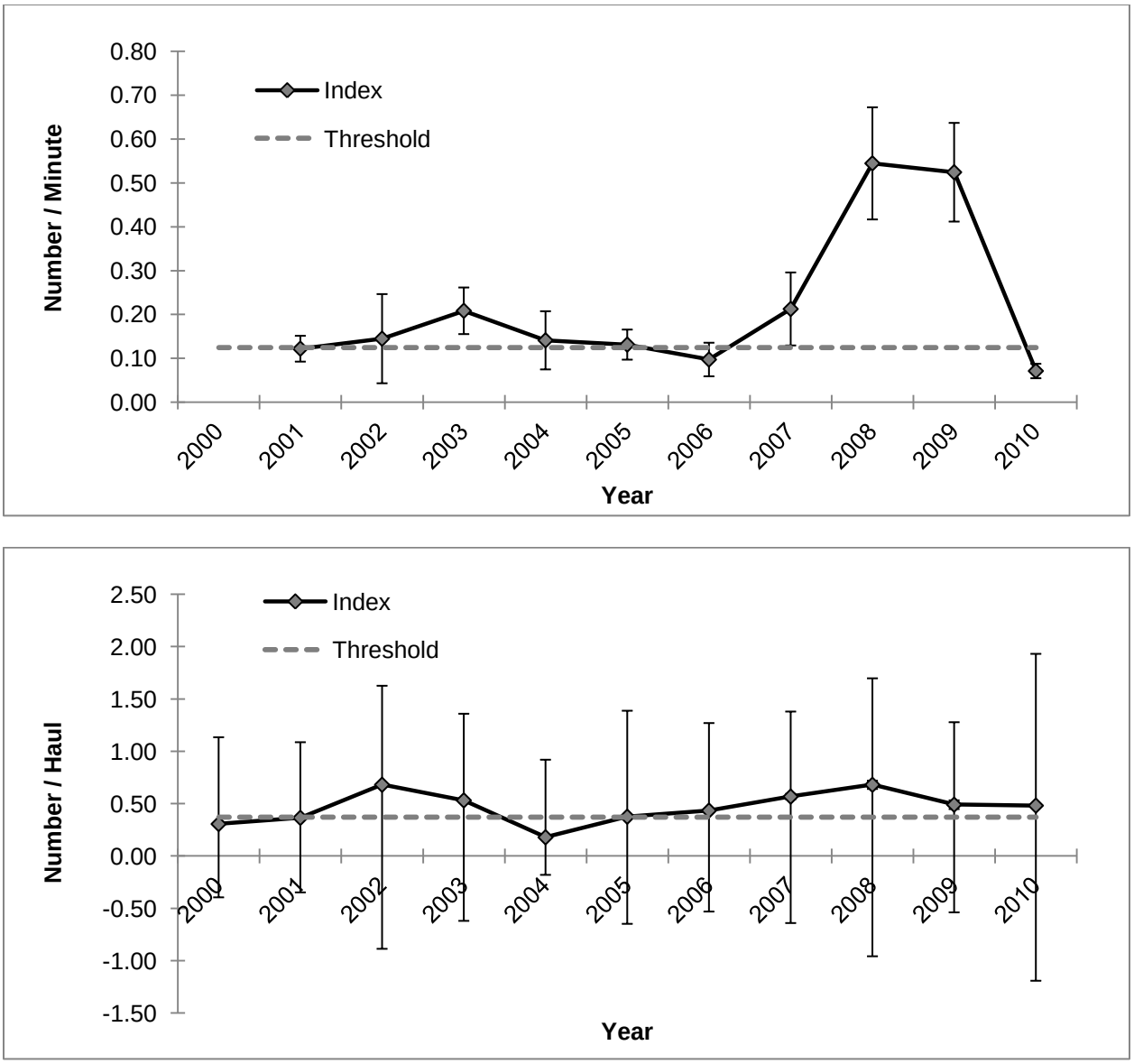


Figure 3. Female index from electrofishing survey (March–May; top graph) and female index from IGNS (January–May; bottom graph) for Albemarle Sound, 2000–2010. The error bars represent ±1 standard deviation. Threshold represents 25th percentile (where 75% of all values are greater).

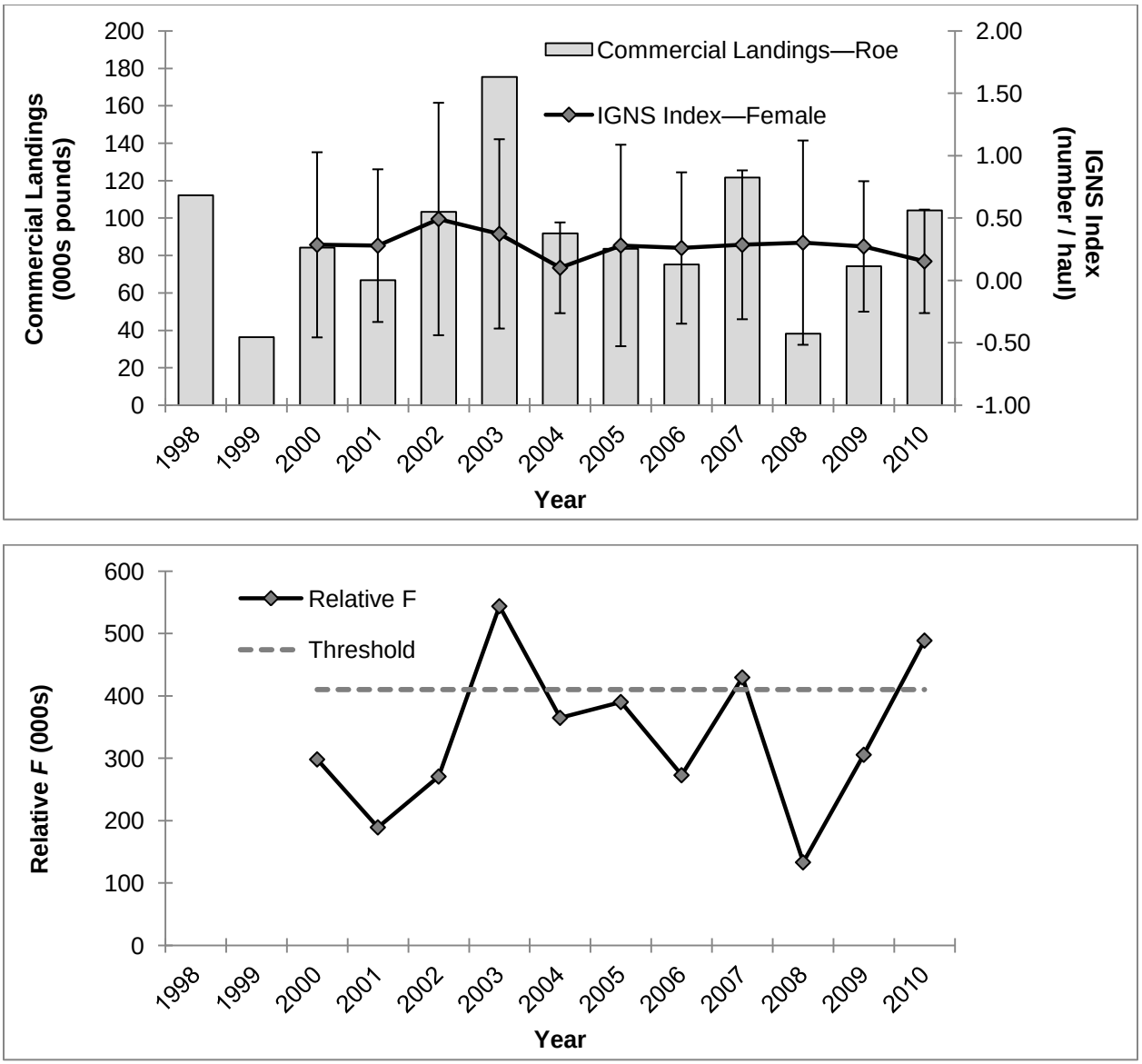


Figure 4. Commercial gill net landings of roes (February–April) compared to the female IGNS index (5.0, 5.5 and 6.0-inch mesh sizes, February–April; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for Albemarle Sound, 2000–2010. The error bars in the top graph represent ±1 standard deviation. The threshold represents the 75Th percentile (where 25% of all values are greater).

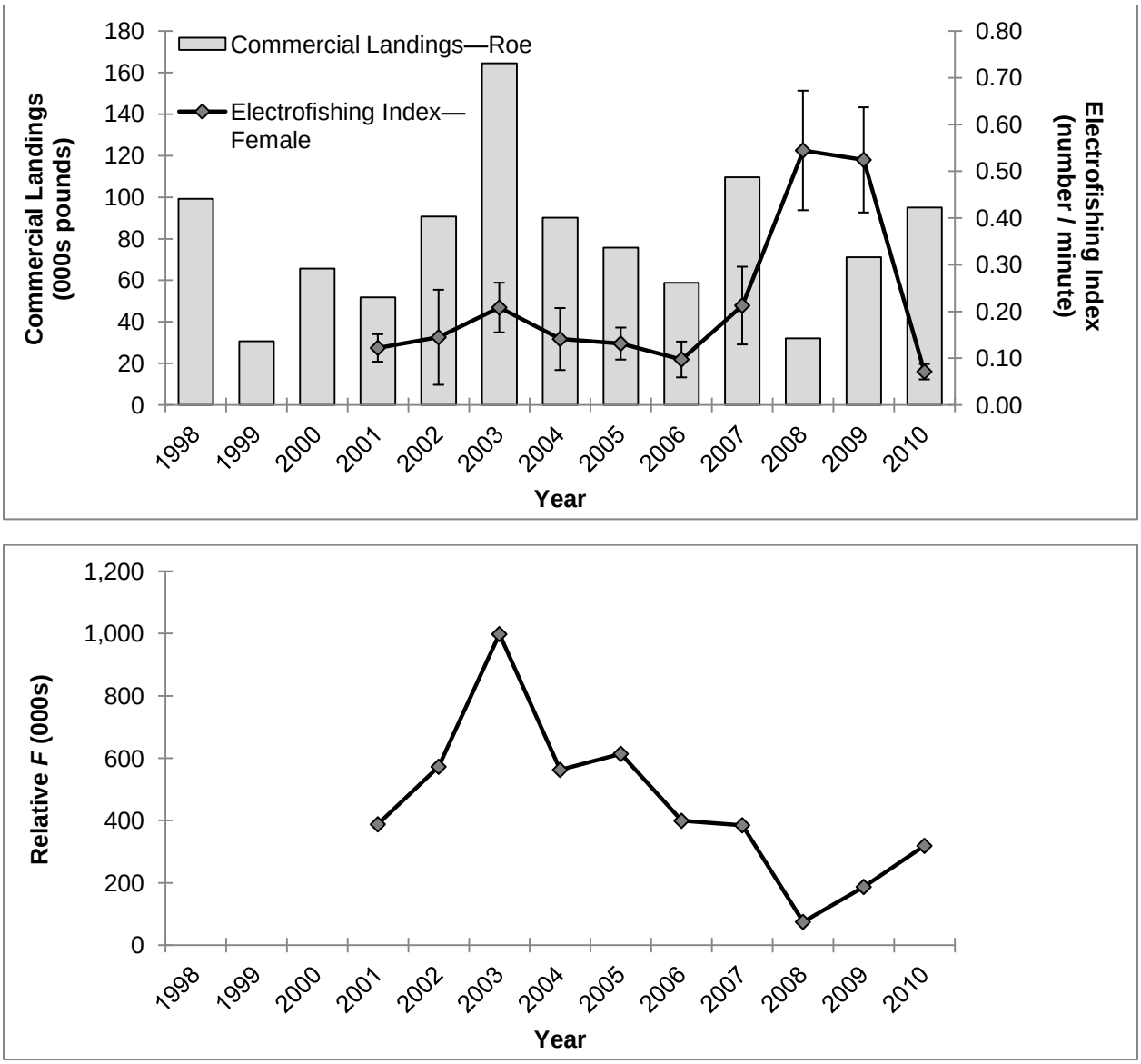


Figure 5. Commercial landings of roes by all gear types (March–May) compared to the female electrofishing index (March–May; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for Albemarle Sound, 2000–2010. The error bars in the top graph represent ±1 standard deviation.

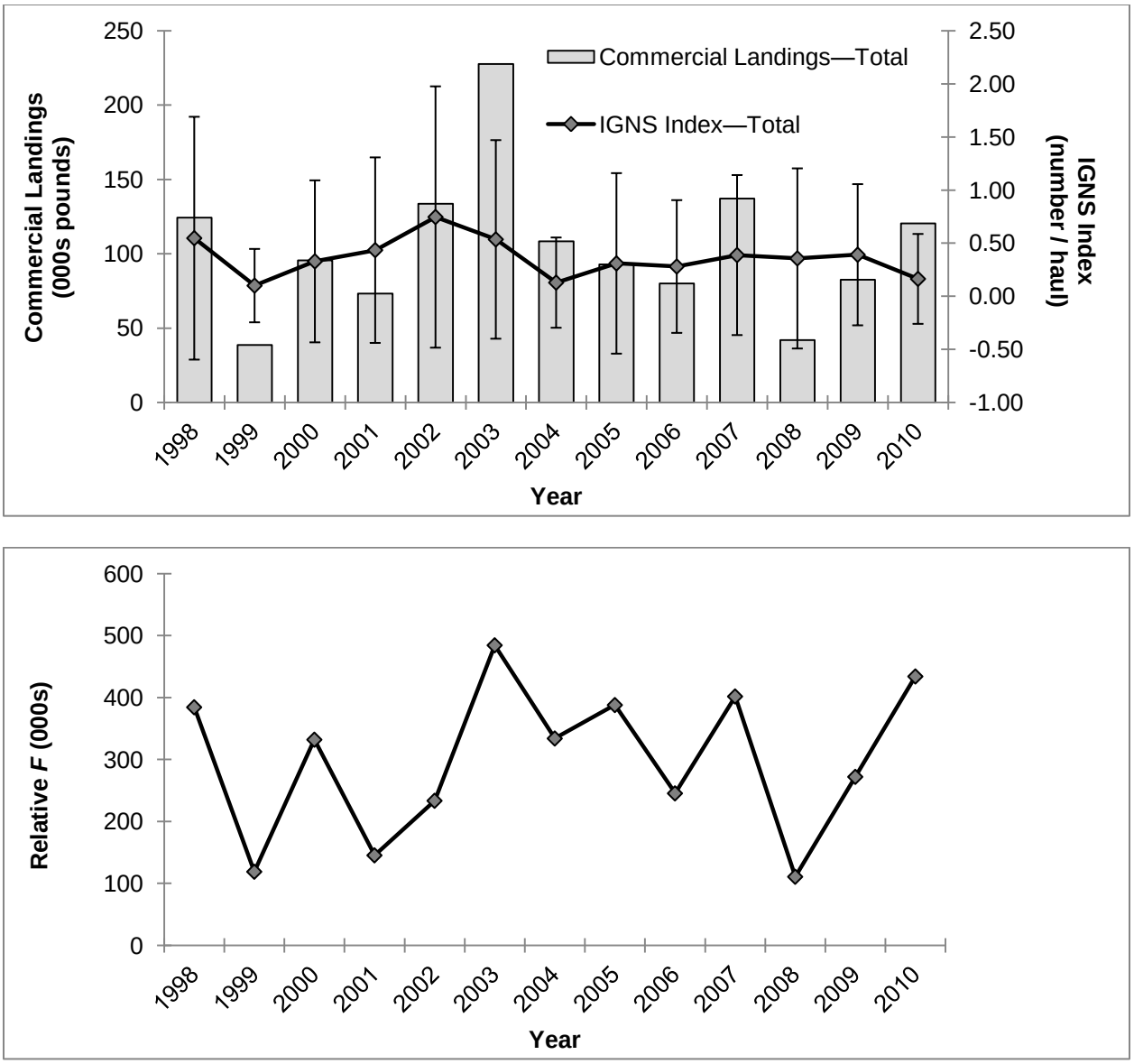


Figure 6. Commercial gill net landings (February–April) compared to the total IGNS index (5.0, 5.5 and 6.0-inch mesh sizes, February–April; top graph) and annual estimates of total relative *F* based on these data (bottom graph) for Albemarle Sound, 1998–2010. The error bars in the top graph represent ±1 standard deviation.

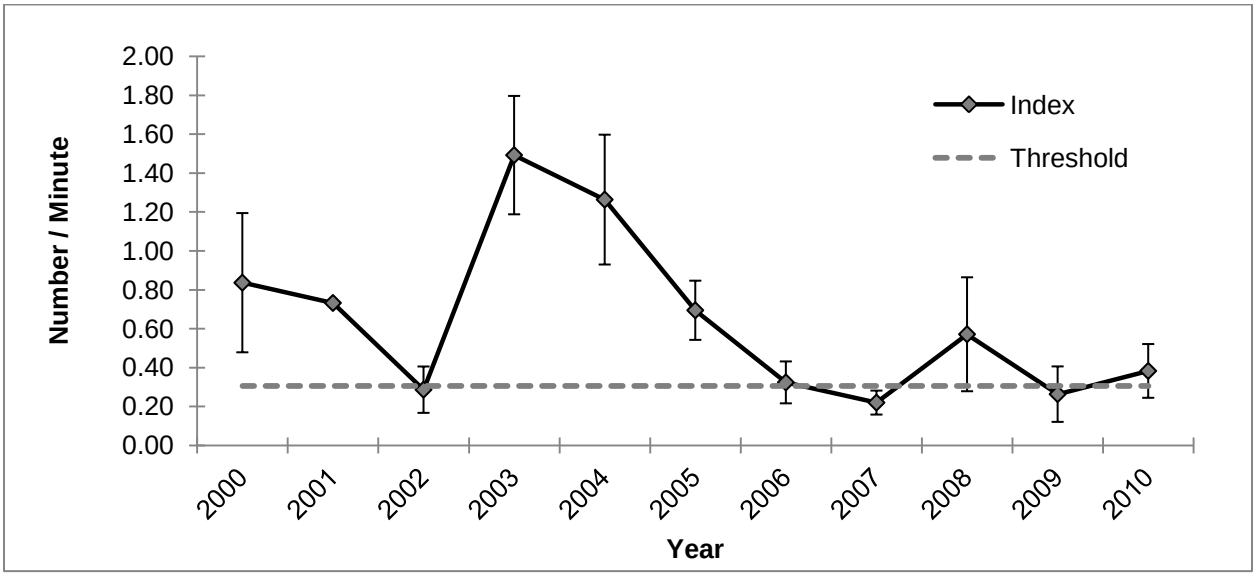


Figure 7. Female electrofishing index (March–May) for the Tar-Pamlico River, 2000–2010. The error bars represent ±1 standard deviation. The threshold represents the 25th percentile (where 75% of all values are greater).

