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Submitter Information

20

Name: James Bacon
Submitter's Representative: James Bacon, Esq.
Organization: Riverkeeper, Inc.

General Comment

See attached file(s)

Attachments

Pisces NRC SGEIS comments

FERC_AIM_LetterFinal

Pisces 2015 Report Part 1

Pisces 2015 Report Part 2

Final 3-4-16 SGEIS comments

SUNSI Review Complete
Template = ADM – 013
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Add= M. Wentzel (mSw2)

March 4, 2016

VIA REGULATIONS.GOV

Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
ATTN: Rulemakings and Adjudications Staff
Rulemaking.Comments@nrc.gov

Re: Comments of Riverkeeper, Inc. on Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 5, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment (NUREG–1437) ID NRC-2008-0672

Dear Rulemakings and Adjudications Staff:

Please accept the following comments on behalf of Riverkeeper, Inc. (Riverkeeper) on the above-referenced second Draft Supplemental Generic Environmental Impact Statement (2DSGEIS) the Nuclear Regulatory Commission (NRC) is reviewing pursuant to the National Environmental Policy Act (NEPA) for the relicensing of the Indian Point Energy Center (IPEC).

I. RIVERKEEPER'S INTEREST

Riverkeeper is a non-profit, membership-supported, environmental advocacy organization dedicated to the protection of the environmental, recreational, and commercial integrity of the Hudson River and its tributaries, as well as the drinking water of nine million New York City and Hudson Valley residents. Since its inception in 1966, Riverkeeper has used litigation, science, advocacy, and public education to raise and address concerns relating to the environmental impacts caused by the operation of IPEC. Riverkeeper is headquartered in Ossining, New York, approximately 10 miles from IPEC, and has approximately 8,000 members and/or subscribers that reside within at least 50 miles of the plant and who are concerned about IPEC's ongoing environmental impacts.

Riverkeeper has commented extensively on the proposed IPEC relicensing environmental review and is involved in related issues contested before the NRC's Atomic Safety Licensing Board ("ASLB").

II. NRC'S CONTINUING DUTY TO EXAMINE POTENTIALLY SIGNIFICANT IMPACTS

It is well-settled that NEPA imposes "action-forcing" procedures that require federal agencies (1) to take a hard look at the environmental impact of major federal actions and

(2) to inform the public regarding the environmental decisionmaking process. *Baltimore Gas & Elec. Co. v Nat. Res. Def. Council, Inc.*, 462 US 87, 97 (1983); see also 40 CFR §1500.1(a) (describing the policy and function of NEPA). NEPA's "hard look" doctrine is designed "to ensure that the agency has adequately considered and disclosed the environmental impact of its actions and that its decision is not arbitrary or capricious." *Nat'l Comm. for the New River, Inc. v. FERC*, 373 F.3d 1323, 1327 (D.C. Cir. 2004).

An agency's NEPA duties do not end with the preparation of an environmental impact statement. "A federal agency has a continuing duty to gather and evaluate new information relevant to the environmental impact of its actions, even after release of an EIS." *Enos v. Marsh*, 769 F.2d 1363, 1373 (9th Cir.1985). And, if '[t]here are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts," the agency must supplement the EIS. 40 C.F.R. § 1502.9(c)(1).

It is also well settled that NEPA requires cumulative examination of "actions occurring in the same general location, such as body of water, region, or metropolitan area." *Churchill County v. Norton*, 276 F. 3d 1060, (9th Cir. 2001) citing 40 C.F.R. §1502. (See also *Kleppe v. Sierra Club*, 427 US 390, 410 [1976]; "when several proposals ... that will have cumulative or synergistic environmental impact upon a region are pending concurrently before an agency, their environmental impacts must be considered together….")

III. DISCUSSION

The 2DSGEIS is inadequate to satisfy NEPA's requirement to consider new and significant information in three respects. First, key issues identified previously by Riverkeeper have not been adequately addressed nor resolved. Primarily, the 2DSGEIS fails to discuss potential adverse environmental impacts relating to IPEC's continued storage of spent fuel.

Second, to the extent the 2DSGEIS does discuss new and significant information, its analysis of environmental impacts is inadequate to satisfy NEPA's "hard look" test. And, the 2DSGEIS ignores new and significant information that affects the environmental impacts of IPEC, with respect to 1) fish mortality, 2) IPEC safety, 3) the Algonquin Incremental Market (AIM) natural gas pipeline, and 4) changes to the power grid that warrant renewed consideration of the alternative of not renewing IPEC's operating license.

It is also well settled that NEPA requires cumulative examination of "actions occurring in the same general location, such as body of water, region, or metropolitan area." *Churchill County v. Norton*, 276 F. 3d 1060, (9th Cir. 2001) citing 40 C.F.R. §1502. (See also *Kleppe v. Sierra Club*, 427 US 390, 410 [1976]; "when several proposals ... that will have cumulative or synergistic environmental impact upon a region are pending concurrently before an agency, their environmental impacts must be considered together….")

3-L20-1

A. <u>The 2DSGEIS's Discussion of Spent Fuel Storage Impacts Is Inadequate to Satisfy NEPA</u>

The 2DSGEIS states that NRC is now relying on the Continued Spent Fuel Storage Generic Environmental Impact Statement (Continued Spent Fuel Storage GEIS) for impact findings regarding continued storage of spent fuel after cessation of operations, including pool leaks, fires, and dry storage for an extended period. Draft 2SEIS at iii, 115-123. The Continued Spent Fuel Storage GEIS is inadequate to support the re-licensing of Indian Point Units 2 and 3 because it suffers from the following failures:

- In blatant violation of NEPA and the Court's decision in *State of New York v. NRC,* 681 F3d 471 (DC Cir 2012) (*"New York I"),* the Continued Spent Fuel Storage GEIS fails to examine the probability and consequences of failure to site a repository. Instead of examining the risk of failing to site a repository, the GEIS rationalizes the risk away, by arbitrarily assuming that spent fuel will be protected by "institutional controls" for an infinite period of time at reactor sites. This assumption is not only absurd and inconsistent with the Nuclear Waste Policy Act ("NWPA"), but it also defeats the Court's purpose of forcing NRC to reckon with the environmental consequences of its failure to site a repository.

- The GEIS fails to acknowledge that the Continued Spent Fuel Storage Rule enables licensing and relicensing, and therefore it distorts the statement of purpose and need for the rule as relating solely to administrative rather than environmental concerns. As a result, the GEIS also mischaracterizes the alternatives that must be considered. Instead of evaluating alternatives related to storage and disposal of spent fuel, the GEIS examines alternatives related to the administrative question of how to prepare an EIS. The result is a farcical cost-benefit analysis that utterly fails to address alternatives for avoiding or mitigating the environmental impacts of storing spent fuel or siting a repository.

- The GEIS' analysis of the environmental impacts of extended spent fuel storage ignores the fact that NRC knows very little about the behavior of spent fuel in long-term or indefinite storage conditions, especially the potentially significant effects of long-term dry cask storage on high burnup fuel integrity. In violation of NEPA, the NRC makes no attempt to quantify these uncertainties.

- The GEIS fails to fully consider the environmental impacts of spent fuel pool leaks and fires. In violation of NEPA, the GEIS relies upon incomplete data, adopts a flawed concept of risk, and ignores a range of causes for accidents.

- In violation of NEPA, the GEIS makes no attempt to show how the environmental impacts associated with the Continued Spent Fuel Storage Rule will be quantified and incorporated into cost-benefit analyses for nuclear reactors. Although spent fuel disposal and long-term storage costs are high enough to tip the balance of a cost-benefit analysis for reactor licensing away from licensing, nowhere does the NRC explain how it will take these costs into account in reactor licensing decisions.

3-L20-1 cont'd

- In violation of NEPA, the GEIS fails to support the limited conclusions in the Continued Spent Fuel Storage Rule and GEIS regarding the technical feasibility of spent fuel disposal.

- The NRC has splintered the analysis of environmental impacts associated with storage and disposal of spent fuel into an array of safety findings and environmental analyses. While the issues covered by these separate findings and analyses overlap and involve cumulative impacts, the NRC refuses to integrate them. The NRC also refuses to correct inconsistencies between them.

These deficiencies are discussed in detail in Riverkeeper's comments on the proposed version of the Continued Spent Fuel Storage GEIS and accompanying Rule.[1] The Riverkeeper et al. Comments were supported by expert declarations by Dr. Arjun Makhijani, David Lochbaum, Dr. Gordon Thompson, and Mark Cooper (ADAMS Accession No. ML14030A152). Riverkeeper has appealed the Rule and GEIS to the U.S. Court of Appeals for the D.C. Circuit.[2]

Riverkeeper recognizes that the NRC Staff is precluded by 10 C.F.R. § 51.23 from modifying the 2DSGEIS to address Riverkeeper's comments. Riverkeeper respectfully submits that such preclusion is unlawful, given the Continued Spent Fuel Storage GEIS' complete failure to comply with NEPA in addressing the environmental impacts of continued storage of spent fuel or reasonable alternatives to the continued generation of spent fuel through the re-licensing of Indian Point Units 2 and 3.

B. <u>The 2DSGEIS's Discussion of Aquatic Impacts is Inadequate to Satisfy NEPA</u>

3-L20-2

1. Fish Mortality

a) Entrainment and Impingement

As indicated by the herewith reports of Pisces, the 2DSGEIS does not cure the NRC's earlier inadequate analysis of impacts to aquatic species and the new information

[1] *See* Comments by Environmental Organizations on Draft Waste Confidence Generic Environmental Impact Statement and Proposed Waste Confidence Rule and Petition to Revise and Integrate All Safety and Environmental Regulations Related to Spent Fuel Storage and Disposal (Dec. 20, 2013, corrected Jan. 7, 2014) (Corrected comments posted on ADAMS at ML14024A297) ("Riverkeeper et al. Comments").
[2] See *New York et al. v. NRC,* Docket Nos. 14-1210, 14-1212, 14-1216, and 14-1217 (Consolidated) (filed October 31, 2014) ("*New York II*").

continues to raise concerns that singnificant adverse impacts have not been adequately disclosed. Thus, Riverkeeper respectfully incorporates by reference the accompanying technical comments of Pisces Conservation LTD, and the Pisces 2015 update to the previously-submitted 2008 Report *Status of the Fish Populations of the Hudson River.*

3-L20-2 cont'd

b) Cumulative Impacts upon Sturgeon

The 2DSGEIS at 5.14.6 addresses cumulative impacts to aquatic resources and includes discussion of cumulative adverse impacts resulting to oyster habitat from IPEC's operations and the construction of the Tappan Zee Bridge ("TZB"). See page 107 line 20. While this analysis is appropriate, it falls short by limiting examination to oyster habitat and ignoring impacts to Sturgeon, a federally-listed endangered species. Troublingly, recent data shows TBZ construction has increased Sturgeon mortality 20-fold:

Year	Number of sturgeon mortalities reported to DEC	Tappan Zee Bridge replacement project activity
2007	7	None
2008	0	None
2009	0	None
2010	1	None
2011	5	None
2012	8	Pile installation testing
2013	25	Start of construction
2014	43	Ongoing construction
2015	48	Ongoing construction

[3]

Riverkeeper has plotted Sturgeon deaths on a map of the Hudson River demonstrating an alarming increase in mortality in the vicinity of IPEC since the TZB commenced construction.[4]

Because 10 CFR Part 51 specifically requires examination of cumulative impacts, the NRC must examine and disclose the levels of Sturgeon mortality from both IPEC and TZB construction during the IPEC's relicensing period. The Draft 2SGEIS must examine whether NRC's prior assumptions of ultimate Sturgeon mortality impacts and baseline data remain valid in light of the unexpected increases in mortality resulting from the TZB construction.

[3] NYSDEC sturgeon mortality data from 2013-2015 obtained by Riverkeeper Freedom of Information Law requests. See http://www.riverkeeper.org/news-events/news/preserve-river-ecology/riverkeeper-puts-nys-on-notice-over-endangered-species-clean-water-act-violations-at-tappan-zee-project-site/.

[4] https://www.google.com/maps/d/u/0/viewer?mid=ziyNQF0hkS6k.kulf9p6eWt98.

3-L20-3

C. The 2DSGEIS's Safety Analysis is Inadequate to Satisfy NEPA

Since the DGEIS was issued in 2014, the IPEC has suffered a series of significant safety related mishaps. On February 29, 2015 New York State sent a letter (attached herewith) to the Federal Energy Regulatory Commission (FERC) highlighting IPEC's safety problems which have grown worse over time.[5] The Governor has ordered four state agencies to conduct "a full investigation into recent significant issues at IPEC" and listed several safety incidents:

- May 7, 2015 IPEC's nuclear reactor Unit 3 was shut down by plant operators to repair a steam leak associated with the steam generator.
- May 9, 2015 a main transformer at Unit 3 short-circuited and caught fire due to a failure of insulation within the transformer. The plant shut down automatically and Entergy declared an unusual event level emergency.
- June 15, 2015 Unit 3 automatically shut down after an electrical disturbance in the switchyard caused a turbine to shut down.
- July 8, 2015 Unit 3 was shut down by plant operators after they determined that steam generator water levels were lowering due to the unexplained failure of a condensate pump.
- December 5, 2015 IPEC's nuclear reactor Unit 2 was powered down after approximately 10 control rods inserted into the reactor core.
- December 14, 2015 Unit 3 shutdown due to an electrical disturbance in the switchyard.
- February 6, 2016 a radioactive tritium leak at IPEC that has caused groundwater radioactivity levels to rise more than 65,000 percent.

The tritium leak is just the latest of an increasing number of safety incidents at the IPEC in the past year. Nuclear reactor Units 2 and 3 at IPEC have shutdown unexpectedly seven times in 2015. An investigation is underway to determine the impacts of these shutdowns on operations of the units and to determine whether Entergy is appropriately investing in capital expenditures and operation and maintenance budgets to ensure reliable and adequate operations of the facility.

[5] "Governor Cuomo Directs an Immediate Independent Safety Analysis of the Algonquin Pipeline Near Indian Point Nuclear Power Plant." Available at https://www.governor.ny.gov/news/governor-cuomo-directs-immediate-independent-safety-analysis-algonquin-pipeline-near-indian.

It is possible that this investigation will pinpoint the IPEC spent fuel storage areas as the source of the contamination. Thus, in order to meet its NEPA obligations the NRC cannot simply rely on generic nation-wide waste storage protocols. Examination must be made now of precisely why the tritium levels suddenly increase by many orders of magnitude and whether the fuel pools are the source. In the absence of such an investigation, the NRC cannot have taken a "hard look" at the potential impacts resulting from the long-term storage of nuclear waste at IPEC. 3-L20-3 cont'd

D. The 2DSGEIS Violates NEPA by Failing to Address the Environmental Impacts of the AIM Project

3-L20-4

In violation of NEPA, the 2DSGEIS briefly mentions the AIM project but fails to provide any specific information about the project or discuss its potentially significant environmental impacts. As above, the amended 10 CFR Part 51 specifically requires examination of cumulative impacts at IPEC.

The AIM project proposes to re-site and expand the diameter of a natural gas pipeline by tunneling beneath the Hudson River and onto and across the IPEC site. The 2GEIS does not address the AIM and IPEC cumulative impacts to water quality and aquatic species impacts in the Hudson.

As above,, New York State has launched a multi-agency investigation into potential impacts relating to placing the AIM pipeline on IPEC property. The state's February 29, 2016 letter identifies potentially synergistic impacts relating to the construction, operation and potential accidents involving the proposed pipeline. Specifically, the state advised:

> The AIM Project's path will require horizontal directional drilling under the Hudson River and adjacent to Indian Point. While the applicant has committed to build the pipeline to a more stringent standard on the Indian Point grounds, including laying two concrete liners above the pipeline to prevent excavation damage, burying the pipeline deeper than required, and using a stronger grade of steel than is required even in high consequence areas, it is imperative to determine if this is enough in light of the recent significant tritium leak and other operational difficulties at the nuclear facility. An independent safety risk analysis will address the adequacy of those mitigation efforts. We will share the results with you immediately upon receiving them.
>
> Until this independent safety risk analysis is completed, we ask the FERC stay and reconsider its prior determination to grant a certificate of public convenience and necessity to ensure that the health and safety of all New Yorkers is adequately protected. Specifically, FERC must reconsider whether the proximity to Indian Point and the construction methods required to install the Project would have an impact on the recent increasing leaks of tritium into

ground water or otherwise increase the potential for serious operational problems at Indian Point.

3-L20-4 cont'd

The placement of the pipeline also raises the potential for an accident disrupting the spent fuel containment pools.[6] IPEC's spent fuel pools are not housed under containment, but rather in non-reinforced cinderblock industrial buildings that may fail as the result of a pipeline failure/explosion. The results of a release of spent nuclear fuel could be catastrophic potentially contaminating a significant portion of the 10-mile emergency planning zone and the 50-mile ingestion pathway zone affecting millions of people.[7]

3-L20-5

Thus, the NRC should postpone issuing a record of decision or a relicensing decision until the state completes its investigations.

