

## **Response to Biological Aspects of NYSDEC 401 Certification Letter**

Lawrence W. Barnthouse, Ph. D.  
LWB Environmental Services, Inc.

Douglas G. Heimbuch, Ph. D.  
AKRF, Inc.

Mark T. Mattson, Ph. D.  
Normandeau Associates, Inc.

John R. Young, Ph. D.  
ASA Analysis and Communications, Inc.

## Overview

These comments respond to the following items in the New York State Department of Environmental Conservation's (NYSDEC or Department) April 2, 2010 Notice of Denial ("Notice") that address biological aspects of NYSDEC's proposal:

1. *NYSDEC's statements regarding assessments of potential impacts of Indian Point Energy Center Nuclear Generating Units 2 and 3 on striped bass and other fish populations performed by the Atomic Energy Commission (AEC), Nuclear Regulatory Commission (NRC) and U.S. Environmental Protection Agency (EPA) prior to the Hudson River Settlement Agreement (HRSA) (pages 3-5).* As detailed below, NYSDEC's statements regarding these historical proceedings are in error, as is the Department's use of these proceedings as a justification for its current position regarding cooling water withdrawals at Units 2 and 3.
2. *The status of fishery resources in the Hudson River (p. 7-8).* As detailed below, commercial fisheries in the Hudson River have declined because of overfishing, not because of the operation of Units 2 and 3.
3. *NYSDEC's approach to the calculation of comparative effectiveness of cylindrical wedgewire screens vs. closed-cycle cooling (p. 18).* As detailed below, NYSDEC's definition of Adverse Environmental Impact (AEI) is scientifically unsupported and inconsistent with positions taken by NYSDEC in other proceedings; moreover, even accepting NYSDEC's definition, immediate installation of cylindrical wedgewire (CWW) screens would preserve far more fish eggs and larvae over the remaining lifetimes of Units 2 and 3 than would the installation of closed-cycle cooling.
4. *The through-plant survival of entrained early life stages of fish, e.g., eggs and larvae (p. 19).* As detailed below, substantial through-plant survival of larvae of

striped bass and other fish species has been demonstrated in studies performed at Units 2 and 3, with NYSDEC's concurrence and oversight. NYSDEC's should consider these results, consistent with its position in permit proceedings at other Hudson River power plants.

5. *NYSDEC's statements regarding published studies of the effectiveness of wedgewire screens at reducing entrainment (pp. 20-21).* As detailed below, NYSDEC's statements concerning these studies are not supported by the actual content of the studies, which provide substantial support for Entergy's contentions concerning the potential effectiveness of CWW screens at reducing entrainment.
6. *NYSDEC's statements regarding the Oak Creek facility.* As detailed below, Oak Creek underscores the feasibility of constructing and operating such screens at a facility with an intake capacity comparable to Indian Point Units 2 and 3.
7. *NYSDEC's statements regarding entrainment and impingement of shortnose sturgeon and Atlantic sturgeon.* As detailed below, biological monitoring indicates that sturgeons are not entrained at Units 2 and 3, and concerns about impingement are not supported.

I. Assessments of impacts of Units 2 and 3 on striped bass and other fish populations performed by the Atomic Energy Commission (AEC), Nuclear Regulatory Commission (NRC) and U.S. Environmental Protection Agency (EPA) prior to HRSA

On Page 3 of its Notice, NYSDEC states: “The licenses issued by the AEC for Units 2 and 3 initially allowed for the operation of those facilities with once-through cooling systems. However, the Final Environmental Statements issued by the AEC and NRC, respectively, called for installation of closed-cycle cooling systems at the facilities, by certain dates, because of the potential for long term environmental impact from the once-through cooling systems on aquatic biota inhabiting the Hudson River which would result in permanent damage to and severe reduction in the fishery, particularly striped bass.”

First, the basis for the statements attributed to the AEC/NRC staff several decades ago in the Final Environmental Impact Statements (FEIS) for operational licensing of Units 2 and 3 was the projected potential future impacts of the construction and operation of the Units on the long-term abundance and productivity of the Hudson River striped bass population, not estimates of the numbers of eggs or larvae that might be entrained.<sup>1</sup> The AEC and NRC staff statements, made several decades ago, were based on theoretical models of striped bass entrainment and population dynamics<sup>2</sup> that could not at that time be verified using empirical data, because neither unit had begun commercial operation and the data necessary to test the models was not available. In the intervening decades, the actual impacts of the Units have been extensively studied, with comprehensive empirical data obtained and rigorously evaluated. As detailed below, these data demonstrate that no such impacts to Hudson River fish populations have occurred, and

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<sup>1</sup> Barnthouse, L. W., J. Boreman, S. W. Christensen, C. P. Goodyear, W. Van Winkle, and D. S. Vaughan. 1984. Population Biology in the Courtroom: the Hudson River Controversy. *Bioscience* 34:14-19. All of the authors of this paper were government scientific consultants during one or more of the AEC, NRC, and EPA proceedings discussed in the Notice of Denial.

<sup>2</sup> Unit 2 FEIS, Appendix V, as documented in Barnthouse et al. (1984).

that NYSDEC's reliance on the historic FEIS to support the Notice is not scientifically appropriate.

The AEC staff model developed for the Unit 2 FEIS predicted that the abundance of young striped bass produced each year from the Hudson would be reduced by 30%-50% due to entrainment.<sup>3</sup> However, the licensing decision to require closed-cycle cooling, which was based on the FEIS was subject to review and actually overturned on appeal on the grounds that the AEC staff's entrainment model was unrealistic and inferior to a model produced by consultants to Consolidated Edison, which predicted much lower potential impacts.<sup>4</sup> The model used by the NRC<sup>5</sup> staff to support the FEIS for Unit 3 also predicted much higher impacts on the abundance and productivity of striped bass than did an alternative model produced by consultants to Consolidated Edison, however, neither model could be verified using empirical data,<sup>6</sup> and the data collected over more than 30 years of intensive monitoring has since eclipsed the early predictions of these models. Thus, reliance on these outdated documents to support a Section 401 determination is not appropriate.

On Page 4 of its Notice, NYSDEC states: "Subsequently, the NRC sought to amend the licenses for Units 2 and 3 to terminate the use of once-through cooling and to require the facilities to construct and operate wet closed-cycle cooling systems due to the unacceptability of long-term impacts of entrainment and impingement on the Hudson River fishery. Thus, the license for Unit 2 was amended by the NRC in 1975 and the license for Unit 3 was amended by the NRC in 1976 to include requirements for the installation and operation of wet closed-cycle cooling systems at the facilities."

Contrary to NYSDEC's statement in the Notice, the NRC's order for cessation of once-through cooling at both Units 2 and 3 by May 1, 1979 included express provisions

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<sup>3</sup> Unit 2 FEIS, Appendix V, as documented in Barnthouse et al. (1984).

<sup>4</sup> Atomic Safety and Licensing Appeal Board of the U.S. Atomic Energy Commission, 1974, Decision in the Matter of Consolidated Edison Company of New York, Inc. (Indian Point Station Unit No. 2), as documented in Barnthouse et al. (1984).

<sup>5</sup> In 1974, Congress abolished the Atomic Energy Commission and created the Nuclear Regulatory Commission to administer the regulatory programs formerly administered by the AEC.

