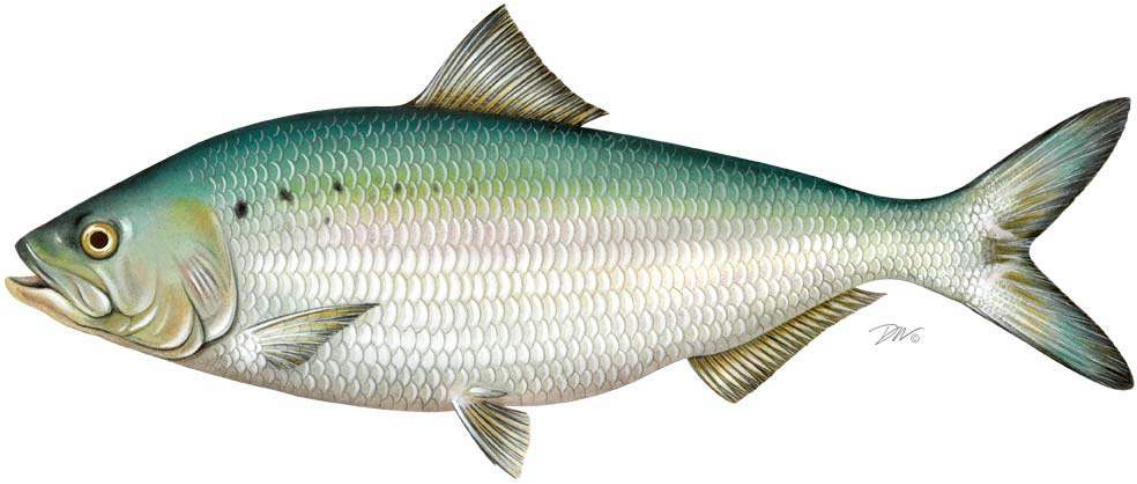
Pennsylvania Fish and Boat Commission

American Shad Habitat Plan



Submitted to the Atlantic States Marine Fisheries Commission as a requirement of Amendment 3 to the Interstate Management Plan for Shad and River Herring

Approved February 6, 2014

Pennsylvania

Susquehanna River Habitat Plan

Submitted to:
Atlantic States Marine Fisheries Commission
to fulfill the requirements of Amendment 3 to the
Interstate Fishery Management Plan for Shad and River Herring

August 1, 2013

Submitted for the:

Susquehanna River Anadromous Fish Restoration Cooperative

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I. AMENDMENT 3 REQUIREMENTS

Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring requires states to develop habitat plans for American shad, focusing on threats that are deemed most significant. The Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) has determined that the most significant threats to American shad are **barriers to migration** and **water quality**. We will focus on these threats in the remainder of this plan. Specific Amendment 3 requirements can be found beginning on page 42 as quoted below:

6.2. Habitat Plans

The following is the recommended framework for the Habitat Plan. The Management Board should task the Technical Committee to review, modify as needed, and approve this framework. This outline is designed to be an inclusive framework for organizing information on habitat, and threats to that habitat. As such, it is likely that data may not yet be available for some items. In those cases, states and jurisdiction should indicate data status (e.g., not available, being collected, being analyzed, under review).

1) **Habitat Assessment** – Assess the habitat (historic and currently available) and impediments to full utilization of the habitat.
   a. Spawning Habitat
      i. Amount of historical in-river and estuarine spawning habitat (e.g., river kilometers, water surface area (hectares)).
      ii. Amount of currently accessible in-river and estuarine spawning habitat (i.e., habitat accessible to adult fish during the upstream spawning migration).
   b. Rearing Habitat
      i. Amount of historical in-river and estuarine young-of-year rearing habitat (e.g., river kilometers, water surface area (hectares)).
      ii. Amount of currently utilized in-river and estuarine young-of-year rearing habitat (i.e., habitat available to larval stage and young-of-year fish through natural spawning or artificial stocking of hatchery reared juvenile fish).

2) **Threats Assessment** – Inventory and assess the critical threats to habitat quality, quantity, access, and utilization (see - *Appendix C* for a detailed habitat description). For those threats deemed by the state or jurisdiction to be of critical importance to restoration or management of an American shad stock, the state or jurisdiction should develop a threats assessment for inclusion in the Habitat Plan. Examples of potential threats to habitat quality, quantity, and access for American shad stocks include:
   a. Barriers to migration inventory and assessment
      i. Inventory of dams, as feasible, that impact migration and utilization of historic stock (river) specific habitat. Attribute data for each dam should be captured in an electronic database (e.g., spreadsheet) and include: name of dam, purpose of the dam, owner, height, width, length, impoundment size, water storage capacity, location (i.e., river name, state, town, distance from river mouth, geo-reference coordinates), fish passage facilities and measures implemented (i.e., fish passage type, capacity, effectiveness, and operational measure such as directed spill to facilitate downstream passage), and information source (e.g., state dam inventory).

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ii. Inventory of other human–induced physical structures (e.g., stream crossing/culverts), as feasible, that impact migration and utilization of historic habitat (data on each structural impediment should include: type, source, and location).
iii. Inventory of altered water quality (e.g., low oxygen zones) and quantity (e.g., regulated minimum flows that impact migration corridors and/or migration cues), as feasible, impediments that impact migration and utilization of historic habitat (data on each water quality and quantity impediment should include: type, source, location, and extent).
iv. Assess barriers to migration in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.

b. Water withdrawals inventory and assessment
   i. Inventory of water withdrawals (both permitted and known unpermitted), as feasible, that impact or have the potential to impact (e.g., fish entrainment and impingement, instream habitat alteration, and/or alteration of instream flow) migration and utilization of historic habitat.
   ii. Assess water withdrawals in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.

c. Toxic and thermal discharge inventory and assessment
   i. Inventory of toxic and thermal discharge of water, where applicable, that impact or have the potential to impact (e.g., create a barrier, lethal concentration, and/or reduce fitness) migration and utilization of historic habitat.
   ii. Assess toxic and thermal discharge in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.

d. Channelization and dredging inventory and assessment
   i. Inventory of channelization and dredging projects, as feasible, that impact or have the potential to impact (e.g., create a barrier, degrade substrate, and/or reduce water quality) migration and utilization of historic habitat.
   ii. Assess stream channelization and dredging in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.

e. Land use inventory and assessment
   i. Inventory of land use in the watershed that impact or have the potential to impact (e.g., alter run-off regimes, degrade riparian habitat, increase siltation, reduce water quality and/or diminish riparian buffers) migration and utilization of historic habitat.
   ii. Assess land use in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.

f. Atmospheric deposition assessment
   i. Assess atmospheric deposition in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.

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g. Climate change assessment
    i. Assess potential climate change impacts in the watershed and characterize their impact on American shad migration and utilization of historic habitat.
h. Competition and predation by invasive and managed species assessment
    i. Assess competition and predation by invasive and managed species in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.

3) **Habitat Restoration Program** – For threats deemed to be of critical importance to the restoration and management of American shad stocks within its jurisdiction, each state or jurisdiction should develop a program of actions to improve, enhance and/or restore habitat quality and quantity, habitat access, habitat utilization and migration pathways. These programs may include plans to take direct corrective actions within the state or jurisdictions' authority, or to consult with agencies that have management authority over the threat, inform them of the impacts the threat is having on American shad stocks, and recommend potential alternatives or corrective actions to alleviate that threat. Section 5.5 Habitat Restoration, Enhancement, Utilization, and Protection Recommendations should be consulted for potential actions that could be included in the Habitat Restoration Program. While this amendment proposes the development of such programs, the implementation of these programs is not required. Programs could include:

a. Barrier removal and fish passage program – Develop a program to eliminate, minimize, or mitigate impacts from barriers identified in 2 (a) above.
b. Hatchery product supplementation program – Consider the stocking of hatchery reared larvae or juveniles to spawning or rearing habitat that is underutilized due to migration barriers or to new habitat following barrier removal.
c. Water quality improvement program - A program should be developed to address identified impacts of poor water quality to spawning success and juvenile recruitment in 2 (b) and (c) above.
d. Habitat improvement program - A program should be developed to address identified impacts to habitat in 2 (d) and (e) above and to protect quality habitat.
e. Project permit/licensing review program for water withdrawals, toxic and thermal discharge, channelization and dredging, and land use and development, that includes development of recommendations and conditions to avoid, minimize, or mitigate associated impacts to American shad migration and utilization of historic habitat - A program should be developed to identify, review, assess, and comment or condition permitted/licensed development projects that could impact aquatic habitat or restoration efforts
f. Programs to avoid, minimize, or mitigate associated impacts to American shad migration and utilization of historic habitat from atmospheric deposition and climate change – Atmospheric deposition and climate change may impact restoration efforts and will need to be addressed through cooperative engagement with the public and regulatory bodies that can influence positive change, or

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eliminate/diminish the identified impacts. It is recommended that a program be developed to engage in the public debate and/or regulatory actions in order to attain full consideration of impacts of atmospheric deposition and climate change on American shad habitat and restoration efforts. It is also recommended that the ASMFC should consider developing a plan to engage as a unified body in the atmospheric deposition and climate change debate, and formulate a position statement on future action by regulatory agencies that address the identified impacts.