E. The 2DSGEIS Does Not Address New and Significant Information Regarding the Benefits of the No-Action Alternative

3-L20-6

A robust alternatives' analysis is the linchpin of any federal agency's permitting review. The comparative evaluation of alternatives to the proposed action "is the heart of the environmental impact statement" because it "sharply defin[es] the issues and provid[es] a clear basis for choice among options by the decisionmaker and the public." 40 C.F.R. § 1502.14. Therefore, agencies must "[r]igorously explore and objectively evaluate all reasonable alternatives[.]" Id. § 1502.14(a). The assessment of the environmental impacts is the "scientific and analytic basis for the comparison[]" of alternatives. 40 C.F.R. § 1502.16. *Defenders of Wildlife v. North Carolina Department of Transportation*. 44 ELR 20181. No. 13-2215, (4th Cir. 08/06/2014).

Riverkeeper has consistently called upon the NRC to fully assess alternatives including examining alternate sources of energy to replace IPEC's power generation.[8]

Recent developments, not evaluated in the 2DSGEIS, demonstrate that closing IPEC is a viable option that would avoid or mitigate potential impacts because New Yorkers' energy needs can be met today, with full reliability, without IPEC, even in peak demand Summer months. These developments include:

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[6] Approximately 1,500 tons of spent nuclear fuel waste is currently stored in densely packed spent fuel pools at IPEC. Two of the spent fuel pools, in addition to an unknown number of other pipes, have already exhibited structural failures resulting in unpermitted quantities of radioactive waste contaminating the groundwater and leaking the Hudson River.

[7] *See* NRDC Fact Sheet: Nuclear Accident at Indian Point: Consequences and Costs, http://www.nrdc.org/nuclear/indianpoint/files/NRDC-1336_Indian_Point_FSr8medium.pdf

[8] See Riverkeeper comments (footnote 2) on IPEC DSEIS dated November 5, 2010: "Explaining how recent information regarding a proposal for a new high- voltage direct current energy transmission project bears upon the NRC Staffs obligation to fully assess alternatives to license renewal in the IP DSEIS, including alternative sources of energy to replace the power generated by Indian Point."

- Recent increases in downstate NY area generating capacity [1,047 mW];

- Recent transmission improvements in the power grid to allow downstate NY access to more capacity from outside the downstate NY area [400 mW];

3-L20-6 cont'd

- Increases in energy efficiency made by Con Edison under order of the Public Service Commission [109 - 142 mW];

- Reductions in downstate peak demand forecasted for 2016 thanks to better-than-expected results on distributed renewable energy, increased energy efficiency, and general shifts in peak consumption patterns [549 mW] and;

- Reduction in demand for centralized power sources like IPEC due to increases in distributed renewable energy

As discussed below, these four critical electricity resource factors total between 2,105 and 2,138 mW (greater than Indian Point's capacity of 2,040 mW), allowing for overall sufficient "resource adequacy" for the region to maintain energy reliability if Indian Point is taken permanently offline.

1. <u>Recent increases in downstate NY generating capacity</u>

Recently restored supply includes the restoration of the Danskammer power plant [493 mW], which was shut down after Hurricane Sandy, the restoration of capacity that had been damaged at the Bowline power plant [net increase of 377 mW], (Danskammer and Bowline are both located in the Hudson Valley), and the reactivation of the Astoria No. 2 power plant in Queens [177 mW]. *Total recent increases in generating capacity - 1,047 mW.*

2. <u>Recent transmission improvements in the grid allowing access to more energy outside the metro area</u>

Transmission improvements allow more power to flow from upstate to downstate, allowing for less energy from Indian Point. Con Edison and other transmission owners in New York State are in the process of completing — by June 2016 — major reinforcements and additions to part of the high-voltage power grid in and around the region stretching from central New York down to the Ramapo-Rock Tavern area in Orange and Rockland counties. Also, Con Edison has completed improvements to transmission facilities on Staten Island that allow for more power flow to the other boroughs from Staten Island. Together, these improvements were made under an Order by the New York Public Service Commission (PSC) to consider reliability impacts of Indian Point Energy Center retirement. The key Order associated with these improvements was made in November of 2013 and is available on the PSC website:

http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={5AFE13E9-181F-40CF-A91C-5AEC0E066AC9}[9]

The total increased capacity due to grid improvements is roughly 400 mW.

3-L20-6 cont'd

Therefore, if IPEC closed this Spring, economically-competitive replacement energy would come through the regional power grid, as enhanced above, and from the varied mix of resources that currently supply the wholesale energy requirements in the New York, Pennsylvania-New Jersey-Maryland (PJM) and New England competitive electricity markets. That includes energy from the newer, cleanest combined-cycle gas-fired resources in the region. By the early to mid-2020s, the vast majority, if not all of the energy sources replacing Indian Point will be solar photovoltaic resources, wind energy, hydropower and lower demand due to energy efficiency and demand management.

3. Recent energy efficiency improvements

Targeted energy efficiency improvements are upgrades made at many buildings throughout the Con Edison service territory that reduce the amount of electricity they use. This includes more efficient lighting, air conditioning, and refrigeration equipment. As part of the NY PSC order noted above on transmission, ConEd was required to develop additional energy efficiency plans to obtain 125 megawatts (MW) of power savings. They are on track to complete this request by June 2016, as indicated in this recently filed status report, "Third Quarter 2015 Demand Management Status Report" http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={1E3E3728-7E41-4F88-A82C-2CBB2EE47048}.

Significantly, Con Ed's most recent projected savings through these improvements are between 109 and 142 mW.

4. Reduction in downstate peak energy demand forecasts for Summer 2016

The New York Independent System Operator (NYISO), a no - profit organization formed in 1997 to manage New York's bulk energy grid and oversee the state's wholesale electricity markets, is New York's source for electricity supply and demand information, such as the annual NYS "Comprehensive Reliability Plan."

NYISO's 2014 Comprehensive Reliability Plan[10] concluded that 500 MW of "compensatory MW" would be needed in downstate New York ("SENY", or southeast

[9] The press release associated with those developments is available at: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={1D2A3C42-9CAE-49AE-9E5B-0B2DABD0E015}.

[10] This study is publicly available [see page 23], here: http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Planning_Studies/

New York) if Indian Point were to be shut down by the summer of 2016, to meet summer peak needs.

3-L20-6 cont'd

However, NYISO's most recent forecast, issued in December 2015, shows a 549 MW drop in peak demand forecasted for Southeast New York in summer 2016 -- that drop is from 22,337 mW to 21,788 mW -- compared to the earlier demand forecast on which the 2014 Comprehensive Reliability Plan was based.

Importantly, the 2014 prediction of additional need should IPEC close was based on the then-available peak demand forecast for 2016 for the key downstate New York region, which are NYISO zones G through J (essentially, lower Hudson Valley through and including New York City), and Long Island (zone K). That forecast came from the NYISO document known as the 2014 "Load and Capacity" report, commonly known as the NYISO "Gold Book."[11]

The 2014 Gold Book shows on page 14, in "Table I-2b-2: Baseline Forecast of Non-Coincident Peak Demand – G to J Locality" a forecast peak demand in the summer of 2016 of 16,749 MW for downstate zones G to J (lower Hudson Valley to New York City); and at the top of page 13, a summer 2016 peak load forecast for Long Island (zone K) of 5,588 MW. *In total, the 2014 forecast of peak downstate demand in the summer 2016 was 22,337 mW.*

The 2014 Gold Book forecast of peak Summer 2016 demand *has been superseded* by a December 2015 forecast of peak demand in summer 2016, *amounting to 21,788 for these regions, or 549 MW less than the earlier forecast.* The newest draft load forecast for 2016, which will become a formal forecast in the 2016 Gold Book, to be released by the NYISO in April 2016 forecasts a total of 21,788, for zones G-J (16,310 MW) and zone K, Long Island (5,478 MW).[12] (See slide 4).

5. Reduction in demand for centralized power sources like IPEC due to increases in distributed renewable energy

Localized renewable power sources, in particular solar PV installed in downstate New York, are an alternate means of meeting demand for consumption of energy at residences and commercial buildings. This alternative supply allows reduction in demand for centralized power sources transmitted to homes over the wires of the state's power grid.

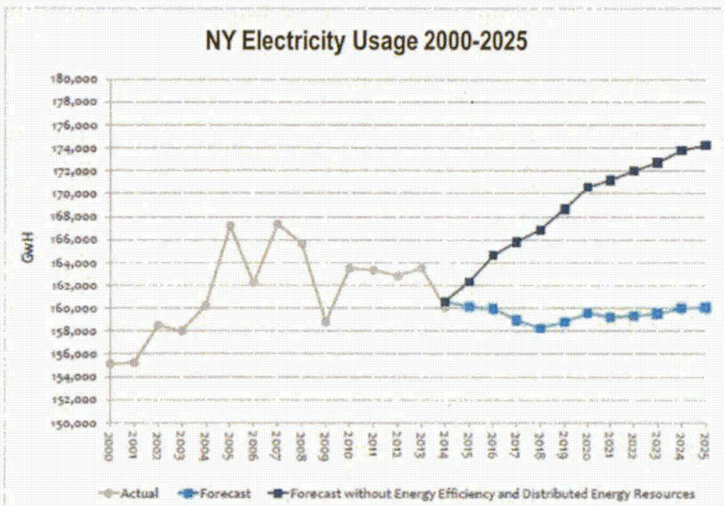
Reliability_Planning_Studies/Reliability_Assessment_Documents/2014CRP_Final_20150721.pdf

[11] Available at:
http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2014_GoldBook_Final.pdf

[12] www.nyiso.com/public/webdocs/markets_operations/committees/bic_icapwg_lftf/meeting_materials/2015-12-18/2015%20Final%20Weather%20Adjusted%20Loads%20V2.pdf

These localized renewable power sources are one of the reasons that the latest forecast of peak summer demand in 2016 is *549 mW less than what was forecast back in 2014.* Another reason is the significant increase, beyond 2014 projections, in installed energy efficiency resources (e.g., more efficient lighting (such as LED), air conditioning equipment, motors, and refrigeration), that has been achieved throughout the downstate region. 3-L20-6 cont'd

The following graph shows NYISO's current forecast as to how energy efficiency and distributed power generation will reduce grid-based electricity demand in New York by 8%, over the next ten years, essentially allowing New York to grow without adding capacity demands to our power grid.



(Source: New York Independent System Operator)

F. <u>Reservation of Rights With Respect to State Water Quality Certification Denial Appeal and State Pollutant Discharge Elimination System Permit (SPDES) Proceeding</u>

3-L20-7

Riverkeeper understands that NRC Staff is directed to comply with NEPA, and further understands that NRC Staff is reviewing the environmental impacts within its jurisdiction which relate the continued operation of IPEC as presently configured. NRC is Staff is similarly aware that the State of New York has denied a 401 water quality certification IPEC and is completing proceedings combining Entergy's administrative appeal of the denial of a water quality certification with an ongoing SPDES proceeding. In that regard, Riverkeeper notes that Section 511(c)(2) of the Clean Water Act (CWA) precludes the NRC from second-guessing state conclusions and conditions contained in NPDES permits. 33 USC §1371(c)(2); *see also Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions and Related Conforming Amendments, 49 FR 9352-01* (*Public Service Co. of New Hampshire* (Seabrook Station, Units 1 and 2), CLI–77–8, 5 NRC 503 (March 31, 1977); *In the Matter of Consol.*

Edison Co. of New York, Inc. (Indian Point, Unit No. 2) Power Auth. of the State of New York (Indian Point, Unit No. 3), 13 NRC 448, 449 (May 12, 1981). The NRC may not impose effluent limitations. *In the Matter of Pub. Serv. Co. of Oklahoma Associated Electric Coop., Inc. W. Farmers Electric Coop., Inc. (Black Fox Sta., Units 1 and 2),* 8 NRC 281, 283 (Aug. 24, 1978) (*In the Matter of S. Texas Project Nuclear Operating Co. (S. Texas Project, Units 3 & 4),* 72 N.R.C. 101, 137; (*In the Matter of Carolina Power and Light Co. (H. B. Robinson, Unit No. 2),* 10 NRC 557, 561 [Oct. 31, 1979]; *see also In the Matter of Tennessee Val. Auth. (Yellow Cr. Nuclear Plant, Units 1 and 2),* 8 NRC 702, 711-12 [Dec. 27, 1978]).

IV. CONCLUSION

3-L20-8

In sum, because the 2DSGEIS fails to adequately address existing and new information concerning the IPEC's significant adverse environmental impacts, it cannot serve as a basis supporting a relicensing decision, especially when numerous issues remain outstanding such as New York State's analysis of IPEC's water quality impacts.

Dated: March 4, 2016

Respectfully submitted,

James Bacon

Attorney for Riverkeeper

To: Jim Bacon and Mark Lucas - Riverkeeper

From: Richard Seaby

Date: 04 March 2016

Re: The NRC supplemental information of the Indian Point GEIS

Notes on Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 5, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment (NUREG–1437)

NRC has issued a new analysis of aquatic impacts in the second supplement to the FEIS[1] for Indian Point (IP) units 2 and 3.

In this document I review the major findings of this document and discuss their conclusions. Entergy submitted a reduction in the several impacts on the RIS species (Page 26), *i.e.*:

- blueback herring would change from Large to Small,
- hogchoker would change from Large to Moderate,
- rainbow smelt would change from Moderate-Large to Small, and
- white perch would change from Large to Small.

After reanalysing the data the NRC disagreed with some of these changes. For example on the blueback herring (Page 29):

Therefore, the NRC staff disagrees with Entergy's (2014b) assertion that NMFS's listing document for blueback herring (78 FR 48944) and ASMFC supporting material support a change in the NRC staff's findings for this species from Large to Small.

For rainbow smelt (page 33):
Therefore, the NRC staff finds that the extirpation of Hudson River rainbow smelt does not warrant changing the finding from Moderate-Large to Small.

On page 130, NRC show the new text for the FEIS in which they have changed the aquatic impact due to impingement and entrainment from "Small to Large" to "Small to Medium". This does not seem warranted, given the overall decline in fish in the Hudson.

[1] Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 38, Volume 5, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment (NUREG–1437).

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In table A-13 (reproduced below) the assessment for several different measures of population are given. In this table the value 4 is shown every time a detected decline is found. Note that out of the 18 species listed, 11 species show a detected decline in one or more of the metrics used, another 4 were not possible to analyse and only 3 show no signs of any decline. This is a greater proportion of species showing a population decline that we found in our report *"The status of fish populations and the ecology of the Hudson (2015)"*.

Table A13: Assessment of Riverwide Population Impacts. Species with a least one metric showing a decline marked in bold.

Species	CPUE			Abundance Index			Riverwide Assessment
	LRS	FSS	BSS	LRS	FSS	BSS	
Alewife	1	1	1	N/A(a)	N/A	1	1
American Shad	**4**	**4**	**4**	**N/A**	**N/A**	**4**	**4**
Atlantic Menhaden	N/A	N/A	N/A	N/A	N/A	N/A	Unknown
Atlantic Sturgeon	N/A	N/A	N/A	N/A	N/A	N/A	Unknown
Atlantic Tomcod	**4**	**4**	**4**	**4**	**N/A**	**N/A**	**4**
Bay Anchovy	**1**	**1**	**1**	**N/A**	**4**	**N/A**	**1.8**
Blueback Herring	**1**	**4**	**1**	**N/A**	**N/A**	**4**	**2.5**
Bluefish	**4**	**4**	**1**	**N/A**	**N/A**	**1**	**2.5**
Gizzard Shad	N/A	1	1	N/A	N/A	N/A	1
Hogchoker	1	1	1	N/A	1	N/A	1
Rainbow Smelt	**4**	**4**	**N/A**	**4**	**N/A**	**N/A**	**4**
Shortnose Sturgeon	N/A	N/A	N/A	N/A	N/A	N/A	Unknown
Spottail Shiner	**1**	**4**	**1**	**N/A**	**N/A**	**1**	**1.8**
Striped Bass	**1**	**4**	**1**	**N/A**	**N/A**	**1**	**1.8**
Weakfish	**1**	**1**	**1**	**N/A**	**4**	**N/A**	**1.8**
White Catfish	**1**	**4**	**1**	**N/A**	**N/A**	**4**	**2.5**
White Perch	**1**	**1**	**1**	**N/A**	**N/A**	**4**	**1.8**
Blue Crab	N/A	N/A	N/A	N/A	N/A	N/A	Unknown

To assess the impact of the station, the NRC undertook two further calculations, the first to assess the strength of the connection (SOC) between fish present in river section 4 and the fish impinged or entrained on the station (the SOC measures presented in table A-16). Secondly the NRC used the population trends in River section 4 (from river mile 39 to 46) to compare against the overall river trends to attempt to find if the decline in the population is relatable to the station (Weight of evidence – (WOE) Table A-14).