<sup>6</sup> Barnthouse et al. (1984).

allowing once-through cooling beyond that date if new evidence showed closed-cycle cooling to be unnecessary to protect the striped bass population. Following the transfer of authority for cooling-system permitting to the EPA, additional information concerning the potential impacts of once-through cooling on Hudson River fish populations was provided to EPA and NYSDEC, among others.<sup>7</sup> As a result, the imposition of closed-cycle cooling was delayed pending the outcome of an EPA administrative process<sup>8</sup> in which NYSDEC participated.

As detailed below, that process was resolved through the Hudson River Settlement Agreement (HRSA), to which NYSDEC is a signatory, and in which closed cycle cooling was not required for the Units (or certain other Hudson River power plants). The HRSA instead required ongoing intensive biological monitoring of the Hudson. Using the 30 years of data on the riverwide distribution and abundance of eggs, larvae, juveniles, and (for some species) adults belonging to important Hudson River fish populations, together with other information provided by federal fisheries management agencies and the published scientific literature, Entergy's Adverse Environmental Impact Report (AEI Report)<sup>9</sup> demonstrated that entrainment and impingement associated with more than 30 years of cooling-water withdrawals by Units 2 and 3 have not had an adverse impact on any Hudson River fish population.

On page 5 of its Notice, NYSDEC states: 'As previously noted, in 1977 the then-owners of the Indian Point nuclear facilities sought an adjudicatory proceeding to overturn the USEPA-issued permit determinations that limited the scope of the facilities' cooling water intake operations. The USEPA's adjudicatory process lasted for several years before culminating in a multi-party settlement known as the Hudson River Settlement Agreement (HRSA)."

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<sup>7</sup> Barnthouse et al. (1984). This new evidence included data from two years of riverwide monitoring data and a new set of assessment models specifically designed for use with these data.

<sup>8</sup> Charles Coutant, Ph.D. and Webster Van Winkle, Ph.D. both participated in the administrative process as technical consultants to the EPA, and have confirmed their recollections of these proceedings.

<sup>9</sup> Barnthouse, L. W., D. G. Heimbuch, W. Van Winkle, and J. R. Young. 2008. Entrainment and Impingement at IP2 and IP3: A Biological Assessment. (AEI Report).

In contrast to the assessments performed for the AEC and NRC licensing proceedings, assessments performed by both EPA scientists and Hudson River power plant owners' consulting biologists were based on empirical data concerning the distribution and abundance of susceptible life stages of Hudson River fish species, and on estimates of the survival of entrained and impinged fish.<sup>10</sup> Estimates of potential impacts developed by government consultants for the EPA hearings were much lower than the estimates developed for the earlier AEC and NRC proceedings, and the differences between government and the Hudson River power plant owners' consulting biologists estimates were much smaller than in earlier proceedings.<sup>11</sup> The EPA permit proceedings resolved to end litigation through the HRSA, which provided for reductions in entrainment and impingement but did not require closed-cycle cooling.<sup>12</sup> Again, the HRSA instead required ongoing intensive biological monitoring of the Hudson, that resulted in the AEI Report, which demonstrated that more than 30 years of cooling-water withdrawals by Units 2 and 3 have not had an adverse impact on any Hudson River fish population<sup>13</sup>.

On page 5 of its Notice, NYSDEC states: "The HRSA was initially a ten-year agreement (from December 1980 to December 1990) whereby the owners of certain once-through cooled electric generating plants on the Hudson River, including Indian Point, would collect biological data and complete analytical assessments to determine the scope of adverse environmental impact caused by those facilities."

The monitoring program established as part of the HRSA has now provided more than 30 years of data concerning the distribution and abundance of Hudson River fish populations. As detailed in the AEI Report, data collected through this program, together with additional data collected by NYSDEC and federal fisheries management agencies,

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<sup>10</sup> American Fisheries Society Monograph 4, *Science Law, and Hudson River Power Plants*. Papers by Muessig et al. (pp. 123-132), Christensen and Englert (pp. 133-142), Englert and Boreman (pp. 143-151), Boreman and Goodyear (pp. 152-160), Mattson et al. (pp. 161-169), Muessig et al. (170-181), and Barnthouse and Van Winkle (pp. 182-190).

<sup>11</sup> Englert, T. L., and J. Boreman, American Fisheries Society Monograph 4, pp. 143-151.

<sup>12</sup> Barnthouse, L. W., J. Boreman, T. L. Englert, W. L. Kirk, and E. G. Horn. American Fisheries Society Monograph 4, pp. 267-273.

<sup>13</sup> AEI Report

show that the operation of Indian Point Units 2 and 3 has not caused an adverse impact on any of these populations.<sup>14</sup>

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<sup>14</sup> AEI Report

## II. Status of fishery resources in the Hudson River

On pages 6 and 7 of its Notice, NYSDEC states: “The estuary, particularly the area around the Indian Point facilities, serves as a spawning and nursery ground for important fish and shellfish species, such as striped bass, American shad, Atlantic and shortnose sturgeon, and river herring.”

“While the Hudson once supported rich commercial fisheries throughout its tidal waters, today its commercial fisheries are almost extinct.”

The Hudson River estuary has historically supported, and still does support, a diverse community of fishes. A total of 140 species were reported to be present in the 1970s, including both native species and non-native species introduced by migration through the Erie Canal and other man-made waterways.<sup>15</sup>

Various early life stages of fish and shellfish are seasonally present in the vicinity of Indian Point; however, few species spawn near Indian Point, and even for those species, the Indian Point region is only a small part of total area in which early life stages are present. For example, in most years striped bass spawn primarily between Poughkeepsie and Kingston and, although striped bass larvae are found in the vicinity of Indian Point, they are more abundant up-River.<sup>16</sup> American shad and river herring spawn predominantly in the freshwater upper estuary, and early life stages of these species occur only in relatively low densities near Indian Point.<sup>17</sup> Atlantic sturgeon and shortnose sturgeon spawn in deep channel habitats, predominantly in fresh water of the upper

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<sup>15</sup> Beebe, C. A., and I. R. Savidge, 1988, “Historical perspective on fish species composition and distribution in the Hudson River Estuary,” American Fisheries Society Monograph 4:25-36, 140 different

<sup>16</sup> DEIS, Figure V-33; Boreman, J., and R. J. Klauda. 1988. Distributions of early life stages of striped bass in the Hudson River estuary, 1974-1979. American Fisheries Society Monograph 4, pp. 53-58.

<sup>17</sup> Schmidt, R. E, R. J. Klauda, and J. M. Bartels, 1988, “Distributions and movements of the early life stages of three species of *Alosa* in the Hudson River, with comments on mechanisms to reduce interspecific competition, pp. 193-215 in C. L. Smith, ed., Fisheries Research in the Hudson River, State University of New York Press, Albany, NY.

estuary.<sup>18</sup> Eggs of both sturgeon species adhere to the channel bottom, and larvae of both species are also limited to deep channel areas. Consequently, early life stages of both sturgeons are rare in the vicinity of Indian Point Units 2 and 3. Between 1974 and 2008, only 1 young-of-the-year Atlantic sturgeon, 1 larval shortnose sturgeon, and 1 unidentified larval sturgeon were collected in the Indian Point near-field region, out of 13,868 ichthyoplankton samples collected in that region by the Long River Survey. No sturgeon eggs or larvae have ever been collected in entrainment samples at Units 2 and 3.