II. THE SUSQUEHANNA RIVER SHAD RESTORATION PLAN

The SRAFRC Policy Committee approved the **"Migratory Fish Management and Restoration Plan for the Susquehanna River Basin"** on November 15, 2010. A Powerpoint presentation on this plan was given to the ASMFC Shad and River Herring Technical Committee at the September, 2011 meeting. The plan was very well received with several state representatives asking for copies to use as a template for their own plan. Because of the many habitat focused tasks, it was even suggested that this plan could be used as our submission to ASMFC to fulfill the requirements as a Habitat Plan. The Susquehanna plan was three years in the making and ultimately required four word-by-word revisions. As such, adoption of a separate "Habitat Plan" for ASMFC would require similar effort and Policy Committee approval. More importantly, the net result would be the existence of two approved plans with different formats. SRAFRC believes the habitat related tasks in its restoration plan adequately address habitat issues that are within its jurisdiction and that a separate habitat plan is unnecessary.

The goal of the Susquehanna restoration is to: "**Restore self-sustaining, robust, and productive stocks of migratory fish capable of producing sustainable fisheries, to the Susquehanna River Basin throughout their historic ranges in Maryland, Pennsylvania, and New York. The goals are 2 million American shad and 5 million river herring spawning upstream of the York Haven Dam. Goals for American eel and other migratory species are yet to be determined."**

The full text of the SRAFRC Shad Restoration Plan can be found at: http://fishandboat.com/pafish/shad/susq/SRAFRC-RestorationPlan.pdf. The plan includes five Objectives and numerous Tasks under each Objective. Two of the Objectives relate to habitat: Objective A - Restore access to historic habitats for juvenile and adult migratory fish; and Objective B- Maintain or improve existing migratory fish habitat. The 20 specific tasks related to habitat are provided below:

Objective A: Restore access to historic habitats for juvenile and adult migratory fish.

This objective calls for development of passage plans and performance measures to achieve specified minimum passage efficiency for American shad, American eels, and other migratory fish species at major basin dams. Specified minimum passage efficiencies are much higher than currently experienced at major Susquehanna River barriers.

> **Task A1:** Develop and implement upstream passage plans and performance measures at all four lower river hydroelectric dams to ensure that each facility passes at least 75 percent of the adult American shad passed at the next downstream facility, or at least 85 percent of the adult American shad reaching project tailwaters. Incorporate upstream passage plans and evaluation requirements in FERC licenses. Recommend or conduct evaluation studies as necessary. Require additional fish passage capacity, as needed, to meet fish passage targets. Report fish passage results annually.
>
> **Priority:** 1
>
> **Implementation:** FERC relicensing, 401 certification, and Susquehanna River

Technical Committee (SRTC) for Conowingo and Fish Passage Technical Advisory Committees for Holtwood, Safe Harbor and York Haven; in cooperation with dam owners.
Status: In conjunction with FERC licensing and compliance.
Cost: SRAFRC-Overhead to be borne by SRAFRC member agencies. Hydro owner costs depend upon measures needed to improve fishway performance to target levels.[1]
Funding: SRAFRC member agencies and Dam Owners.
Lead: Fish Passage Technical Advisory Committees (FPTAC) and SRTC.
Timeline: Upon completion of FERC relicensing in 2014at Conowingo, Holtwood and York Haven dams. Upon agreement with Safe Harbor by 2015.

Task A2: Develop and implement downstream passage plans and measures for adult Alosines at the four lower river hydroelectric dams to ensure at least 80 percent survival at each dam. Incorporate adult downstream passage plans and evaluation requirements in FERC licenses.

Priority: 1
Implementation: Fish passage technical committees for hydroelectric dams (SRTC for Conowingo and FPTAC for Holtwood, Safe Harbor, and York Haven) will meet annually to review and revise (as needed) downstream passage plans and operational measures to maximize survival (FERC requirement).
Status: Ongoing.
Cost: SRAFRC-Overhead to be borne by SRAFRC member agencies. Hydro owner costs depend upon measures needed to improve fishway performance to target levels.
Funding: SRAFRC member agencies and Dam Owners.
Lead: FPTAC and SRTC
Timeline: Upon completion of FERC relicensing in 2014 at Conowingo, Holtwood and York Haven dams. Upon agreement with Safe Harbor by 2015.

Task A3: Develop and implement juvenile downstream passage plans and performance measures at all four lower river hydroelectric dams to ensure 95 percent survival of juvenile alosines at each facility. Incorporate juvenile downstream passage plans and evaluation requirements in FERC licenses. Include operational measures at all

[1] Agency costs will be time and overhead associated with: FERC licensing consultation; assessment of impacts related to hydroelectric project operation; development of protection, mitigation and enhancement (PM&E) terms and conditions; negotiation of agreement with Safe Harbor; and post licensing/agreement compliance verification. Hydroelectric project owner implementation costs are difficult to estimate at this time and would likely be associated with lost generation due to required spillage and/or differentials in generation revenue from turbine shutdowns or restricted operation during the passage season. There may also be capital costs associated with potential installation of fish passage and protection facilities and out year annual operation and maintenance costs for these facilities.

hydroelectric dams as needed to enhance downstream passage survival of juvenile alosines.

Priority: 1
Implementation: FERC relicensing, 401 certification, SRTC for Conowingo and Fish Passage Technical Advisory Committees for Holtwood, Safe Harbor and York Haven; in cooperation with dam owners.
Status: In conjunction with FERC licensing and compliance.
Cost: SRAFRC-Overhead to be borne by SRAFRC member agencies.
Hydro owner costs depend upon measures needed to improve fishway performance to target levels.
Funding: SRAFRC member agencies and Dam Owners.
Lead: FPTAC and SRTC
Timeline: Upon completion of FERC relicensing in 2014 at Conowingo, Holtwood and York Haven dams. Upon agreement with Safe Harbor by 2015.

Task A4: Develop and implement upstream passage plans at FERC-licensed dams to ensure adequate passage of American eels. Incorporate upstream passage plans and evaluation requirements in FERC licenses. Recommend or conduct evaluation studies as necessary. Report eel passage results annually.

Priority: 1
Implementation: FERC relicensing, 401 certification, and SRTC for Conowingo and Fish Passage Technical Advisory Committees for Holtwood, Safe Harbor and York Haven; in cooperation with dam owners.
Status: In conjunction with FERC licensing and compliance.
Cost: SRAFRC-Overhead to be borne by SRAFRC member agencies.
Hydro owner costs depend upon measures needed to implement fish passage and meet target levels. Measures for upstream eel passage cost much less compared to those for other species.
Funding: SRAFRC member agencies and Dam Owners.
Lead: FPTAC and SRTC
Timeline: Upon completion of FERC relicensing in 2014 at Conowingo, Holtwood and York Haven dams. Upon agreement with Safe Harbor by 2015.

Task A5: Develop and implement downstream passage plans and performance measures for silver eels at FERC-licensed dams to ensure at least 85 percent survival at each hydroelectric development. Incorporate downstream passage plans and evaluation requirements in FERC licenses, 401 certifications, and other regulatory proceedings and settlement agreements. Establish operational measures at all FERC hydroelectric projects, to ensure survival of silver eels passing downstream. Where needed require installation of fish passage facilities and associated measures.