There are several issues with this analysis. The first is that the data are only available for the period after the power plant had started operation; IP2 started in 1974 and IP3 in 1976. The data used most in the analysis (table 4-1, page 34) are from 1985 – 2011. The exception is the utilities' river wide index, which extended from 1974 - 2011. The result of this is that if the power plant were impacting the fish populations, much of the impact would be invisible using these data, as the station had already been running for more than a decade before the analysis started. The NRC acknowledge this issue; for example, looking at the young of year (YOY) (Page A-7):

The YOY populations may have responded soon after operation began and subsequently restabilized at lower levels before 1985, which argues for using data starting in 1975 as in the FSEIS, but the sampling protocols from 1985 through 2011 were relatively consistent and did not include the gear change for bottom and shoal strata in the FSS in 1984–1985, which simplifies the analysis and is used here.

River section 4 analysis was undertaken mainly in the 1985-2011 data. The Riverwide data is from 1974-2011.

Secondly, the use of the River Segment 4 fish population as a surrogate for the impact of the station is problematic. This section of river (from River mile 39-46) is only 8 miles long. In a tidal system such as the Hudson, young fish can move several miles in a day and as such can rely on a long stretch of river. Several of the fish species impacted are migratory. These species may not spend long in the vicinity of the power plant, but that does not mean the impact is any less significant.

Thirdly, attempting to assign cause from a single source of impact on to a population is difficult. There is a lot of random noise in ecological data, both from the true variability of a species and the intrinsic errors in the sampling methodologies. This means that a population must often vary by a large amount before the change is detectable in the sampling results. For some highly variable species, even proving a reduction by half in the size of a population is difficult and requires a lot of data.

The NRC acknowledges that the river is warming (page 90), as did we in our status report. This means that the thermal load added to the river by the power plant is likely to become more important as the river warms if climate warming continues. This warming has also contributed to changes in the fish community, as we state in our "*Status of the Hudson*" report:

All the evidence points to the Hudson ecosystem presently being in a state of change, with declining stability. Neither the ecosystem as a whole nor many of the individual species' populations are in a healthy state.

This view is supported in the NRC report (page 30):

Furthermore, Hattala et al. (2012) observed:

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The underlying reason for the wide variation in YOY river herring indices is not clear. The same erratic trend that occurs since 1998 is also evident for American shad (Hattala and Kahnle 2007). The trend in all three alosines may indicate a change in overall stability in the system.

This conclusion regarding stability is similar to the conclusion that the NRC staff reached.

and again at page 92:

O'Connor et al. (2012) examined the effects of climate change on the Hudson River estuary fish community over 32 years from 1974 through 2005 using data from the sampling surveys done by the Hudson River electric utilities; these surveys are the same ones that the NRC staff examined in other sections of this supplement. O'Connor et al. chose a variety of resident marine, freshwater, and anadromous fish species and life stage combinations to represent the fish community. They found that the Hudson River estuary fish community has changed significantly over the 32-year time period and that similar changes have been reported in other estuaries. They examined 20 species life stage combinations and found that changes correlate with local hydrology (freshwater flow and water temperature) and regional climate.

Finally, the document does not consider the effect to the Tappan Zee bridge construction project as an in combination effect with the power plant, particularly with the endangered sturgeon species. The bridge appears to have increased the number of sturgeon (both Atlantic and shortnose) that are being killed in the river. The building project has several years to go and the in combination effects of this project and the continued operation of the power plant should be considered.

The overall conclusion of the NRC that the impact of the station on impingement and entrainment is now "Small to moderate" rather than "Small to Large". I do not agree with this for the reasons outlined above. Populations which are declining cannot take any additional morality, without it having an impact on the population. The fact that the reason for decline is multifactorial is not in doubt, but all parties must do what they can to reduce their damage.

For the NRC to change the assessment of the thermal impact from "Small to Large" to "Small" is at odds with the evidence they present on climate change and the warming of the Hudson River.

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NEW YORK STATE | Homeland Security and Emergency Services

ANDREW M. CUOMO
Governor

JOHN P. MELVILLE
Commissioner

February 29, 2016

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission (FERC)
888 First Street NE, Room 1A
Washington, DC 20426

RE: Docket No. CP14-96-001: New York State Request for Reconsideration of the March 2015 Order providing a certificate of public convenience and necessity to construct and operate the Algonquin Incremental Market (AIM) Project ("Project") in order to commence an immediate independent safety risk analysis

Dear Secretary Bose,

New York Governor Andrew M. Cuomo has directed the Department of Homeland Security and Emergency Services (DHSES), the New York State Department of Environmental Conservation (NYSDEC), the New York State Department of Health (NYSDOH) and New York State Department of Public Service (DPS) to immediately commence an independent safety risk analysis of Spectra Energy's Algonquin Incremental Market (AIM) project, specifically near Entergy's Indian Point Nuclear Facility (known as Indian Point Energy Center or IPEC).

At the direction of the Governor, our agencies are currently undertaking a full investigation into recent significant issues at IPEC. Specifically:

- May 7, 2015 IPEC's nuclear reactor Unit 3 was shut down by plant operators to repair a steam leak associated with the steam generator.
- May 9, 2015 a main transformer at Unit 3 short-circuited and caught fire due to a failure of insulation within the transformer. The plant shut down automatically and Entergy declared an unusual event level emergency.
- June 15, 2015 Unit 3 automatically shut down after an electrical disturbance in the switchyard caused a turbine to shut down.

- July 8, 2015 Unit 3 was shut down by plant operators after they determined that steam generator water levels were lowering due to the unexplained failure of a condensate pump.
- December 5, 2015 IPEC's nuclear reactor Unit 2 was powered down after approximately 10 control rods inserted into the reactor core.
- December 14, 2015 Unit 3 shutdown due to an electrical disturbance in the switchyard.
- February 6, 2016 a radioactive tritium leak at IPEC that has caused groundwater radioactivity levels to rise more that 65,000 percent.

The investigation is specifically looking into whether operational problems have caused this most recent leak. The tritium leak is just the latest of an increasing number of safety incidents at the Indian Point Nuclear Facility in the past year.

Nuclear reactor Units 2 and 3 at IPEC have shutdown unexpectedly seven times in 2015. An investigation is underway to determine the impacts of these shutdowns on operations of the units and to determine whether Entergy is appropriately investing in capital expenditures and operation and maintenance budgets to ensure reliable and adequate operations of the facility.

The AIM Project's path will require horizontal directional drilling under the Hudson River and adjacent to Indian Point. While the applicant has committed to build the pipeline to a more stringent standard on the Indian Point grounds, including laying two concrete liners above the pipeline to prevent excavation damage, burying the pipeline deeper than required, and using a stronger grade of steel than is required even in high consequence areas, it is imperative to determine if this is enough in light of the recent significant tritium leak and other operational difficulties at the nuclear facility. An independent safety risk analysis will address the adequacy of those mitigation efforts. We will share the results with you immediately upon receiving them.

Until this independent safety risk analysis is completed, we ask the FERC stay and reconsider its prior determination to grant a certificate of public convenience and necessity to ensure that the health and safety of all New Yorkers is adequately protected. Specifically, FERC must reconsider whether the proximity to Indian Point and the construction methods required to install the Project would have an impact on the recent increasing leaks of tritium into ground water or otherwise increase the potential for serious operational problems at Indian Point.

These ongoing State investigations may reveal newly discovered information related to the environmental, health and safety risks posed by siting the Project near IPEC. Such new information may warrant reopening the record on this issue, which could ultimately necessitate a different conclusion by FERC. Until these investigations are complete and the analysis of the safety issues done, the Project should not be allowed to proceed. Thank you for your consideration and prompt attention to this matter.

Sincerely,

John Melville
Commissioner
Department of Homeland Security and Emergency Services

Audrey Zibelman
Chair
Public Service Commission

Basil B Seggos
Commissioner
Department of Environmental Conservation

Howard Zucker M.D.

Howard Zucker
Commissioner
Department of Health

The status of fish populations and the ecology of the Hudson

Pisces Conservation Ltd,
June 2015

Prepared by
Drs Peter A. Henderson and Richard M. H. Seaby

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Executive Summary

Using the 2013 and earlier year class reports back to 1974 for fish in the Hudson estuary, an assessment of the present status and the trends in fish populations is presented. The physical environment is the foundation upon which the biological community of the estuary rests. Long-term data from the Poughkeepsie Water Treatment Facility show that water temperature in the Hudson is increasing. The mean annual temperature in recent years is about 2 °C (3.6 °F) above that recorded in the 1960s, an increase sufficient to impact some fish. There is, however, not a simple pattern of temperature increase. Recent observations show that the seasonal temperature variation is becoming more extreme. Daily temperatures in 2005 for several summer months were close to the maximum ever recorded. However, in the winter, there were some of the lowest temperatures recorded over a 53-year period. This pattern is repeated in the more recent period. High levels of dissolved oxygen are essential for a healthy ecosystem. Probably linked to the zebra mussel invasion and to a lesser extent the average increase in temperature, there has been a marked decrease in dissolved oxygen in the estuary.

Statistical analysis shows that the fish community of the Hudson estuary has been continuously changing since systematic recording began in the 1980s. It is concluded that the fish community has been changing rapidly since 1985 and is now showing clear signs of increased instability with greater year-to-year variation in abundance. It is notable that these changes have not been accompanied by changes in total fish species number, which has undergone no appreciable change since 1985.

Of the 13 key species subject to intensive study, six species have shown no trend in abundance since the 1980s. The other 7 species have declined in abundance, some greatly. Particularly significant negative trends are observed in yearling white perch, and juvenile American shad, white catfish, tomcod, blueback herring and weakfish. The vulnerability of white perch was even noted in 1974 "*Overall, the degree of exposure to entrainment and impingement at the five power plants is probably highest for white perch, ...*" (page II-9 of the 1974 year class report). The dynamics of the white catfish and American shad are indicative of population heading towards local extinction. The rainbow smelt has seemingly gone locally extinct. Many other important species of fish are also showing long-term declines in abundance. For example, the American eel has greatly declined.

In 2008 we reported that striped bass, bluefish and spottail shiner had shown a trend of increasing abundance since the 1980s. This is no longer the case and there are indications that striped bass have started to decline post-2001.

All the evidence indicates that the Hudson estuary ecosystem is in a state of change, with declining between-year stability since 2000. Neither the ecosystem as a whole, nor many of the individual constituent species' populations, is in a healthy state.

Contents

Figures

Tables

1 Introduction

In 2008 Riverkeeper asked Pisces Conservation to assess the state of the fish in the Hudson, using the latest available data. Their report reviewed the fish populations and ecology of the Hudson using the 2005 Year Class Report for the Hudson River Estuary Monitoring Program, reports and assessments prepared by the New York State Department of Environmental Conservation (NYSDEC) and the Atlantic States Marine Fisheries Commission (ASMFC), as well as published materials and other literature then available. This document is a revision of this original report using data available from the 1974 and 2013 Year Class Reports.

2 Large scale and synoptic features

As we will describe below, the fish community is not stable in the Hudson. The ecosystem appears to be declining in terms of stability. The estuary is in a state of flux, with temperatures increasing, dissolved oxygen decreasing, invasive species, including diseases, expanding their range, and indigenous species both increasing and decreasing.

Because the physical environment is the foundation upon which the biological world is built, we first consider recent changes in temperature and oxygen levels in the estuary. Both these variables are influenced by the power plant discharges. The natural temperature regime in the Hudson is notably extreme for a temperate estuary, with one of the largest known seasonal ranges for a large estuarine habitat. This in turn influences the fish community, and makes the species present particularly vulnerable to changes in temperature, or the local effects of a power plant cooling water discharge.

2.1 Temperature in the Hudson

In 2008 we wrote "*water temperature in the Hudson is increasing. This is clearly demonstrated by the statistically significant increase in mean average annual water temperature measured at Poughkeepsie Water Treatment Facility (Figure 1). The mean annual temperature in recent years is about 2 °C (3.6 °F) above that recorded in the 1960s.*" This trend is continuing as shown in Figure 1 below. Note that the average temperature in 2012 was the highest yet recorded.

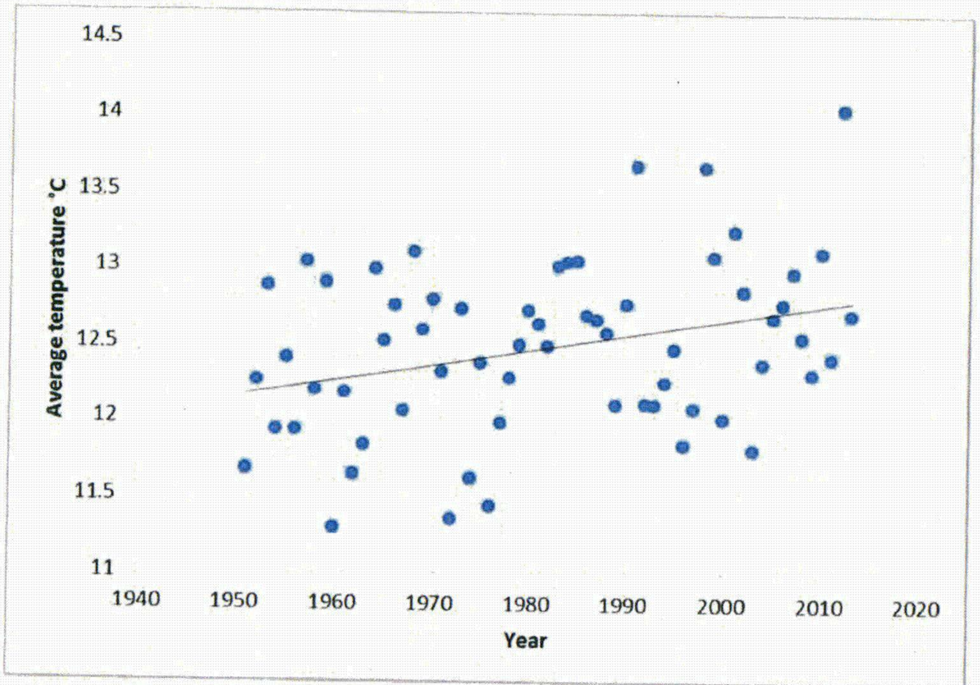

Figure 1: Average annual water temperature (°C) as measured at Poughkeepsie's Water Treatment Facility, 1951 to 2013

($a = 0.0101$, $b = -7.591$, $F = 7.514$, $p = 0.00802$).

Data from 2013 Year Class report – Appendix B, Table B - 6

In 2008 we noted that examination of the daily temperatures for 2005 plotted against the mean, minimum and maximum temperatures from 1951 to 2004, showed that the temperature for several summer months in 2005 was close to the maximum ever recorded (Figure 2). However, in the winter, it also reached some of the lowest temperatures recorded over a 53-year period. In summary, the temperature regime is becoming more extreme. This conclusion from 2008 still holds. In Figure 3 we plot the 2013 data against the maximum/minimum temperatures from 1954-2012.

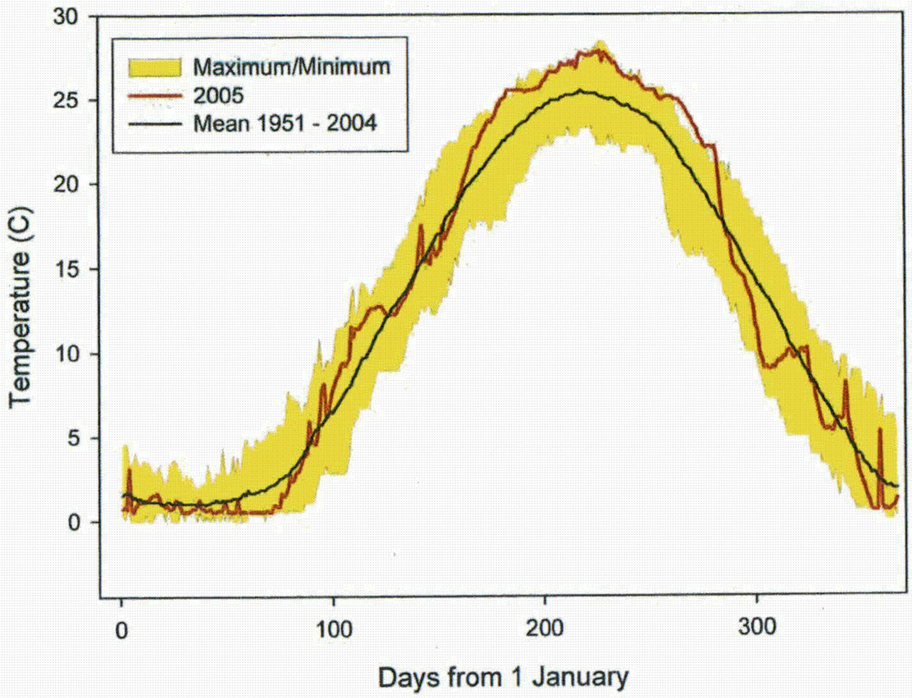

Figure 2: Poughkeepsie's Water Treatment Facility data; mean, minimum, and maximum temperature (°C) for each day of the year, 1951 to 2004. 2005 data plotted in red.