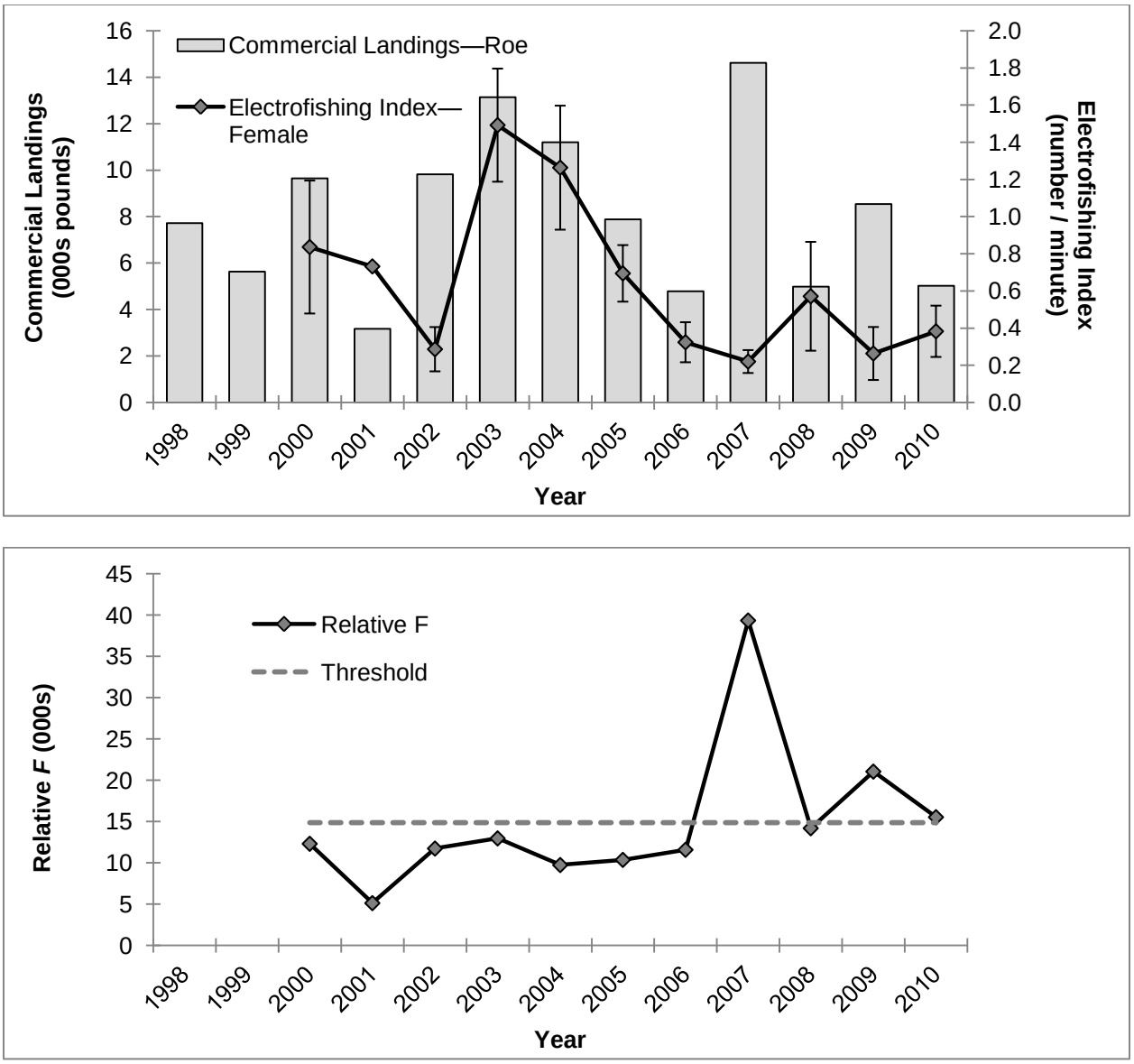


Figure 8. Commercial landings of roes by all gear types (March–April) compared to the female electrofishing index (March–May; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for the Tar-Pamlico River, 2000–2010. The error bars in the top graph represent ±1 standard deviation. The threshold represents the 75th percentile (where 25% of all values are greater).

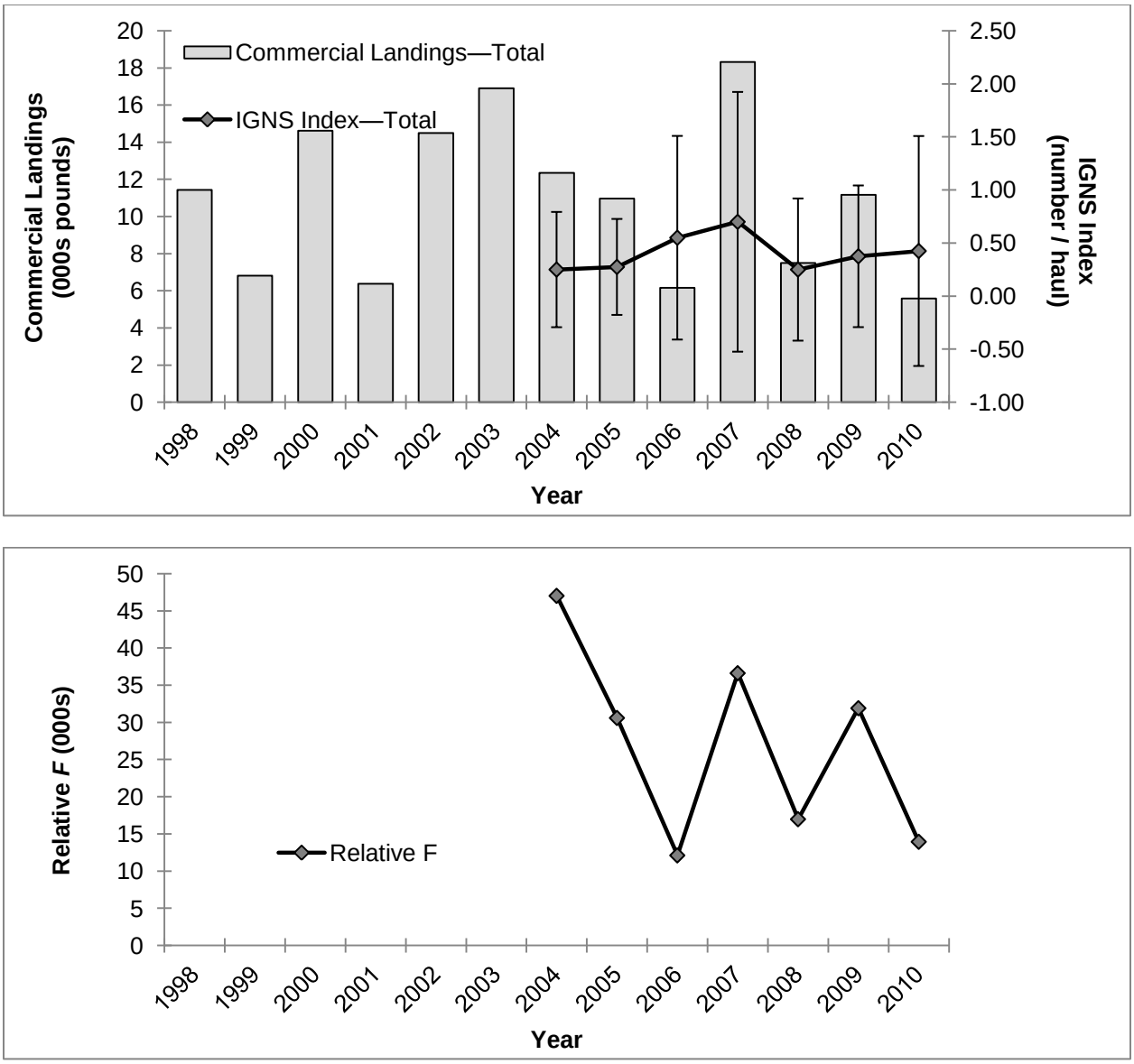


Figure 9. Commercial gill net landings (February–April) compared to the total IGNS index (4.5, 5.0, 5.5, 6.0, and 6.5-inch mesh sizes, February–April; top graph) and annual estimates of total relative *F* based on these data (bottom graph) for the Tar-Pamlico River, 2004–2010. The error bars in the top graph represent ±1 standard deviation.

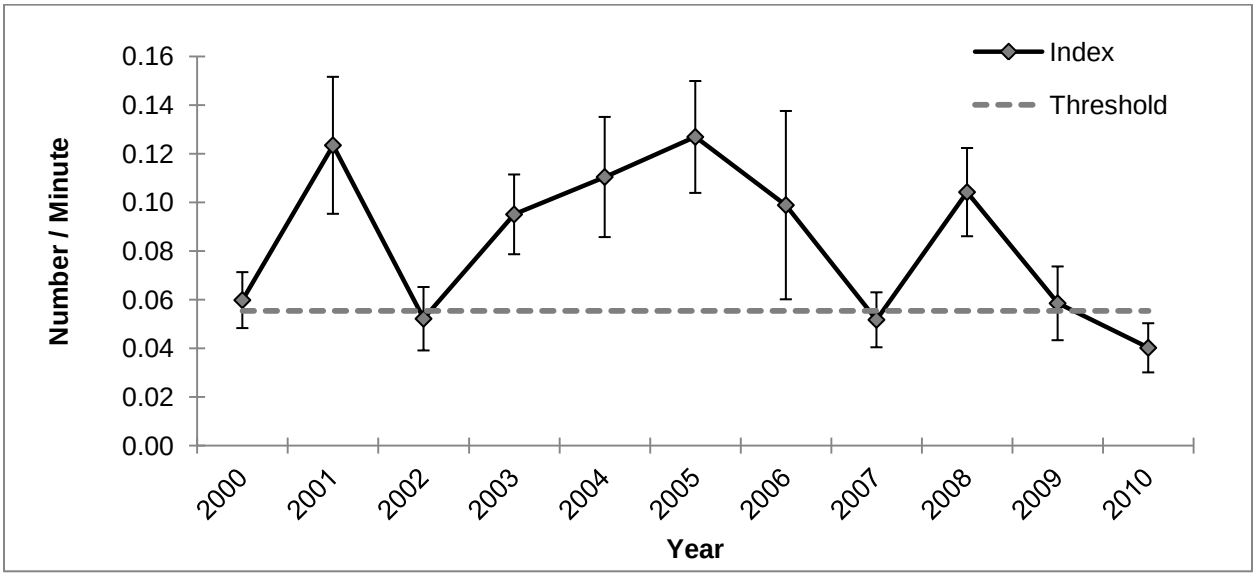


Figure 10. Female electrofishing index (March–May) for the Neuse River, 2000–2010. The error bars represent ±1 standard deviation. The threshold represents the 25th percentile (where 75% of all values are greater).

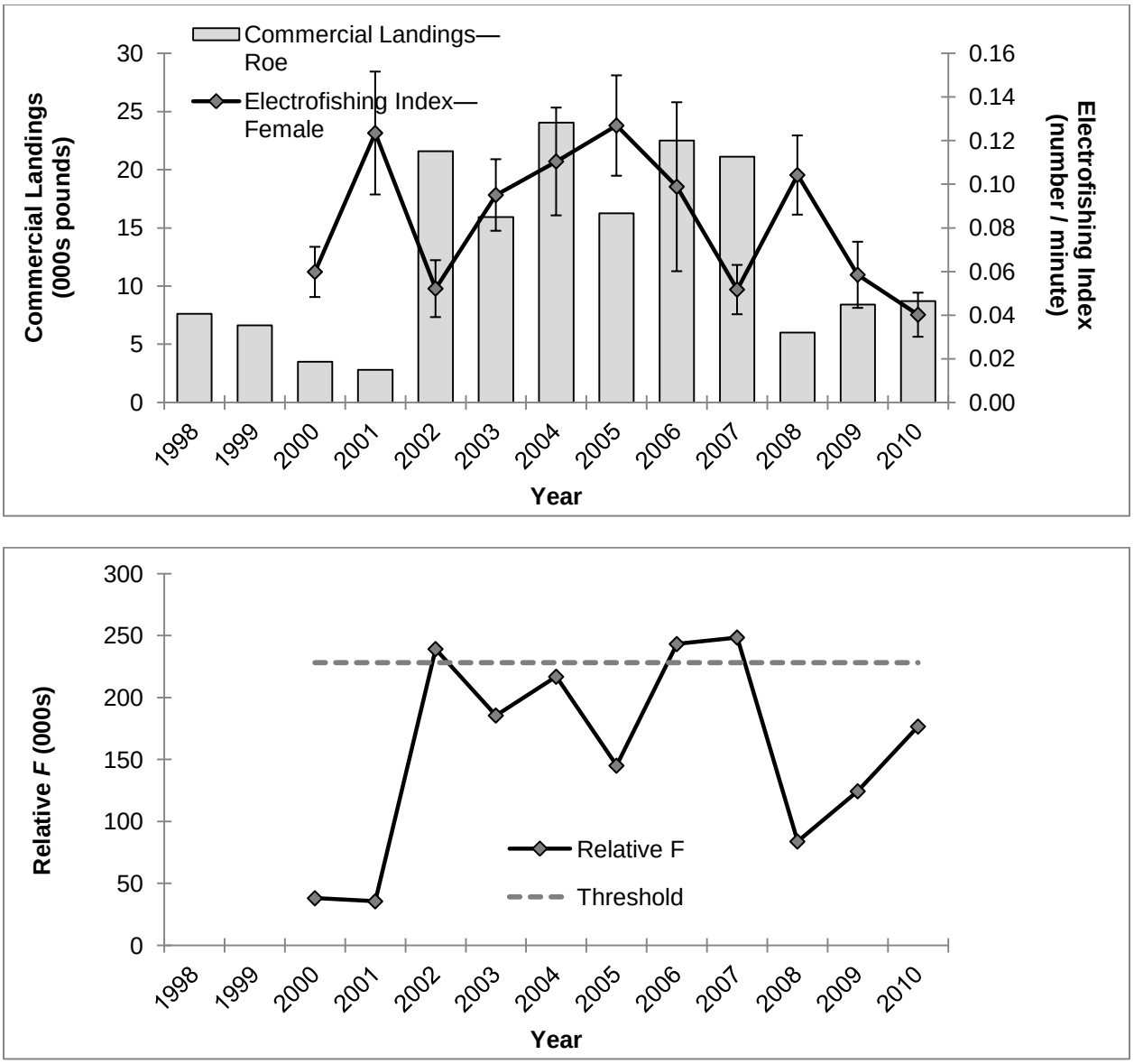


Figure 11. Commercial landings of roes by all gear types (March–May) compared to the female electrofishing index (March–May; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for the Neuse River, 2000–2010. The error bars in the top graph represent ±1 standard deviation. The threshold represents the 75th percentile (where 25% of all values are greater).