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Only small fractions of the eggs, larvae and juveniles of striped bass, American shad, and river herring produced in the Hudson River each year are lost due to entrainment or impingement at Indian Point Units 2 and 3.<sup>20</sup> Moreover, whereas these species are susceptible to entrainment and impingement only during their first year of life, once they reach a harvestable size they are vulnerable to fishing mortality for the remainder of their life spans. The effects of this lifetime susceptibility to harvest are well known to fisheries scientists and are the principal reason that excessive fishing mortality leads to depletion of fish populations.<sup>21</sup> Fishing decreases the survival rate and expected life span of the harvested species, and also reduces the number of eggs a female fish can be expected to spawn over her lifetime. If fishing mortality exceeds a critical threshold, the number of eggs produced by a female over her lifetime will fall below the number needed to sustain the population. Once egg production falls below this level, recruitment (the number of fish entering the population each year) will begin to decline, and will

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<sup>18</sup> Bain, M.B. 1997, Atlantic and shortnose sturgeons of the Hudson River: common and divergent life history attributes. *Environmental Biology of Fishes* 48:347-358.

<sup>19</sup> Barnthouse et al. 2009, Appendix A..

<sup>20</sup> Over the years 1974-1997, conditional mortality rates due to entrainment and impingement combined (a conservative estimate of the fraction by which the abundance of young-of-the-year fish is reduced due to entrainment and impingement) averaged 8.0% for striped bass (DEIS Table V-18), 0.6% for American shad (DEIS Table 5-26), 1.3% for alewife (DEIS Table 5-30), and 1.4% for blueback herring (DEIS Table 5-28).

<sup>21</sup> Mace, P. M. and M. P. Sissenwine. 1993. How much spawning pre recruit is enough? p. 101-118. In: S. J. Smith, J. J. Hunt and D. Rivard [ed.] Risk evaluation and biological reference points for fisheries management. *Canadian Special Publication in Fisheries and Aquatic Sciences* 120.

continue to decline unless fishing is reduced to a level that once again allows lifetime egg production to meet or exceed the replacement level.<sup>22</sup>

The commercial fishery for striped bass in the Hudson River was closed by NYSDEC in 1976 because of PCB contamination not attributed to Indian Point. Since then, and all during the operation of Units 2 and 3, the striped bass population has rebounded.

Similarly, the shortnose sturgeon population in the Hudson River, another species protected from harvesting, has greatly increased in abundance during the time Units 2 and 3 have been operating. Compared to population estimates in the late 1970s, the Hudson River population has increased by more than 400%.<sup>23</sup> This recovery has been attributed to strong recruitment of juveniles during the period from 1986 through 1992, following improvements in water quality in spawning and nursery habitat in the upper estuary.<sup>24</sup>

As detailed below, Hudson River populations of Atlantic sturgeon, American shad, and river herring have declined to very low levels, however, NYSDEC's own studies have shown that overfishing is the primary cause of these declines.

Because of their long lifespan and low reproductive rate, Atlantic sturgeon are highly vulnerable to overfishing, especially if female fish are harvested before they have had a chance to reproduce at least once. For more than 10 years, fisheries scientists informed NYSDEC that the 48-inch length limit for legally harvesting Atlantic sturgeon in New York should be raised to 72 inches to protect immature females.<sup>25</sup> NYSDEC

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<sup>22</sup> Sissenwine, M. P. and J. G. Shepherd. 1987. An alternative perspective on recruitment over-fishing and biological reference points. *Canadian Journal of Fisheries and Aquatic Sciences* **44**:913-918.

<sup>23</sup> Bain, M.B., Haley, N., Peterson, D.L., Arend, K.K., Mills, K.E. and P.J. Sullivan. 2007. Recovery of a US endangered fish. *PLoS ONE* 2(1): e168. doi:10.1371/journal.pone.0000168.

<sup>24</sup> Secor, D. H. and R.J. Woodland. 2005. Recovery and status of shortnose sturgeon in the Hudson River. Final Report to Hudson River Foundation for Science and Environmental Research, Inc. August 2005. 108 pages.

<sup>25</sup> William L. Dovel, 1979, "Atlantic and shortnose sturgeon in the Hudson River estuary," testimony report for the U.S. Environmental Protection Agency; Young, J. R., T. B. Hoff, W. P. Dey, and J. G. Hoff.

maintained the 48-inch length limit until 1990<sup>26</sup>. From 1984 through 1987, annual landings of Atlantic sturgeon in New York waters averaged more than 40,000 pounds per year.<sup>27</sup> During this same period, the abundance of juvenile Atlantic sturgeon in both the commercial fishing bycatch and utility-sponsored monitoring began to decline, indicating a decrease in Atlantic sturgeon reproductive success.<sup>28</sup> In 1990 the Atlantic States Marine Fisheries Commission (ASMFC) required all member states to raise the minimum length limit for Atlantic sturgeon to 72 inches, close their sturgeon fisheries, or implement alternative measures sufficient to protect the sturgeon population from overfishing. NYSDEC proposed an alternative approach that raised the length limit to 60 inches and established seasonal harvesting restrictions and a landings target.<sup>29</sup> NYSDEC managed the Atlantic sturgeon fishery from 1993-1995 using this alternative approach. Subsequent data showed that the landings target was exceeded during all three years and that the population was continuing to decline. The fishery was closed in 1996.<sup>30</sup> This information indicates that overfishing, not cooling water withdrawals by Units 2 and 3, was responsible for the decline in the Hudson River Atlantic sturgeon fishery.

The abundance of Hudson River American shad has been declining for more than 100 years, and the fact that fishing is a major contributor to that decline has been known for nearly as long.<sup>31</sup> While, more than 10 years ago, individual NYSDEC scientists warned that harvests of American shad should be reduced to protect the population<sup>32</sup>,

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1988. Management recommendations for a Hudson River Atlantic sturgeon fishery based on an age-structured population model. Pp. 353-365 in C. L. Smith (ed.) *Fisheries Research in the Hudson River*. State University of New York Press, Albany, NY

<sup>26</sup> ASMFC 1990. Fishery Management Plan for Atlantic Sturgeon. Fisheries Management Report no. 17 of the ASMFC.

<sup>27</sup> ASMFC 1990, Table 4

<sup>28</sup> Waldman, J. R., 2006, "The diadromous fish fauna of the Hudson River: life histories, conservation concerns, and research avenues, pp. 171-188 in J. S. Levinton and J. R. Waldman, eds., *The Hudson River Estuary*, Cambridge University Press.

<sup>29</sup> Kahnle, A., K. Hattala, and K. McKown, 1992, "Proposed New York state Atlantic sturgeon regulations,"

<sup>30</sup> ASMFC 1998, Atlantic sturgeon stock assessment peer review report.

<sup>31</sup> Limburg, K. E., K. A. Hattala, and A. Kahnle. 2003. American shad in its native range. *American Fisheries Society Symposium* **35**:125-140.

<sup>32</sup> Hattala, K. A., and A. W. Kahnle. 1998. Stock status and definition of overfish rate for American shad of the Hudson River estuary. Attachment C to the 1998 ASMFC American Shad stock assessment peer review report.