Priority: 1
Implementation: During FERC relicensing, 401 certification, and during annual consultations with the SRTC for Conowingo and FPTAC for Holtwood, Safe Harbor and York Haven in cooperation with dam owners.
Status: Ongoing in conjunction with FERC re-licensing and annual fish passage review and consultation.

Costs: SRAFRC-Overhead to be borne by SRAFRC member agencies.
Hydro owner costs depend upon measures needed to implement fish passage and meet target levels.
Funding: SRAFRC agencies and Project Owners.
Lead: SRAFRC and the FPTAC and SRTC.
Timeline: Upon completion of FERC relicensing in 2014 at Conowingo, Holtwood and York Haven dams. Upon agreement with Safe Harbor by 2015.

Task A6: Develop targets for upstream passage of migratory fish at all non-FERC licensed dams.

Priority: 3
Implementation: SRAFRC Technical Committee with input from water development project owners, and water resource regulators.
Status: Ongoing.
Cost: SRAFRC-Overhead to be borne by SRAFRC member agencies.
Dam owners- minimal costs for participation in planning process.
Funding: Resource agencies.
Lead: SRAFRC
Timeline: When migratory fish are detected at the project.

Task A7: Provide adequate upstream passage (safe, timely, effective, and efficient) for migratory fish at all non-FERC licensed dams.

Priority: 3
Implementation: Water development project owners, and water resource regulators.
Status: Ongoing.
Cost: SRAFRC-Overhead to be borne by SRAFRC member agencies. Dam Owners- unknown, several thousand to one million dollars per site, depending on site characteristics.
Funding: Water development owners, resource agencies, National Fish and Wildlife Foundation, NOAA, and non-governmental organizations.
Lead: SRAFRC agencies.
Timeline: Within four years of when migratory fish are detected at a project.

Task A8: Develop and update, as needed, fishway and migratory fish protection operating plans for non- FERC-licensed water resource development projects.

Priority: 3
Implementation: Convene a meeting of the SRAFRC TC and appropriate experts to develop a technical guide for use by water developers and regulatory agencies.
Status: Approximately 10 existing fishways do not have operating plans.
Costs: SRAFRC- Overhead to be borne by SRAFRC member agencies.
Dam owners - minimal, participation in planning process.
Funding: Resource agencies and water developers.
Lead: SRAFRC
Timeline: Issue guidance by 2012 (One day meeting and follow up drafting/editing of guidance document).

Task A9: Minimize delays at fishways to foster adult spawning fish migration to the upper limits of historical spawning habitat in the watershed.

Priority: 1
Implementation: Review of passage effectiveness at dams and other blockages. For FERC-licensed dams this will occur during upcoming licensing and compliance proceedings.
Cost: SRAFRC **-**Overhead to be borne by SRAFRC member agencies. Dam Owners **-** unknown, several thousand to one million dollars, depending on site characteristics.
Funding: Water project developers and resource agencies.
Lead: SRAFRC
Timeline: For FERC licensed dams, by 2014. For non-FERC projects upon agreement with dam owner and availability of funding.

Task A10: Advocate free-flowing streams (dam / barrier removal) as a preferred alternative to reconstruction of damaged or unneeded dams, and encourage regulatory agencies to require fish passage at any new or rebuilt dams.

Priority: 1
Implementation: Convene a meeting of the SRAFRC TC and appropriate experts to develop a position statement with supporting documentation. Participate in project permit review process and public hearings. Establish new fish passage advisory committees, as needed, including USFWS, PFBC, NYSDEC, MDNR, Pennsylvania Department of Environmental Projection (PA DEP), U.S. Army Corps of Engineers (USACE), and SRBC.
Status: Ongoing.
Cost: SRAFRC- Overhead to be borne by SRAFRC member agencies.
Funding: SRAFRC partners
Lead: SRAFRC
Timeline: Position statement by 2012. Permit review process ongoing.

Task A11: Complete fish passage facilities at both the east and west sides of the inflatable dam at Shikellamy State Park in Sunbury, PA. The confluence of the West Branch and mainstem Susquehanna River occurs just upstream of the inflatable dam. As a result, water flowing from the West Branch tends to hug the west shore and water flowing from the Susquehanna River tends to hug the east shore downstream from the inflatable dam. Thus, anadromous fish homing to the West Branch will migrate up the west shore of the Susquehanna River and concentrate on the west side of the inflatable dam. Conversely, fish homing to the Susquehanna River will concentrate on the east side of the inflatable dam. Passage facilities and measures at the inflatable dam need to ensure that migratory anadromous fish homing to both the West Branch and mainstem Susquehanna River can pass in a safe, timely, and effective manner.

Priority: 1
Implementation: PA Department of Conservation and Natural Resources (PA DCNR), Bureau of State Parks owns and operates the inflatable dam for recreational boating. PA DCNR, PFBC, USFWS, and SRBC have participated on

the Shikellamy Shad Advisory Committee (SSAC). Maintain contact with DCNR and local legislators to ensure adequate funding is available to complete these projects. Revive the SSAC to facilitate implementation, monitoring, and oversight of fish passage.

Status: Design and modeling contract was let by Pennsylvania DGS in late 2001 for construction of vertical slot fishway on the East bank capable of passing 500,000 American shad. Construction bids exceeded available funds. Construction has been delayed due to escalating costs and insufficient funds. In 2007, discussions were renewed and in 2008, PA
DCNR agreed to obtain a cost estimate for a "nature-like" fishway consisting of a rock-lined channel going around the existing dam structure on the west bank. In 2009, authorization was received by the design consultant to formulate plans for a nature-like bypass channel fishway. Design was completed in 2010.

Cost: SRAFRC- Overhead to be borne by SRAFRC member agencies.
DCNR- $4.5 million for West side by-pass, $9 million for East side vertical slot fishway.

Funding: Commonwealth of Pennsylvania ($4.5 million committed for west bank fishway; east bank fishway currently unfunded.).

Lead: SRAFRC

Timeline: West bank, 2012. East bank, when funding is secured.

Task A12: Reconstruct the existing, ineffective fish ladder at Pennsylvania Department of Conservation and Natural Resources (PA DCNR) owned Hepburn Street Dam on the West Branch Susquehanna River at Williamsport according to the design plan developed by the USFWS in 2009.

Priority: 2

Implementation: SRAFRC in cooperation with the PA DCNR.

Status: The dam is owned by the PA DCNR and operated by Bureau of Forestry. A final design and an opinion of probable construction cost for a fishway upgrade were completed in 2009 by an engineering firm under contract to the USFWS. Additional funding will be needed for construction and implementation of improved fish passage.

Costs: Staff resources to investigate and secure funding. Permitting and construction costs $5.9 million.

Funding: Seeking funding from state and federal grants and appropriations.

Lead: SRAFRC and PA DCNR.

Timeline: Anticipate fund raising initiative in 2012, construction in 2014.

Task A13: Construct a fishway at the Grant Street Dam on the West Branch Susquehanna River in Lock Haven according to the new design plan developed by the USFWS in 2009.

Priority: 2

Implementation: SRAFRC in cooperation with the City of Lock Haven, PA.

Status: City of Lock Haven, PA owns and operates the Grant Street Dam. A final design and an opinion of probable construction cost for a fishway were completed

in 2009 by an engineering firm under contract to the USFWS. Additional funding will be needed for construction and implementation of improved fish passage.
Costs: Staff resources to investigate and secure funding. Permitting and construction costs $1.5 million.
Funding: Funding is needed to construct Grant Street fishway. Seeking funding from state and federal grants and appropriations.
Lead: SRAFRC in cooperation with the City of Lock Haven, PA.
Timeline: Anticipate fund raising initiative in 2012, construction in target 2014.

Task A14: Construct a fishway at the First Quality Tissue paper mill dam on Bald Eagle Creek, Mill Hall, PA.