Data from 2005 Year Class report – Appendix B, Table B - 5

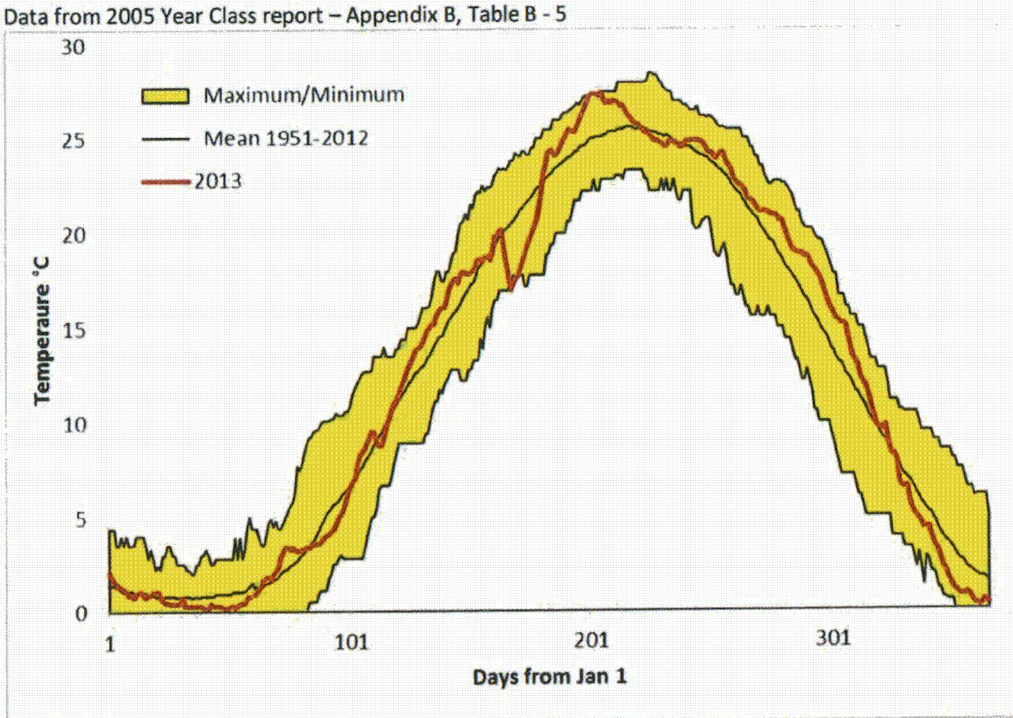

Figure 3: Poughkeepsie's Water Treatment Facility data; mean, minimum, and maximum temperature (°C) for each day of the year, 1951 to 2012. With 2013 data plotted in red.

Data from 2013 Year Class report – Appendix B, Table B - 5

2.2 *Thermal tolerance of fish species found in the Hudson*

The effects of temperature on the biology and ecological requirements of fish have been extensively studied and reviewed. Temperature can affect survival, growth and metabolism, activity, swimming performance and behaviour, reproductive timing and rates of gonad development, egg development, hatching success, and morphology. Temperature also influences the survival of fishes stressed by other factors such as toxins, disease, or parasites. Many of these effects will occur well below the upper lethal temperatures, which are tabulated below for a range of common Hudson fish. In Table 1, the upper temperatures that a range of Hudson River fish can tolerate are given, together with the acclimation temperature. When no size is given, the values are for adults. Generally, young and small fish are more vulnerable to elevated water temperatures than adults. Maximum summer water temperatures in the Hudson are about 81 °F (27.2 °C), which the table shows most fish can just tolerate. For some, such as the tomcod, it is too hot and they must seek cooler waters (for example by heading towards the ocean).

The least temperature-tolerant of the species in Table 1 are tomcod, alewife, rainbow smelt, yellow perch and American shad. As will be discussed later, this list includes species that have seen recent large declines in abundance.

Table 1: The upper tolerance limit for common Hudson estuary fish.

The temperature at which the fish were acclimated prior to testing is also given.
Source: Henderson & Seaby (2007).

Species	Latin name	Acclimation temperature, °C	Upper tolerance limit, °C
Carp	*Cyprinus carpio*	20	31-34
Largemouth bass	*Micropterus salmoides*	20	32.5
		30	36.4
Blue gill	*Lepomis macrochirus*	15	30.7
3-spined stickleback	*Gasterosteus aculeatus*	25-26	30.6
Yellow perch	*Perca flavescens*	15	27.7
Alewife	*Alosa pseudoharengus*	15	23
Rainbow smelt	*Osmerus mordax*		21
Sea lamprey	*Petromyzon marinus*		34
Tomcod	*Microgadus tomcod* 2 cm		19-20.9
	14-15 cm		23.5-26.1
	22-29 cm		25.8-26.1
Common shiner	*Notropis cornutus*	15	30.3
Brown bullhead	*Ictalurus nebulosus*	15	31.8
Striped bass	*Morone saxatilis* yolk sac		Mortalities start at 26
	Post yolk sac		Mortalities start at 30
	Early juveniles		Mortalities start at 34
American shad	*Alosa sapidissima*		28
White perch	*Morone americana*		32-34

2.3 Oxygen in the Hudson

In 2008 we noted a decline in oxygen and assumed that this decline was likely related to increased average water temperatures, as oxygen solubility declines with increasing water temperature. We noted the following features. *"The temperature of water has a direct effect on the dissolved oxygen (DO) concentration, which declines with increasing water temperature. This results in many fish and other aquatic organisms living in below-optimal oxygen levels during hot summer periods. As would be predicted, the significant upward trend in temperature has resulted in a statistically significant downward trend in DO (Figure 4 and Figure 5). The sharp decline in DO in 2004 and 2005 is particularly notable."*

By 2013 the decline in oxygen has not been reversed although it may have stabilised at a new, lower, level (Figure 6 & Figure 7). Using the data from 1980 to 2012 for which there are no missing years, a break-point analysis was undertaken to detect step changes in oxygen levels. It is clear that sometime between 1999 and 2006 there was a notable decline in dissolved oxygen. Since our 2008 report the evidence has been accumulating that the decline in oxygen is linked to the zebra mussel invasion[1]. It is therefore likely that the major decline in dissolved oxygen is primarily driven by zebra mussel respiration, with increased temperature making a smaller contribution.

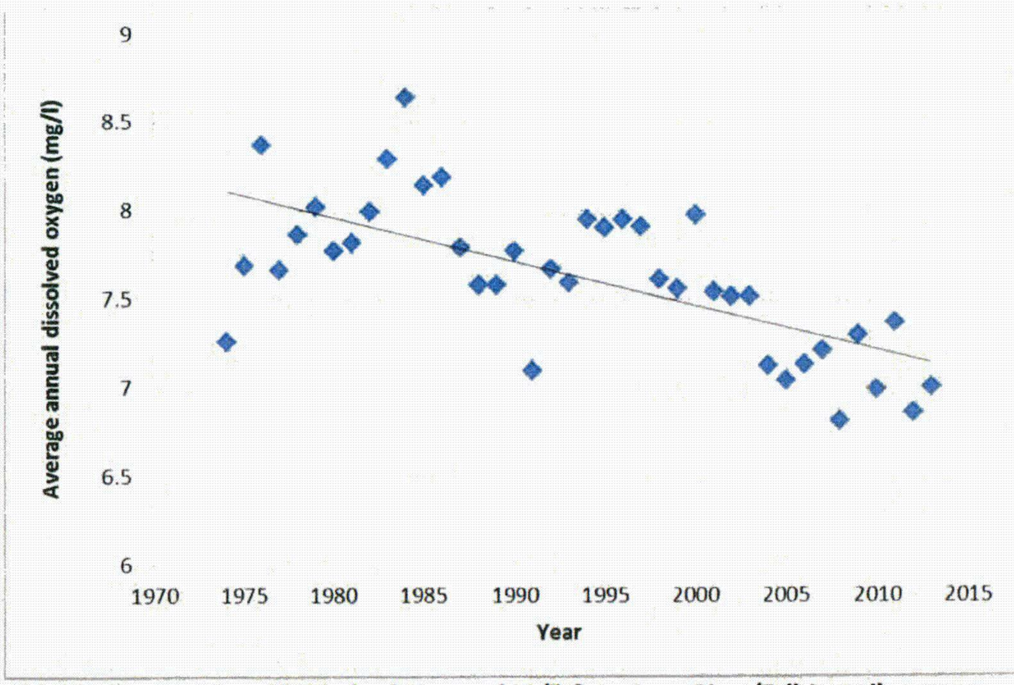

Figure 4: Average Annual Dissolved Oxygen (mg/l) from Long River/Fall Juvenile surveys, 1974 to 2013.
($a = -0.0247$, $b = 56.83$, $F = 30.8$, $p < 0.0001$).
Data from 2013 Year Class report – Appendix B, Table B - 14

[1] Caraco, Nina F., *et al.* "Dissolved oxygen declines in the Hudson River associated with the invasion of the zebra mussel (*Dreissena polymorpha*)." Environmental science & technology 34.7 (2000): 1204-1210.

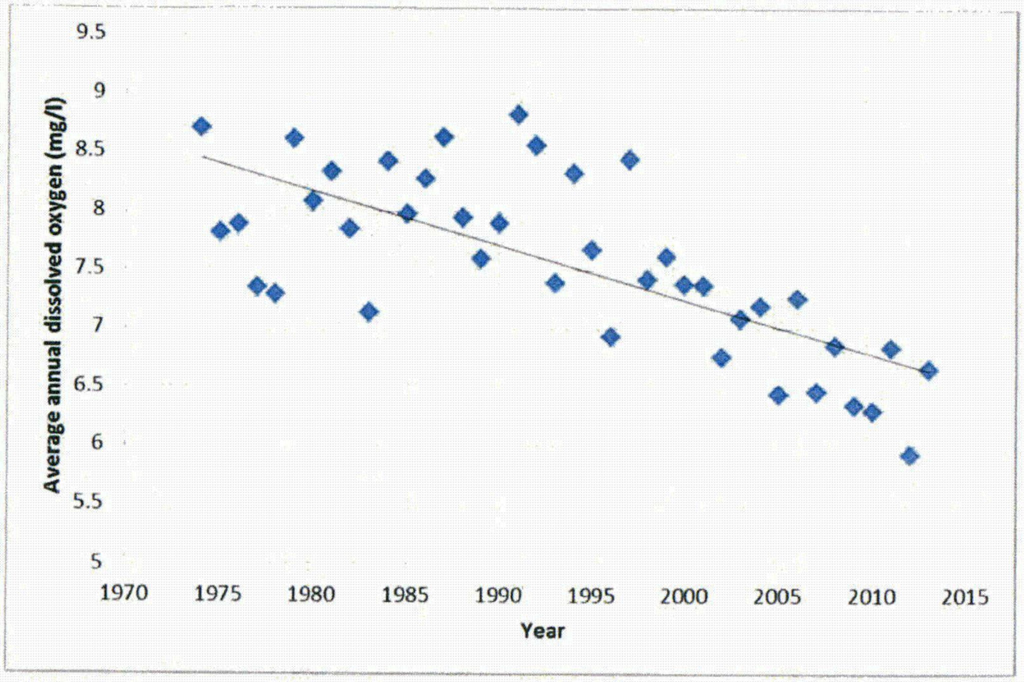

Figure 5: Average Annual Dissolved Oxygen (mg/l) from Beach Seine surveys, 1974 to 2013

(a =-0.0463, b = 99.75, F =39.55, p < 0.001).

Data from 2013 Year Class report – Appendix B, Table B - 16

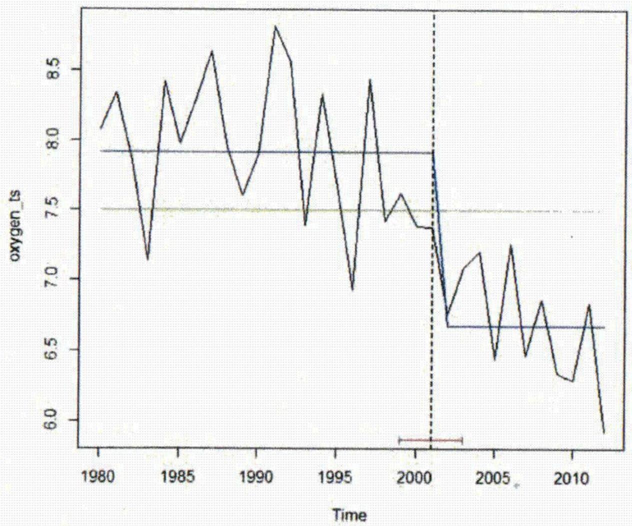

Figure 6: Average Annual Dissolved Oxygen (mg/l) from Beach Seine surveys, 1980 to 2012. The dotted line marks the year in which break-point analysis indicates a clear change in oxygen availability occurred. The red line indicates that this break point could be located over a range of years between 1999 and 2003.

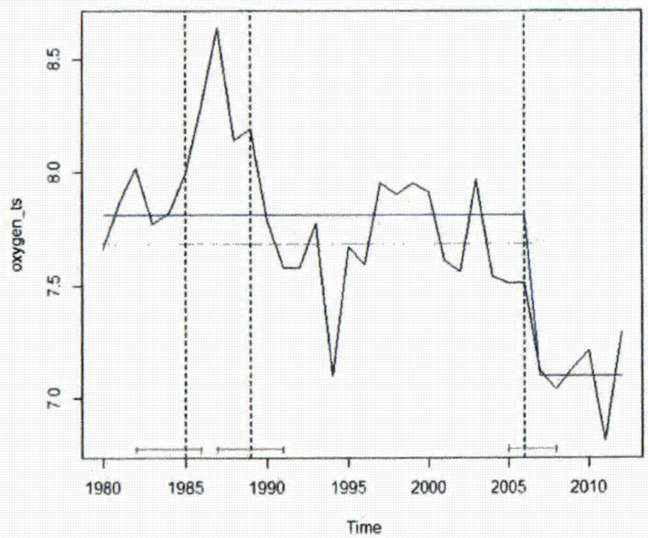

Figure 7: Average Annual Dissolved Oxygen (mg/l) from Long River/Fall Juvenile surveys, 1980 to 2012. The dotted lines mark the years in which break-point analysis indicates a clear change in oxygen availability occurred. The red lines indicate the range of years over which each break may have occurred.

Given the considerable efforts that have been taken to reduce organic pollution, and the great improvement in water quality in the vicinity of New York City, these declines in DO are disappointing, and potentially important indicators of a decline in water quality for fish.

The distribution of DO within the water column is complex. It can be affected by many factors including tidal flow, riverine metabolism, stratification and atmospheric diffusion. A typical profile of DO versus depth is shown in Figure 8.

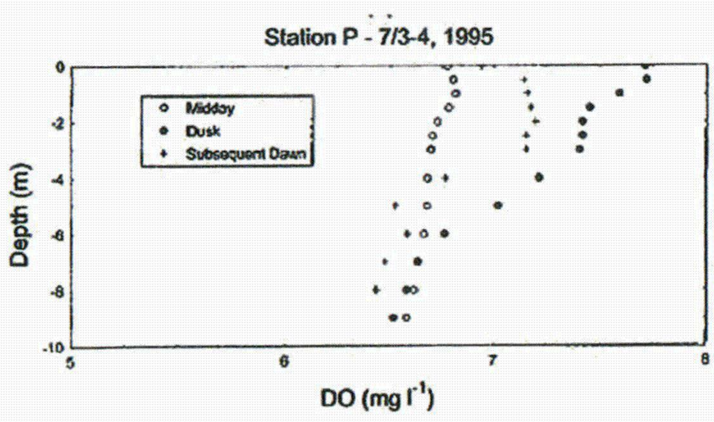

Figure 8: Typical depth profiles of DO measured on 3–4 July 1995 at Haverstraw Bay.

Profiles for three sample times are shown for each station.
Source: Swaney *et al* 1999

This figure shows that in 1999 the amount of oxygen in the water is often higher at the surface, and is increased during daylight hours as result of oxygen released by photosynthesis. The levels of DO are often reduced overnight as oxygen is metabolised by the organisms in the river. This diurnal pattern may have changed post-2003 as zebra mussel filtration has reduced the available phytoplankton.

3 The abundance of fish

3.1 *The Annual Year Class Index*

Since 1973, data have been collected from the Hudson in an attempt to quantify the size of the populations of 16 species of fish that are found in the Hudson. The 16 species of fish were identified by the New York State Department of Environmental Conservation (NYSDEC) as being of interest in relation to the Hudson Settlement Agreement power plants' environmental impact. The data collection changed significantly in 1988, when a new area (Battery) was introduced to the sampling.

The fish of the Hudson live in many different parts of the river, in many different habitats. No single method of surveying fish can adequately represent this variation. The Year Class Index is therefore estimated from three separate studies (Table 2).

Table 2: Names and lengths of the three surveys that make up the Annual Year Class Index

Name	Dates	Known as
Long River Ichthyoplankton Survey	1974-2013	LRS or Long River Survey
Fall Juvenile Survey	1979-2013	FJS or Fall Shoals Survey
Beach Seine Survey	1974-2013	BSS

3.1.1 Brief descriptions of each survey.

3.1.1.1 Longitudinal River Ichthyoplankton Survey

Sampling encompassed the entire length of the Hudson River estuary, from River Mile (RM) 1 at the Battery in Manhattan to RM 152 at the Federal Dam in Troy.