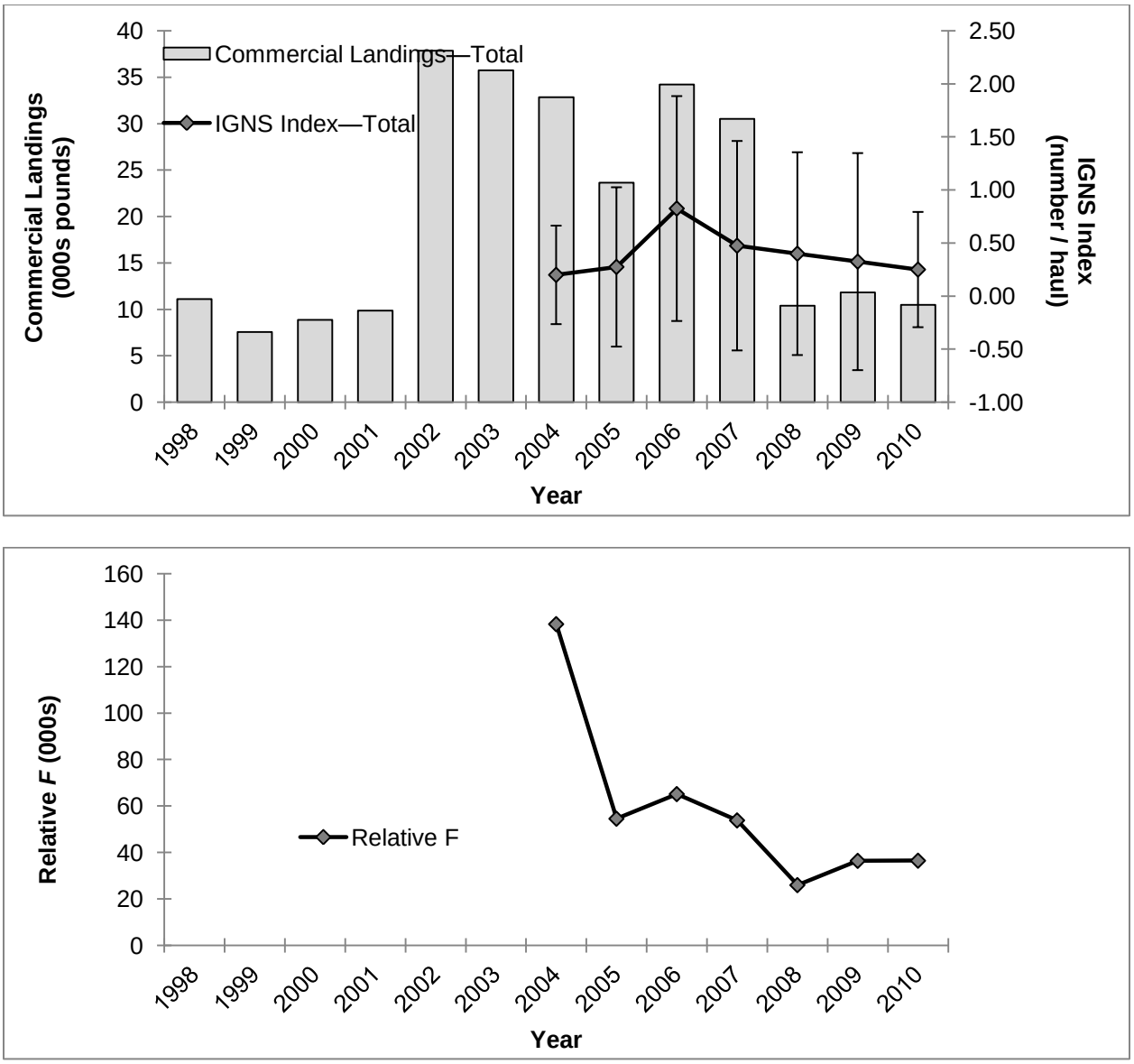


Figure 12. Commercial gill net landings (February–April) compared to the total IGNS index (4.5, 5.0, 5.5, 6.0, and 6.5-inch mesh sizes, February–April; top graph) and annual estimates of total relative *F* based on these data (bottom graph) for the Neuse River, 2004–2010. The error bars in the top graph represent ±1 standard deviation.

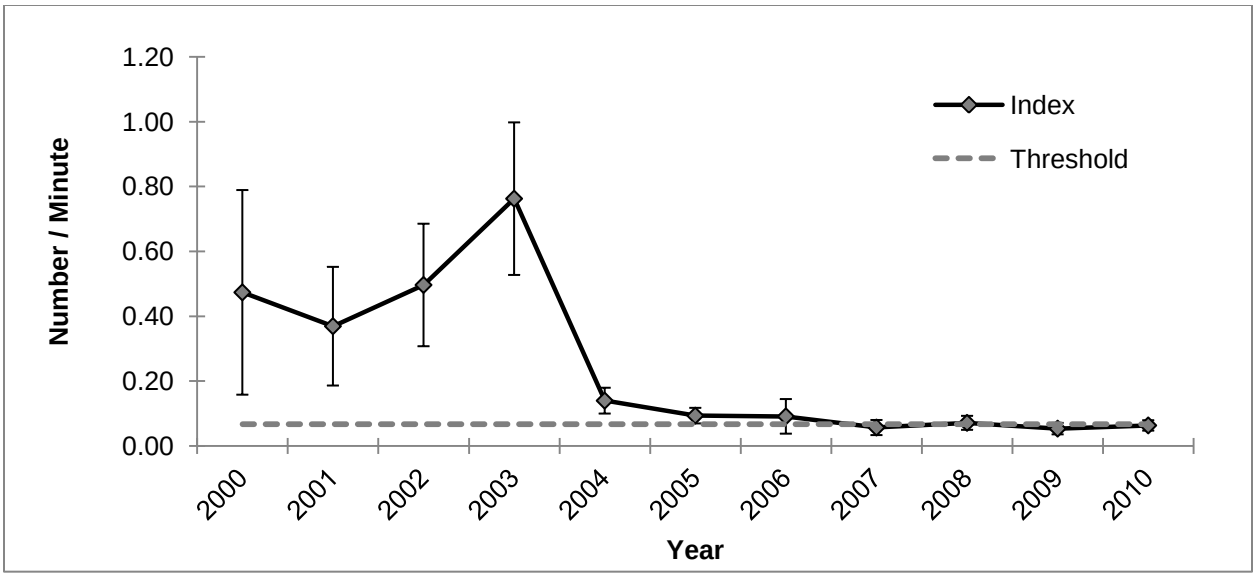


Figure 13. Female electrofishing index (March–May) for the Cape Fear River, 2000–2010. The error bars represent ±1 standard deviation. The threshold represents the 25th percentile (where 75% of all values are greater).

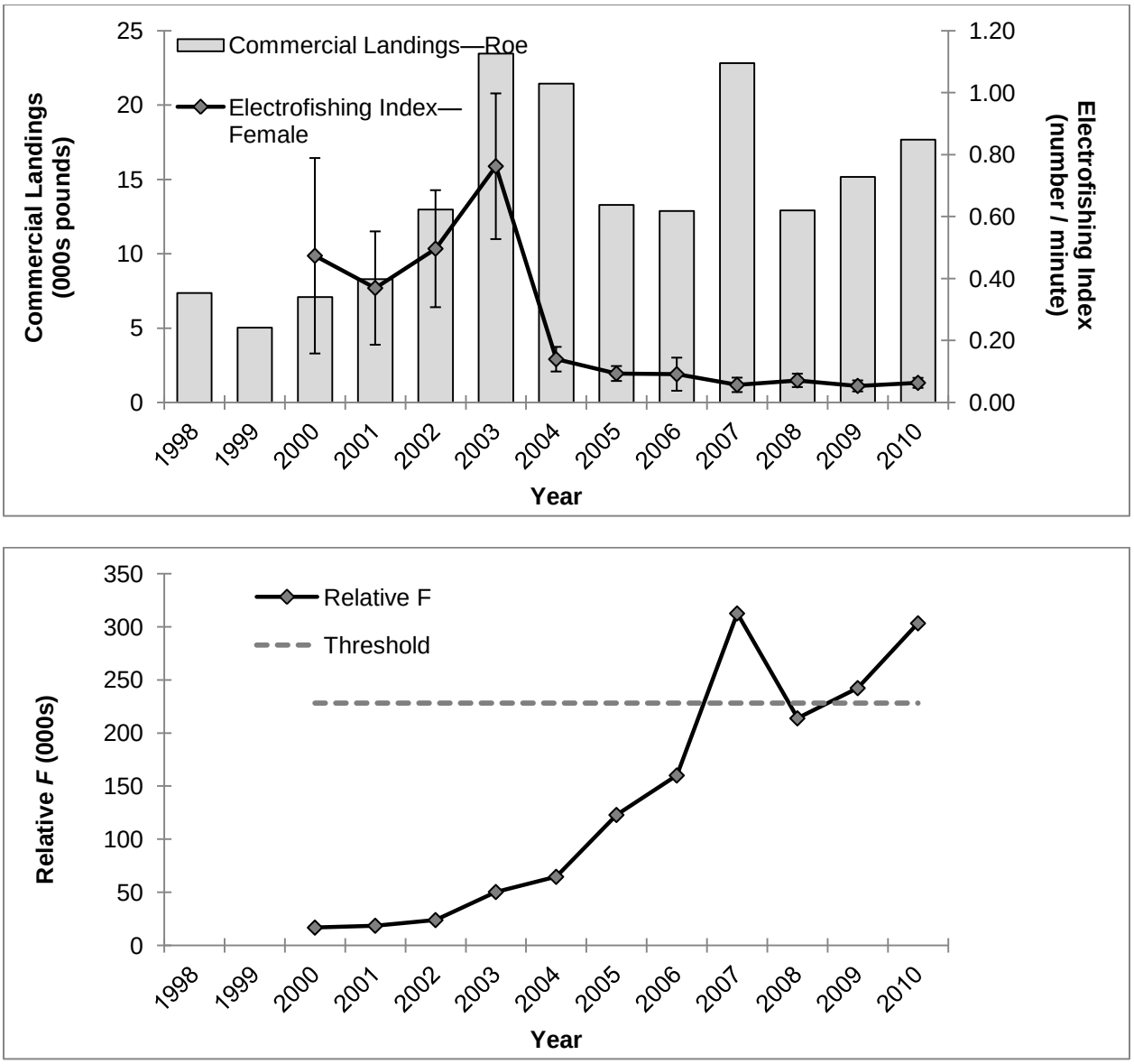


Figure 14. Commercial landings of roes by all gear types (March–May) compared to the female electrofishing index (March–May; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for the Cape Fear River, 2000–2010. The error bars in the top graph represent ±1 standard deviation. The threshold represents the 75th percentile (where 25% of all values are greater).

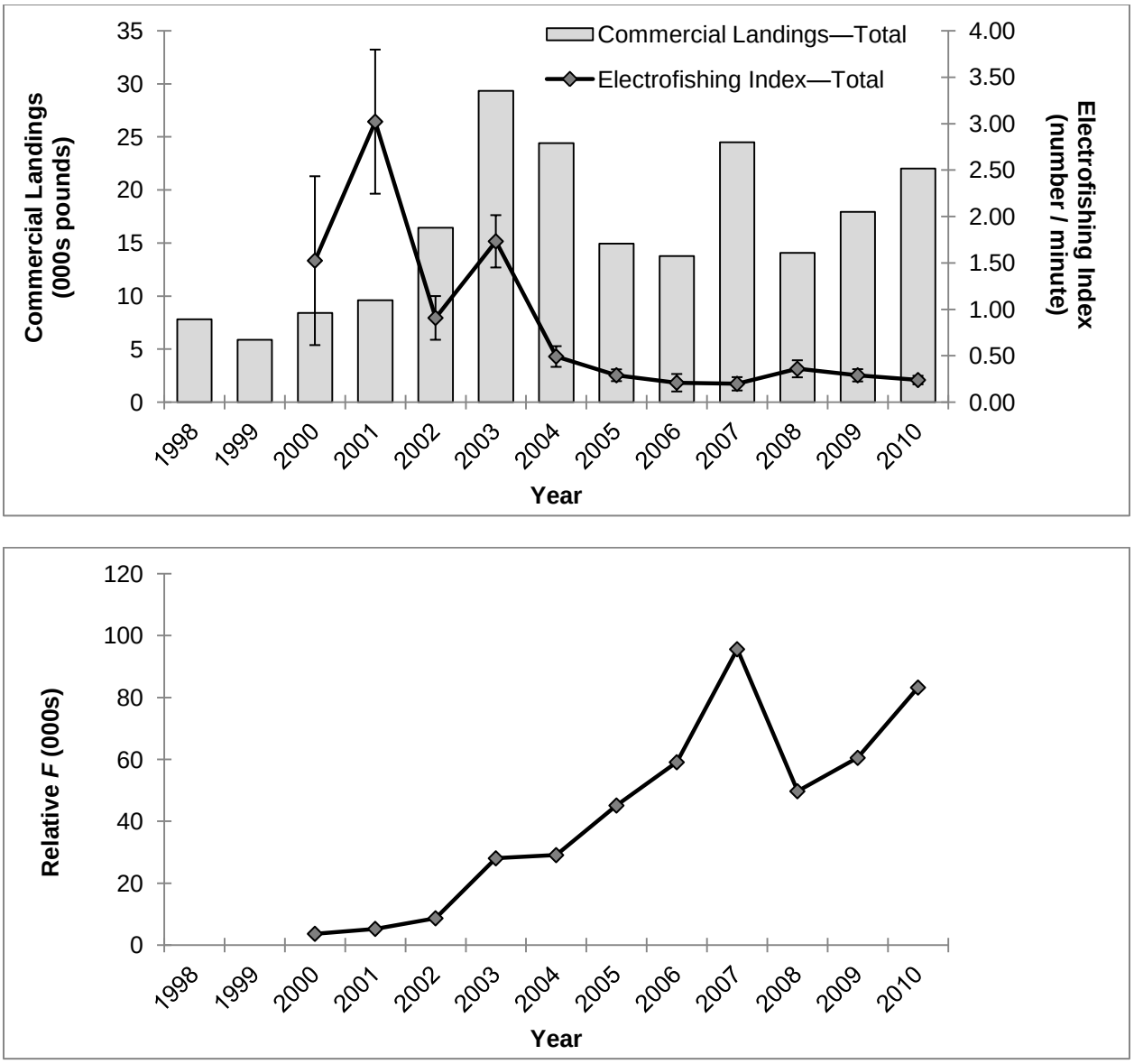


Figure 15. Commercial landings by all gear types (March–May) compared to the total electrofishing index (March–May; top graph) and annual estimates of total relative *F* based on these data (bottom graph) for the Cape Fear River, 2000–2010. The error bars in the top graph represent ±1 standard deviation.

ASMFC American Shad Sustainable Fishing Plan for Georgia

Submitted by
Don Harrison
Georgia Department of Natural Resources
Wildlife Resources Division
P.O. Box 2089, 108 Darling Avenue
Waycross, Georgia 31501
(912) 285-6094

Introduction:

The purpose of this sustainable fisheries management plan for American shad is to allow the continuation of existing American shad fisheries in Georgia rivers where it has been determined continuation of fishing will not adversely impact the Atlantic Coast American shad stock. This plan is submitted to fulfill requirements of Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management).

Management of American shad in Georgia is shared between the Coastal Resources Division and the Wildlife Resources Division's Fisheries Management Section of the Georgia Department of Natural Resources (GADNR). The river complex utilized by fish stocks defines Georgia's management units. Historically, all of Georgia's Atlantic-slope rivers supported a commercial fishery for American shad (Figure 1). However, in recent years, commercial landings of American shad have been reported from only three (Altamaha, Savannah, and Ogeechee) of these five rivers. There have been no reports of commercial landings from the Satilla or St. Marys rivers since 1989. Small-scale recreational fisheries for American shad exist in the Savannah and Ogeechee rivers.

During 2010, the Georgia Board of Natural Resources adopted new commercial shad fishing rules based on a recommendation from GADNR. These changes modified the temporal and spatial components of commercial shad fishing effort in Georgia's Atlantic-slope rivers, both to provide the basis for American shad sustainability plans and to address shortnose sturgeon bycatch issues.

The commercial shad (American and hickory) season is open each year from January 1 to March 31. Drift gill nets with mesh sizes of at least 4-½ inches (stretch mesh) are legal gear in all waters open to commercial shad fishing. Set gill nets with mesh sizes of at 4-½ inches (stretch mesh) are legal gear in waters open to commercial shad fishing in the Altamaha and Savannah Rivers. The St. Marys and Satilla rivers are now closed to commercial shad fishing.

The Altamaha River is open to commercial shad fishing from the U.S. Hwy 1 Bridge (rkm 183) downstream to the Atlantic Ocean. Including the waters of its major tributaries, this is an area approximately 347 rkm or 65% smaller than previously open to commercial shad fishing. The Altamaha River is open Monday through Friday below the saltwater demarcation line and Tuesday through Saturday above the saltwater demarcation line.

The Savannah River is open to commercial shad fishing from the U.S. Hwy 301 Bridge (rkm 192) downstream to the Atlantic Ocean, an area approximately 103 rkm or 35% smaller than previously open to commercial shad fishing. The Savannah River is open from Tuesday through Friday east of the I-95 Bridge and Wednesday through Saturday west of the I-95 Bridge.

The Ogeechee River is open to commercial shad fishing from the Georgia Hwy 204 Bridge (rkm 71) downstream to the Atlantic Ocean, an area approximately 137 rkm or 66% smaller than previously open to commercial shad fishing. The Ogeechee River is open on Friday instead of Friday and Saturday as was permitted prior to 2011. The use of set gill nets is prohibited in the Ogeechee River.

Georgia has a statewide 8 shad (American and/or hickory) recreational daily creel limit.

Georgia's American Shad Fishery

A. Brief Description

The Altamaha River supports the state's largest commercial shad fishery and is Georgia's largest watershed, draining 37,192 km^2. The Altamaha is formed by the confluence of the Oconee and Ocmulgee rivers and flows for approximately 220 kilometers to the Atlantic Ocean. The Altamaha is free of dams for the entire length of the river; however dams are located on both the Oconee and Ocmulgee rivers. Drift and set gill nets are the gear types used to commercially fish for shad throughout the river. Most full-time commercial fishermen prosecute their effort in the lower 60 kilometers of the river. Drift nets are the most prevalent gear type in the lower river, whereas set nets are more prevalent in the upper river (upstream of the City of Jesup). No directed hook and line fishing for shad takes place in the Altamaha River.

The Savannah River drains a watershed of approximately 17,022 km^2 and forms the boundary between Georgia and South Carolina. The first barrier to upstream migration on the Savannah River is the New Savannah Bluff Lock and Dam (NSBLD) located at river km 301. American shad are passed through this dam via lockage. The upper commercial fishing boundary is approximately 109 rkm below NSBLD, thus fish reaching this point have escaped the commercial fishery. Above NSBLD are three dams located from river km 333 to river km 355. Both drift and set gill nets are used to commercially fish for shad throughout the river. Most of the commercial activity takes place in the lower reach of the river and drift gill nets are the primary commercial gear used east of the I-95 Bridge. A recreational fishery also exists in the tail waters of the NSBLD.

The Ogeechee River, which drains a watershed of approximately 14,300 km^2, rises out of the east central piedmont and flows southeasterly approximately 564 km to the Atlantic Ocean. There are no barriers to upstream migration the entire length of the Ogeechee River. In recent years, a very small commercial fishery has persisted in the Ogeechee River with all reported landings coming from the lower section of the river. Drift and set gill nets have traditionally been used in this river. Additionally, a small sport fishery also exists on the Ogeechee River.