NYSDEC acted on that warning in 2008 and restricted in-River harvests.<sup>33</sup> Individual NYSDEC scientists also concluded that, from 1974 through 1997, power plants located on Newburgh Bay and south of Newburgh Bay (which would include Indian Point) may have removed only about 3 % of shad production per year.<sup>34</sup> The authors did not cite a source for this value, but the most likely source is Table V-26 of the Draft Environmental Impact Statement (DEIS). This table shows that Indian Point accounts for less than one third of the removal by the five power plants located on Newburgh Bay and south of Newburgh Bay.<sup>35</sup> This conclusion by NYSDEC scientists is confirmed by analyses documented in the AEI Report, which found that entrainment at Units 2 and 3 had no adverse impact on the Hudson River American shad population.

Similarly, NYSDEC's scientists have documented a rapid decline in the abundance of river herring (blueback herring and alewife) in the Hudson River.<sup>36</sup> Following similar declines in other Atlantic coastal rivers, Massachusetts, Rhode Island, Connecticut, Virginia, and North Carolina voluntarily closed their river herring fisheries.<sup>37</sup> Yet, at least through 2009, NYSDEC did not restrict river herring harvests in New York waters. Tables V-28 and V-30 of the DEIS show that, using the same data source used by NYSDEC scientists to draw their conclusions concerning impacts of power plants on American shad, Indian Point Units 2 and 3 may have removed only 1.3% of alewife production and 1.4% of blueback herring production per year from 1974 through 1997. These percentages reflect negligible impacts on the alewife and blueback herring populations by Indian Point, as documented in the AEI Report.

In summary, all available evidence, including evidence provided by NYSDEC's own fisheries scientists, unambiguously demonstrates that Indian Point Units 2 and 3

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<sup>33</sup> Hattala, K. A., and A. W. Kahnle. 2009a. Status of American shad in the Hudson River, New York – 2009 update. ([http://www.dec.ny.gov/fish\\_marine\\_pdf/hrshadstatus.pdf](http://www.dec.ny.gov/fish_marine_pdf/hrshadstatus.pdf))

<sup>34</sup> Hattala, K. A., and A. W. Kahnle. 2008. American shad in the Hudson River: a resource in trouble. Newsletter of the Hudson River Environmental Society Vol XXXVII, No. 1, Spring 2008

<sup>35</sup> Roseton, Danskammer, Indian Point, Lovett, and Bowline Point.

<sup>36</sup> Hattala, K., M. DuFour, R. Adams, and A. Kahnle. 2009b. Hudson River herring stocks. Newsletter of the Hudson River Environmental Society Vol XXXVIII, No. 2, Spring 2009

<sup>37</sup> ASMFC 2009. Amendment 2 to the Interstate Fisheries Management Plan for Shad and River Herring (River Herring Management).

have not caused declines in Hudson River commercial fisheries. Rather, overfishing, has been shown to be the cause of these declines.

III. NYSDEC's definition of AEI and calculation of comparative effectiveness of cylindrical wedgewire screens vs. closed-cycle cooling for reducing AEI

On page 18 of its notice, NYSDEC states: "The Alternative Technology Report estimates that the use of 2.0 mm cylindrical wedge-wire screens on Units 2 and 3 will result in an 89.7% reduction in mortality of ag-1 equivalent organisms. The Department defines adverse environmental impact under 6 NYCRR §704.5 as the total numbers of aquatic organisms killed by a CWIS, not only age-1 equivalents. Based upon this, the estimated entrainment reductions included in the Alternative Technology Report (Table 10 of Attachment 6, page 32) concludes that the use of wedge-wire screens at Units 2 and 3 will only result in a 72.82% to 73.5% reduction in entrainment (2.0 mm-9.0 mm slot width) from the calculation baseline based on total number of eggs and larvae. Therefore, the proposed wedge-wire technology does not provide commensurate minimization benefits as compared to those obtainable with a closed-cycle cooling system (i.e. 90% or greater reductions), particularly when considering reductions in mortality of individuals."

The Department's position on the definition of AEI in the statement acknowledges that mortality is required, by using the word "killed." Thus entrainment and impingement, without mortality, are not sufficient to cause an AEI. The reality of organisms ability to survive entrainment is discussed in the following section below.

With respect to age-one equivalents, the Department's position in the statement is both more narrow than and inconsistent with longstanding Department policy in this proceeding and its position (and sworn testimony) in other proceedings. Most notably, in its official written comments to EPA on the new 316(b) rule, the Department specifically underscored the importance of properly valuing the different life stages, and suggested

that “juvenile equivalents,”<sup>38</sup> an analogous metric to the age-1 equivalent metric used in the “Evaluation of Alternative Intake Technologies at Indian Point Units 2 & 3” (Alternative Technology Report), be used to properly value the different life stages.<sup>39</sup> The Department now offers no basis for reversing this position in favor of raw counts of organisms killed. The raw counts summed across all life stages, without the context of the natural history of the fish populations, can give a misleading impression of the actual biological impacts of entrainment and impingement mortality. For instance, an entrainment loss of 3 million striped bass eggs annually actually represents the spawning potential of a few, perhaps only one, large female fish.<sup>40</sup> Although the entrainment of this many eggs, or even one egg, would be deemed adverse by the Department, fishing mortality imposed at levels approved by NYSDEC and other fisheries management agencies cause much greater losses of spawning potential without being considered to be AEI (see discussion in previous section).

The Department's policy also contrasts sharply with a scientific assessment process in which the *relative* ecological value of entrainment losses is considered. The use of equivalent age 1 fish (the number of age 1 fish that eggs, larvae, and juveniles lost to entrainment would have been expected to produce had they not been entrained) as the measurement metric, as proposed in the Alternative Technology Report is a way to ensure that mitigation efforts are actually effective at protecting the fish populations. This methodology has been available for over 35 years<sup>41</sup> and remains widely employed.<sup>42</sup> In

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<sup>38</sup> the number of entrained eggs and larvae that would have survived to the juvenile stage had they not been entrained.

<sup>39</sup> Comment 316bEFR.402.008 by D. Sheehan, NYSDEC Commissioner: "As an alternative to quantifying losses due to entrainment by a tally of the total numbers of organisms entrained, without differentiating between eggs and larval stages, the Department suggests converting all the early life stages to Juvenile Equivalents. Estimates of natural mortality for early life stages of many species are available in scientific literature. This information would enable conversions of the numbers of eggs, yolk sack and post yolk sack fishes to one consolidated number for each species which reflects life stage value."

<sup>40</sup> Hoff, T. B., J. B. McLaren, and J. C. Cooper. 1988. Stock characteristics of Hudson River striped bass. American Fisheries Society Monograph 4:59-68.

<sup>41</sup> Horst, T. J. 1975. The Assessment of Impact Due to Entrainment of Ichthyoplankton. in Saila, S. (editor) Fisheries and Power Production.