The LRS is designed to estimate the numbers, and distribution of eggs, larvae and post yolk sac larvae (PYSL) for selected Hudson River fish species – it also catches some juveniles. The primary species were Atlantic tomcod (*Microgadus tomcod*), American shad (*Alosa sapidissima*), striped bass (*Morone saxatilis*), white perch (*M. americana*) and bay anchovy (*Anchoa mitchilli*). LRS sampling is undertaken during the peak period for the young life stages of the fish, which is spring, summer, and early fall.

The survey is undertaken using a 1 m Tucker trawl towed upstream. The Tucker trawl is mounted on an epibenthic sled to sample the deeper waters.

3.1.1.2 *Fall Juvenile Survey*

Samples are collected every other week from the Battery to the Troy Dam in mid-summer and fall.

The FJS is designed to estimate the number of Young of the Year (YOY) fish in the estuary, and their distribution. The target species are Atlantic tomcod, American shad, striped bass, and white perch.

The survey is undertaken using a 1 m Tucker trawl and a 3 m beam trawl towed upstream.

3.1.1.3 *Beach Seine Survey (BSS)*

Samples were collected in alternate weeks to those of the FJS, using a beach seine from mid-June through October. The samples are taken from George Washington Bridge (RM 12) to the Troy Dam.

The BSS is designed to estimate the number of Young of the Year (YOY) fish in the estuary, and their distribution. The target species are American shad, Atlantic tomcod, striped bass, and white perch during periods when these species were concentrated primarily in the shallow, near-shore areas.

The survey is undertaken using a 30.5 m beach seine. The area sampled was approximately 450 m^2 per haul.

3.1.2 Where in the river is sampled

The 13 sections of the river (Figure 9) were divided into four habitat types:

- **Shore** - That portion of the Hudson River estuary extending from the shore to a depth of 10 feet (the stratum defined only for BSS).
- **Shoal** - That portion of the Hudson River estuary extending from the shore to a depth of 20 feet at mean low tide.
- **Bottom** - That portion of the Hudson River estuary extending from the bottom to 10 feet above the bottom where river depth is greater than 20 feet at mean low tide.
- **Channel** - That portion of the Hudson River estuary not considered bottom where river depth is greater than 20 feet at mean low tide.

Sampling is spread among the different habitats and river sections, throughout the year. Table 3 shows where the samples were taken from for each survey type.

Table 3: Habitat samples in the 13 regions of the Hudson in 2013

(-- indicates no sampling scheduled)

Source: 2013 Year Class report, Table 2-1.

			River	2013 surveys			
Region	Abbreviation	River miles	Kilometers	Shore	Shoal	Channel	Bottom
Battery	BT	1-11	1-19	--	--	X	X
Yonkers	YK	12-23	19-39	X	X	X	X
Tappan Zee	TZ	24-33	39-55	X	X	X	X
Croton-Haverstraw	CH	34-38	55-63	X	X	X	X
Indian Point	IP	39-46	63-76	X	X	X	X
West Point	WP	47-55	76-90	X	--	X	X
Cornwall	CW	56-61	90-100	X	X	X	X
Poughkeepsie	PK	62-76	100-124	X	--	X	X
Hyde Park	HP	77-85	124-138	X	--	X	X
Kingston	KG	86-93	138-151	X	--	X	X
Saugerties	SG	94-106	151-172	X	--	X	X
Catskill	CS	107-124	172-201	X	--	X	X
Albany	AL	125-152	201-246	X	--	X	X

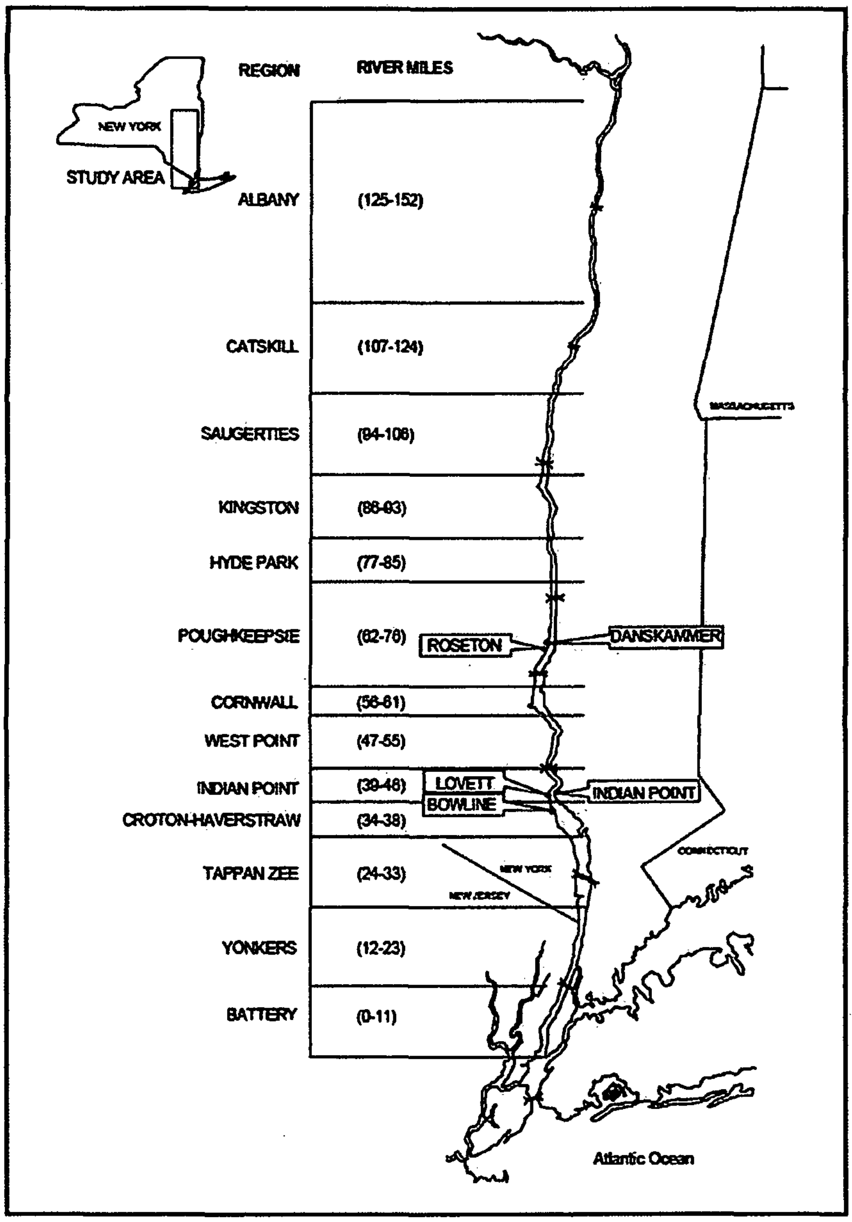

Figure 9: The 13 geographical locations with river mile boundaries used in the Hudson River surveys.

Source: 2005 Year Class report, Figure 2-1.

3.1.3 What ages of fish are sampled

During the sampling, several different life stages of fish are caught. The definitions for each stage are given in Table 4.

Table 4: Life stages of fish sampled.

Source: 2013 Year Class report, page 2-6.

Egg	Embryonic stage from spawning to hatching
Yolk Sac Larvae (YSL)	From hatching to development of a complete and functional digestive system
Post Yolk Sac Larvae (PYSL)	From development of a complete digestive system to transformation to juvenile form
Young of Year (YOY)	From completed transformation to Age 1.

An index is calculated separately for each of the life stages. For some species only some life stages are well-sampled. For example, bay anchovy breeds at the mouth of the estuary and therefore an index is only calculated for YOY.

3.1.4 How the fish are counted

Each of the three surveys used slightly different methods to catch the fish. Each method has advantages and disadvantages, and a direct one-to-one comparison of the results is not meaningful. Therefore, a series of indices derived from the catch data are used to combine the data into a single value, indicating the population size.

3.1.5 Calculations of the index

Gathering fish sampling data, and processing that information, is not a straightforward procedure. To obtain a reasonable estimation of how many fish of what age are in the Hudson in any year requires three separate surveys, which are undertaken over several months. Combining the data from these surveys is complex, as the efficiency of the fishing gear, effort used in each survey, and the age of the fish, are all different.

In a survey that is carried out over many years, it is inevitable that some factors will change between years. This can occur in several ways. For example, each year the total number of samples and volume sampled will vary (Figure 10 and Figure 11) due to gear failure, weather, and management decisions. In addition, sample sites may be added or removed from the survey, altering the coverage of fish species; for instance the introduction of sampling in the Battery area in the mid-1980s improved the estimate of bay anchovy numbers.

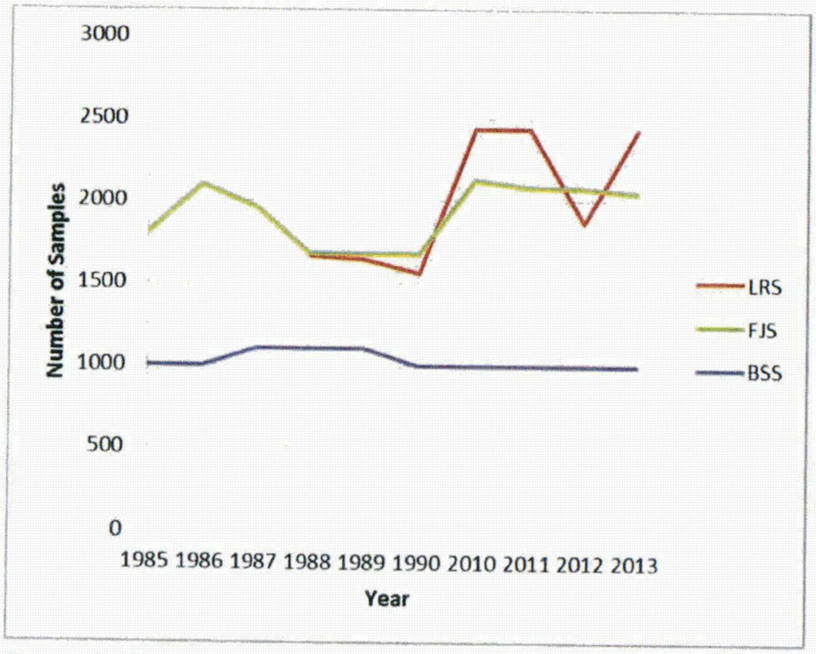

Figure 10: The number of samples per year for the three Hudson River surveys

Source: 2013 Year Class report, Tables C1 to C3

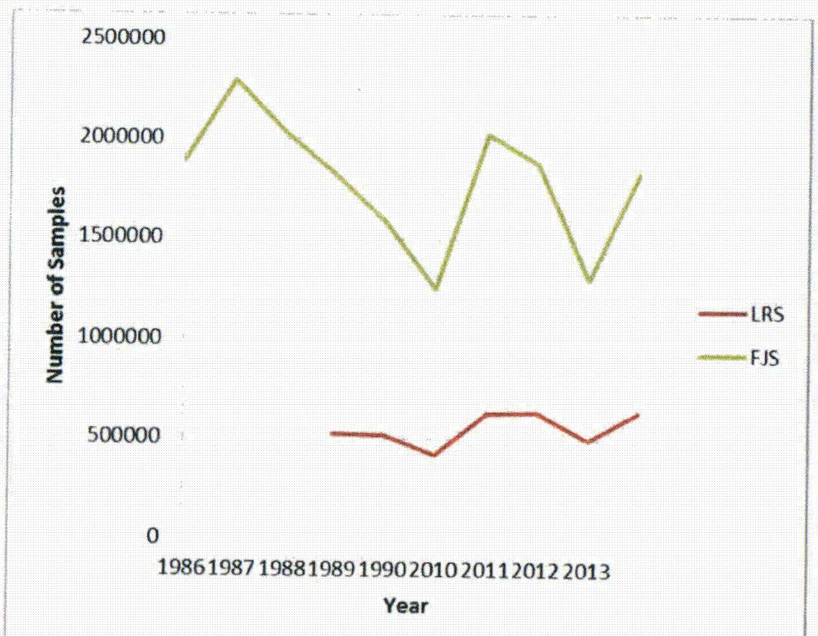

Figure 11: The volume of water sampled in the Long River Survey and the Fall Juvenile Survey.

Source: 2013 Year Class report, Tables C1 and C2.

To cope with the variations in the sampling between years, and also the sampling effort in different areas, an index needs to be calculated that indicates how many fish are present in each year. The actual calculation is complex, but in essence the number of fish actually caught is adjusted in each life stage to a number representing the number caught under some standardized sampling effort.

As a simple example, if 200 fish were caught in a survey of 50 samples in one year, and 100 fish were caught in 10 samples the next year, the index might be standardised at 25 samples, giving an index of 100 for year one and 250 in year two.

Full explanations are given in the 2013 Year Class report, pages 2-10 to 2-23.

3.2 Changes in community structure

The extensive data sets produced by the Long River, Fall Juvenile and Beach Seine Surveys allow a general analysis of the change in fish community structure since the 1980s.

Since 1985, there is no evidence for an appreciable change in total fish species number in the estuary. However, this apparent stability hides great changes in the actual species present and their relative abundances. To compare the structure of the communities through time, the annual abundance data from all three surveys were analysed, using a number of multivariate statistical methods. As all the methods investigated lead to the same conclusion, we use here Principal Components Analysis (PCA), which is a standard technique familiar to most scientists. PCA is a method used to summarise the relationship between objects. Here we use it to summarise the relationship between the fish communities living in the Hudson in different years. PCA allows us to plot a simple graph in which the most similar years, in terms of their fish community, are plotted closest together, and the years which are most different in terms of their fish are furthest apart. So, for example, in Figure 12 B, the green triangular points represent the fish community in the 1980s. The 5 points forming a distinct cluster towards the right of the graph, indicating that the fish community in these years was similar. In contrast, the blue red and orange points for the post-1989 years are all to the left, indicating that the community after 1989 was different from that observed in the earlier 1980s.

The graphs in Figure 12 clearly show that there has been a progressive change in the fish community sampled by all three surveys, with a particularly large change occurring during the 1990s. Samples collected in the 1980s (green triangles) form a distinct group, indicating that the community during this period had a characteristic composition which differs from that now observed. In comparison, the community post-2000 is considerably different, and shows increased between-year variability, in that they are more widely dispersed across the plot. Further, the Long River Survey analysis indicates that 2012 and 2013 are considerably different from any other year and the Fall survey results indicate that 2010-2013 fish fauna was the most different yet observed from that present in 1980s. It can be concluded that the fish community has been changing rapidly since 1985 and is showing clear signs of increased between-year instability, in that between-year differences are generally larger than observed in earlier periods. Increasing between-year variation has been previously noted by Hurst *et al* (2004).

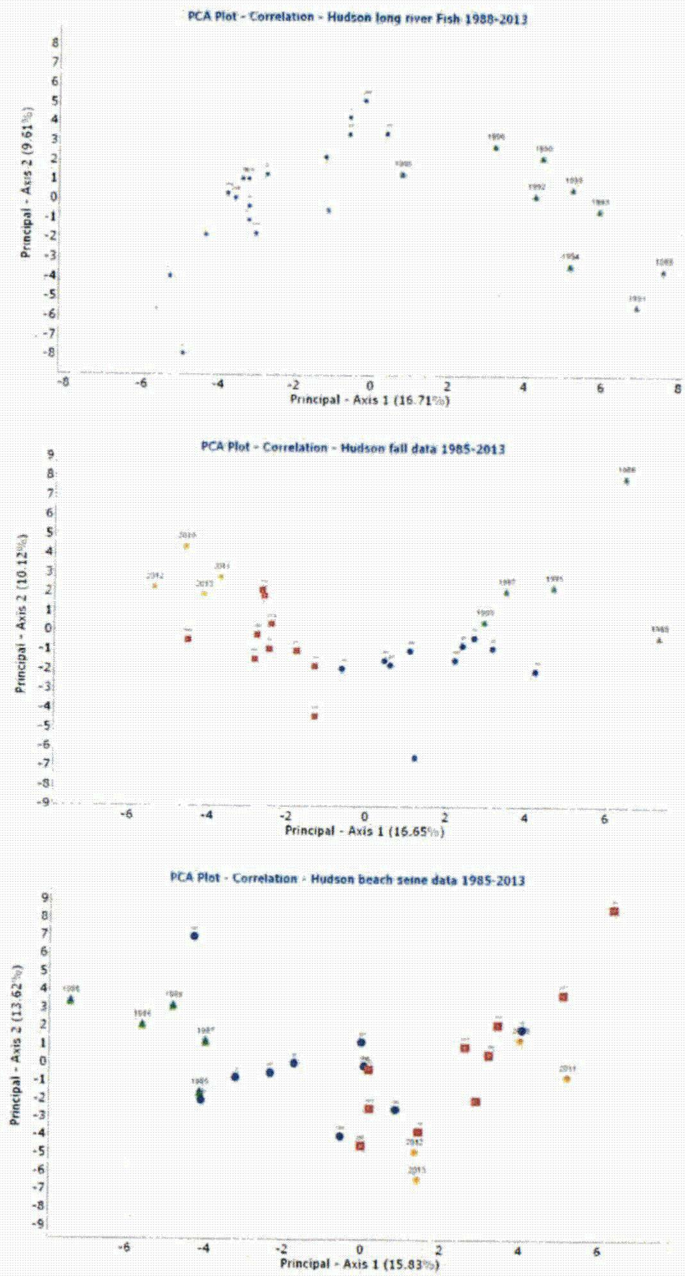

Figure 12: Principal Components Analysis of fish survey data shows the change in the community from the 1980s to 2013.