The Satilla River rises out of the coastal plain south of Fitzgerald, GA and flows southeasterly 328 km to the Atlantic Ocean. The river drains approximately 9,143 km^2 of land. There are no barriers to upstream migration the entire length of the Satilla River. There has been no known commercial fishing activity on the Satilla River since 1982. No directed hook and line fishing for shad takes place on the Satilla River.

The St. Marys River originates in the southeastern portion of the Okefenokee Swamp and flows 239 km to the Atlantic Ocean, draining a watershed of approximately 3,900 km^2. There are no barriers to upstream migration the entire length of the St. Marys River. There has been no known commercial fishing activity on the St. Marys since 1989. There is no directed recreational fishery for shad on the St. Marys River.

B. Landings

Reported commercial landings of American shad are available from the National Marine Fisheries Service and the State of Georgia through GADNR, which has recorded river-specific landings since 1962. In 2001, Georgia instituted a mandatory reporting system that requires an individual record (trip-ticket) to be completed at the time of sale for each catch sold to a seafood dealer. Data collected includes the river of capture, type of gear, total net soak time, etc. Numbers of wholesale dealers processing shad have declined over time and during 2010 and 2011 there were less than 3 dealers that purchased shad from commercial fishermen. Due to the low number of dealers and corresponding confidentiality agreements, commercial landings data obtained from trip-tickets during 2010-2011 must be excluded from reports.

GADNR has conducted periodic recreational creel surveys on the Ogeechee River since 1986 to estimate harvest and catch-per-unit-effort (CPUE). The number of American shad caught per hour of fishing time has varied from a low of 0.2 shad/hour in 1986 and 2010 to a high of 0.5 fish/hour in 1995. It is important to note that flow conditions can have a significant impact on angler catch rates in this fishery. Total effort and fish harvested has ranged from a high of 2,210-angler hrs and 1,053 shad harvested in 1996 to a low of 1,010-angler hrs and 155 shad harvested in 2010. Effort data from the last four creel surveys has averaged 1,542-angler hrs and total shad harvested has averaged 486 fish.

Recreational creel surveys were conducted on the Savannah River in the late 1990s by GADNR (1997) and South Carolina Department of Natural Resources (1998 and 1999). Estimates of catch from these surveys varied from year to year largely due to dramatically different flow conditions. Catch estimates from each of these creel surveys were provided by Boltin (1999).

C. Fishery Dependent Indices

Reported American shad landings from the Altamaha River reached a high of 471,700 lbs in 1968 and then declined for several years. Landings averaged approximately 299,000 lbs during 1962-1969 and approximately 130,000 lbs during 1970-1979. Reported Altamaha River shad landings peaked in 1983 at 143,963 lbs and again in 1995 at 121,811 lbs (Figure 2). Total reported landings have fluctuated at less than 62,000 lbs

since 2000. Ogeechee River shad reported landings exhibited a similar pattern and peaked in 1972 at 133,400 lbs before declining. Ogeechee River landings data is not available for 1983-1988, so it cannot be determined if landings increased anytime in this period. However, there was an increase in reported total pounds of American shad landed from the Ogeechee River in the mid-1990s that coincided with the increase in Altamaha River landings. Therefore, it is possible that the same trend occurred in the Ogeechee River in the mid-1980s. Savannah River landings data was supplied to SCDNR and will be combined with their landings data and reported in the South Carolina sustainability plan. In addition to collecting landings data, a commercial fishery creel survey was completed from 1982-1991 on the Altamaha River.

The ASMFC Shad Technical Committee (TC) asked GADNR to compare mean annual flows with commercial landings to provide precursory insight into whether or not there is a potential relationship between flow and landings. Figures 3 and 4 compare mean annual flows and January-March mean flows for the Altamaha River at the Doctortown gauge with reported landings. Correlation analysis between river flow and commercial landings resulted in R^2 values of 0.03 and 0.18 for annual and January-March mean flows, respectively.

Since 2001, commercial shad fishing effort has been quantified based on total number of reported commercial trips. The highest recorded statewide effort was 860 commercial fishing trips for the Altamaha River and 17 trips for the Ogeechee River in 2001 (Figure 5). During 2002-2011, commercial fishermen have averaged approximately 277 trips/yr for the Altamaha River and 6 trips/yr for the Ogeechee River. Effort data for the Savannah River was supplied to SCDNR and will be combined with their effort data and reported in the South Carolina sustainability plan.

D. Fishery Independent Indices

GADNR has utilized gill net surveys to generate population size and exploitation rate estimates for American shad through mark and recapture efforts in the Altamaha River since 1982 and CPUE since 1986. The American shad population was also estimated in 1967.

Adult shad electrofishing surveys were initiated in 2010 on the Ogeechee and Savannah rivers in preparation for future monitoring under the sustainability plans to be submitted pursuant to requirements of Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). GADNR staff will conduct these surveys twice monthly for three months during the spawning migration.

GADNR estimated juvenile American shad abundance from trawl surveys on the Altamaha River during 1982-1991 and the Ogeechee River during 1982-1985. Juvenile catch rates could not be correlated to estimated spawning populations nor future adult spawning return rates, so juvenile sampling ceased after 1991. However, GADNR reinstated a juvenile sampling program utilizing a 50-ft seine in 2010 on the Atlamaha, Ogeechee, and Savannah rivers in preparation for future monitoring under the sustainability plans to be submitted pursuant to requirements of Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad

Management). Seine mesh size and site locations were both experimental in 2010 and will become standardized. Current plans are to annually sample 3-6 sites/river twice a month from July-September.

E. Sustainable Fisheries

Altamaha River

GADNR has produced annual Lincoln-Peterson population estimates and exploitation rates from a tagging study that was initiated in 1982. Adult American shad are captured via gill nets in the lower 25 miles of the Altamaha River and tagged with a T-bar anchor tag produced by Floy Tag & Mfg, Inc. Tagging efforts are conducted on Saturday and Sunday each week of the commercial shad season that runs January 1 through March 31. These days were chosen due to the fact that the commercial fishery is closed in this portion of the river on weekends, thus allowing the fish to naturally disperse before potential recapture by commercial fishermen. Before the start of the season, 500 tags are randomly assigned values of $4, $10, $50, or $100. Two percent of the tags receive a $100 value, 3% are $50, 20% are worth $10, and 75% worth $4. Tag values are not printed on the tag. Upon capturing a tagged fish, commercial fishermen are required to remove tags and mail them into GADNR to receive the monetary award. GADNR keeps record of the number of fish tagged (M) and recaptured (R) and then utilizes reported commercial landings data to produce the total number of fish captured (C). In an effort to account for non-reported commercial landings and produce a more accurate estimate of "C", GADNR conducted a roaming creel survey from 1982-1992. After the 10 year creel survey was completed, GADNR staff developed a statistically based formula to account for non-reporting. From 1993 to present, "C" is calculated by entering the total reported commercial drift net landings into the formula "C"=$(2.322x10^{-6}+0.214/\text{Reported Landings})^{-1}$.

From 1982 to present, the estimated size of the adult American shad population has ranged from a low of 70,396 shad in 1990 to a high of 284,442 fish in 1996. After 1996, estimated shad abundance declined for six consecutive years before showing a moderate rebound (Figure 6). However, the 2011 mark and recapture efforts revealed a sharp increase in American shad abundance with a population estimate of 277,824 fish. Trends in GADNR tagging CPUE data appear to be similar to those observed in GADNR's mark and recapture population estimates (Figure 7) and have ranged from a low of 0.7 shad/ft-hr in 1987 to a high of 3.05 shad/ft-hr in 1996. Exploitation rates estimated from recaptures of tagged fish were consistently greater than 30% from 1982 through the early-1990s before declining to present levels (Figure 6). From 2006-2010, exploitation of American shad averaged 21%, ranging from 17.8% to 24%. On January 1, 2011, new commercial regulations that closed approximately 65% of the Altamaha River system went into effect and during this first year total exploitation was 8.6%. Fisher attrition continues to reduce effort, as well.

Juvenile sampling on the Altamaha River was initiated in 2010, and 291 juvenile shad were collected in 12 seine hauls utilizing a combination of two 50-ft bag seines (one with ½-inch mesh and one with $^{3}/_{8}$-inch mesh). The resulting geometric mean was 14.6 shad/haul. However, staff observed juvenile shad escaping through both of these nets. Therefore, catch rates would have been higher if a smaller mesh seine had been utilized.

For 2011 and future years, GADNR staff are utilizing a 50ft bag seine with ¼-inch mesh to sample juvenile shad. During July 2011, 1,282 juvenile shad were captured in 20 seine hauls with a resulting geometric mean of 38.4 shad/haul. During July 1968, Godwin and Adams (1969) utilized a similar seine to collect juvenile shad and reported an arithmetic mean of approximately 15 shad/haul. Therefore, the CPUE of juvenile shad observed in July 2011 is seems to indicate that American shad reproduction is currently at a sufficient level to sustain the population.

The ASMFC American Shad Stock Assessment Sub-committee (SASC) utilized catch-per-unit-effort data (CPUE) through 2005 from GADNR tagging efforts on the Altamaha River as an indicator that the Altamaha stock was in decline when the 2007 stock assessment was completed. During 2006-2011, CPUE data from GADNR tagging efforts averaged 1.97 shad/ft-hr, which is 74% higher than the average of 1.13 shad/ft-hr observed from 2000-2005 (Figure 8). This fact along with the apparent increase in population abundance, decreased exploitation rates, and recent juvenile abundance data supports the fact that the current fishery appears to be sustainable. In addition, GADNR believes that the 2011 regulations will allow sufficient escapement of adults and help ensure that fishery removals will not adversely impact the Atlantic Coast American Shad population.

The SASC and TC expressed concerns with utilizing population estimates and exploitation rates generated from annual tagging efforts as stock indicators since GADNR has not studied non-reporting rates, tag loss, tagging mortality or post tagging movements. Instead, the TC recommends using annual CPUE data as a benchmark. Therefore, GADNR will continue to monitor the Altamaha stock through a fishery independent gill netting survey in order to develop annual CPUE data for use as a stock abundance indicator. GADNR will utilize a CPUE benchmark of 75% of the mean for 3 consecutive years. The TC asked GADNR to consider two potential CPUE benchmark means. The first would utilize the entire time series of data (1986-2011) to calculate the mean, resulting in a benchmark CPUE of 1.11 shad/ft-hr (Figure 8). The second option was to exclude the first seven years and utilize data from 1993 through 2011 to present and would establish a CPUE benchmark of 1.29 shad/ft-hr. GADNR believes it is more appropriate to utilize the entire time series of data to establish the benchmark CPUE since it encompasses a greater degree of environmental and population variability, the Altamaha shad population has historically shown the capacity to rebound after 7 consecutive years below this benchmark, and historically a benchmark of 1.29 shad/ft-hr would not have triggered action any more frequently than a benchmark of 1.11 shad/ft-hr. If gill netting CPUEs drop below 1.11 shad/ft-hr for 3 consecutive years, GADNR will evaluate commercial fishing regulations and harvest data and consider modifications to the Altamaha fishery to ensure the fishery remains sustainable. In the future, utilization of a juvenile index of abundance may be added once GADNR has collected several years of data in order to establish a CPUE benchmark appropriate to the Altamaha River.

Since the TC was interested in examining the effects of river flow and commercial landings, GADNR also compared CPUE data collected during tagging efforts and flow on the Altamaha River (Figures 9 and 10). As with reported commercial landings, there did not appear to be a strong relationship between river flow and CPUE. Correlation

analysis revealed that approximately 12% of the variability in catch rate could be explained by flow for both annual and January-March mean flows.

Savannah River
Historically, GADNR was not required to collect fishery independent data from the Savannah River. In 2010, GADNR initiated fishery independent sampling for both adults and juveniles. Savannah River data collected by GADNR was provided to SCDNR to be combined with their data and reported in the South Carolina sustainability plan.

Ogeechee River
Historically, GADNR was not required to collect fishery independent data on the American shad fishery in the Ogeechee River. In 2010, GADNR initiated fishery independent sampling for both adults and juveniles. Adult electrofishing CPUEs were 15.19 shad/hr in 2010 and 11.84 shad/hr in 2011. Utilizing data from six sites where juvenile shad were consistently captured in 2010, the geometric mean for juveniles collected using 50-ft seine with $^{1}/_{8}$-inch mesh was 17.2 shad/haul. The Ogeechee River commercial fishery is extremely small and over the last ten years has averaged six commercial fishing trips/yr with a total reported harvest averaging less than 400 lbs. Even though the fishery is very small, due to the lack of data, GADNR has closed approximately 66% of the waters that were previously open to commercial fishing and reduced the number of days that commercial fishing activity can take place to 1-day/week (a 50% reduction). GADNR believes that this will allow adequate escapement to ensure the sustainability of the population. At this time, GADNR is hesitant to establish sustainability benchmarks from adult electrofishing CPUE data or juvenile abundance indices since there is only one complete year of data available. Once data has been collected for several years, appropriate benchmarks will be established.

Satilla River and St. Marys River
The Satilla and St. Marys rivers are currently closed to commercial fishing for American shad and there are no plans to open these rivers in the foreseeable future. If it were deemed prudent to open these rivers to commercial shad fishing, GADNR will submit, prior to opening the rivers, a sustainability plan for each river.

F. Adaptive Management

GADNR will continue to monitor the commercial shad fishery through fishery dependent and independent sampling on the Altamaha, Savannah, and Ogeechee rivers. Data from the Savannah River will be shared with SCDNR, and the agencies will work cooperatively towards the management of this population.

If three consecutive years of data show that CPUE of adults is decreasing, and/or juvenile abundance is decreasing beyond established benchmark levels, GADNR would evaluate and identify the causes thereof and initiate appropriate actions. Potential actions may include reducing the number of fishing days, modifying season dates, or altering legal fishing gears. In the event such actions are not successful in reversing negative trends, GADNR would then consider closing the fishery in that river system.

Figure 1. Georgia Atlantic-Slope Rivers.

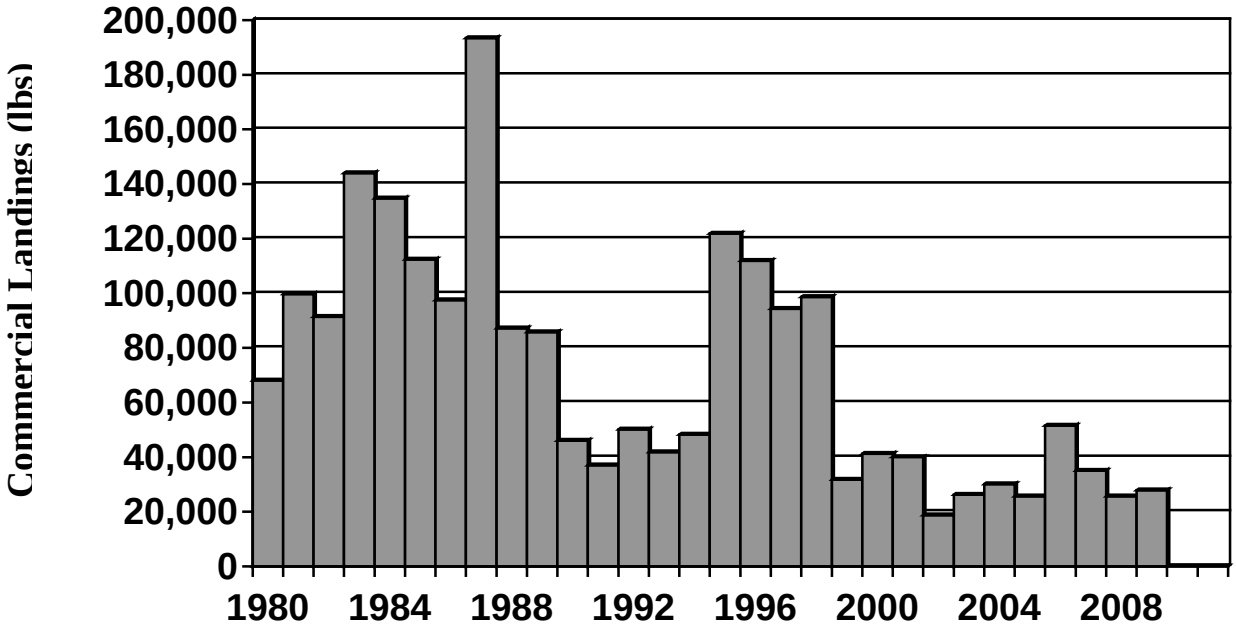


Figure 2. Reported commercial landings of American shad from the Altamaha River, Georgia. Due to confidentiality agreements, data from 2010-2011 have been excluded.