<sup>42</sup> Electric Power Research Institute, 2003, Extrapolating impingement and entrainment losses to equivalent adults and production foregone, EPRI Report No. 1008471.

fact, the use of equivalent adult calculations to support applications for license renewals is specifically prescribed in NRC guidance.<sup>43</sup>

An example of a science-based approach to entrainment and impingement impacts is that used for the Seabrook Station.<sup>44</sup> There, annual entrainment of winter flounder, pollock, and red hake eggs and larvae ranged from 2 million to 159 million. These losses were put into an ecological context by converting them to equivalent adults (the number of mature adult fish the entrained eggs and larvae would have been expected to produce had they not been entrained).<sup>45</sup> Despite the large numerical entrainment losses, adverse impacts were not attributed to the station.<sup>46</sup> Loss of winter flounder in the year of highest entrainment were the ecological equivalent of 3 days catch of a small inshore trawler.<sup>47</sup> Similar findings that entrainment and impingement losses, when expressed as equivalent adults, are small in comparison to fishery harvests have been noted elsewhere.<sup>48,49</sup>

The Department's method of quantifying entrainment and impingement impact provides no distinction among the various life stages that may be affected. The loss of an egg, fertilized or not, is counted as equal to the loss of a mature adult fish, even though from an ecological or sociological perspective the mature adult is of far greater value.

Even accepting the Department's view that the reduction in total numbers of organisms entrained and impinged is the appropriate metric for comparing technologies,

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<sup>43</sup>Nuclear Regulatory Commission Regulatory Guide 4.2S1, section 4.2 states: "Sufficient information should be provided in the ER to put into perspective the loss to entrainment of fish and shellfish in their early life stages, not only in terms of the overall numbers of eggs, larvae, and juveniles in the water body, but also in terms of the numbers of adult fish and shellfish that these losses represent."

<sup>44</sup>Saila et al. 1997. Equivalent adult estimates for losses of fish eggs, larvae, and juveniles at Seabrook Station with the use of fuzzy logic to represent parameter uncertainty. *North American Journal of Fisheries Management* 17:811-825.

<sup>45</sup>"the equivalent adult model is considered a valuable expedient because it quantifies the relative importance of early life history stages of fish in terms of their future contribution to the adult stock, and this is a matter of importance to regulators." Saila et al. 1997. pg 812.

<sup>46</sup>"It seems clear from the available information that the Seabrook Station has had a negligible adverse ecological impact on winter flounder, pollock, and red hake to date." Saila et al. 1997. pg 823

<sup>47</sup>Saila et al. 1997. pg 823.

<sup>48</sup>Turnpenny, A.W.H. 1988. Fish impingement at estuarine power stations and its significance to commercial fishing. *Journal of Fish Biology* 33(SA):103-110.

<sup>49</sup>Greenwood, M. F. D. 2008. Fish mortality by impingement on the cooling-water intake screens of Britain's largest direct-cooled power station. *Marine Pollution Bulletin* 56:723-739.

the conclusion that cylindrical wedge-wire screens will not achieve the performance obtainable with cooling towers is incorrect. In fact, cylindrical wedgewire screens, which could be installed within a few years, would achieve far greater cumulative reductions in entrainment and impingement over the remaining years of plant operation than could be achieved with cooling towers.

This cumulative impact is addressed in the Alternative Technology Report Attachment 6 (Pages 33-34, Tables 7 and 8). Selection and installation of wedgewire screen technology by 2013 and 2015, would result in estimated numerical losses of 6.1 to 7.3 billion eggs, larvae, and early juveniles due to entrainment over the remaining period of operation (2033 and 2035). In contrast, installation of closed cycle cooling, estimated to be completed in 2029 would result in a loss of 9.9 billion. The same conclusion is reached using equivalent age 1 losses: 8.4 to 8.9 million with wedgewire screens<sup>50</sup> compared to 40.1 million with closed cycle cooling. Thus, no matter which loss metric is used to compare technologies, when the time required to install the technologies is taken into account wedgewire screens substantially outperform closed-cycle cooling. For these reasons, NYSDEC's suggestion (in the Notice, pp. 17-18). that WWS are not as effective as CCC during the license renewal period is not supported.

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<sup>50</sup> The range reflects differences in losses associated with CWW slot widths ranging from 1 to 9 mm.

#### IV. The through-plant survival of entrained fish larvae

On Page 19 of its notice NYSDEC states: “The Alternative Technology Report claims, and thereby presumes, a "significant" through-plant survival of fish larvae at Units 2 and 3. The Department requires Department-approved, contemporary site-specific studies to clearly demonstrate that through-plant survival actually occurs at a facility. The data used by Entergy to model the estimated through-plant survival in the Alternative Technology Report were taken from studies conducted by Consolidated Edison nearly 30 years ago. The Department did not recognize significant through-plant survival at Indian Point three decades ago, and Entergy has not submitted any new data to indicate that significant change has occurred regarding through-plant survival at Indian Point now. However, even if the Department concurred with the purported amount of through-plant survival, the entrainment reductions estimated by Entergy with the use of wedge-wire screens would still fall short of those that could be obtained by the use of a closed-cycle cooling system and would be needed to meet the BTA requirement of the State water quality standard in 6 NYCRR §704.5. *See also* fn. 11. “

The Department’s position on entrainment survival in the statement above differs from its past positions in this proceeding, e.g., during preparation of the 1999 DEIS, and in other Hudson River proceedings, e.g., during the Danskammer Point State Pollutant Discharge Elimination System (SPDES) permit hearings..

The Department has not disputed the evidence for entrainment survival, but has apparently, for some unstated reason, refused to approve its application for Indian Point. Demonstration of substantial through-plant survival by consultants acting on behalf of the Hudson River generators, and verification of the results by studies conducted by the EPA technical team at Oak Ridge National Laboratory, was a significant factor in bringing about the 1981 HRSA,<sup>51</sup> to which the Department was a party.

After the HRSA, additional entrainment survival studies were conducted at the Indian Point Units 2 and 3 in 1985 and 1988, with the Department's concurrence and under its oversight. Indeed, the 1988 studies were very successful in terms of both sample sizes and demonstrating significant survival, including for key species identified by the Department, e.g., striped bass.<sup>52</sup> During the 1980s, many monitoring program reports were produced by the regulated community, and accepted by the Department, that incorporated the results of the entrainment survival studies, e.g., at Indian Point and elsewhere.<sup>53</sup>

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<sup>51</sup> Christensen et al. 1981. Science and the Law: Confluence and Conflict on the Hudson River. Environmental Assessment Review 2:63-88. pg 81. "The history of the Hudson River Power Case, considered over the eight-year period from 1972 through 1980, reveals both successes and failures from the viewpoint of a developing field of applied science. The successes are best represented by the issues on which reasonable agreement, at least on general approach, was reached. The question of the relative contribution of Hudson River striped bass to the Atlantic fisheries is one such issue. Another is the entrainment mortality factor (f-factor). Advances made by the utilities' consultants in improving sampling gear for estimating entrainment mortality were largely responsible for the reductions in ORNL's estimates of power plant impact over the years."

<sup>52</sup> EA. 1989b. Indian Point Generating Station 1988 entrainment survival study. Report to Consolidated Edison Company of New York and New York Power Authority. EA Engineering, Science and Technology, Inc. New York.

<sup>53</sup> Reports for the Indian Point stations included:

EA. 1984b. Indian Point Generating Station entrainment abundance and outage evaluation. 1983 annual report to Consolidated Edison Company of New York and New York Power Authority. Ecological Analysts. New York.

EA. 1985b. Indian Point Generating Station entrainment abundance and outage evaluation. 1984 annual report to Consolidated Edison Company of New York and New York Power Authority. Ecological Analysts. New York.