Data from 2013 Year Class report – Appendix C, Tables C-1 to 3.

4 Hudson River fish populations

4.1 *Striped bass (Morone saxatilis)*

Striped bass are anadromous (marine fish that breed in freshwater) members of the temperate bass family. They are found from the St Lawrence River in Canada to Florida. The species has been introduced successfully into several freshwater systems. The Hudson is one of the main breeding rivers for this species. They breed from 4 years old and can live for many years. In the Hudson, spawning occurs from mid-May to mid-June in the middle reaches of the river. As adults they are top predators.

We reported in 2008 that striped bass populations were known to be doing well in the north east coast of the USA, and the population had shown a steady increase from the early 1980s (Figure 13). This improvement is shown in the Hudson River Data up to 2005 (Figure 14).

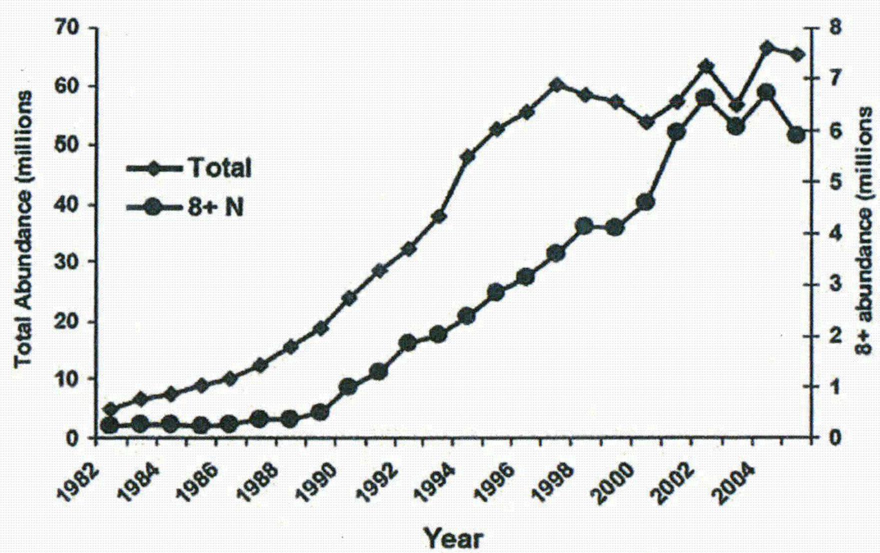

Figure 13: Striped bass population abundance estimates, from 2004 ADAPT model.

Source: Committee for the Atlantic Striped Bass Management Board 2005.

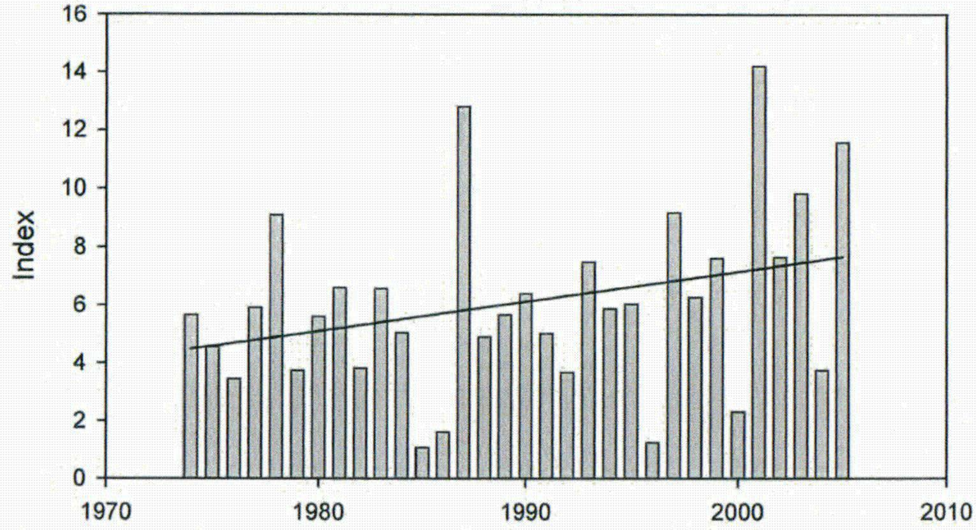

Figure 14: The juvenile index for striped bass in the Hudson, showing an increasing trend through time up to 2005.

Data from 2005 Year Class report – Appendix D, Table D – 2

However, as shown in Figure 15 there has been a decline in bass abundance post-2005. Undertaking a break-point analysis indicated a change in dynamical behaviour in 2001 when the juvenile index recorded its maximum for the time series (Figure 16).

It is clear that the period of increasing striped bass abundance has now ended. It is, as yet, unclear if the species is in population decline or is simply moving towards equilibrium. It is notable that the juvenile index post-2005 is similar in magnitude to that in the 1970s, when the population was in poor condition.

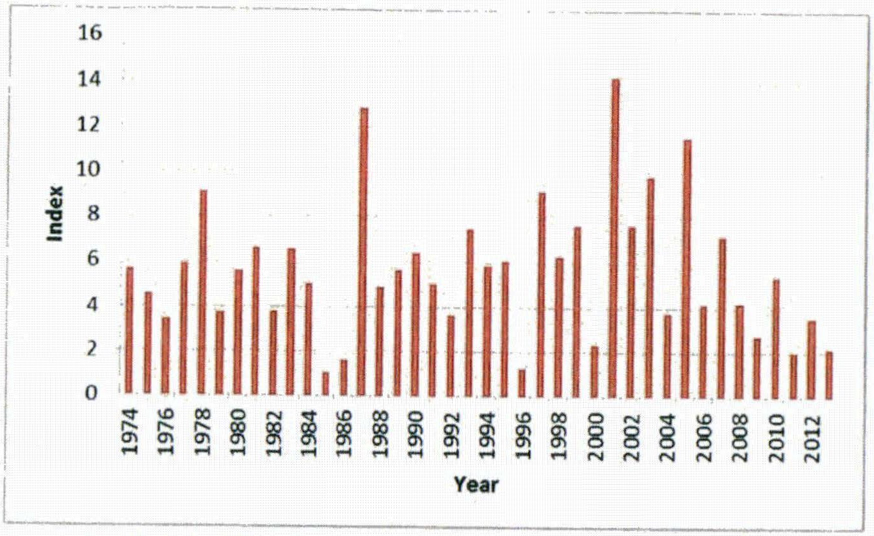

Figure 15: The juvenile index for striped bass in the Hudson, showing an increasing trend through time up to 2001, followed by decline.

Source: NYSDEC 2013 Year Class report

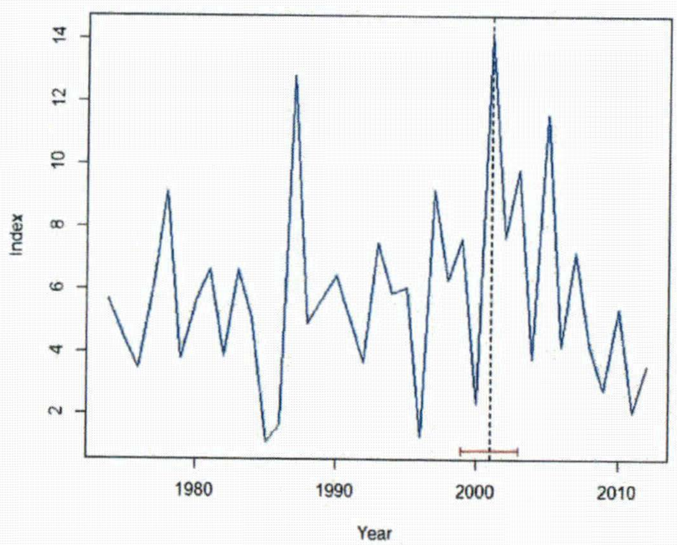

Figure 16: The juvenile index for striped bass in the Hudson, showing an increasing trend through time up to 2001. The dotted line represented the identified break point after which the population index starts to decline.

4.2 *Spottail shiner (*Notropis hudsonius*)*

The spottail shiner is a small minnow, which lives in freshwaters in many parts of Canada and the United States. In the Hudson it lives in the middle and upper reaches of the estuary. They are opportunistic predators feeding on a wide range of foods.

In 2008 we reported that *"the spottail shiner has generally increased in abundance, but has also become far more variable in abundance (Figure 17)"*. This was linked to changes in habitat availability, as this fish particularly favours vegetated shallows, and Strayer *et al.* (2004) showed that species in the Hudson which preferred vegetated habitat have done well since the invasion of zebra mussel, *Dreissena polymorpha.*

Analysing data up to 2013 shows that there is no longer a positive trend in shiner abundance, and 2013 reported the lowest abundance index ever recorded (Figure 18). The previous observation that the juvenile index was becoming more variable through time still holds. There are grounds for concern that the population of this species is becoming unstable.

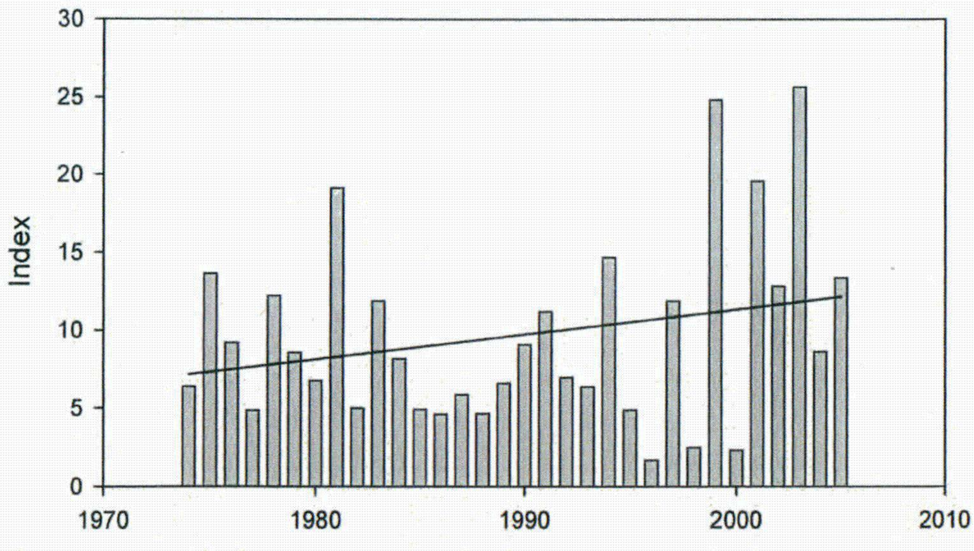

Figure 17: The juvenile index for spottail shiner in the Hudson, showing an increasing trend through time up to 2005.

Data from 2005 Year Class report – Appendix D, Table D – 11

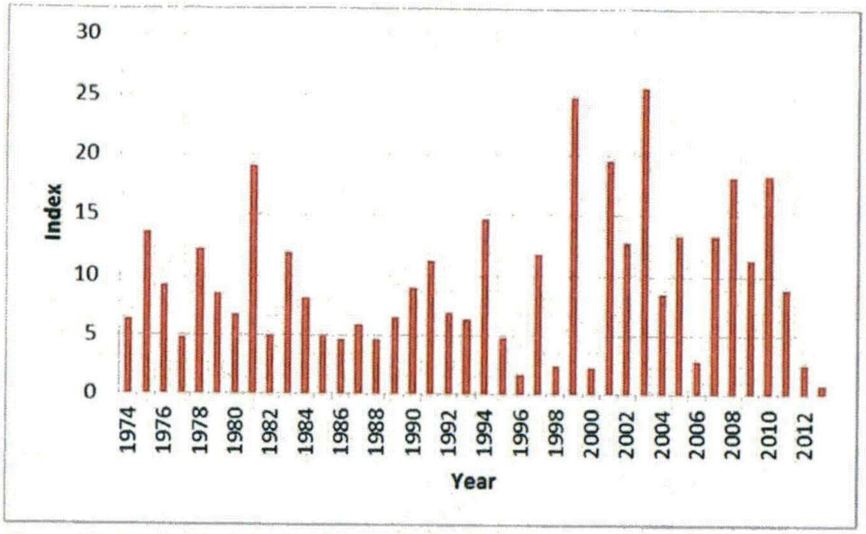

Figure 18: The juvenile index for spottail shiner in the Hudson through time up to 2013.

Data from 2013 Year Class report

4.3 *Bluefish (Pomatomus saltatrix)*

The bluefish is a predaceous oceanic fish, which is found in the western Atlantic. It comes inshore from May to November. Juvenile fish migrate into estuaries and bays, which they use as nursery grounds. In the Hudson they are commoner in the higher salinity regions of the estuary.

In 2008 we reported that the index of juvenile bluefish showed a slight increase over the sampling period. This is no longer the case (Figure 19). There is now no detectable trend in abundance. The species population was particularly large in 1999, 2001 and 2002. However, abundance has now declined to levels similar to, or even lower than, those observed in the 1980s, suggesting that there has been no sustainable long-term increase in abundance.

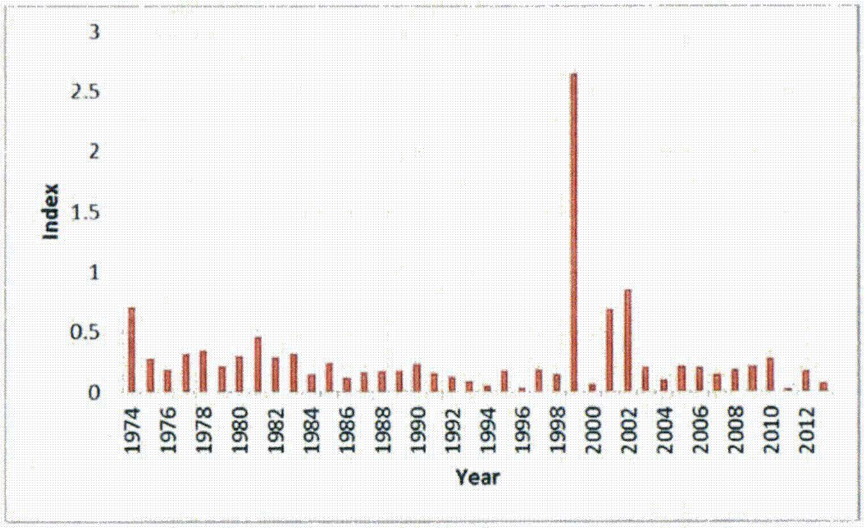

Figure 19: The juvenile index for bluefish in the Hudson 1974-2013.

Data from 2013 Year Class report – Appendix D, Table D – 8.

The biomass of bluefish is estimated in the Atlantic each year by the Atlantic States Marine Fisheries Commission. The numbers of fish dropped from 1982 to 1994, but have subsequently been slowly recovering (Figure 20). The juvenile numbers in the Hudson show a similar decline in the mid 1990s, but seem to have recovered faster.

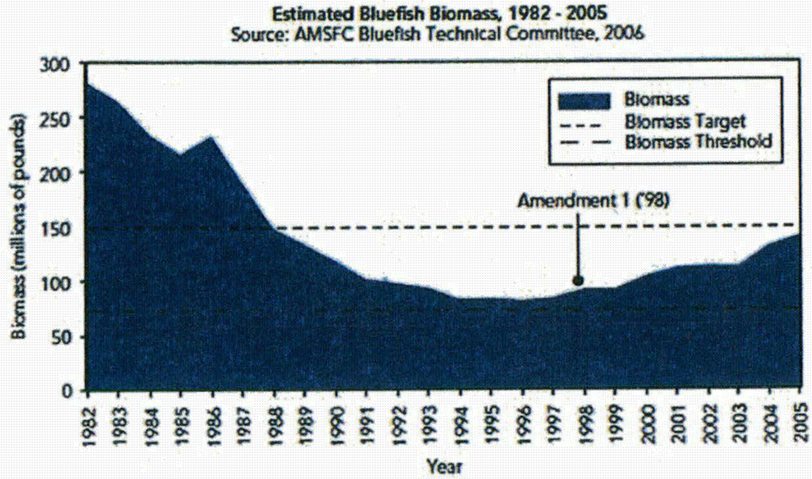

Figure 20: Estimated bluefish biomass.