Priority: 1
Implementation: SRAFRC and PFBC in cooperation with the City of Lock Haven, PA.
Status: First Quality Tissue, LLC owns and operates a dam at Mill Hall, PA on Bald Eagle Creek a major tributary to the West Branch Susquehanna River. A final design and an opinion of probable construction cost for a fishway were completed in 2009 by an engineering firm under contract to the USFWS. Funding is currently in place through a congressional appropriation to the USFWS Partner for Fish and Wildlife Program, and a subsequent grant to the PFBC for construction and implementation of fish passage. The PFBC contracted with First Quality Tissue, LLC in 2010 to build the fishway. Construction is expected to be complete in fall 2011.
Costs: Staff resources to implement funding logistics and review installation of the fishway. Permitting and construction costs $600,000.
Funding: Funding already available to build Bald Eagle Creek fishway.
Lead: SRAFRC, USFWS, PFBC and First Quality Tissue, LLC.
Timeline: Construction of the new fishway is expected to be complete in fall 2011.

Task A15: Implement fish passage at three Susquehanna River dams in New York State.

Priority: 3
Implementation: Complete formal designs and cost estimates for construction of Denil and/or "Nature-like Fish Passage Channels" at all three dams. Evaluate cost and projected effectiveness of both designs to determine which plan is to be implemented. Owners of both dam are potentially interested in creating a whitewater recreation facility at both of these dams so fish passage plans will need to be sensitive to this possibility. A fish passage design is also needed for a third dam, formerly known as Goudey Station Dam, on the Susquehanna River at Binghamton but nothing has been done to date. Goudey Station Dam poses a fish passage barrier under "normal" early summer flows but is passable under higher flows.
Status: USFWS fish passage designers are expected to provide conceptual plans and preliminary cost estimates for Denil fish ladders at both Rockbottom Dam on the Susquehanna River and Chase-Hibbard Dam on the Chemung River by January 2011. Funding is needed to develop final designs and an opinion of

probable construction cost for construction of "nature-like" fish passage channels at both of these dams. Funding is also required to develop plans for Goudey Station Dam.
Cost: Design (Nature-like Passage Channels) - $10,000-$30,000 each
Construction - $300,000 each
Funding: Unfunded
Lead: SRAFRC / NYSDEC
Timeline: All designs completed by January 2013. Funding secured for construction by 2015. Construction completed at all three dams by 2018.

Task A16: Provide for adequate fish passage at Oakland Dam in Susquehanna County Pennsylvania.

Priority: 2
Implementation: SRAFRC to work with FERC, the dam owners, and interested parties to ensure adequate fish passage at the site.
Status: A powerhouse was installed at this dam in 1982 via a FERC license exemption. Fish passage was to be addressed as part of the FERC order. A fish ladder was installed in the middle of the dam, but was not designed to accommodate migratory fish passage needs, and was never tested for effectiveness for resident riverine fish passage. Fish entrainment and turbine passage impacts were never adequately addressed regarding safe downstream passage of fish. The powerhouse was damaged by floodwater in 2000 and has been offline since then. The fish ladder structure failed in 2007 resulting in a partial breach of the dam. The FERC exemption was transferred to River Bounty and it is attempting to develop plans and secure financing to repair the dam, install fish passage, and put the power station back online. River Bounty has consulted with PFBC and USFWS regarding fish passage needs, and the agencies are assessing existing and future fish passage at the site. In the current breached condition, upstream fish passage may be adequate for larger fish species at some river flows, but the breach does not appear to allow passage of all fish. Fish entrainment in turbines is not currently a problem due to the powerhouse being offline. If the dam is repaired, and the station put back in service, adequate fish passage facilities and measures will be required.
Costs: Agency staff resources to work with FERC, the dam owners, and interested parties to ensure adequate fish passage is implemented at the site. Capital, operation and maintenance costs for fish passage are unknown at this time.
Funding: SRAFRC partner agencies for the consultation and the dam owner/hydro project operator for capital, operation and maintenance costs for fish passage.
Lead: SRAFRC, PFBC, and USFWS.
Timeline: Upon agreement with dam owner or via FERC process. FERC decision on dam status expected by 2012.

Objective B: Maintain or improve existing migratory fish habitat.

This objective focuses on essential habitat issues by inventorying blockages and assessing the impact of fish passage impediments through active involvement of SRAFRC in watershed project reviews while supporting monitoring and improving water quality.

Task B1: Inventory tributary blockages, assess quantity and location of habitat, set priorities, and reopen blocked habitat for migratory fish through dam removals and fish passage development.

Priority: 3
Implementation: MDDNR, PFBC and NYSDEC in respective waters.
Status: Numerous barrier removals and passage projects have been completed with additional removals proposed and planned. Some dam removals already completed or proposed within the Maryland, Pennsylvania and New York portions of the Susquehanna Basin. A blockage inventory was completed in 2009 for New York portions of the Basin. A blockage inventory is also complete in Maryland. In Pennsylvania, a blockage inventory is completed on Susquehanna River tributaries up to, but not including, the Juniata River.
Cost: SRAFRC-Inventory: $50,000. Dam Owner-Removal or fish passage construction unknown, varies site to site.
Funding: ASMFC, CBP and others.
Lead: SRAFRC
Timeline: Inventory: 2015. Removal or fish passage: upon agreement with owner and securing funding.

Task B2: Assess and mitigate the impacts of hydroelectric projects and their operation on migratory fish spawning and rearing habitat within the project area immediately downstream and upstream of the project.

Priority: 1
Implementation: Impacts to migratory fish spawning and rearing habitat associated with the construction and operation of the hydroelectric project will be assessed during FERC licensing and compliance proceedings at each project. When impacts are identified, appropriate protection, mitigation and enhancement measures will be developed to avoid, minimize, or mitigate these impacts. Recommend/require that appropriate measure be implemented through agreement or regulatory measures.
Status: Ongoing via FERC licensing.
Costs: Staff resources to work with FERC, the dam owners, and interested parties to ensure adequate migratory fish habitat protection, mitigation and enhancement measures will be implemented at each project. Capital, operation and maintenance costs for fish habitat measures are unknown at this time.
Funding: SRAFRC member agencies for assessment and development of mitigation measures and hydropower developers for capital and operation and maintenance costs for fish habitat, protection, mitigation and enhancement measures.
Lead: SRAFRC member agencies

Timeline: Assessment of impacts and development of mitigation measures 2010-2012. Implementation of mitigation upon completion of FERC relicensing in 2014 at Conowingo, Muddy Run, Holtwood and York Haven hydroelectric projects, and upon agreement with Safe Harbor.

Task B3: Advocate avoidance, minimization, or mitigation of impacts to migratory fish migration, spawning, rearing, or habitat associated with construction, maintenance and operation of dams or other developments that require agency consultation, a permit, or license.

Priority: 1
Implementation: Participate in project permit/license consultation and review process, and associated public hearings. Establish permanent or ad hoc SRAFRC advisory committees, as needed to engage in permit and licensing proceedings.
Status: Ongoing, as needed.
Costs: SRAFRC-Overhead to be borne by SRAFRC member agencies.
Capital and operation and maintenance costs for fish habitat measures are unknown at this time and would be borne by the project proponent.
Funding: SRAFRC, project permit/licensee applicant, project sponsor and affected resource agencies.
Lead: SRAFRC member agencies.
Timeline: As needed.

Task B4: Advocate Policy level actions that maintain existing designated uses and support additional water quality improvements within the Susquehanna River Basin.

Priority: 1
Implementation: States and EPA are required to maintain water quality for designated uses under the Clean Water Act. EPA is developing a Total Maximum Daily Load (TMDL), or "pollution diet" for the Chesapeake Bay, and is also requiring states to develop and execute Watershed Implementation Plans under the Chesapeake Bay TMDL. The Chesapeake Bay TMDL will benefit both the bay and local watersheds in the Susquehanna River Basin. Maintenance and improvement of water quality by state, federal, local, and private interests is also addressed under SRBC's Comprehensive Plan for the Water Resources of the Susquehanna River Basin.
Status: State and local water quality activities are ongoing. The Chesapeake Bay TMDL is scheduled for completion by the end of calendar year 2010. SRBC's comprehensive plan was updated in 2008.
Costs: SRAFRC overhead to be borne by SRAFRC member agencies.
The total amount of funding for activities conducted by state, federal, local, and private entities has not been determined, and will depend on the magnitude of water quality improvements required under the Chesapeake Bay TMDL and state Watershed Implementation Plans.
Funding: Water developers, state and federal agencies.
Lead: States and EPA.
Timeline: Ongoing with the Chesapeake Bay TMDL to be completed in calendar year 2010.