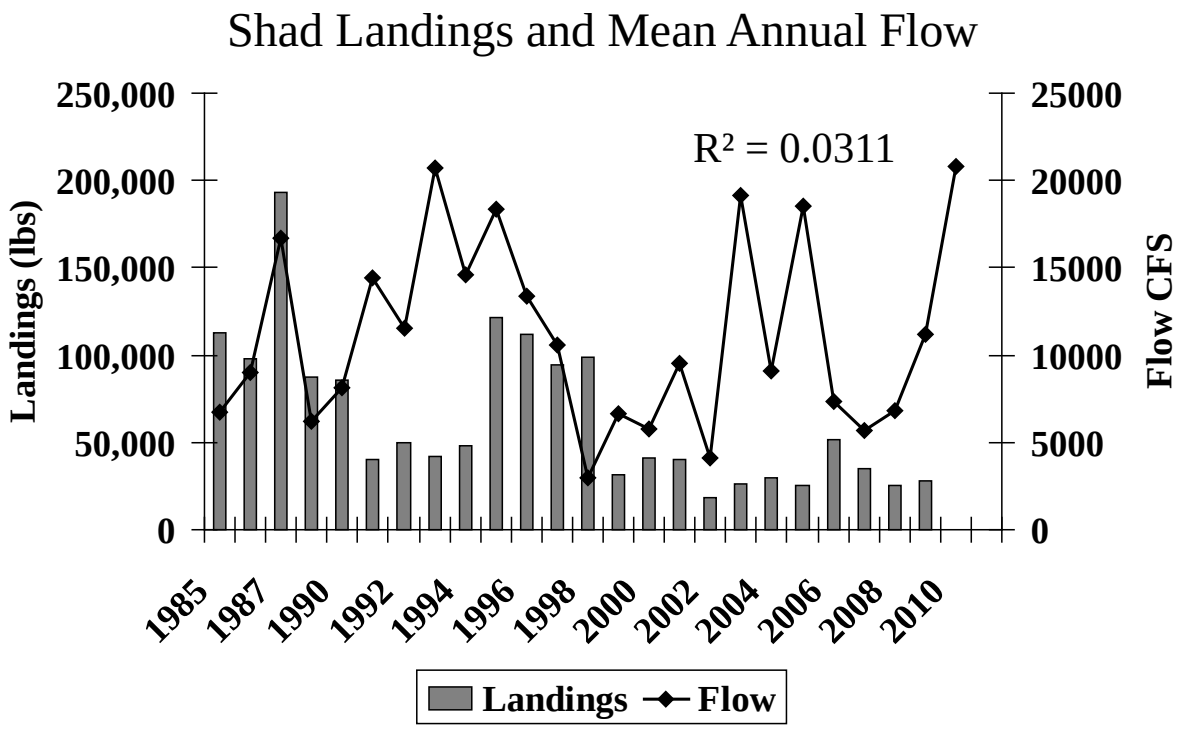


Figure 3. Reported commercial landings of American shad and mean annual flow from the Altamaha River, Georgia. Due to confidentiality agreements, landings data from 2010-2011 have been excluded.

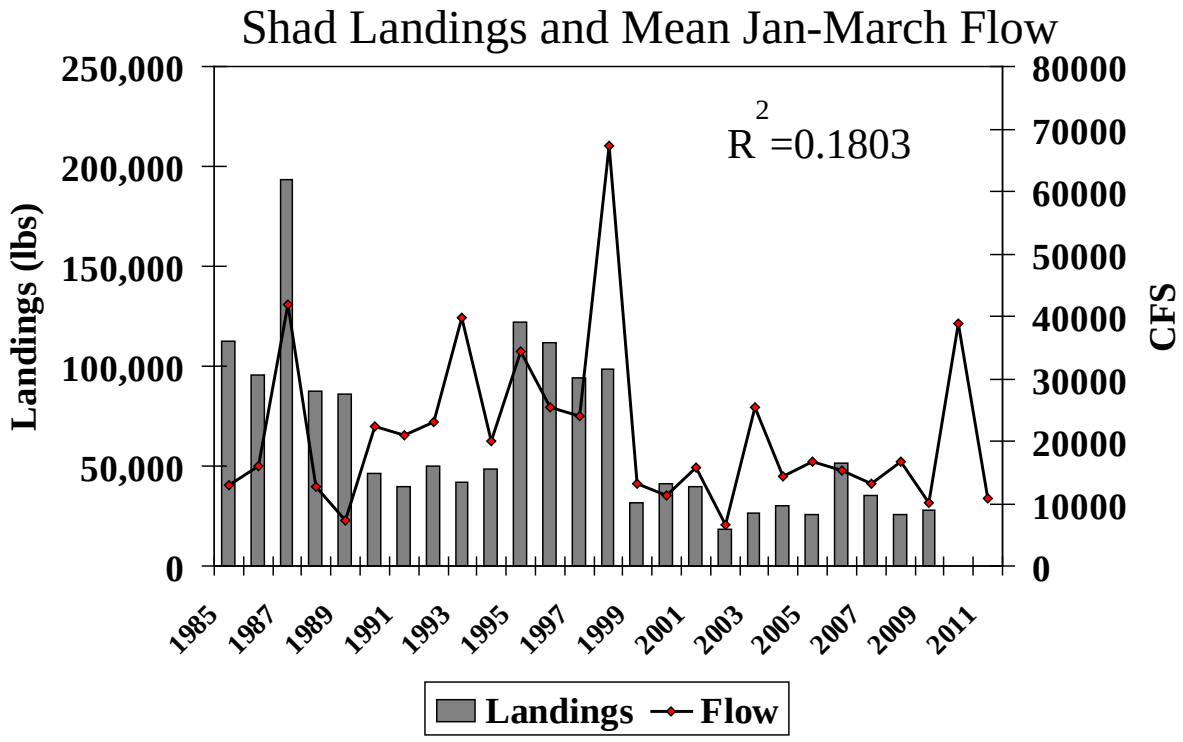
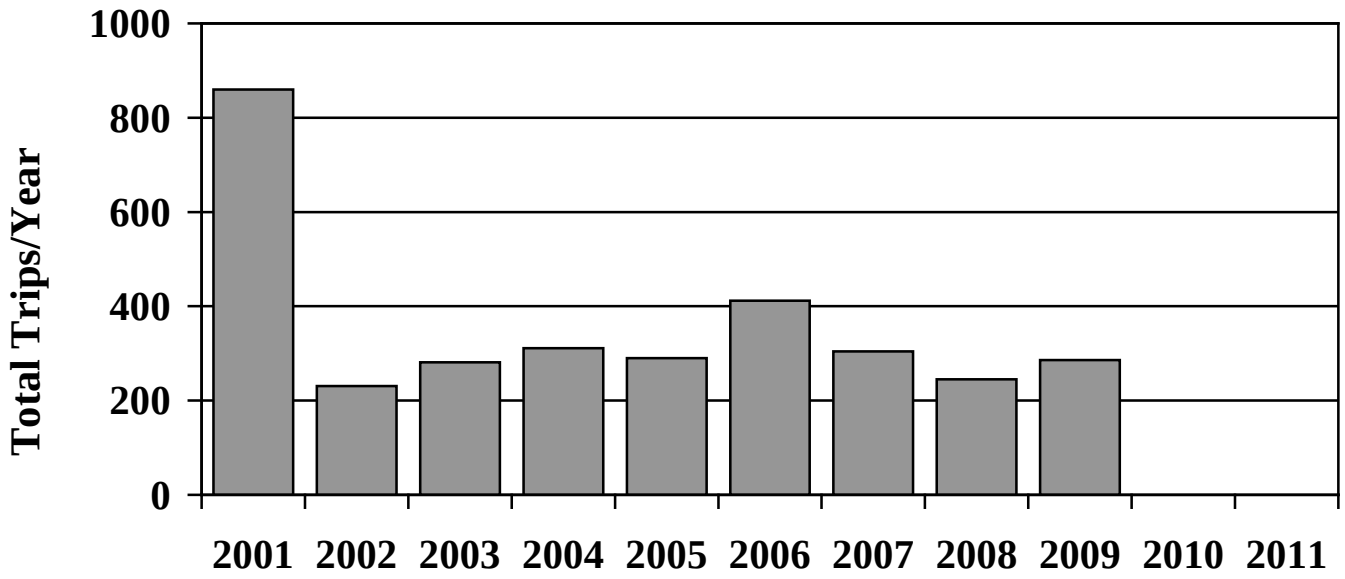


Figure 4. Reported commercial landings of American shad and January-March mean flow from the Altamaha River, Georgia. Due to confidentiality agreements, landings data from 2010-2011 have been excluded.



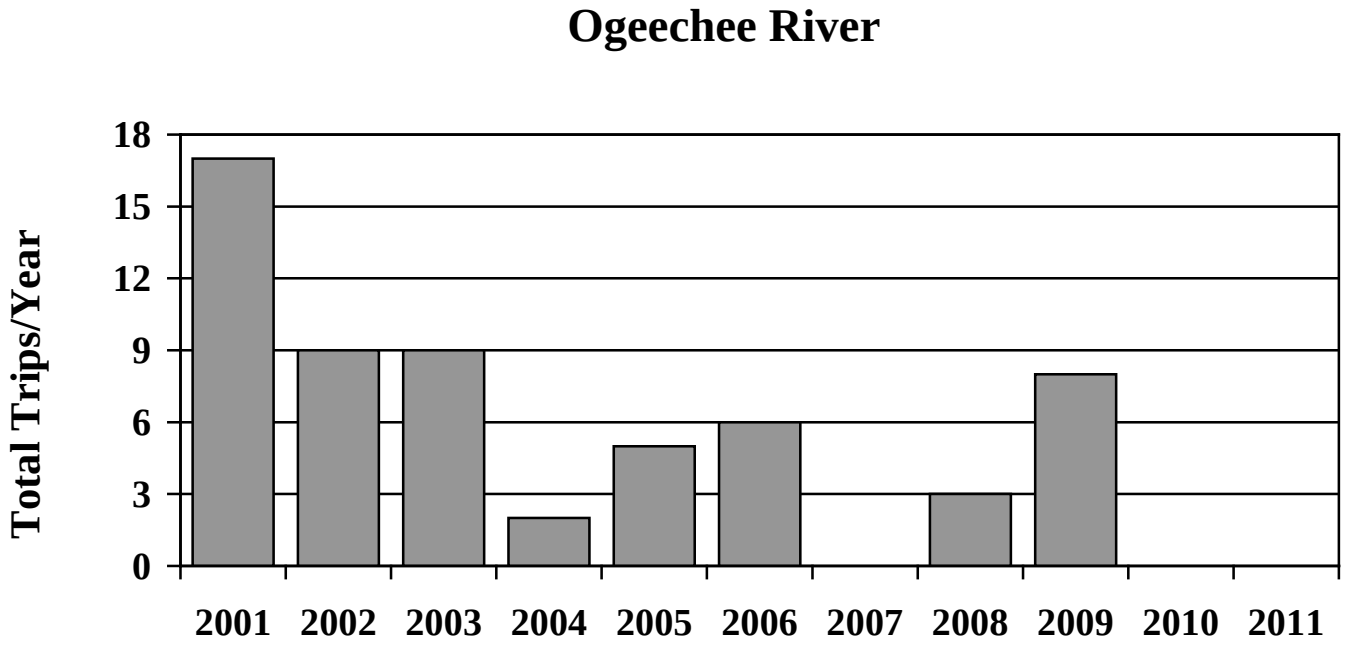


Figure 5. Total commercial fishing effort for American shad in the Altamaha and Ogeechee rivers. Due to confidentiality agreements, data from 2010-2011 have been excluded.

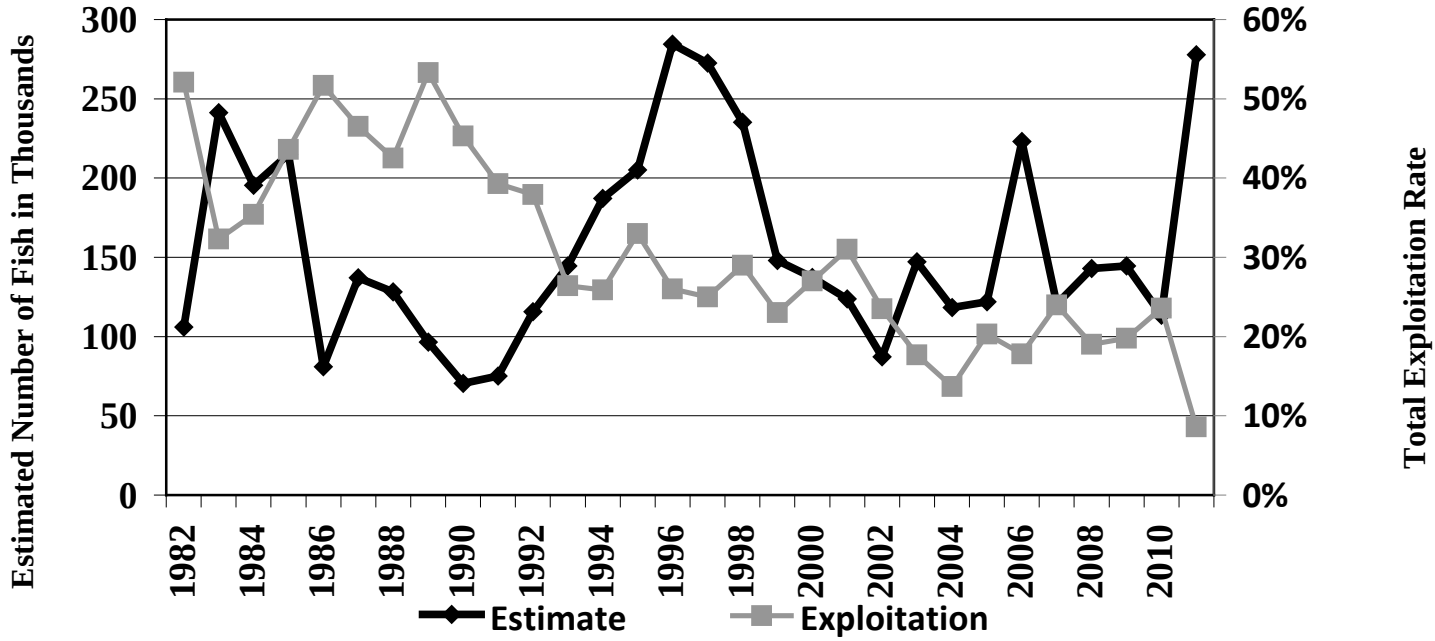


Figure 6. Population estimates and exploitation rates of American shad from the Altamaha River, GA.

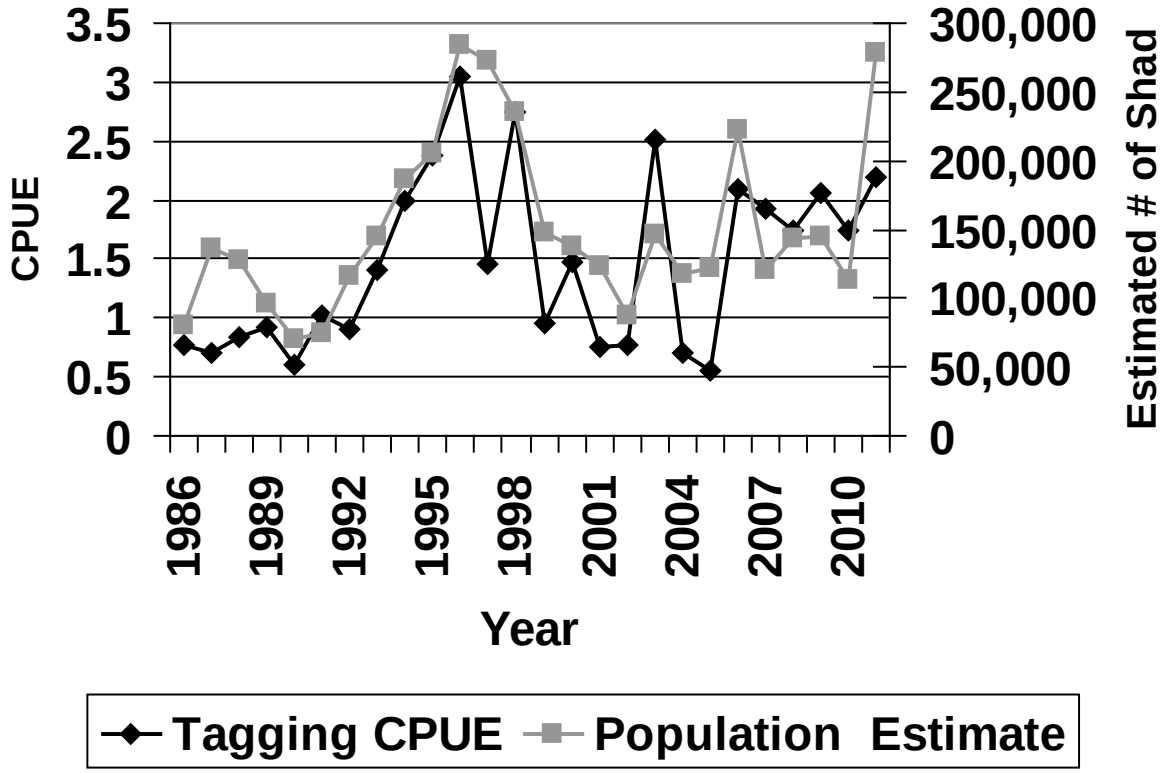


Figure 7. Fishery-independent catch-per-unit-effort (CPUE-number caught per foot-hour) of American shad and population estimates from GADNR mark and recapture efforts.

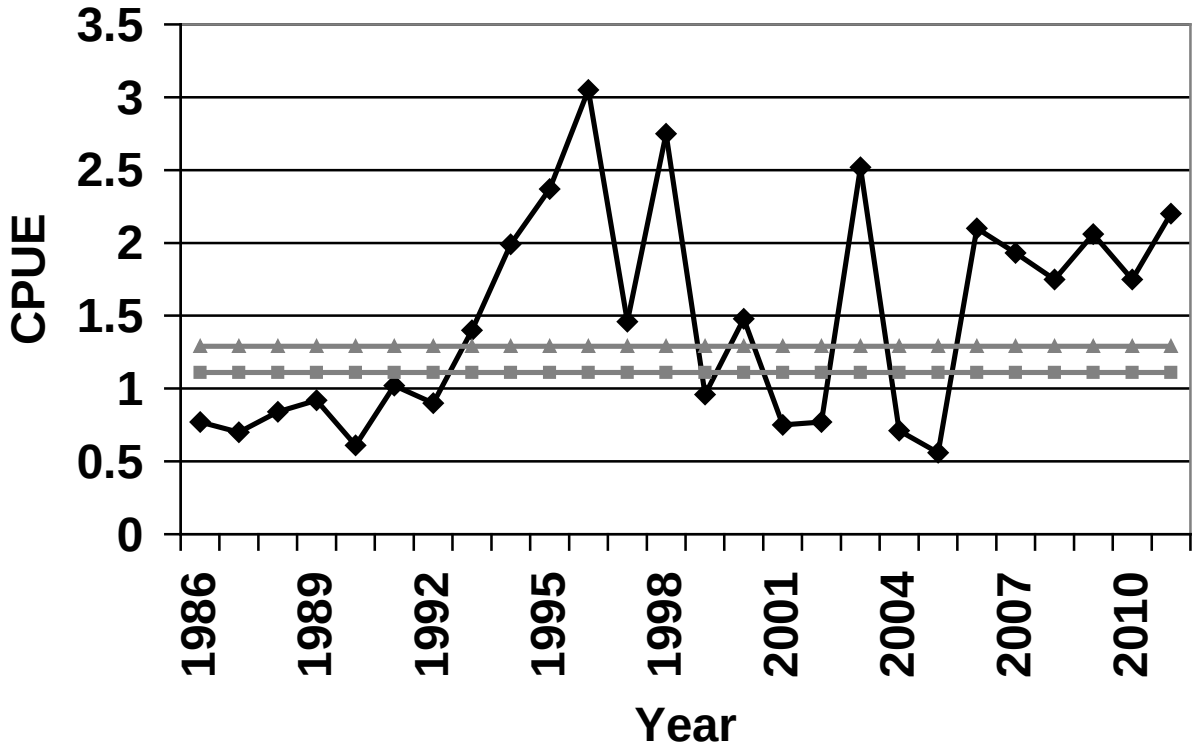


Figure 8. Fishery-independent catch-per-unit-effort (CPUE-number caught per foot-hour) of American shad and potential benchmarks developed from GADNR gill-net tagging data.