Source: 65th Annual Report of the Atlantic States Marine Fisheries Commission 2006 (2007)

4.4 *White perch (Morone americana)*

White perch are similar to striped bass, but only grow to a fraction of the size. White perch are estuarine, and are found from Canada to Carolina, and in fresh waters near the coast. They over-winter in the lower estuary, and migrate upstream to freshwater to breed. In the Hudson, breeding usually occurs between mid-May and early July, primarily north of Croton Bay. In the Hudson, some fish mature at 2, but most at 3 to 4 years old.

White perch are showing a decreasing trend in the juvenile index over time (Figure 21).

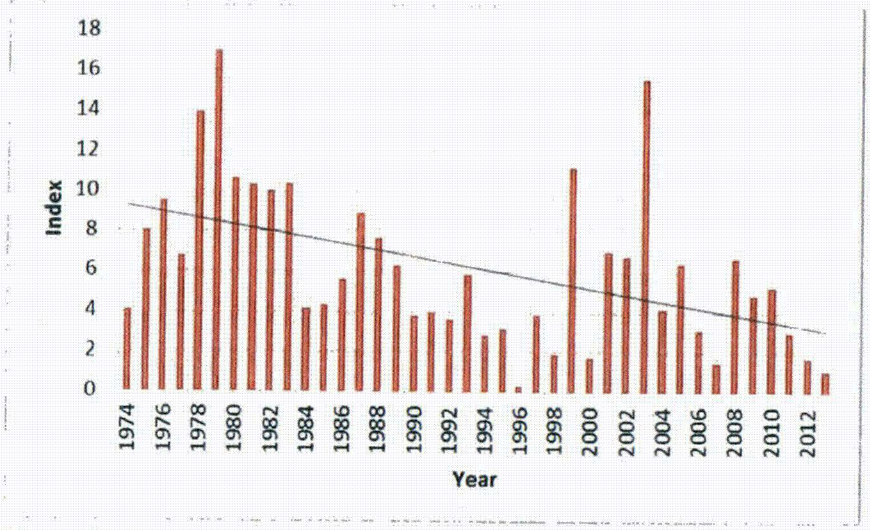

Figure 21: The juvenile index for white perch in the Hudson, showing a decreasing trend through time.

The trend is significant (a = -0.1572, b = 9.4166, F = 10.54, p = 0.002441).

Data from 2013 Year Class report

The dramatic decline in white perch abundance is much more clearly shown in the changing abundance of yearling and older age classes (Figure 22).

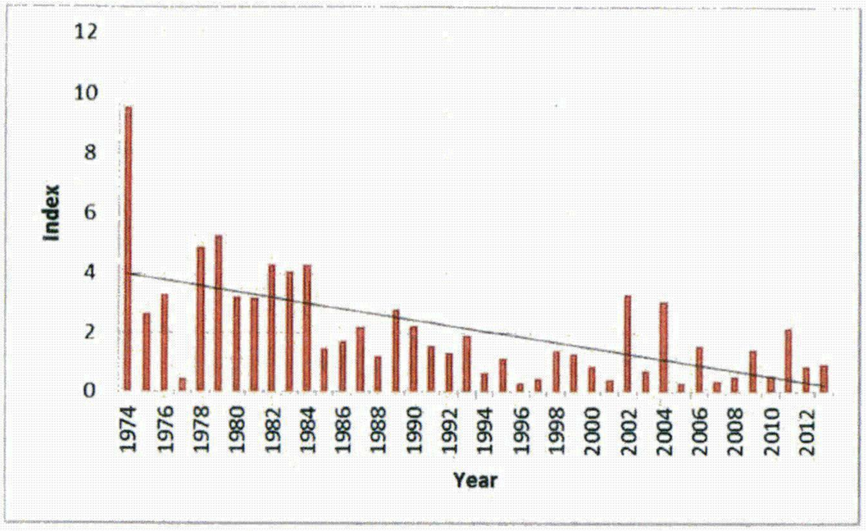

Figure 22: The index for yearling white perch in the Hudson, showing a decreasing trend through time.

The trend is significant (a = -0.0959, b = 4.076, F = 22.743, p = <0.0001).

Data from 2013 Year Class report

It is widely accepted that white perch are in decline and the present population size is probably 30% or less of that present in the 1970s and 1980s (See FEIS page 62, NYSDEC 2007).

4.5 *Atlantic tomcod (Microgadus tomcod)*

The Atlantic tomcod is an inshore species that ranges from Labrador to the Chesapeake Bay. It is anadromous, and reaches its southern spawning limit in the Hudson. Tomcod enter estuaries in mid-winter to spawn in brackish water. The main spawning area in the Hudson is between West Point and Poughkeepsie. They are unusual in that their growth slows and stops as the water temperature rises.

There are no reliable records of tomcod abundance before the 1970s. The Atlantic tomcod population is showing considerable year-to-year variation, but is clearly in long-term decline (Figure 23). The average standardised index from 1975 until 1995 is 0.158, in comparison the index for the next ten years of sampling (1996-2005) was only 0.0617. In the 17 years up to 2013 only 2001 produced a good recruitment.

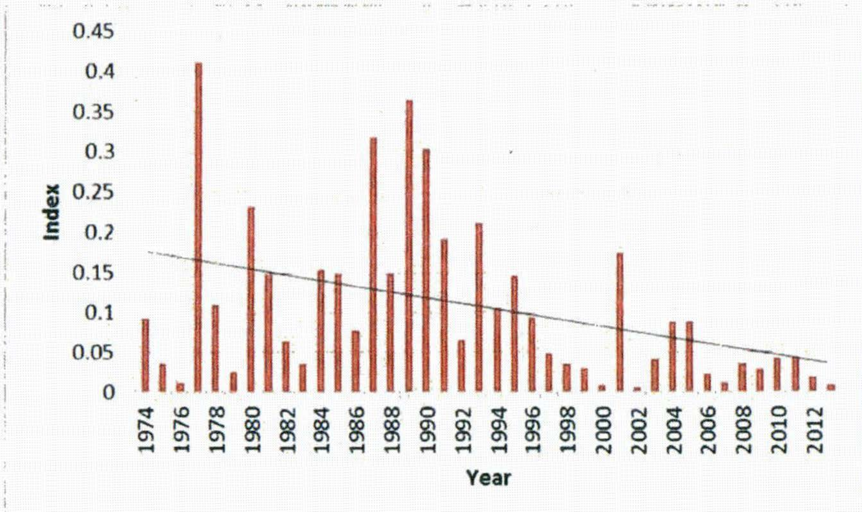

Figure 23: The juvenile index for Atlantic tomcod in the Hudson, showing a decreasing trend through time.

The trend is significant (a = -0.0036, b = 0.1799, F = 7.535, p =0.0092).

Data from 2013 Year Class report

There is also an annual survey of the tomcod to estimate its breeding population (Normandeau Associates, 2007). This survey uses a range of techniques to look at the structure and size of the tomcod population. These data are used to estimate the size of the breeding population each year. Figure 24 shows a similar decline in numbers, as seen in the juvenile index, above.

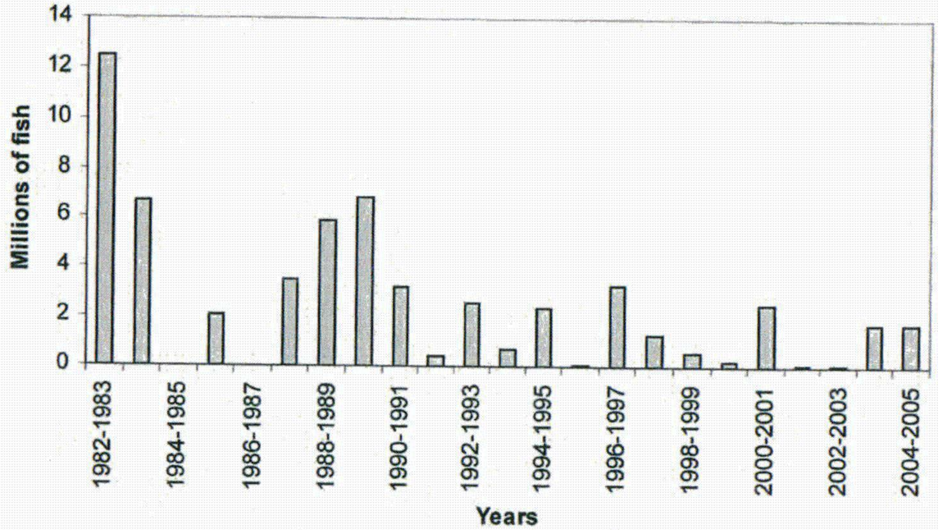

Figure 24: The Petersen estimates of the Hudson River Atlantic tomcod spawning population, winters of 1982-1983 through 2004-2005.

Source: Normandeau Associates, 2007.

The fate of tomcod may be related to river water temperature. The tomcod is a small, short-lived member of the cod family. Because it is at the southern extremity of its geographical range within the Hudson estuary, sensitivity to climatic factors, particularly temperature, would be anticipated.

4.6 *Bay anchovy (Anchoa mitchilli)*

The bay anchovy is a small fish of inshore waters, found along the whole of the United States coast. It is tolerant of a range of salinities, and will remain in estuaries the whole year. Bay anchovy are a shoaling fish that feed on plankton. They are short-lived, rarely living for more than 2 years. They spawn in the lower part of the Hudson, with each female spawning many times in a single year.

Bay anchovy populations can occasionally reach high abundances, as was observed in 1988, 1989, 1995 and 2012 (Figure 25), there has been a long-term declining in average abundance, but this is not statistically significant. Schultz *et al.* (2006) noted that the abundance of adults in the Hudson has declined 10-fold from the peak levels observed in the late 1980s.

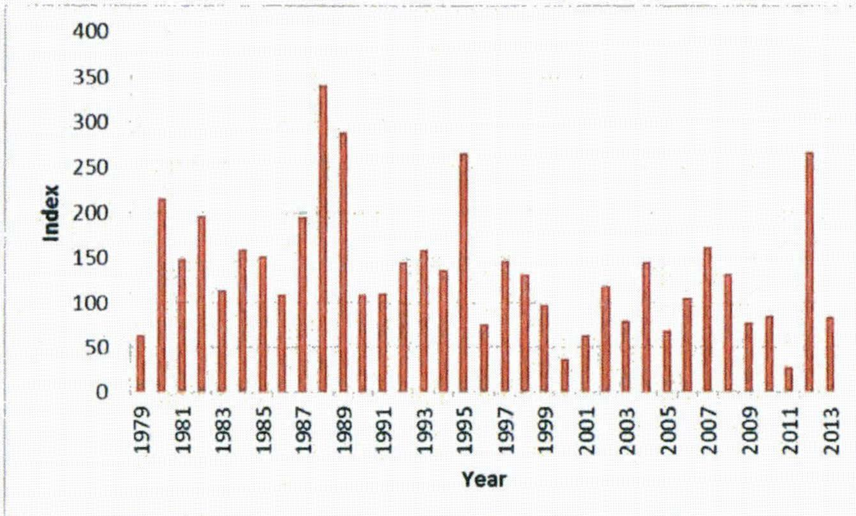

Figure 25: The juvenile index for bay anchovy in the Hudson, 1978-2013.

Data from 2013 Year Class report

Schultz *et al* (2006) noted a negative correlation of anchovy abundance with that of PYSL striped bass, and a positive correlation with PYSL and juvenile tomcod abundance. They suggest that the positive correlation between tomcod and bay anchovy is probably due to both having negative correlations with striped bass. Thus, the observed decline may be linked to the increase in abundance of the predatory striped bass. If this is the case, then the strong index in 2012 may reflect the recent decline in striped bass recruitment.

4.7 *American shad (Alosa sapidissima)*

American shad are the largest of the North American species of anadromous herrings. They may live to 13 years and usually become sexually mature after 2-6 years at sea. They have a well-developed homing ability. They are found from Newfoundland to Florida. They return to sea after spawning. Most spawning occurs in May in the upper estuary in the Hudson.

The American shad shows a significant decreasing trend in juvenile abundance (Figure 26). The last 8 years have reported the lowest 7 indices since records began. This population has all the characteristics of a population heading towards local extinction.

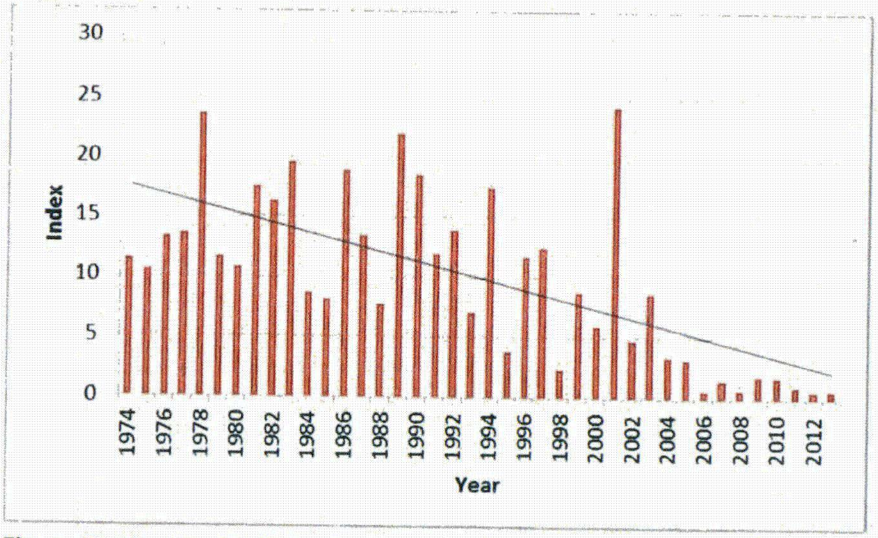

Figure 26: The juvenile index for American shad in the Hudson showing a decreasing trend through time.

The trend is significant ($a = -0.3957$, $b = 18.009$, $F = 29.796$, $p < 0.0001$).

Data from 2013 Year Class report

American shad has been declining in the Hudson for many years because of overfishing, pollution and other anthropogenic effects (such as entrainment and impingement at power plants like Indian Point) (Figure 27). Even in the 1970s and 1980s, the population was a small fraction of historical abundance (see Figure 27 for the trend in commercial landings). In an attempt to allow the shad population to recover, the ocean intercept fishery was closed in 2005, and further restrictions on river fishing introduced (Atlantic States Marine Fisheries Commission 2007).

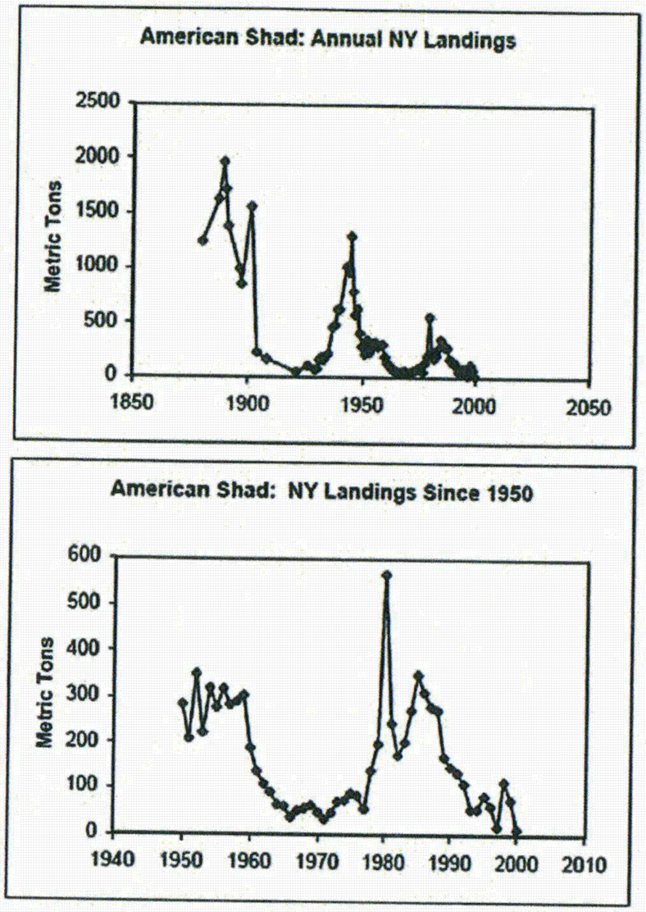

Figure 27: Catches of American shad in New York State. Most of the catches are from the Hudson.

Top panel: trends since 1880. Bottom panel: trends since 1950. Note differences in scale. Sources: National Marine Fisheries Statistics, Walburg and Nichols (1967). Taken from Limburg *et al* 2006.

4.8 *Alewife (Alosa pseudoharengus)*

Alewife is similar to, but smaller than, the American shad, and is indistinguishable from blueback herring when young. The alewife spawns most actively when the water is 51 – 71 °F. They prefer slow-moving waters, spawning in the upper estuary and spreading to the middle portion of the Hudson as they grow. It is an anadromous species found from Newfoundland to South Carolina, which starts spawning at 3-4 years old and can live for around 9 years. It feeds on plankton, but will take small fish and fish eggs.

The alewife juvenile index shows no trend in the Hudson (Figure 28). The most important feature of the population is the between-year variability in juvenile abundance. This suggests a population that is destabilised.