III. WATER QUALITY

In the early years of the American shad restoration effort, larval shad survival was phenomenal, with some cohorts requiring stocking of less than 100 larvae to recruit one adult shad to the fish lifts at Conowingo Dam (Hendricks 2013). Not only was shad survival high, but growth was also outstanding, with some YOY out-migrants reaching 250 mm total length (TL). The American shad restoration effort was poised for success, with Conowingo fish lift catches doubling every five years, culminating in the passage of over 190,000 adult American shad in 2001 (Figure 1). Unfortunately, after 2001, coast-wide shad populations declined and the shad lift catch at Conowingo crashed. The cause of this crash has been speculated to be due to increased fishing mortality as bycatch in ocean fisheries; principally the Atlantic herring or the squid, mackerel, butterfish fishery. In addition to decreased numbers of returning adults, survival of hatchery-reared larval shad was high through 2001 (Figures 2 and 3) but has declined since that time and has remained low despite improvements in hatchery techniques. Similar decreases in survival and recruitment of juvenile smallmouth bass have also been documented in the same reaches of the Susquehanna River suggesting that Susquehanna River Basin-specific factors are also contributing to the declines in Susquehanna River stocks of American shad.

Beginning in 2005, wide-scale mortality of YOY smallmouth bass was documented during mid-July and early-August. Dead and moribund smallmouth bass usually displayed lesions caused by opportunistic bacterial infections. Since 2005, annual disease-related mortality events have occurred among YOY smallmouth bass populations in the Susquehanna River and large tributaries but they have varied in prevalence both spatially and temporally (Figure 4). The middle Susquehanna River (Sunbury, PA – York Haven, PA) has been most impacted by decreased survival of YOY smallmouth bass and subsequent recruitment as a result of disease. Relative abundance of YOY smallmouth bass (CPUE, fish/ 50 m) within this reach have consistently fallen below the long-term median for this reach (Figure 5) despite hydrologic conditions being optimal for reproduction and recruitment for six of the last eight years. In contrast, for the period 1990 to 2001, 10 of 12 cohorts were above the median (Figure 5). The relative abundance of adult smallmouth bass (CPUE, fish/ h) follows a similar declining trend (Figure 6) owing largely to the reproductive ecology of smallmouth bass and the decreases in survival of juvenile individuals. The upper Susquehanna River was the least impacted by the disease and recruitment, although abundance is variable, it has remained normal. Interestingly, the Delaware River to the East and the Allegheny River to the West have not shown signs of disease, nor have their fisheries declined suggesting that the larger, climatic conditions have been favorable for population stability.

Young-of-year smallmouth bass were found to be heavily infested with myxozoan and tremotode parasites characterized by inflammation, occasional hemorrhaging, vertebral misalignment and muscle damage. These parasites utilize intermediate hosts during different life stages and many of these hosts (e.g. benthic worms, snails) are often correlated with degraded water quality. Further, there have been severe cases of intersex and other forms of endocrine disruption documented (Blazer et al. *In Review*). Cases of intersex (testicular oocytes) in male smallmouth bass were found to be severe and frequent; with up to 100 percent of individuals sampled at a site displaying intersex. Additionally, high concentrations of the egg-precursor protein vitellogenin, which should not be measurable in male fish, has been found in both white suckers and

smallmouth bass in the Susquehanna Basin (Blazer et al. *In Review*). These anomalies are evidence that endocrine disrupting compounds are present in the system at concentrations that have biological effects to at least fish species. Many of these compounds (e.g. PCBs, flame retardants, personal care products, herbicides, pesticides, pharmaceuticals, etc.), in addition to causing endocrine disruption are also known to cause immune suppression.

This also coincides with anecdotal reports of increased blooms of nuisance filamentous algae. The algae grow on the substrate and periodically senesce; breaking off and floating through water column, fouling anglers' lines and making angling nearly impossible.

Taken together, these observations suggest that the Susquehanna River suffers from some water quality issue(s) which have resulted in impacts to American shad and Smallmouth bass YOY survival. The agencies which make up the SRAFRC do not have jurisdiction over water quality in Pennsylvania and cannot take corrective action. We will continue to conduct studies, within budget constraints, and advocate for water quality improvements.

IV. LITERATURE CITED

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Blazer, V.S., D.D. Iwanowicz; H.L. Walsh, A.J. Sperry; L.R. Iwanowicz, D.A. Alvarez, R.A. Brightbill, G. Smith, R. Manning, and W. Foreman. *In Review*. Reproductive health of fishes in Pennsylvania watersheds: association with chemicals of emerging contaminants. Ecotoxicology.

Chaplin, J.J and J.K. Crawford. 2012. Streamflow and water-quality monitoring in response to young-of-year smallmouth bass *Micropterus dolomieu* mortality in the Susquehanna River and major tributaries, with comparison to the Delaware and Allegheny rivers, Pennsylvania, 2008-10. USGS Open File Report 2012-1019, 39 p.

Chaplin, J.C., J.K. Crawford, and R.A. Brightbill. 2009. Water-quality monitoring in response to young-of-the-year smallmouth bass *Micropterus dolomieu* mortality in the Susquehanna River and major tributaries: 2008. USGS Open File Report 2009-1216.

Figure 1. Catch of adult American shad at the Conowingo Dam Fish Lifts.