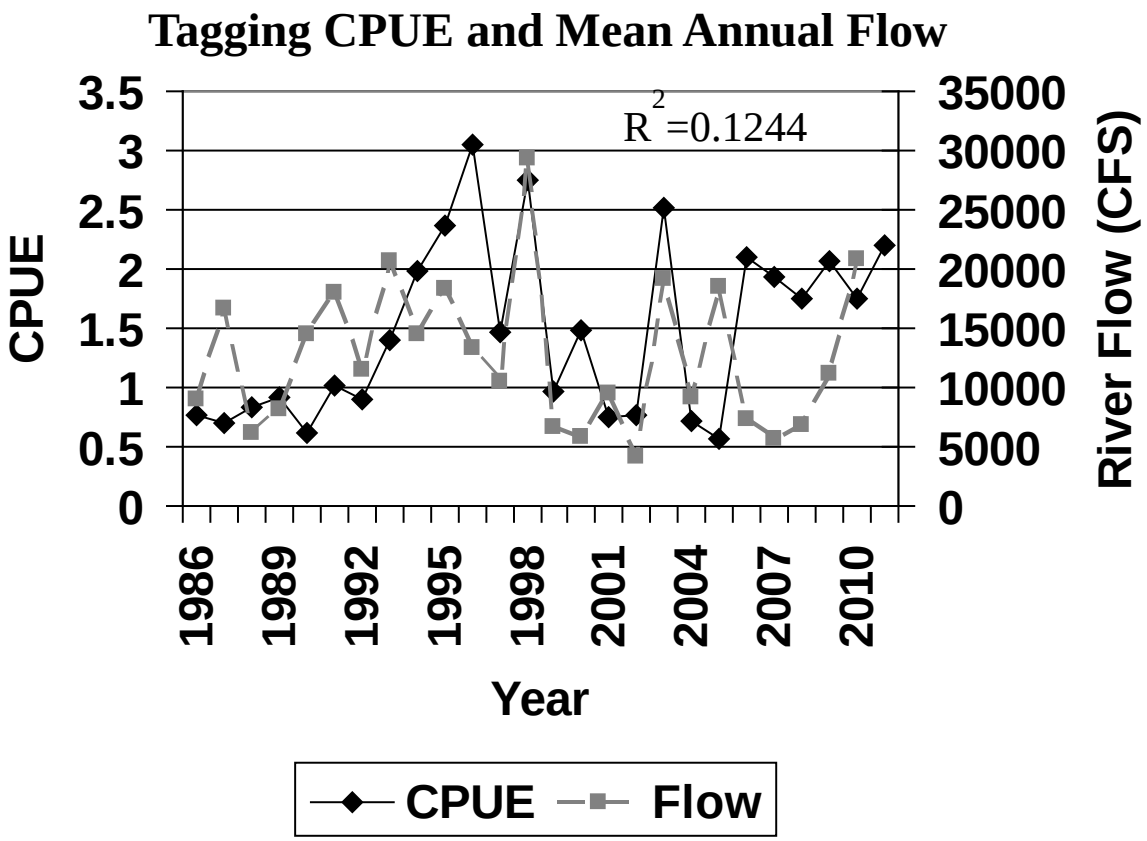


Figure 9. Fishery-independent catch-per-unit-effort (CPUE-number caught per foot-hour) of American shad from GADNR gill-net tagging data and mean annual flow for the Altamaha River at the Doctortown gauge.

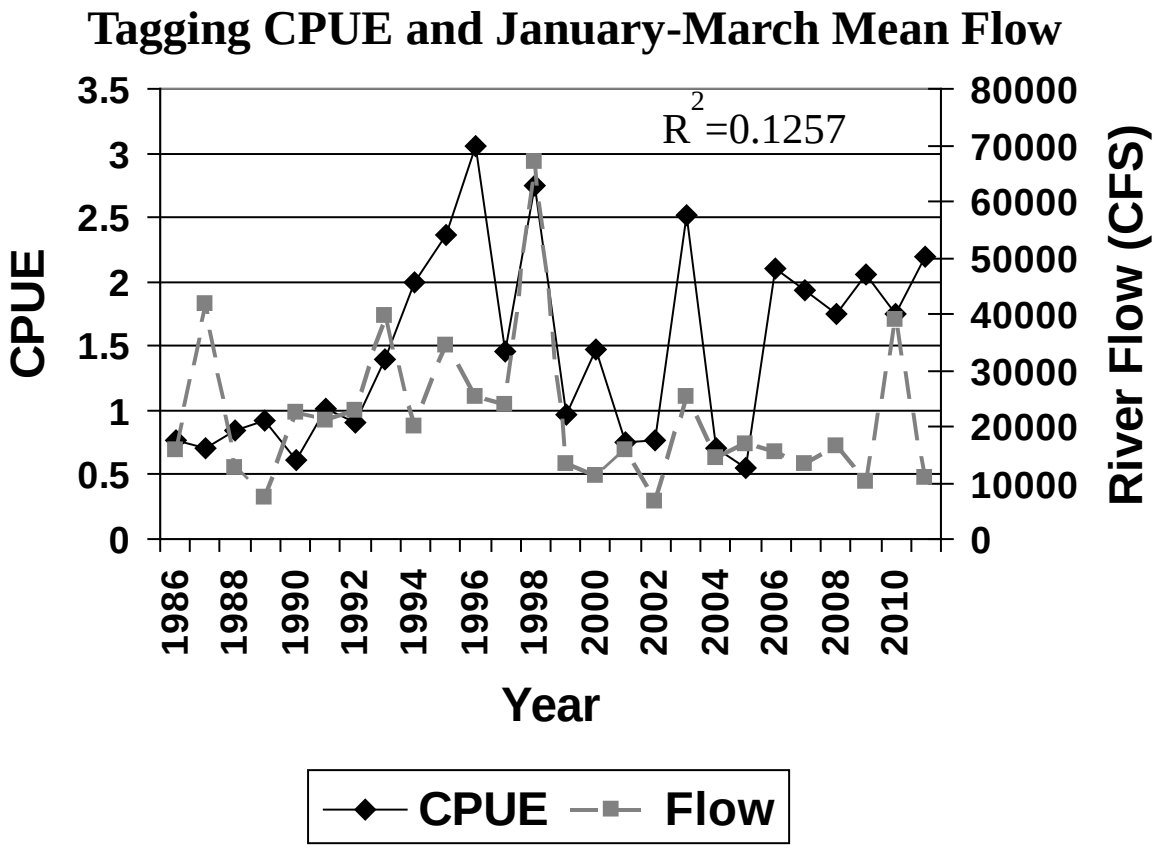


Figure 10. Fishery-independent catch-per-unit-effort (CPUE-number caught per foot-hour) of American shad from GADNR gill-net tagging data and January-March mean flow for the Altamaha River at the Doctortown gauge.

Literature Cited

Godwin, W.F. and J.G. Adams. 1969. Young Clupeids of the Altamaha River, Georgia. GA Game and Fish Comm., Mar. Fish. Div., Contribution. Ser. No. 15.

Amendment 3
American Shad Recovery Plans
New Hampshire
Delaware
Maryland
District of Columbia

Submitted to the
Shad & River Herring Board
February 2012

New Hampshire ASMFC American Shad Fishing/Recovery Plan

New Hampshire Fish and Game Department
August 2011

1. Sustainable Fishery Plan

a. **Request for fisheries**
   None requested.
b. **Definition of sustainability-***(Not applicable)*
c. **Summary of current stock status-***(Not applicable)*
d. **Benchmark goals and objectives or restoration goals/targets-***(Not applicable)*
e. **Proposed time frame for achievement-***(Not applicable)*
f. **Discussion of management measure(s) to be taken if sustainable target is not achieved within indicated timeframe-***(Not applicable)*

2. Stock Monitoring Programs

a. Fishery Independent

i. Juvenile abundance indices

Exeter River:
A beach seine survey is conducted at 15 fixed stations along New Hampshire coastal waters each month between June and November. Mean catch rates of juvenile American shad within the beach seine survey are used as relative indicators of occurrence of spawning activity from year to year and resulting juvenile abundance. The survey has an estuary-wide design with five sites in the Great Bay, six additional sites in the estuary, and four sites in the Hampton/Seabrook Estuary. While there is no sampling site located in the Exeter River, a relative abundance index for juvenile American shad in the estuary that the Exeter River flows into can be calculated via the mean catch rate using the 11 sites in the Great Bay Estuary System.

Merrimack River:
Electrofishing boats are used to sample for juvenile American shad in the Merrimack River. Electrofishing CPUE can be compared between years and sites; however sampling efficiency is dependent on many variables, including flow conditions and the timing of downstream migration. Surveys are used primarily to monitor juvenile shad production from trap/transfer and hatchery fry stocking efforts in the upper Merrimack River.

ii. Adult stock monitoring

1. **Relative or absolute abundance**

   Exeter River:

   The number of returning American shad in the Exeter River is determined annually through monitoring of the fish ladder at the head-of-tide dam in Exeter, NH. The fish ladder is checked daily during the peak periods of returning spawning anadromous fish between late April and the beginning of July each year.

   Merrimack River:

   All returning adult shad are counted each spring at the Essex Dam fish lift, in Lawrence, MA. Seasonal employees, hired by the Massachusetts Division of Fish and Wildlife, monitor a counting window upstream of the fish lift. Shad numbers are also recorded at fishways on the next two upstream dams, in Lowell and Manchester, respectively.

2. **Age, size, sex composition**

   Exeter River:

   Each adult American shad encountered in the fish ladder on the Exeter River is sampled to determine the total length, fork length, and sex. A scale sample is taken from each fish for analysis of age and repeat spawning success.

   Merrimack River:

   Between 10 and 20 adult shad are sampled at the Essex Dam fish lift each week during the spawning run. Data collected includes length, weight, and sex. Scale samples are taken to determine the age of each individual.

3. **Total mortality (where possible)**

   Exeter River:

   Given the low number of American shad returning to the Exeter River, these calculations are not currently feasible. If in forthcoming years, the number of American shad returning increase to a level sufficient to provide accurate estimates, they will be determined.

   Merrimack River:

   An estimate of total mortality has not been calculated for the Merrimack River shad population. There is little information available on the number of shad that spawn downstream of the first dam in Lawrence.

4. **Upriver and downriver passage efficiencies (where possible)**

   Exeter River:

   New Hampshire does not currently conduct any measures of passage efficiencies, upriver or downriver, at the head-of-tide fish ladder on the Exeter River.

   Merrimack River:

   Downstream passage efficiency studies have been conducted or are currently underway at each of the five mainstem Merrimack River dams south of Franklin, NH. An upstream passage efficiency study conducted by Sprankle (2005) determined that shad restoration in the upper Merrimack River is limited by poor passage efficiency through the fish lift at the second upstream dam (the Pawtucket Dam) located in Lowell, MA. An acoustic telemetry study was initiated at the Pawtucket Dam in 2011 in an effort to improve passage efficiency at the site.

iii. Hatchery evaluation

1. **Proportion of hatchery fish present in juvenile or adult populations**

   Exeter River:

   No hatchery raised American shad are stocked in the Exeter River; therefore no hatchery evaluation is conducted.

   Merrimack River:

   Approximately 450 adult shad are captured annually at the Essex fish lift and transported to the Nashua National Fish Hatchery (NNFH) and the North Attleboro National Fish Hatchery (NANFH). Shad are spawned in circular tanks and the fry are released into the Merrimack River, with a target of 4,000,000 fry per year. All fry are immersed in an oxytetracycline bath to mark otoliths prior to release. Otoliths from juvenile shad, sampled by electrofishing, and adult shad, sampled at the Essex fish lift, will be read to determine the relative contribution of hatchery raised fry to the restoration effort.

b. Fishery Dependent

i. Commercial fishery

1. **Total catch, landings, and effort**

The commercial harvest of American shad from the state waters of New Hampshire is prohibited. All commercial landings of federal vessels landing American shad in New Hampshire are reported as a condition of their federal permit.

2. **Age, size, and sex composition of harvested fish**
   The commercial harvest of American shad from the state waters of New Hampshire is prohibited, and New Hampshire does not sample American shad bycatch from federal waters.

ii. Recreational fishery

1. **Total catch, landings, and effort or catch per unit effort from a subsample**
   New Hampshire monitors the annual catch, harvest, and effort through estimates produced by conducting the cooperative state/federal Marine Recreational Survey. Additionally, 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 unless they are commercially licensed and are reporting the harvest to the National Marine Fisheries Service. Mandatory monthly reporting of catch and effort is a condition of the permit.

iii. Bycatch and discards
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 (NHFG) unless they are commercially licensed and are reporting the harvest to the National Marine Fisheries Service. Mandatory monthly reporting of catch and effort is a condition of the permit. Bycatch of American shad can be determined as it is one of the required data elements collected from the coastal harvest reports.

3. Fishery Management Program

a. Commercial fishery
The harvest of American shad by any method of commercial fishing is prohibited in the state waters of New Hampshire.

b. Recreational fishery
The harvest of American shad by any method of recreational fishing will be prohibited in the state waters of New Hampshire.

c. Bycatch and discards

No person shall transport, possess or land shad from outside the jurisdiction of the state that exceeds more than 5% of the total landing by weight per commercial trip.

Literature cited:

Sprankle, K. 2005. Interdam movements and passage attraction of American shad in the lower Merrimack River main stem. North American Journal of Fisheries Management 25:1456-1466.

The State of Delaware's American Shad Recovery Plan for the Nanticoke River

Prepared by:
Mike Stangl
Delaware Department of Natural Resources and Environmental Control
Division of Fish and Wildlife
Dover, DE 19901

August 2011

Submitted to the Atlantic States Marine Fisheries Commission as a Requirement of Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring.

1) Sustainable Fishery Plan (None proposed)

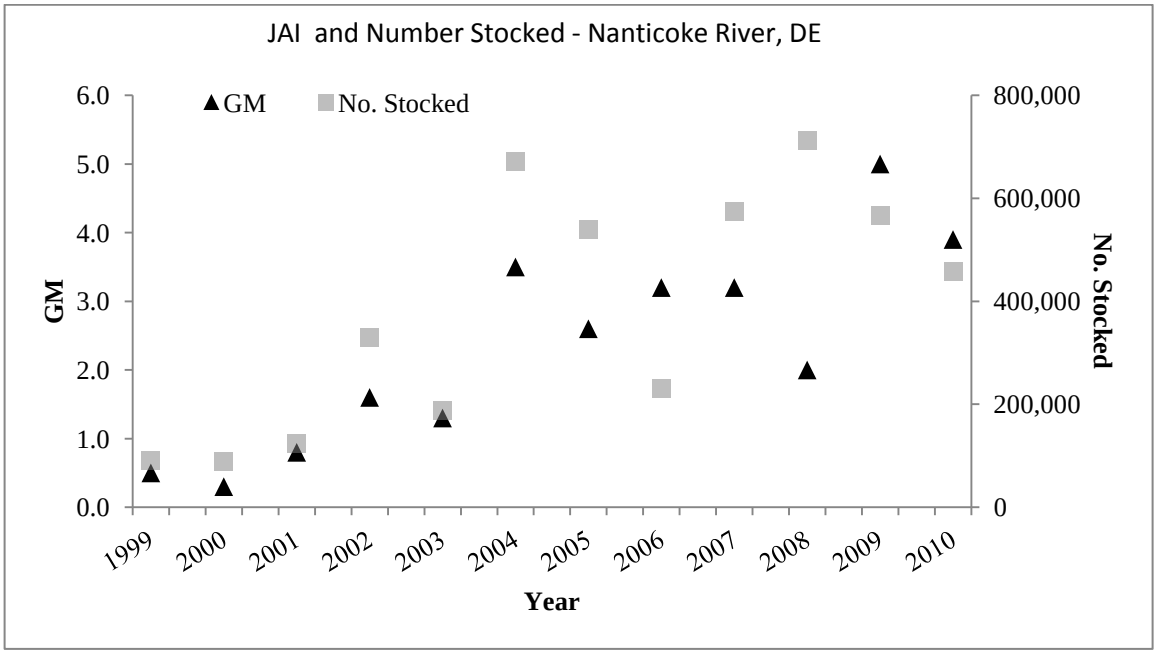
The American shad fishery in the Delaware portion of the Nanticoke River has been closed to harvest since 2000. There are no proposed plans to open this fishery.