Daniels *et al* 2005, state that

> *There is a negative correlation between the number of alewife larvae exiting Hudson River tributaries and the degree of watershed urbanization (Limburg and Schmidt 1990). Overfishing of stocks has led to the decline of once abundant commercially important species (e.g., Bain et al. 2000; Limburg et al. in press)*

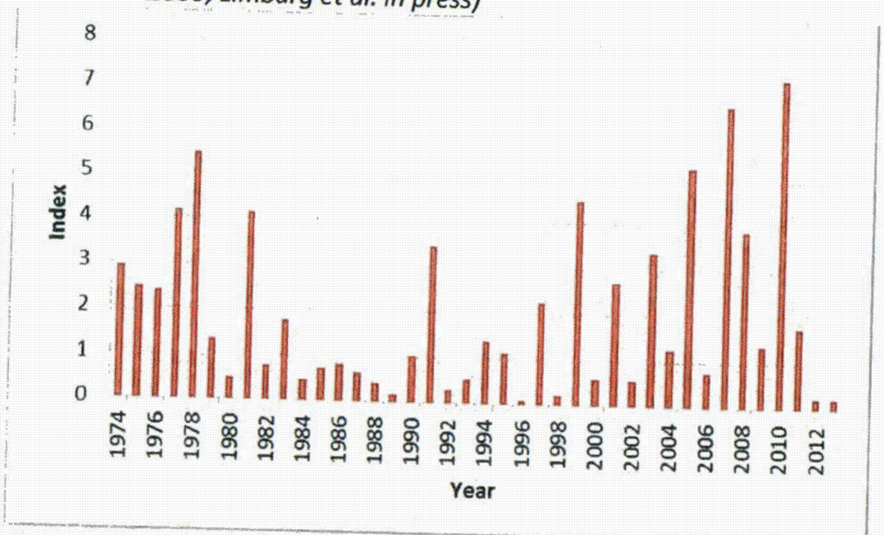

Figure 28: The juvenile index for alewife in the Hudson.

Data from 2013 Year Class report

4.9 *Blueback herring (Alosa aestivalis)*

Blueback herring is also similar to but smaller than the American shad, and is indistinguishable from alewife when young. Blueback herring spawn in May, preferring fast-flowing waters in the tributaries. They spawn in the upper estuary and spread to the middle portion of the Hudson as they grow. Blueback can be found from Nova Scotia to Florida.

The blueback herring juvenile index has decreased over the study period (Figure 29. Strayer *et al* (2004) suggest that the zebra mussel (*Dreissena polymorpha*) has changed the food web within the Hudson, and that this may have reduced herring food resources. Blueback herring used to feed extensively on planktonic crustaceans, however the changes in primary production caused by the zebra mussels appear to have caused them to switch their diet to littoral and benthic macroinvertebrates (Daniels, 2005). Note that at the threshold to the collapse in population abundance, blueback herring had their largest juvenile abundance.

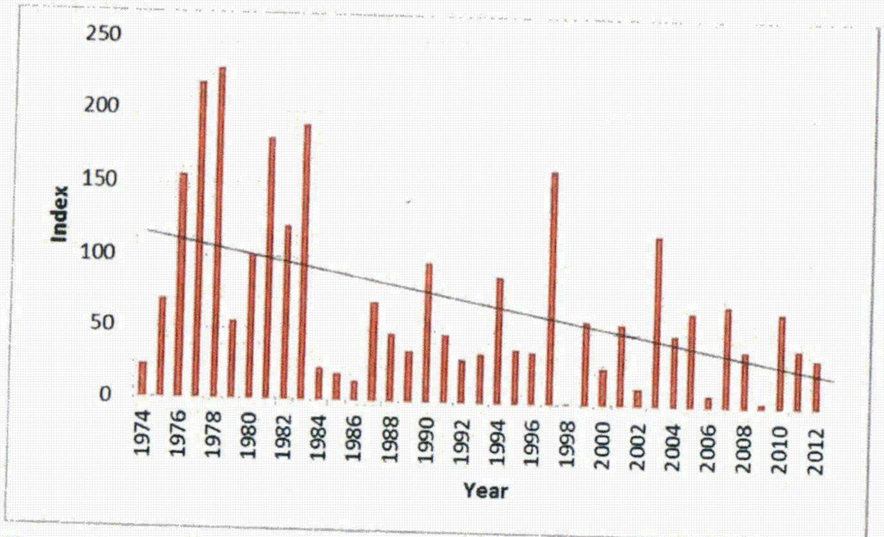

Figure 29: The juvenile index for blueback herring in the Hudson, showing a decreasing trend through time.

The trend is significant (a = -2.4297, b = 118.6, F = 10.84, p = 0.00215).
Data from 2013 Year Class report

Rainbow smelt (Osmerus mordax)

The rainbow smelt is a salmon-like fish which is found from the northern part of the western Atlantic and in many naturally land-locked populations. They can spend most of the year within estuaries. The rainbow smelt spawns in the lower reaches of tributaries at night. They mature at 1 to 5 years old. Historically, juvenile fish were found in mid-June to August in the middle and lower estuary.

Juvenile rainbow smelt have disappeared from the survey since the mid-1990s (Figure 30). This may to be due to a change in their distribution, possibly due to the invasion of zebra mussels, which occurred from 1992 onward (Strayer, 2004). However, as shown in Table 1, rainbow smelt has one of the lowest upper temperature tolerances of Hudson fish. It is therefore possible that the species has declined because of rising water temperatures.

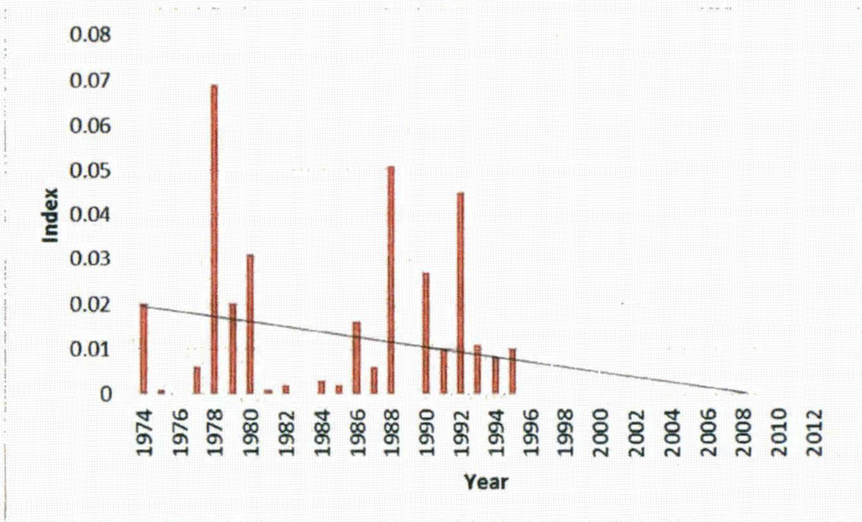

Figure 30: The juvenile index for rainbow smelt in the Hudson, showing a decreasing trend through time. No fish have been recorded since 1995.

Data from 2013 Year Class report

4.10 Hogchoker (*Trinectes maculatus*)

The hogchoker is a small flatfish, maturing at around 4.5 in. and growing to about 8 in., which tolerates a wide range of salinities and is found from Massachusetts Bay to Panama. They overwinter in low salinity areas of estuaries, and spawn in the lower reaches of the estuary in spring and summer. The young move upstream after hatching.

The hogchoker has shown no trend in abundance since the 1970s (Figure 31). There were some large recruitments in the 1980s and 90s and in 2012. However, between 1997 and 2011 abundance was low.

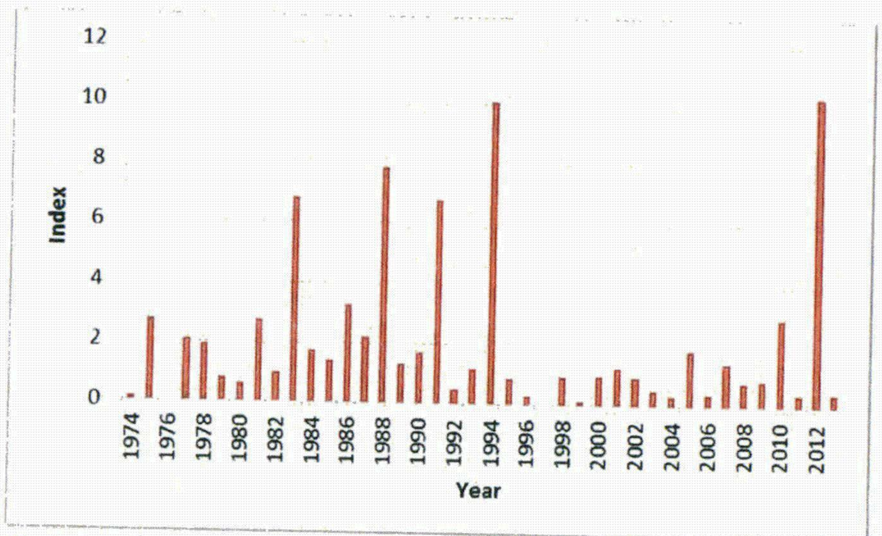

Figure 31: The juvenile index for hogchoker in the Hudson, showing no trend through time.

Data from 2013 Year Class report

4.11 *White catfish (Ameiurus catus)*

White catfish are naturally found in freshwater, and are found in all the estuaries along the Atlantic coast from the Hudson to Florida. They are slow-growing, maturing at 3 - 4 years old. They move into freshwater to breed, building nests on sand or gravel. They breed in late June and July when the water temperature reaches 70°F. Young fish eat insects, while larger fish are piscivorous.

White catfish have been in steep decline in abundance from 1990 onwards (Figure 32). The reasons for this loss are unknown.

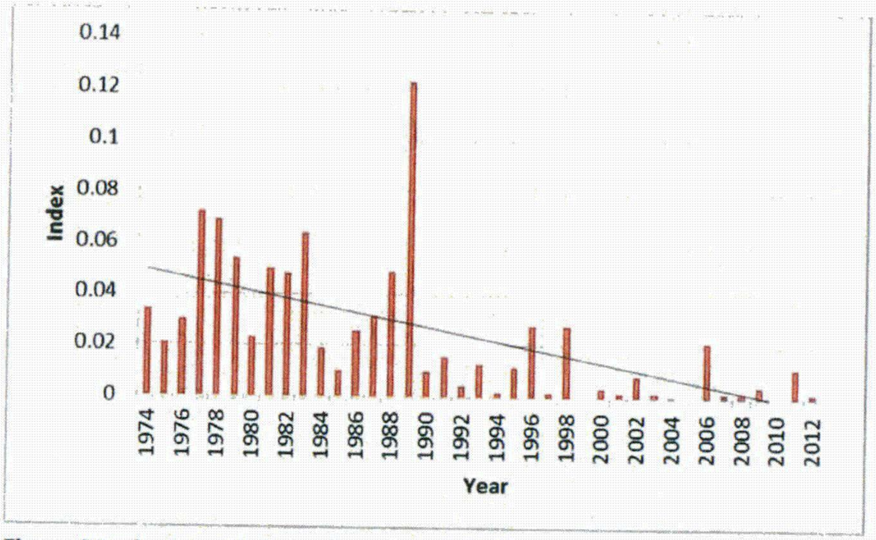

Figure 32: The juvenile index for white catfish in the Hudson, showing a decreasing trend through time.

The trend is significant ($a = -0.0014$, $b = 0.0507$, $F = 22.44$, $p < 0.0001$).
Data from 2013 Year Class report

4.12 Weakfish (*Cynoscion regalis*)

Weakfish are found from New York to North Carolina, offshore in the winter, moving inshore during the spring. Spawning occurs inshore, with larvae rarely being found north of the George Washington Bridge. From June to October the juveniles use the Hudson, with the greatest numbers being found in July

Weakfish have been in steep decline in abundance from 1987 onwards (Figure 33). The reasons for this loss are unknown.

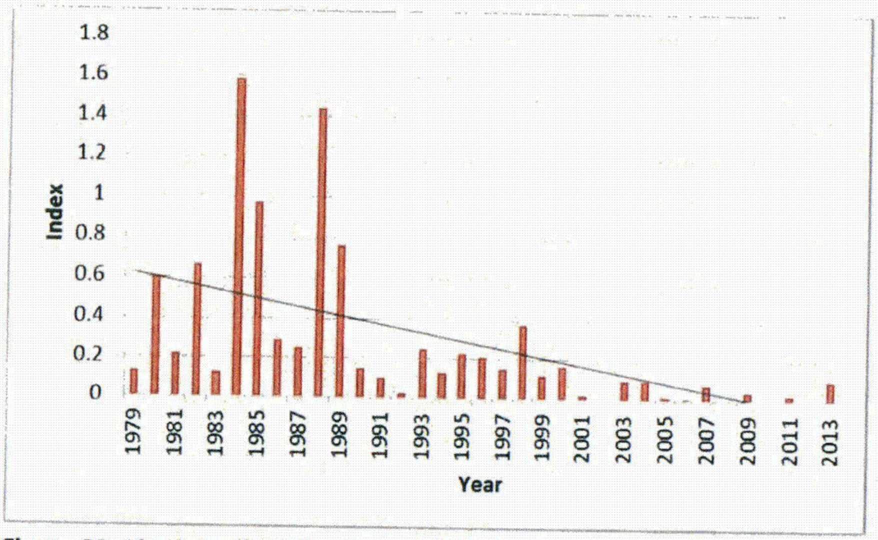

Figure 33: The juvenile index for weakfish in the Hudson, showing a decreasing trend through time.

The trend is significant (a = -0.0205, b = 0.64, F = 13.894, p = 0.0007).

Data from 2013 Year Class report

4.13 *Changes since the 1974 Year Class Report*

The 1974 year class report gives information on the abundance of a number of the most abundant or commercially important fish species in the Hudson Estuary prior to the commissioning of Indian Point Units 2 and 3. It is not possible to consider overall changes in the fish community from 1974 to the present because of the lack of a full species list from 1974. Comments are therefore restricted to the common species.

In the 1974 report the striped bass population was considered to be under density-dependent control, suggesting that the habitat was fully saturated with striped bass. Subsequently, adult numbers have greatly increased and compensatory control and density-dependence is now little discussed. Indeed, it is difficult today to support this early assertion of compensatory dynamics suggestive of a saturated environment if the adult population has subsequently greatly increased. It is possibly of significance that the only species noted as possibly having density-dependent control in the 1974 year class report is the species that has increased greatly in abundance since this time. Perhaps this early research detected the potential of the striped bass population to grow if constraints were relaxed. Species which were found to offer no evidence of density-dependent compensation were American shad, tomcod and white perch and they have all declined. One of the most notable observations in the 1974 year class report is the recognition that white perch are one of the species most vulnerable to power plant losses. *"Overall, the degree of exposure to entrainment and impingement at the five power plants is probably highest for white perch, followed by striped bass, Atlantic tomcod, and American shad in that order."* (page II-9 of the 1974 year class report) The effects of this vulnerability have become apparent with the dramatic decline in white perch (see Figure 22 above).

5 Summary

The fish community of the Hudson estuary has been well-studied from the mid-1980s. It has been continuously changing since systematic recording began in the 1980s. There have been many environmental changes during the sampling, with significant improvements in water quality in some parts of the estuary.

There are clear indications, both at the community and individual population levels, that the populations of fish in the estuary are becoming less stable and showing greater year to year variation in abundance.

Of the 13 key species subject to intensive study, six species have shown no trend in abundance since the 1980s. The other 7 species have declined in abundance, some greatly. Particularly significant negative trends are observed in yearling white perch, and juvenile American shad, white catfish, tomcod, blueback herring and weakfish. The vulnerability of white perch was even noted in 1974 *"Overall, the degree of exposure to entrainment and impingement at the five power plants is probably highest for white perch, ..."* (page II-9 of the 1974 year class report). The dynamics of the white catfish and American shad are indicative of populations heading towards local extinction. The rainbow smelt has seemingly gone locally extinct. Many other important species of fish are also showing long-term declines in abundance; for example, the American eel has greatly declined.

In 2008 we reported that striped bass, bluefish and spottail shiner had shown a trend of increasing abundance since the 1980s. This is no longer the case and there are indications that striped bass have started to decline post-2001.

There has been a recent increase in average water temperature and a decrease in dissolved oxygen levels. This may be influencing some of the changes observed and will increase the impact of thermal discharges. It is important to factor in potentially increasing water temperatures in any discussion of Hudson River fish. Small rises in the background temperature could have a significant effect on the impacts of thermal discharges into the river.

Power companies state that there are not any negative trends in the Hudson River fish populations attributable to the plant operation; this is despite the NYSDEC (2007) finding that the power plants can reduce several of the common fish species' recruitment by between 33 and 79% in a year. Even if the power companies are not the sole cause of degradation of the Hudson River fish community, the loss of such high proportions of the fish populations must be important.

All the evidence points to the Hudson ecosystem presently being in a state of change, with declining stability. Neither the ecosystem as a whole nor many of the individual species' populations are in a healthy state.

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