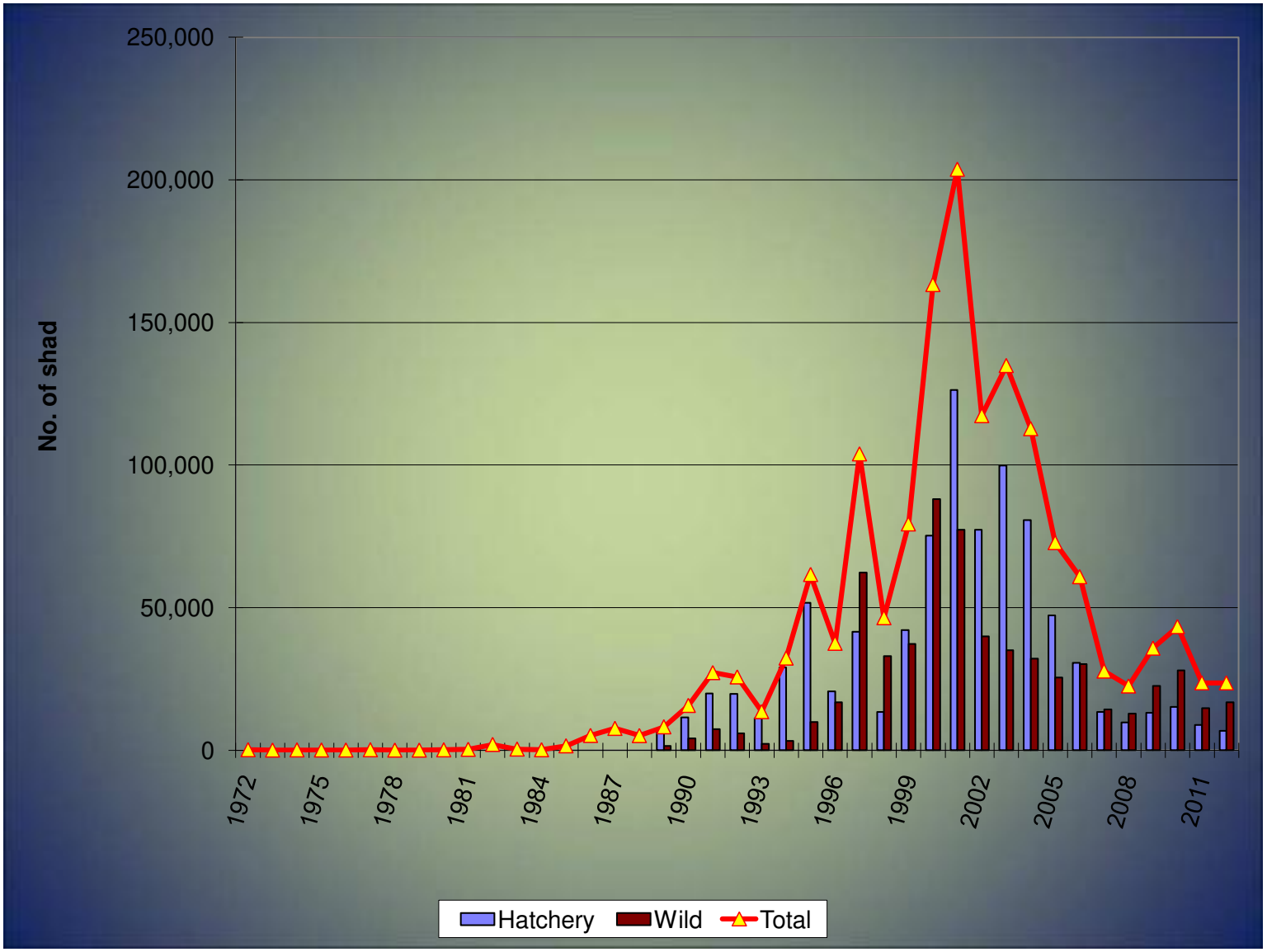

Figure 2. Haul seine CPUE for American shad collections at Columbia in the Susquehanna River. Wild and Hatchery designations based on otolith tagging.

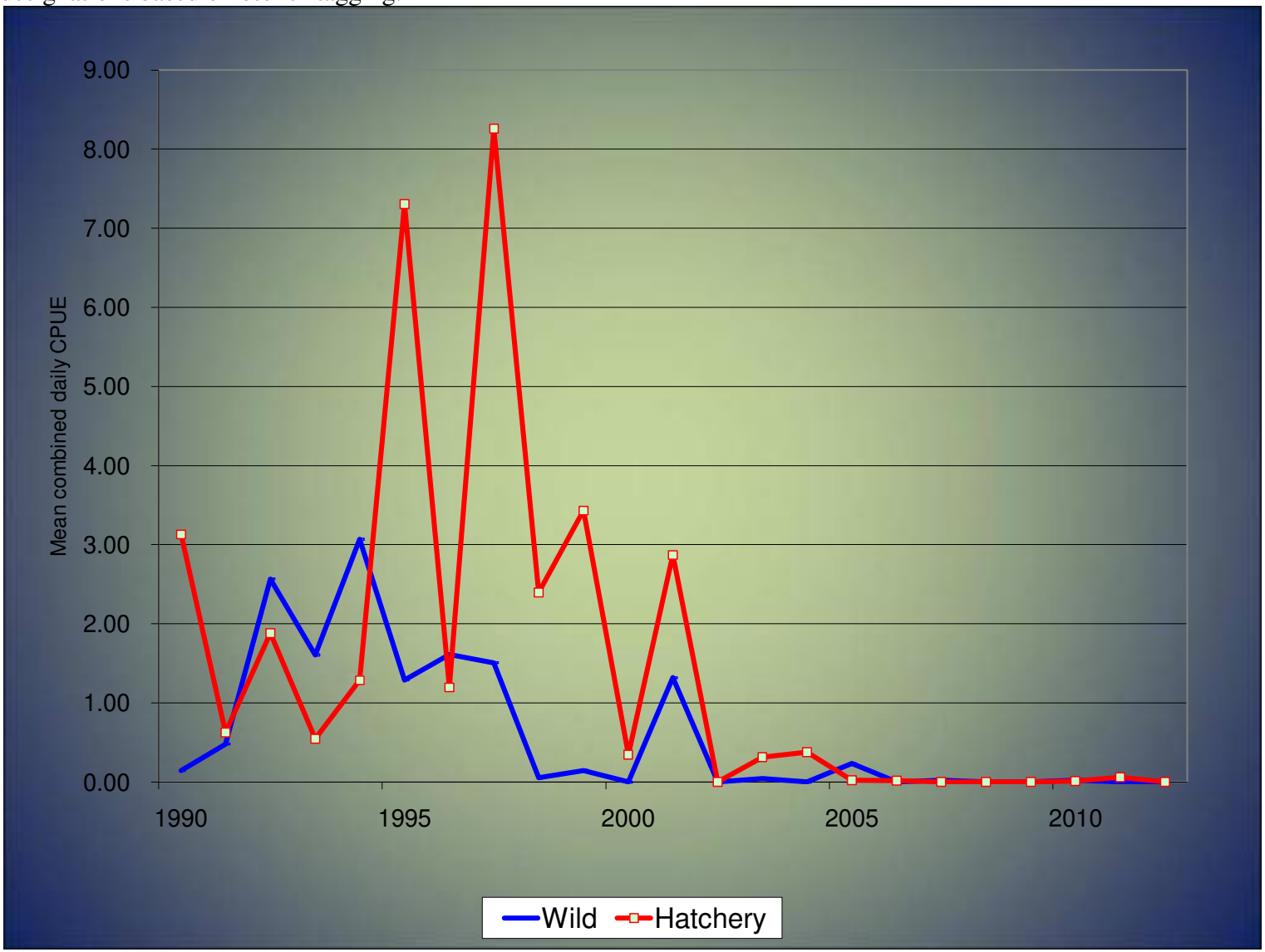

Figure 3. Recovery rate (as YOY in haul seine collections) of hatchery-reared juvenile American shad in the Susquehanna River.