EA. 1989b. Indian Point Generating Station 1988 entrainment survival study. Report to Consolidated Edison Company of New York and New York Power Authority. EA Engineering, Science and Technology, Inc. New York.

NAI (Normandeau Associates). 1987a. Indian Point Generating Station entrainment abundance program. 1985 annual report to Consolidated Edison Company of New York and New York Power Authority. Normandeau Associates, New Hampshire.

NAI. 1987b. Indian Point Generating Station entrainment abundance Program. 1986 annual report to Consolidated Edison Company of New York and New York Power Authority. Normandeau Associates, New Hampshire.

NAI. 1988. Indian Point Generating Station entrainment abundance program. 1987 annual report to Consolidated Edison Company of New York and New York Power Authority. Normandeau Associates, New Hampshire.

During discussions surrounding the 1999 DEIS, the Department indicated that it would consider the actual data-based estimates of entrainment survival as an upper bound for through-plant survival, and insisted that calculations also use zero survival as a lower bound. The Hudson River power plant owners therefore included estimates of entrainment losses and conditional mortality rates done with and without survival included. The Department did not reject this information in the FEIS,<sup>54</sup> although it highlighted estimates that assumed no survival. More recently, the Department explicitly approved the use of survival data collected at Danskammer Point in 1978.<sup>55</sup>

Contemporaneously, EPA's initially pessimistic view of the existing entrainment survival data was controverted by its own outside peer-review panel, which concluded that diverse nation-wide survival studies examined by the agency documented that significant survival exists.<sup>56</sup>

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<sup>54</sup> Hudson River Power Plants FEIS pages 3 & 4: "The generators attempted to estimate through-plant survival, and using those adjustments, the calculations result in a slightly lower number of fish killed by entrainment mortality, as shown in Table 2 (below). Based on data presented in the DEIS and analyses in that and in this FEIS, Department staff conclude that the generators' estimates represent the lower boundary of the actual mortality range, that is, the actual mortality lies somewhere between the generators' number (low end) and 100% (upper end, all entrained organisms die)."

<sup>55</sup> DEC Case No. 3-3346-00011/00002. Hearing Transcript for 12/20/2005 pg 3288. DEC staff Wilson cross-examination by Riverkeeper attorney:

Q: Mr. Wilson, you've testified that the entrainment survival studies at Danskammer are sufficient to apply entrainment survival to the estimates of effective mortality at Danskammer, isn't that correct?

A: I'm sorry, but I'm not sure I follow the estimates .... (interrupted)

Q: You testified that the entrainment survival studies at Danskammer are valid?

A: Yes.

Q: In particular, they are valid for the purpose of estimating entrainment mortality at Danskammer?

A: Yes

Cross -examination by Dynegy attorney on pg 3320:

Q: Mr. Wilson, are you aware if the department staff approved the procedures used in the Danskammer entrainment survival studies?

A: Any of these studies were carried out under the oversight of the department. I would say any of these studies met with the approval of department staff at the time.

<sup>56</sup> M. B. Bain, Ph.D., Director of Center for the Environment, Cornell University, stated "I do not agree with the main conclusion that the 37 studies provide no information indicating survival different than zero. While highly variable data were produced by the studies, I believe some uses can be made of these data, and conclusions can be formed as an alternative to the zero survival position." (External Peer Review of Chapter A7, 9/29/2003).

C. H. Hocutt, Ph.D. Professional Fisheries Scientist, stated "However, does Chapter A7 offer irrefutable evidence in support of the key assumption of zero survivability in entrainment studies? With irony, it is my

In the statement above, the Department appears now to reject entrainment survival estimates derived from substantially more data collected more recently (1979, 1980, 1988) at Indian Point, using state-of-the-art methodology, and that have been subject to peer-review, are published in open scientific literature,<sup>57</sup> and have been provided to Department staff.<sup>58</sup> The scientific question at hand is whether early life stages of certain species of fish can survive passage through the Indian Point cooling systems. If the species have not changed, and the suite of conditions determining survival (salinity, river temperature at which the organisms occur, exposure temperatures, exposure durations, water velocities, use of biocides) have not changed, and they have not except that biocides are no longer used, then there is no reason that estimates derived from the prior data are not useful in the present analysis.

The final point the Department makes is that even if it were to accept the entrainment survival estimates, the entrainment reductions with the proposed technology alternative of wedge-wire screens “would still fall short of those that could be obtained by the use of a closed-cycle cooling system and would be needed to meet the BTA requirement.” As recently as 2003, the Department recognized that quantitative mitigation goals needed to be set in a site-specific manner, rather than uniformly for all facilities.<sup>59</sup> Based on available information, average annual entrainment reductions would approach the level of 90% from a calculated baseline. More importantly, as detailed in the Alternative Technology Report, the much earlier implementation of CWW screens would result in much greater cumulative entrainment reductions over the

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professional opinion that EPA offers substantial evidence to the contrary in Chapter A7. " (Review of Chapter A7, undated).

<sup>57</sup> Young, J. R., W. P. Dey, S. M. Jinks, and D. T. Mosier. 2009. Survival of striped bass entrained into the cooling systems of two Hudson River power stations. *North American Journal of Fisheries Management* 29:1015-1034.

<sup>58</sup> Provided as email attachment from J. Young to C. Neider on 8/5/2009.

<sup>59</sup> Hudson River Power Plant FEIS pg 34-35: 'Each BTA decision must also be found to maximize fish protection while minimizing or avoiding other impacts "... to the maximum extent practicable ..." to satisfy SEQR as well as CWA §316(b). These decisions reiterate that each SPDES permit application involving a CWIS will present an opportunity to make an independent BTA decision. By their very nature, BTA decisions are application-specific, based on site-specific characteristics rather than pre-established quantitative goals applicable to applications generally. This appropriately addresses the unique physical and regulatory aspects of each site, including issues that are land-based and water body-specific, as well as its particular technological limitations or parameters.'

remaining years of operation than would occur with closed-cycle cooling installed after a long and uncertain permitting and construction period<sup>60</sup>.

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<sup>60</sup> Alternative Technology Report Attachment 6, Tables 7 and 8.

V. Interpretation of published studies of the effectiveness of wedgewire screens at reducing entrainment (pp. 20-21)

On page 20 of its Notice, NYSDEC states: “The entrainment reductions estimated in the Alternative Technology Report are based on the unproven assumption that hydrodynamics, coupled with active larval avoidance behavior, and not screen slot width, are responsible for the majority of the entrainment reduction observed with cylindrical wedge-wire (CWW) screens. Moreover, the wealth of available industry literature on this topic does not support this assumption. See Electric Power Research Institute (EPRI) reports of 1998, 2003, and 2005; Taft 2000; Heuer and Tomljanovich 1978; Uziel et al. 1979; Weisberg, et al. 1987.”

NYSDEC’s statement above does not have a literature cited section accompanying it, so we cannot be certain as to which EPRI reports they are referring to. However, we assume that the following references are the ones identified by NYSDEC in support of their assertions, and address below why the Department’s statement does not conform to, and in fact contradicts, the conclusions stated in these reports:

EPRI (Electric Power Research Institute). 1998. Unidentified.