2) Stock Monitoring Programs

a) Fishery Independent

i. Juvenile abundance indices

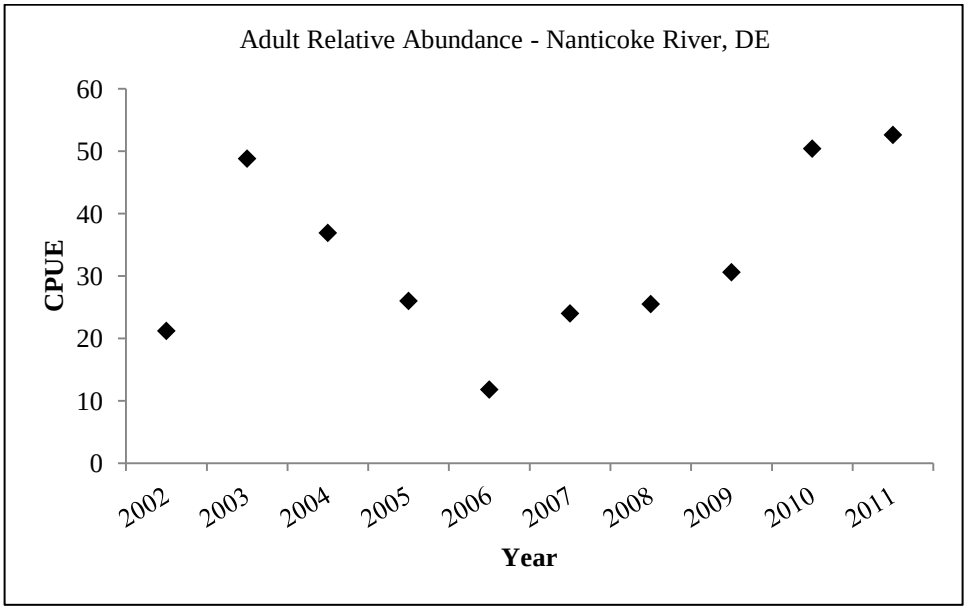
Samples are obtained at ebb or low slack tide using a 45.7-m long x 3.0-m deep haul seine constructed of 6.35-mm nylon mesh netting. One end of the net is anchored to the shoreline with the remainder of the net deployed from the bow of a boat in a semicircle pattern and hauled to shore. Seining is conducted biweekly at 4 sites. The geometric mean is used as an index of relative abundance. Zero catches are included in the analysis of the GM. The GM has been trending upwards since 2003 and appears to be related to the number of fish stocked.



ii. Adult stock monitoring

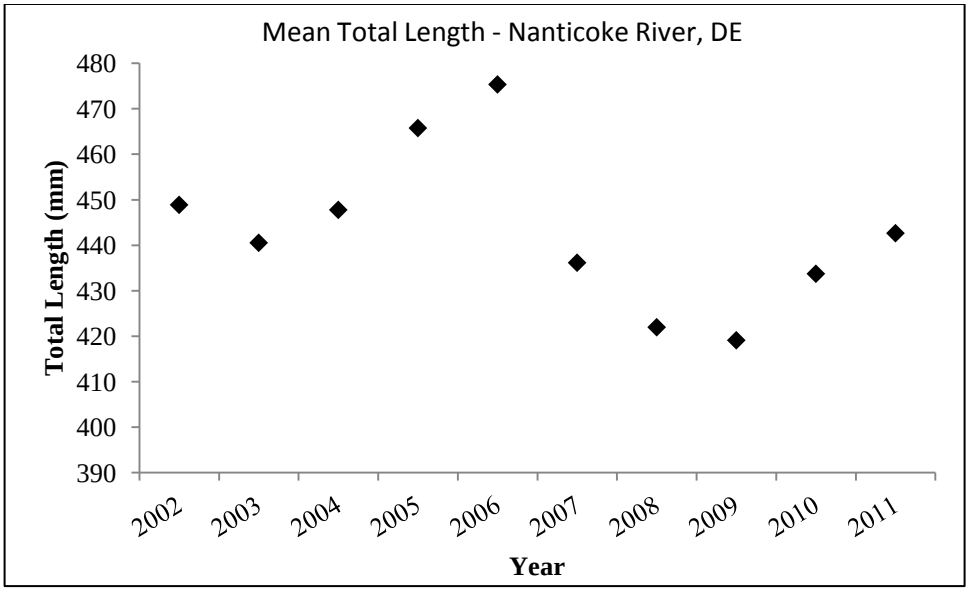
1. Relative or absolute abundance

Electrofishing collections are conducted in two sections of the upper Nanticoke River drainage to establish an annual index of relative abundance (cpue). The catch rate of adult shad taken in Deep Creek and the upper Nanticoke River (Nanticoke Branch) during sampling and brood fish collections are used to calculate the index. An electrofishing raft, outfitted with a 5,000-watt Honda generator and a Coffelt VVP-15 variable voltage pulsator set on pulsed DC current was used for all collections. The relative abundance of adult American shad has been trending upwards since 2006.



2. Age, size, sex composition

Total length, sex and scale samples are collected during electrofishing efforts in the spring to aid in characterizing the adult population. Ages are determined, and analysis of size structure, total length, and repeat spawning marks are performed. There has been no long term trend regarding the length of fish sampled since 2002.



Comparison over the past 10 years suggests that ages 5 and 6 are the dominant classes for females while ages 4 and 5 are the dominant classes for males. Males typically spawn for the first time a year earlier than females.

Percent frequency of age distribution from scales for female and male shad caught electrofishing 2002-2011 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
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

The annual proportion of shad spawning by sex was similar during 2002-2011. Approximately 46% of spawning females and 45% of spawning males were virgin spawners, 34% of females and males were first time repeat spawners, 18% of spawning females and 17% of spawning males were second time repeat spawners, and only 9% of spawning females and 5% of spawning males were third time repeat spawners.

Frequency of occurrence of repeat marks 2002-2011 from the Nanticoke River.

	Repeat mark					
Year	0	1	2	3	4	Total
Female						
2002		100.00				3
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
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

3. Total mortality (where possible)

N/A

4. Upriver and downriver passage efficiencies (where possible)

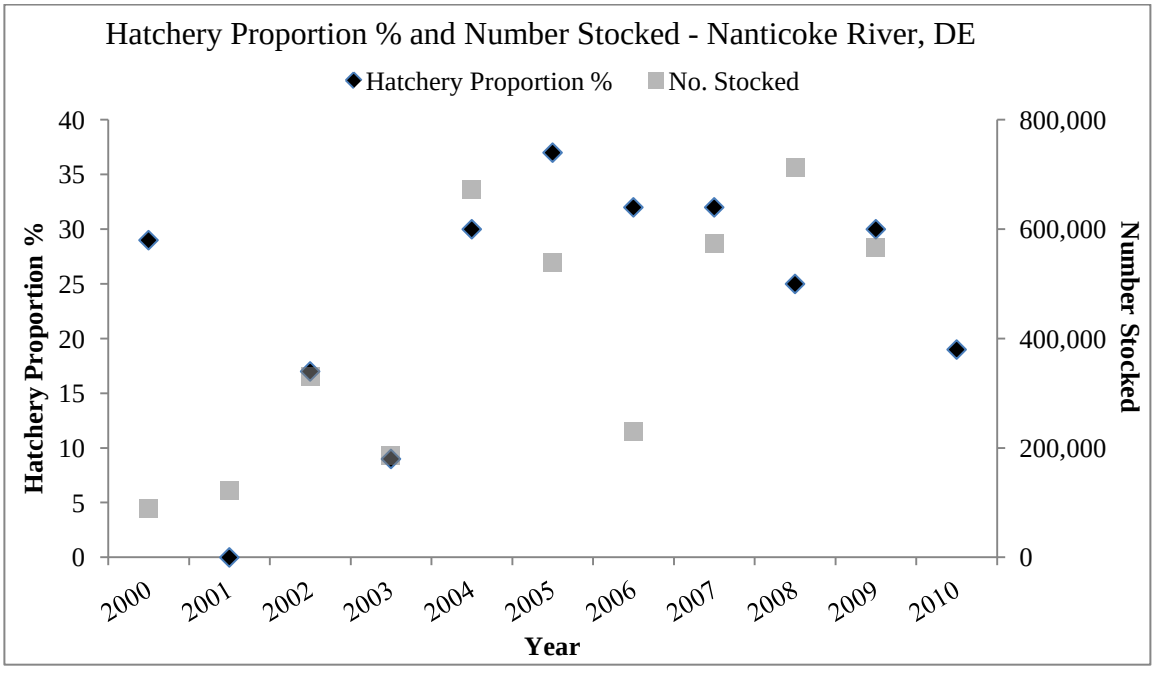
N/A

iii. Hatchery evaluation

The Nanticoke Shad Hatchery has been stocking the Nanticoke River since 2005, utilizing the remnant population as brood stock for tank spawning. The idea was to tank spawn the Nanticoke stock to reduce adult mortality, and provide greater survival for egg and early larval stages of American shad. From 2000-2005, shad were obtained from cooperating agencies in other states for stocking.

1. Proportion of hatchery fish present in juvenile or adult populations

Juveniles - A sub-sample of juvenile shad collected during haul seining are retained for otolith mark analysis. Sagittal otoliths are extracted and mounted on slides with Crystalbond™ 509 adhesive. Otoliths are ground down to the core using 600-grit waterproof sandpaper then examined for the proportion of OTC marks under a 50x objective on a Zeiss Axioscope 40 epi-fluorescence microscope. The presence and location of a mark is recorded to determine the proportion of hatchery-produced and wild fish in the sample. The mean number of fish examined for marks is 95 fish/yr. Greater numbers of shad have been stocked since 2004 and, similar to the JAI, appears to be related to the number of fish stocked.



Adults – Only incidental mortality of adult American shad are retained from Delaware's portion of the Nanticoke for otolith extraction and examination due to low stock size. American shad that died during electrofishing are retained for otolith analysis, as well as spawning tank mortality from the Nanticoke Hatchery. In addition, American shad otoliths obtained from fish captured in commercial pound and fyke nets from the Maryland portion of the Nanticoke River are removed by MD DNR personnel and sent to the Delaware Division of Fish and Wildlife to estimate the proportion of hatchery-reared juveniles that have returned as adults to the upper Nanticoke River and Deep Creek to spawn. The nets are typically sampled at least once per week from late February through April. This increase in the sample size (from MD DNR) has resulted in the detection of marked adult shad in our samples.

% Marked Adults - Nanticoke River, DE

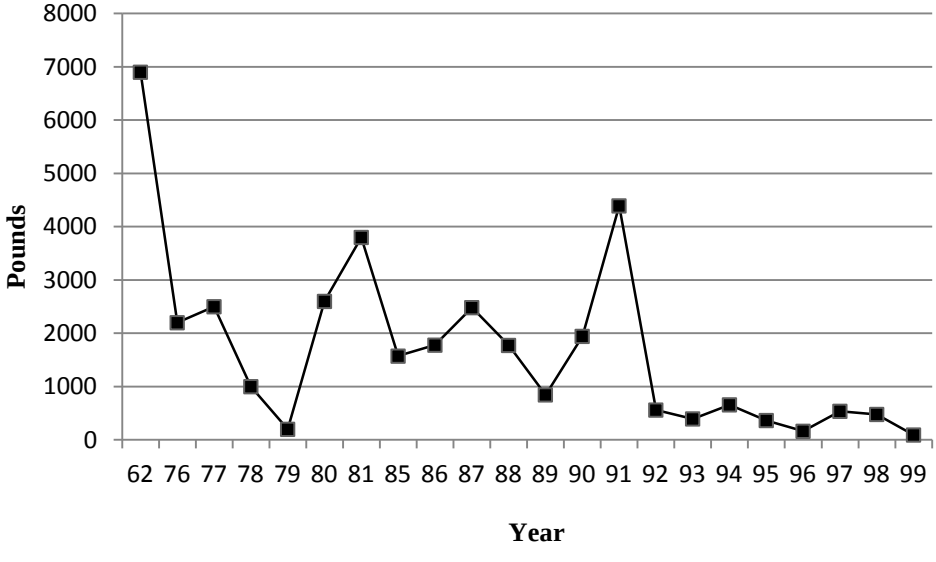
Year	N	% Marked
2005	22	0
2006	10	0
2007*	62	12.9
2008*	40	12.5
2009*	63	20.1
2010*	35	11.4

* - Additional otolith samples provided by MD DNR

b) Fishery Dependent

i. Commercial Fishery

1. Total catch, landings, and effort



Nanticoke River commecial shad landings from the drift gill net fishery in Delaware. The years 1962 through 1981 were based on a canvass survey conducted annually by NMFS port agents. Mandatory reporting by Delaware commercial fishermen began in 1985.

2. Age, size, and sex composition of harvested fish

N/A

ii. Recreational fishery

1. Total catch, landings, and effort or catch per unit effort from a subsample

N/A

c) Bycatch and discards

Two local commercial striped bass fishermen have been issued scientific collection permits to retain any adult shad that died in their gill nets during the striped bass season. The commercial and recreational harvest of striped bass on the Nanticoke River occurred from March 1 to March 31. The early timing of the striped bass season minimizes the impact on adult shad as evidence by the low numbers of shad caught each year as commercial bycatch. The striped bass commercial fishery in 2010 consisted of two watermen.

Striped Bass Bycatch - Nanticoke River

Year	Total
1999	0
2000	2
2001	2
2002	2
2003	0
2004	2
2005	0
2006	0
2007	0
2008	0
2009	0
2010	0
2011	0

3) Fishery Management Program – Summary of our fisheries regulatory program for:

a) Commercial fishery
Closed since 2000.

b) Recreational fishery
Closed to harvest since 2000.

c) Bycatch and discards

There was minimal impact from striped bass fishermen due to the timing of the striped bass season (March 1-March 31) and the low number of commercial striped bass fishermen (2010, N=2) on the Nanticoke River. The dates of peak shad abundance (based on adult CPUE) have typically occurred much later than the commercial striped bass season.

Dates of Shad Peak Abundance

2002	5/2	2007	4/26
2003	5/7	2008	5/1
2004	4/26	2009	5/13
2005	5/6,5/9	2010	4/12
2006	4/26	2011	4/27, 5/6

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Martin O'Malley, Governor
Anthony G. Brown, Lt. Governor
John R. Griffin, Secretary
Joseph P. Gill, Deputy Secretary

Maryland's Fishing/Recovery Plan for American Shad (*Alosa sapidissima*)

Submitted to
Atlantic States Marine Fisheries Commission

Prepared by
Karen M. Capossela and Harry Rickabaugh, Jr.
Maryland Department of Natural Resources
Fisheries Service

kcapossela@dnr.state.md.us
hrickabaugh@dnr.state.md.us

20 July 2011

Introduction

American shad are currently managed under Amendment 3 to Atlantic States Marine Fisheries Commission's (ASMFC) Fishery Management Plan. In order achieve the goals of Amendment 3, current monitoring and regulatory measures for Maryland are described for systems where fishery dependent and independent monitoring is required (the Upper Chesapeake/Susquehanna River, Nanticoke River and Potomac River).

1. Sustainable Fisheries Plan

American shad fisheries will close for states or jurisdictions without an approved sustainability management plan in place by 1 January 2013. Maryland's American shad stocks are currently depleted. Therefore, Maryland will not develop a sustainable fisheries plan for American shad. Commercial and recreational fisheries for American shad are closed in Maryland and will remain closed until stock indicators have increased significantly.

2. Stock Monitoring Programs

a. Fishery Independent

i. Juvenile abundance indices

American shad juvenile indices are derived from the Maryland DNR Estuarine Juvenile Finfish Seine Survey conducted at fixed stations within the upper Chesapeake Bay, the Potomac River and the Nanticoke River. This survey also gathers data from the Choptank and Patuxent Rivers.

ii. Adult stock monitoring

There is no directed adult American shad stock monitoring in the Nanticoke or Potomac Rivers. However, the Maryland DNR Striped Bass Spawning Stock Survey does provide length and sex data and scale samples for adult American shad incidentally captured in the Potomac River during their gill net survey from late March until mid-May. Data availability depends on the continuation of this survey. In addition, the potential for small sample sizes can limit the usefulness of these data to monitor adults in the Potomac River. Data from this survey are not provided for other regions (i.e., the Upper Bay) due to the low number of adult American shad encountered by the gear.

Adult American shad are sampled in the Susquehanna River by hook and line below the Conowingo Dam (tailrace) from mid to late April through late May or early June. Captured American shad are measured to the nearest mm (fork and total length), scales are removed, sex is determined,

and fish are tagged (if in good condition). Scales are cleaned, mounted between two glass slides and read for age and spawning history. Adult fish sampled at the Conowingo Dam tailrace are currently used to examine the following parameters:

1. *Relative or absolute abundance*
   Hook and line geometric mean CPUE are calculated annually.
2. *Age, size, sex composition*
   Length-frequency, age frequency, and sex ratio are examined annually.
3. *Total mortality (where possible)*
   Total instantaneous mortality rate is estimated based on age or repeat spawning marks. The Z calculated for these fish represents mortality associated with repeat spawning.
4. *Upriver and downriver passage efficiencies (where possible)*
   There is no independent estimate of upriver or downriver passage efficiency at the Conowingo Dam. However, turbine mortality is estimated at 25% for fish emigrating back through the Conowingo Dam. A turbine mortality study was planned by the dam owner in 2011, but could not be completed due to high river flow. The study should be conducted in 2012.

iii. Hatchery evaluation

1. *Proportion of hatchery fish present in juvenile or adult populations*
   Adult American shad otoliths are collected from the west lift at the Conowingo Dam (Susquehanna River) and are used to determine the percentage of hatchery fish present (analysis by the Pennsylvania Fish and Boat Commission). The percentage of hatchery fish present in juvenile and adult American shad populations are assessed using electrofishing gear by DNR personnel in the Patuxent and Choptank Rivers. Restocking in the Patuxent River ended in 2008 because this river was considered restored**.** While a small portion of the eggs removed from the Potomac River via broodstock are returned as marked reared larval hatchery fish, Maryland does not conduct a hatchery assessment for American shad in the Potomac River.

b. Fishery Dependent

i. Commercial Fishery

1. *Total catch, landings, and effort*
   The American shad commercial fishery closed in Maryland in 1980. The ocean intercept fishery closed in 2005. Therefore, no catch, landings or effort data are collected.