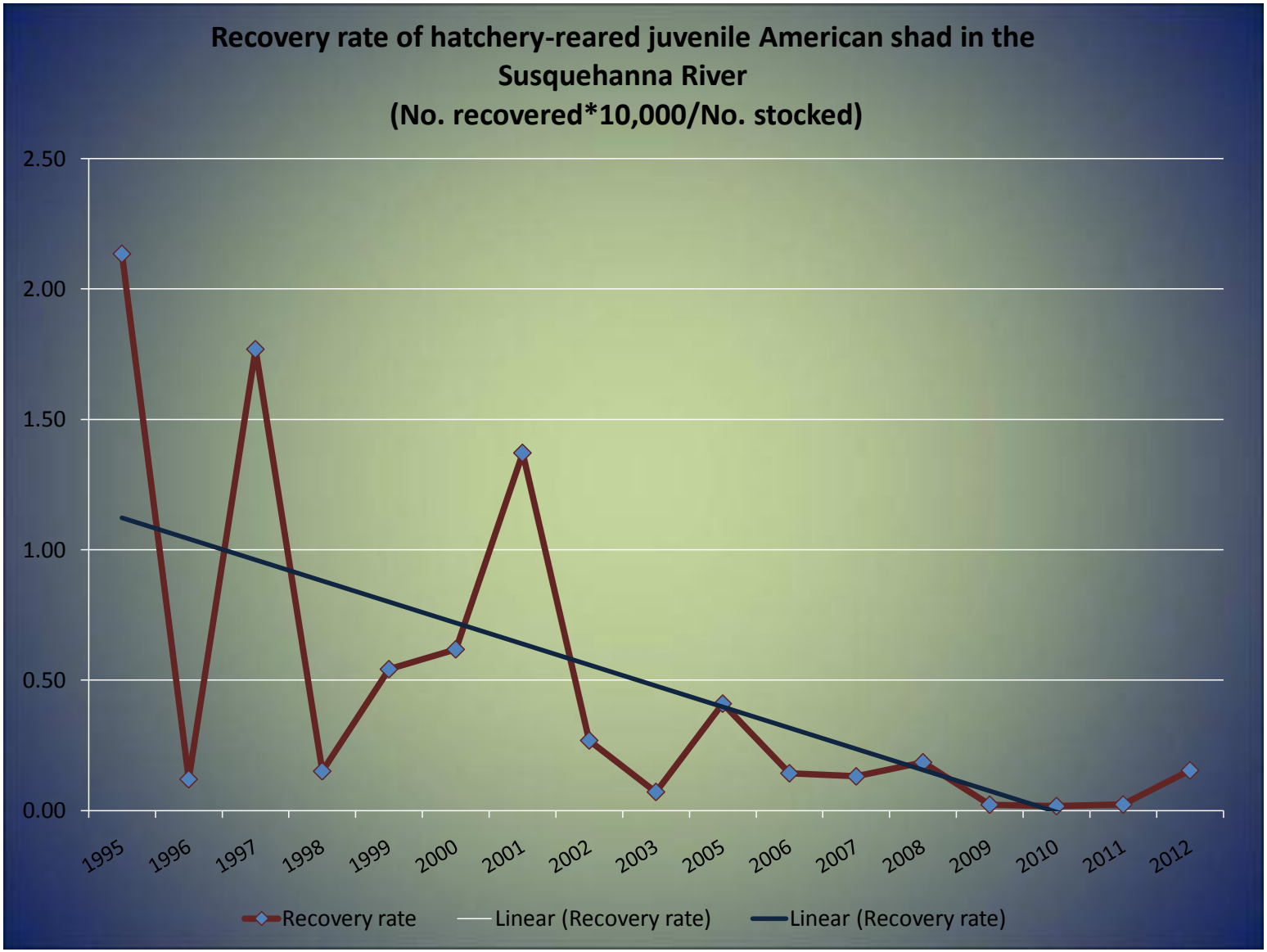

Figure 4. Prevalence of disease (%) among YOY smallmouth bass in difference reaches of the Susquehanna River, 2005-2012.

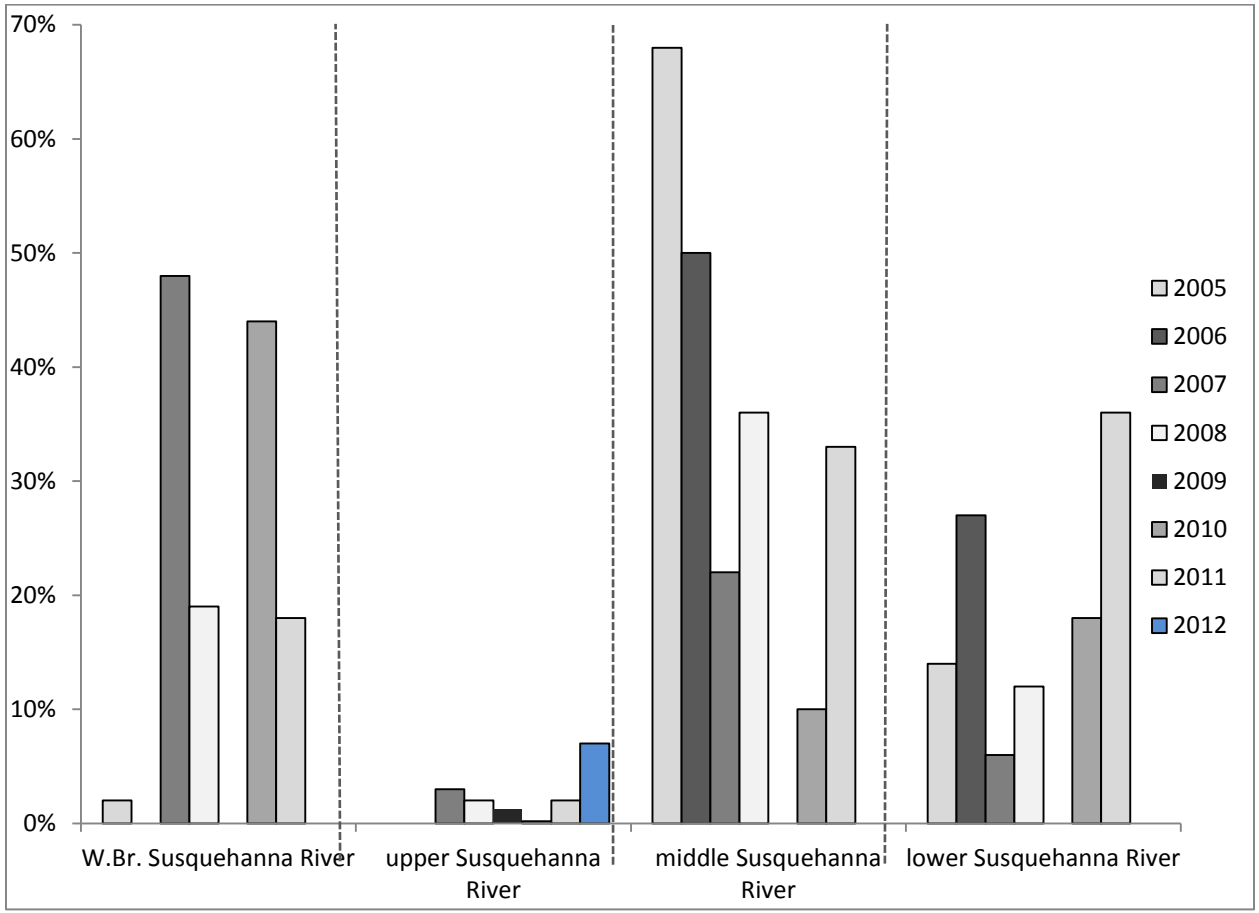

Figure 5. Relative abundance (CPUE, fish/ 50 m) of young-of-year Smallmouth bass in the middle Susquehanna River, 1990 - 2012.

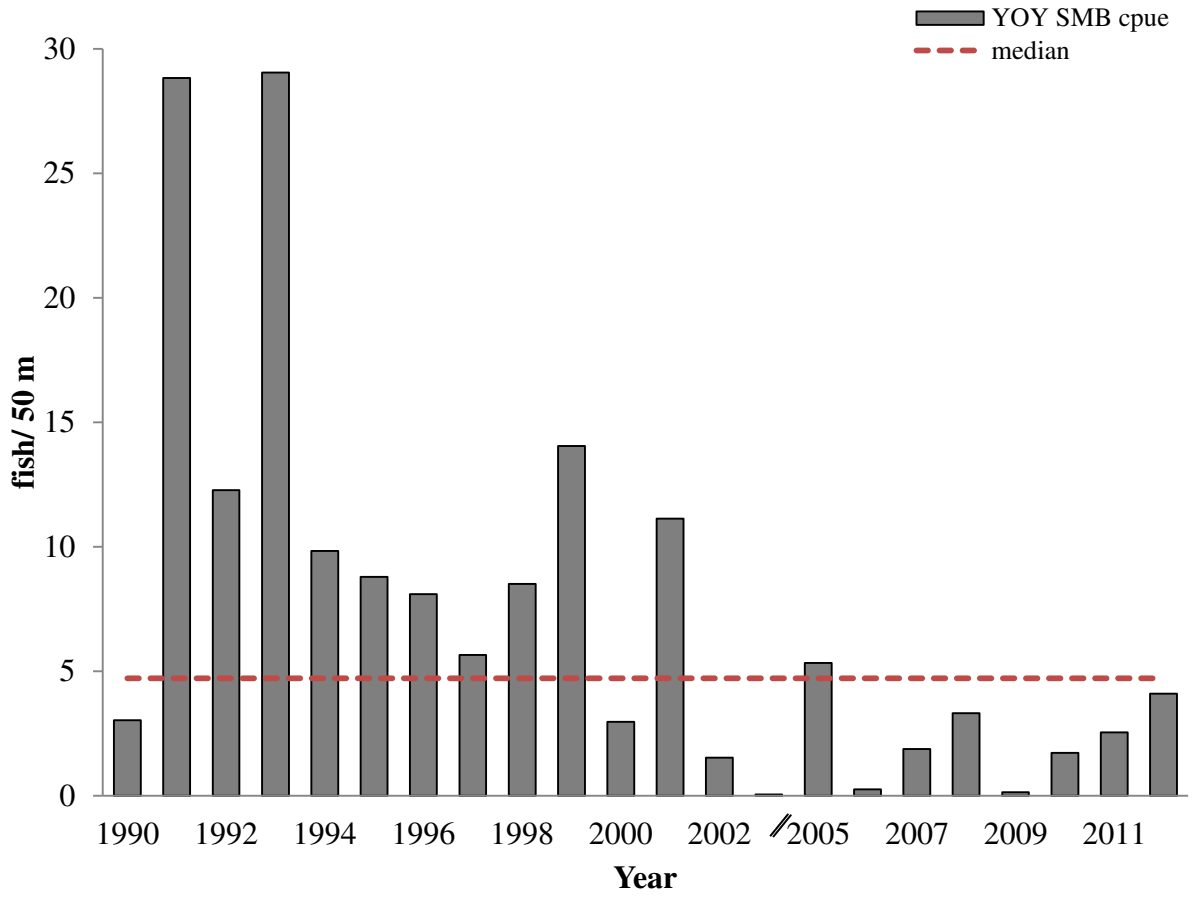

Figure 6. Relative abundance (CPUE, fish/ h) of adult Smallmouth bass in the middle Susquehanna River, 1990 - 2012.