EPRI (Electric Power Research Institute). 2003. Laboratory evaluation of wedgewire screens for protecting early life stages of fish at cooling water intakes. Report 1005339.

EPRI (Electric Power Research Institute). 2005. Field evaluation of wedgewire screens for protecting early life stages of fish at cooling water intakes. Report 1010112.

Heuer, J.H., and D.A. Tomljanovich. 1978. A study on the protection of fish larvae at water intakes using wedge-wire screening. TVA Tech. Note B26. 60 p.

Taft, E.P. 2000. Fish protection technologies: a status report. *Envir. Sci. Pol.* 3(Suppl. 1): S349-S360.<sup>61</sup>

Uziel, M.S., R.F. Carrier, and R.B. McLean. 1979. Entrainment and impingement. *J. Water Poll. Contr. Fed.* 51(6):1554-1573<sup>62</sup>.

Weisberg, S.B., W.H. Burton, F. Jacobs, and E.A. Ross. 1987. Reductions in ichthyoplankton entrainment with fine-mesh, wedge-wire screens. *N. Amer. J. Fish. Manag.* 7:386-393.

The scientific method is a continuous process of evaluation and re-evaluation, based on testing hypotheses developed from the observations and results from prior experimental research. Subsequent studies may either support or negate earlier findings. EPRI undertook a re-evaluation of numerous strategies for fish protection at cooling water intake structures to update the work they funded during the 1990s, and produced a total of 52 technical reports presenting the results of these new studies during the period 2000 through 2009.

Among the references cited by NYSDEC in support of their assertions are two reports<sup>63</sup> and one peer reviewed scientific publication<sup>64</sup>, which are among the references used to develop the entrainment reduction performance of the CWW screens in the Alternative Technology Report for Indian Point. As detailed below, our examination of these studies demonstrates that they provide data and results clearly quantifying the substantial role of active larval avoidance and its contribution to the overall entrainment reduction potential of CWW screens.

Avoidance by larvae and physical exclusion were the two processes contributing to the estimated entrainment reduction potential of the CWW screens evaluated in Indian Point's Alternative Technology Report (see Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report). "Avoidance" refers to the combined effects of active larval avoidance behavior and any hydrodynamic effect that by means of passive

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<sup>61</sup> Literature review summarizing research of others; not a primary reference presenting new information

<sup>62</sup> Also a literature review that does not present any new information

<sup>63</sup> Heuer and Tomljanovich 1978; EPRI 2003.

<sup>64</sup> Weisberg *et al.* 1987

transport prevents larvae from contacting the screen. “Exclusion” refers to the physical blocking of ichthyoplankton (fish eggs and larvae) that come in contact with the screen’s surface but are too large to fit through the rigid CWW slots. Both processes, and specifically active avoidance by larvae of CWW screens, were unequivocally confirmed by the publications cited in NYSDEC assertions above.

The report by Heuer and Tomljanovich (1978) demonstrated that densities of larvae (number of larvae per unit volume of water) in water entrained through flat panel wedgewire screens in a laboratory flume were lower than densities in the water bypassing the screens. The premise behind their study was that larval fish can swim away from wedgewire screens that have sufficiently small openings and sufficiently low through-slot velocities. The authors consistently used the term “avoidance” (or derivatives of this term, like “avoid,” “avoided,” or “avoiding”) a total of 67 times in the 60 page report to explain the reduced entrainment densities that they observed. Although the authors had determined that “six species were small enough in size to be potentially entrainable through the 2.0 mm screen” (of the seven species tested), 106 out of 128 tests with these larvae exposed to a 2-mm slot width screen showed reduced entrainment densities. Therefore, if the larvae were too small to be physically excluded, but were in fact not entrained through the 2-mm slot width wedgewire screen panel, then avoidance provides the only logical explanation for the results of these scientific tests. The evaluation supporting the Alternative Technology Report took the further step of reanalyzing the data from Heuer and Tomljanovich (1978) to estimate the relative proportions of entrainment reduction that were due to avoidance and exclusion (see Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report). Therefore, although Heuer and Tomljanovich (1978) did not specifically quantify the relative contributions of avoidance and exclusion, the data from their report demonstrated that both factors contributed to the performance of the wedgewire panels as evaluated in the Alternative Technology Report and that the authors attributed a portion of the response to active avoidance by swimming fish larvae.

The contribution of Heuer and Tomljanovich (1978) to the avoidance estimates developed in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report is illustrated by the following example for striped bass larvae (a species common in the entrainment samples from Indian Point), exposed to a wedgewire screen of 2-mm slot width (the slot width recommended for Indian Point in the Alternative Technology Report), at a flume velocity of 1.0 ft/s and a through-slot velocity of 0.5 ft/s (velocities within the design range proposed for Indian Point in the Alternative Technology Report). At these velocities, 27% of the entire flume flow was entrained through the 2 mm wedgewire panel<sup>65</sup>. In one experiment during the June testing period, for example, 10.8% of striped bass larvae averaging 5.9 mm in length exposed to a vertically-oriented 2-mm slot width screen panel were entrained. This means that only 40% of the larvae that were exposed to the screen were actually entrained (10.8% divided by the 27% of the flume's flow that was withdrawn through the screen). The average for all four experiments on striped bass under these conditions was 45% of exposed larvae being entrained.

If only 45% of larvae exposed to the screen were entrained, the remaining 55% of the larvae that were exposed to the screen somehow “escaped” being entrained, either by physical exclusion, avoidance, or a combination of the two. The relative contributions of avoidance and exclusion were not estimated by Heuer and Tomljanovich (1978). However, knowledge of the size of striped bass larvae in relation to the slot width of the screens enables apportionment of the experimentally observed 55% escapement into the two components of avoidance and exclusion. Striped bass larvae (and other larvae) swim with their head upstream and their body aligned parallel to the flow vectors entering the screen slots,<sup>66</sup> thus exposing their smallest body dimension to the screen slots. Out of 5,206 measurements of body depths for striped bass larvae between 5 and 7 mm in total

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<sup>65</sup> Heuer and Tomljanovich 1978

<sup>66</sup> Hanson, B.N., W.H. Bason, B.E. Beitz, and K.E. Charles. 1977. A practical intake screen which substantially reduces the entrainment and impingement of early life stages of fish. Pages 393-407 in L.D. Jensen (ed.), Fourth national workshop on entrainment and impingement. E.A. Communications, Melville, N.Y.

length entrained at Indian Point<sup>67</sup> not a single limiting body depth exceeded 2 mm. Since the striped bass tested by Heuer and Tomljanovich (1978) averaged 5.6 mm in April testing and 5.9 mm in June testing, their smallest dimension would have been less than the 2 mm slot width, precluding physical exclusion. Therefore, the only logical conclusion is that 55% of these larvae actively avoided entrainment by swimming upstream and away from the test screen. This same approach was used to extend the results of Heuer and Tomljanovich (1978) to estimate the relative contributions of avoidance and exclusion for other flow conditions and slot widths.