2. *Age, size, and sex composition of harvested fish*
   Maryland DNR continues to sample commercial fyke and pound nets in the Nanticoke River that were traditionally set for shad in addition to other spring spawning species. No American shad are currently harvested from these nets. Captured American shad are measured to the nearest mm (fork and total length), scales are removed and sex is determined. Scales are later cleaned, mounted between two glass slides and read for age and spawning history.

ii. Recreational Fishery

1. *Total catch, landings, and effort or catch per unit effort from a subsample*
   After closure of the recreational American shad fishery in 1980, Maryland has only permitted a catch and release sport fishery. Maryland DNR conducts a roving creel survey by interviewing anglers during the spawning run below the Conowingo Dam on the Susquehanna River. This survey determines the percentage of anglers that target shad (unspecified species) and the catch of American shad per angler hour in a given year. Maryland DNR also characterizes the spring recreational shad fisheries by distributing logbooks for anglers to report daily catch and effort from which the catch of American shad per angler hour is calculated.

iii. Bycatch and discards

Due to funding and staffing constraints, Maryland is limited to monitoring American shad bycatch through Maryland DNR's fishery dependent survey of commercial pound and fyke nets on the Nanticoke River. Under the current reporting system, there is no mechanism for fishermen to report American shad as bycatch. Commercial fishermen are permitted a 2 fish per day bycatch of dead American shad for personal use (no sale is permitted). Maryland currently estimates commercial pound net discard mortality in the Chesapeake Bay as 4,200 pounds (based on previous pound net surveys conducted by Maryland DNR personnel), and recreational release mortality is unknown. A catch and release study was conducted at the Conowingo Dam in 1997. Mortality of American shad (n=309) in the study was 0.97%. However, no reliable estimates of the number of American shad caught and released are available to estimate total Maryland recreational discard mortality.

3. Fishery Management Program

a. Commercial fishery

The American shad commercial fishery closed in Maryland in 1980. The ocean intercept fishery was closed by ASMFC in 2005.

b. Recreational fishery

The American shad recreational fishery closed in Maryland in 1980. Maryland permits a catch and release sport fishery.

c. Bycatch and discards

According to the Code of Maryland Regulations (08.02.05.05), incidental catch of American shad by commercial fishing gear set for other species must be returned to the water. Not more than two American shad may be possessed for personal consumption if shad are found dead when commercial fishing gear operated for other species is retrieved from the water. Maryland does not currently monitor bycatch (with the exception of limited onboard sampling in the Nanticoke River) due to the small allowable possession limit, resource constraints, and the lack of a mechanism for fishermen to report bycatch in the current reporting system.

STATE RECOVERY PLAN FOR SHAD AND RIVER HERRINGS

The District of Columbia Fisheries & Wildlife Management Division currently has a closure on all directed recreational fisheries for American and hickory shad. The possibility of a limited fishery of one fish per day is being proposed if shad stocks improve.

I. **In-river or Estuarine Fisheries**

A. **Description of In-River Management Areas** (including geographic boundaries)

The management area covered by this report is the tidal Potomac and Anacostia Rivers within the geographical limits of District of Columbia. This includes the Potomac River upstream of the Woodrow Wilson Bridge, and downstream of Chain Bridge. For the Anacostia River it includes the area downstream of the New York Avenue Bridge. Approximately nine stream miles on Rock Creek are also included, along with small stretches of tributaries on either side of the rivers.

B. **Restoration Targets for Stocks** (e.g., spawning run size, population targets, etc.)

Due to the extremely low numbers of shad collected, the Districts Fisheries and Wildlife Division has no specific restoration target number with respect to the numbers of shad required for restoration. However, once shad are regularly encountered during our targeted biological surveys, an estimate will then be made. This estimate will also be facilitated by our fall push-net survey of YOY.

C. **Restoration Target Mortality Rate for Individual Stocks**

No restoration target mortality rate has yet been calculated.

D. **Timeline for Restoration of Individual Stocks**

No restoration time-line has been established.

E. **Management Measures to Achieve Restoration**

1. **Commercial quotas, seasons, gear restrictions**

Presently, there are no commercial, or charter fisheries for American or hickory shad, as well as river herring, within the waters of the District of Columbia.

2. **Recreational possession limits, seasons**

Currently, the fisheries for American and hickory shad are closed. There is no regulation on the recreational possession of river herring, but a closure is proposed for 2011.

I. **In-river or Estuarine Fisheries**

E. **Management Measures to Achieve Restoration (cont.)**

3. **Hatchery programs**

In 2003 DDOE began construction of an addition to their Aquatic Resources Education Center. This expansion is being fitted with facilities for hatching eggs collected from locally caught shad. Gillnetting efforts yielded adult American shad that were strip spawned and eggs were hatched out in the facility. Hatchery efforts in 2010 resulted in 2,072,411 American Shad fry released into the Anacostia River. These fish were chemically marked OTC to determine hatchery versus wild fish.

4. **Other programs** (habitat improvement, fish passage, etc.)

The Division is actively cooperating with the Woodrow Wilson Bridge Project to remove or mitigate all of the physical barriers to upstream passage of anadromous and resident fish in Rock Creek. In 2003 the initial work was begun to mitigate, either through removal or modification, each of the eight in-stream blockages to fish passage. Currently, all of the blockages have been mitigated and spawning alosines have had access to all of the 32 stream miles within Rock Creek since 2008.

In the spring of 2008 additional backpack shocking sites in Rock Creek were added in an effort to evaluate the usage of the newly constructed fish ladder at Pierce Mill dam. To date no adult river herring have been observed upstream of the fish ladder.

II. **Ocean-intercept Fisheries**

There are no ocean waters under the District of Columbia's jurisdiction.

MARYLAND - VIRGINIA
"Potomac River Compact of 1958"

Potomac River Fisheries Commission
222 Taylor Street
P.O. BOX 9
Colonial Beach, Virginia 22443
TELEPHONE: (804) 224-7148 · (800) 266-3904 · FAX: (804) 224-2712

January 10, 2012

MEMORANDUM

TO: Michelle Duval, Chair, Shad and River Herring Management Board,
Larry Miller, Chairman, Shad and River Herring Technical Committee,
Kate Taylor, ASMFC Coordinator, Shad and River Herring Management Plan

FROM: A.C. Carpenter, Potomac River Fisheries Commission, Representative, Shad and River Herring Management Board

SUBJECT: Request for a slight increase in a limited commercial by-catch allowance of American shad in the Potomac River beginning in 2012.

This proposal is being re-submitted to the ASMFC Shad and River Herring Management Board and Shad and River Herring Technical Committee as requested by the Board at their 2011 Annual Meeting. The revised PRFC American Shad Fishing/Recovery Plan is being submitted separately, as requested.

Please accept PRFC's request for a slight increase in our limited commercial by-catch allowance of American shad beginning in 2012, as described in the attached report. The PRFC is requesting that the ASMFC Shad and River Herring Management Board review and approve this proposal at its February 2012 meeting.

Proposal for an increase in a limited commercial by-catch allowance of American shad for 2012

The PRFC requests your approval for a slight increase in an American shad limited commercial by-catch allowance beginning in 2012.

This proposal maintains the mandatory daily harvest reporting program with the fishermen on the Potomac River, in which they record daily harvest, effort and discard data. The continuation of this data collection enhances the long term data set that the PRFC maintains, updates and utilizes to monitor the progress of the American shad stock rebuilding and recovery in the Potomac River. The mandatory daily harvest reporting program on the Potomac was modified in 1999 to include information on by-catch and value. The fishermen are required to estimate the amount of fish, by species, discarded or released and record it in one of three categories: no market, too small, or closed season. With this discard data, the PRFC now has the capability of estimating total catch (harvest + discard) for those species that have by-catch limits, such as American shad.

Since the American shad fishery was closed in 1982, the PRFC has been working with the ICPRB, MD DNR, VDGIF, DC Fisheries, USFWS, the Virginia Institute of Marine Science (VIMS) and many others to improve the river and assist in the recovery of the American shad in the Potomac River. We have had millions of shad fingerlings stocked, the Little Falls Dam fish passage was reconstructed, the reappearance of large beds of tidal fresh water SUVs, and maintained the by-catch harvest database. The number of adult shad has increased substantially and juvenile shad abundance has climbed, as illustrated in the Maryland YOY indices (Figure 2). In addition, as noted earlier, American shad from the Potomac River are being used as a source of brood stock for shad restoration in Virginia, Maryland and Delaware.

The PRFC worked VIMS to finalize the American Shad Stock Assessment by comparing the geometric mean (GM) of some Potomac River historical pound net CPUE data with the GM of more recent CPUE pound net data (Figure 1). The GM of the 1940's and 1950's pound net data was 31.1 pounds per net-day; however the GM for the five year period before the fishery closure (1976-80) was only 3.0 pounds per net-day (Figure 1 and Table 2). Since 1999, we have been using the total pound net data (harvest + discards, because the total catch was deemed comparable to the 1944 – 52 period – with no harvest restrictions – as opposed to today's regulations – a one bushel by-catch limit) to determine the CPUE and calculate the GM of the time series (1999 +) each year.

The ASMFC Shad and River Herring Management Board accepted the 2007 Shad Stock Assessment Report, which included the Potomac River benchmark. This benchmark goal of 31.1 became the restoration target for the Potomac River. We have been steadily approaching this goal over time. The GM was

calculated for CPUEs of total pound net data for the years 1999 – 2011, and for the first time the GM exceeded the benchmark goal and restoration target with a value of 32.0 pounds per net-day. The GM has increased every year since 2002, so achieving the target in 2011 was not unexpected. The PRFC has reported this information in the annual compliance report every year.

We are not proposing to reopen the fishery at this time. We are, however, proposing a slight increase from a one bushel to a two bushel by-catch allowance in the commercial pound net and gill net fisheries. We see this as a chance to convert more dead discards into harvest, and eliminate unnecessary waste of this resource. This action would not increase effort in these fisheries because both fisheries are limited entry. Even if we double the commercial by-catch harvest, it would still be significantly lower than the removals from the Potomac River for American shad brood stock takes and resulting mortalities. We have met and exceeded the ASMFC approved benchmark goal/restoration target for the Potomac River as set in the 2007 stock assessment.

Future Plans

The PRFC does not yet consider the American shad stock fully "recovered" in the Potomac River. If the GM falls below the target, then the regulations will automatically revert to the existing one-bushel by-catch allowance and we will curtail brood stock harvest, while maintaining the reporting and monitoring programs currently in place. Any future regulation changes will be submitted for approval prior to implementation.

Table 1

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	0	2,015	450					2,465

Table 2

Geometric Mean (GM) of Pound Net CPUE Data												
Time Series	44-52	76-80	99-02	99-03	99-04	99-05	99-06	99-07	99-08	99-09	99-10	99-11
GM	**31.1**	3.0	8.1	13.1	13.6	16.3	19.6	21.3	23.8	28.1	30.2	**32.0**

Figure 1

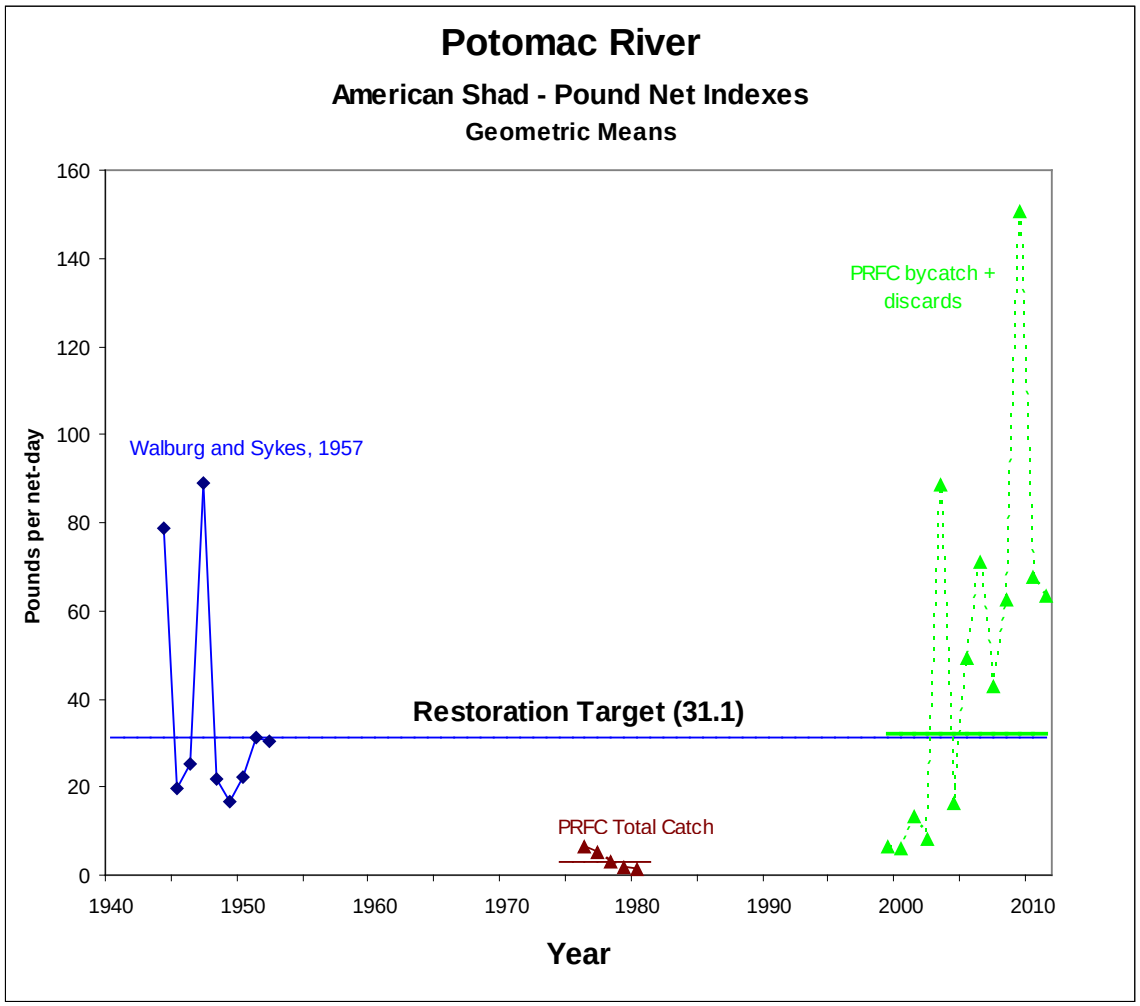
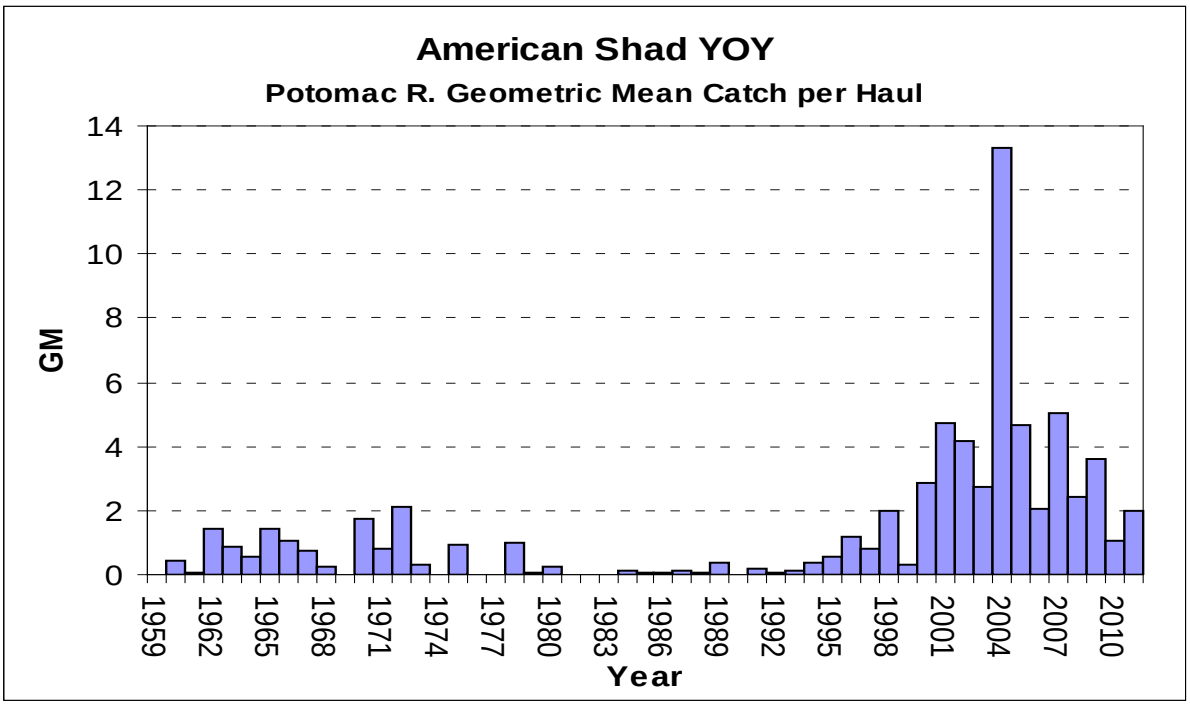


Figure 2


American Shad YOY
Potomac R. Geometric Mean Catch per Haul
GM
14
12
10
8
6
4
2
0
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
Year

Please refer to the Atlantic Herring Section briefing material for a copy of NEFMC Draft Amendment 5 to the Atlantic Herring FMP