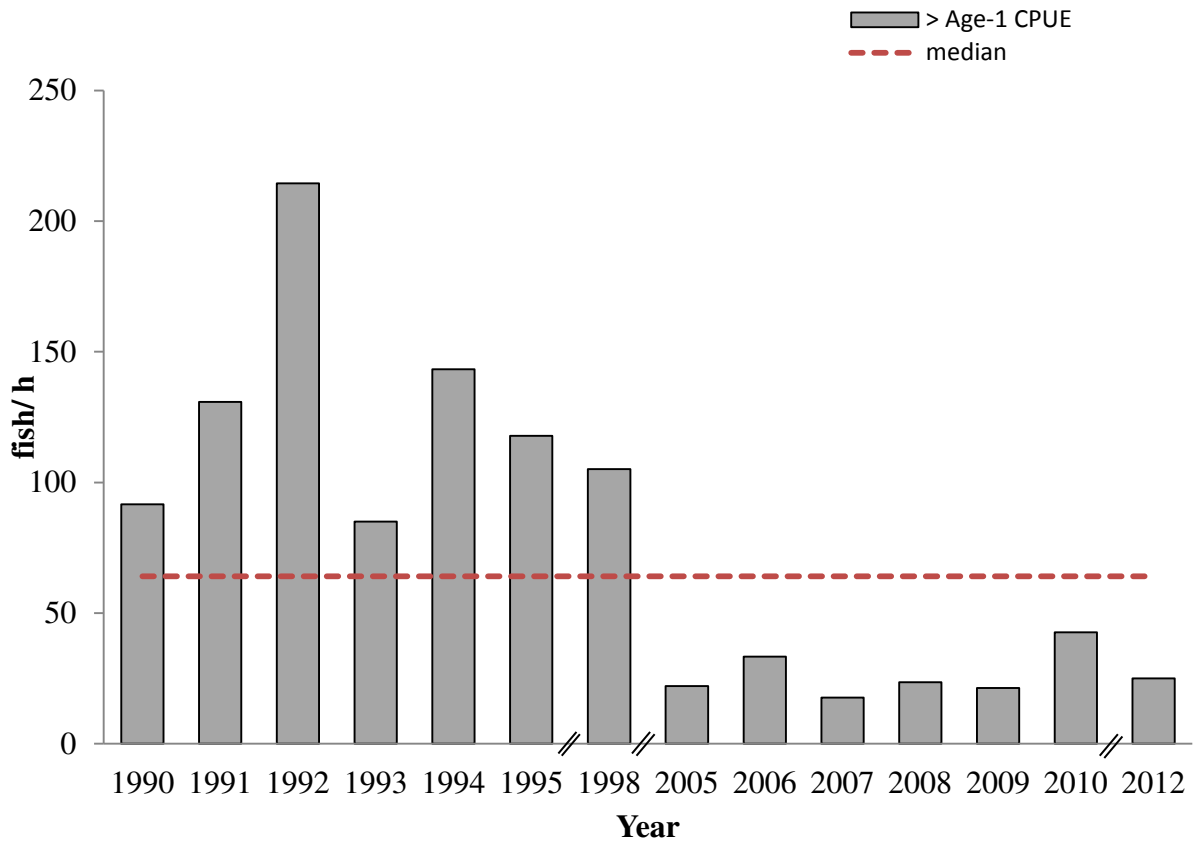
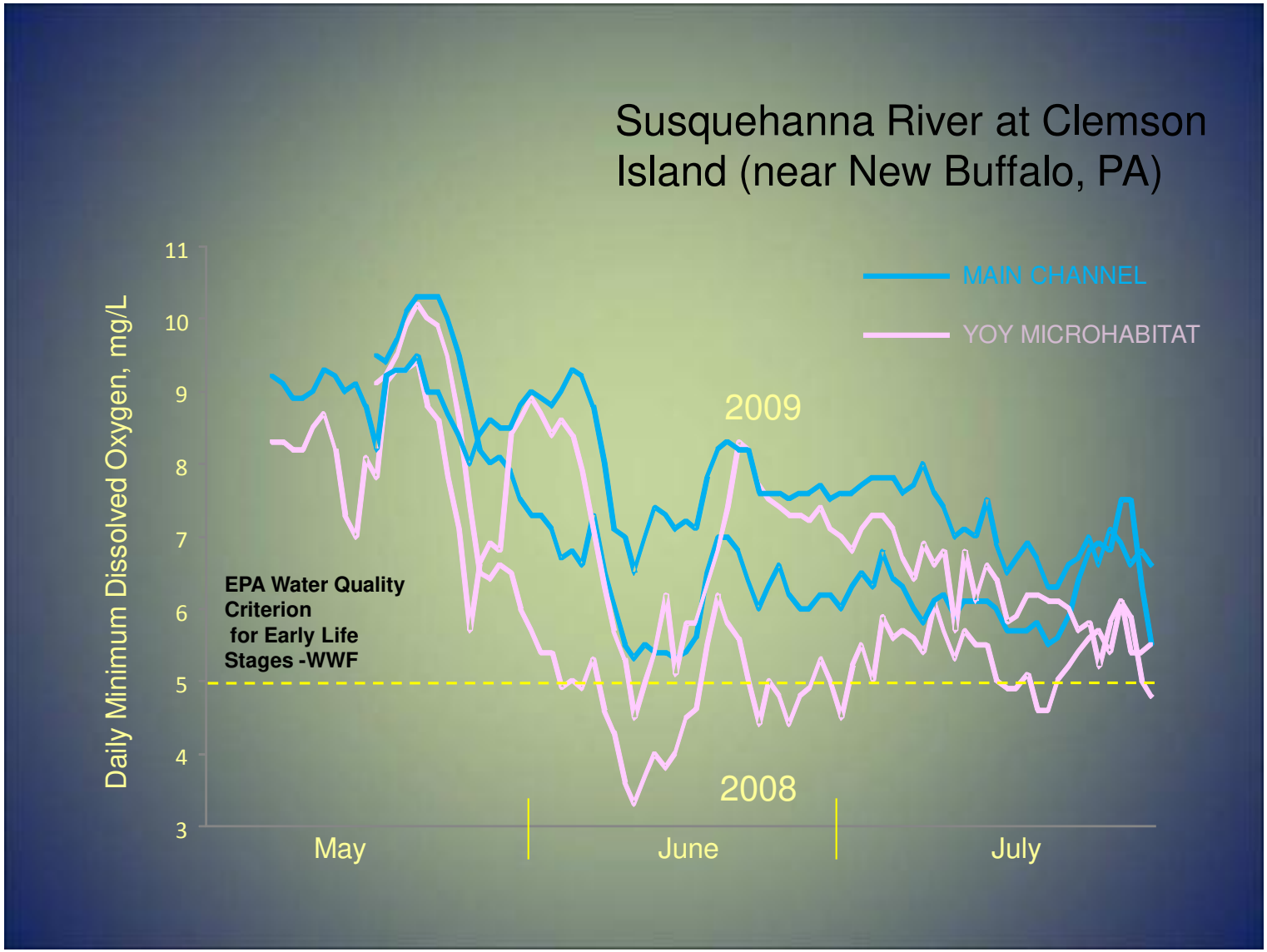
Figure 7. Daily minimum dissolved oxygen concentration (mg/L) in main channel and YOY microhabitat in the Susquehanna River at Clemson Island.