Weisberg *et al.* (1987) demonstrated in a field study that densities of larvae entrained through CWW screens were consistently lower than densities entrained through an unscreened opening. For 5-7 mm larvae as well as for all larger size classes, the average densities entrained through 1-mm, 2-mm, and 3-mm slot widths were lower than densities entrained through the unscreened sampling port. Only the larger size classes (>10 mm in length) were large enough to be physically excluded, but these larger larvae were only large enough in limiting body dimensions to be physically excluded from entrainment into the 1-mm slot width screen. For the 5-7 mm and 8-10 mm size classes of larvae exposed to entrainment through the 1-mm screen, and for all size classes of larvae exposed to entrainment into the 2-mm and 3-mm screens, the authors attributed the density differences to larvae having sufficient swimming ability to escape (i.e., avoid entrainment). Thus Weisberg *et al.* (1987) specifically attributed most of the effectiveness of the 3-mm CWW screens to active larval avoidance behavior rather than to physical exclusion because 5-mm-long larvae of the two dominant species (bay anchovy and naked goby) “were excluded by the 3-mm-mesh screen even though fish as long as 20 mm are narrow enough to fit through this screen.”. The evaluation in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report further developed the relative contributions of avoidance and exclusion by applying larval size data to the Weisberg *et al.* (1987) results by the same method that was used for reanalyzing the Heuer and Tomljanovich (1978) results (as illustrated above).

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<sup>67</sup> Normandeau 1987, cited in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report

EPRI (2003) reported the results of a laboratory flume study using CWW screens. The overall conclusion, as expressed in the report summary, was “results of this study demonstrate that cylindrical wedgewire screens are capable of reducing entrainment and impingement rates to low levels for most species and life stages of fish.” That conclusion was based on EPRI’s findings that entrainment tended to decrease with increasing larval length, increasing channel velocity (sweeping flow), decreasing slot velocity, and decreasing slot width. EPRI (2003) discussed swimming ability of larvae as one of the factors responsible for the entrainment reduction performance of the CWW test screens, but did not quantify the relative contributions of avoidance behavior and physical exclusion. As was true of Heuer and Tomljanovich (1978) and Weisberg *et al.* (1987), EPRI (2003) did provide data that were used in conjunction with larval body depth data in the analysis supporting the Alternative Technology Report to estimate the separate components of avoidance and exclusion.

On page 20 of its Notice, NYSDEC states: “In fact, results from a 1985/1986 entrainment study of a 2.0 mm slot width CWW screen system employed at the Charles Point Resource Recovery Center (Charles Point) in Peekskill, New York, indicated that those screens did not have much of an effect with respect to reducing the entrainment of early life stages of important fish species. Larval striped bass, for example, were entrained by the CWW screen system at Charles Point at densities very nearly equal to those entrained by the Indian Point Facilities (see EA 1986).”

NYSDEC’s statement above misconstrues the cited report, which does not estimate the effectiveness of CWW screens to reduce entrainment and impingement at the Charles Point facility. As such, we do not believe that the Charles Point study informs the Department regarding the effectiveness of the proposed CWW screens for Indian Point.

On page 21 of its Notice, NYSDEC states “The only example of an alleged reduction in entrainment by larger slot width CWW of which the Department is aware is a recent field study at a steam electric facility in Eddystone, Pennsylvania. According to the Alternative Technology Report, the application of CWW with 6.35 mm slot width has resulted in an estimated reduction in entrainment of 60% from baseline at the facility. The Department notes that this claim runs counter to an EPRI report (1998) which found that the 6.4 mm slot width wedge-wire application at Eddystone resulted in no significant entrainment benefits.”

The 316(b) Phase II rule did not exist in the early 1990s when the cooling water intake structure (CWIS) for Eddystone Units 1 and 2, with a design intake flow of 634 mgd, both units combined in a common intake structure, was modified to replace the standard 3/8 inch (9.5 mm) mesh traveling screens with 16 T-type CWW screens with a slot width of 0.25 inches (6.35 mm) and a design, through-slot velocity of 0.41 fps.<sup>68</sup> At that time, the 6.35 mm CWW screens were installed at Eddystone for impingement reductions. However, the proposed 316(b) Phase II Rule (July 2004) created a need to evaluate the performance of the CWW screens at Units 1 and 2 at reducing both entrainment and impingement by comparison to a baseline calculated from entrainment and impingement at Units 3 and 4, which still used conventional travelling screen arrays. A year-long study of both entrainment and impingement performance of these CWW screens at the Unit 1 and 2 CWIS of Eddystone Station was performed from 20 April 2005 through 5 April 2006 (Veritas *et al.* 2008, cited in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report). In this 2005-2006 study, the CWIS for Units 3 and 4 served as the baseline because it was adjacent to the Unit 1 and 2 CWIS and equipped with many baseline features specified by EPA in the Phase II Rule, including 3/8 inch (9.5 mm) conventional traveling screens.

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<sup>68</sup> (Veritas *et al.* 2008, cited in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report)

NYSDEC correctly states “According to the Alternative Technology Report, the application of CWW with 6.35 mm slot width has resulted in an estimated reduction in entrainment of 60% from baseline at this facility.” However, NYSDEC mistakenly did not acknowledge that the 60% reduction in entrainment for Eddystone quoted in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report was calculated as the reduction in the flow-weighted annual total entrainment abundance estimates from a calculation baseline, and this reduction is confounded not only by differences in the densities of fish eggs and larvae entrained through the 6.35 mm CWW screens compared to the adjacent conventional 3/8 inch (9.5 mm) traveling screens, but also by differences between design intake flow and the seasonal timing and magnitude of actual operating flow observed during the one year study. The entrainment reduction from baseline estimated for Eddystone is also influenced by operational controls that were implemented in whole or in part for the purpose of reducing impingement mortality and entrainment (Veritas *et al.* 2008, cited in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report). Therefore, the 60% reduction in entrainment estimated for the 6.35 mm CWW screens installed and operated at Eddystone Units 1 and 2 is a unique and site-specific application of these CWW screens in combination with the actual flow reductions and other operational controls unique to that site.

More importantly, NYSDEC selectively ignored the second half of the same paragraph in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report when they extracted the 60% entrainment reduction value for Eddystone without understanding the basis for calculating this reduction as explained in Veritas *et al.* 2008 (as cited in Section 2.0 of Appendix B of Attachment 6 of the Alternative Technology Report) and summarized here in the preceding paragraph. The correct entrainment reduction performance of the 6.35 mm CWW screens installed at Eddystone Units 1 and 2 that is directly applicable to estimate performance at other facilities of different intake flows and operational procedures is based on the difference in density of fish eggs and larvae between simultaneously collected pairs of 2-hour entrainment samples. In 374 paired entrainment samples from 20 April 2005 through 5 April 2006 at Eddystone, the mean density of larvae entrained through the 6.35 mm slot width CWW screens at the

Unit 1 and 2 CWIS was 82% lower than the mean density of larvae entrained simultaneously through conventional 9.5 mm (3/8-inch) mesh screens at the adjacent Unit 3 and 4 CWIS. These results from Eddystone demonstrate that a high percentage of larvae can avoid entrainment through full-scale cylindrical wedgewire screens operating under estuarine field conditions with a similar species composition as Indian Point, even at a slot width of 6.35 mm. An 82% entrainment reduction based on abundance data is consistent with NYSDEC's draft policy for Best Technology Available (BTA) for Cooling Water Intake Structures (latest revision dated 4 March 2010) and is nearly within 90% of their reported entrainment reduction performance for cooling towers of 93% to 98%. Further reductions would be expected for CWW screens of smaller slot widths or in preferential siting environments.

## VI. The relevance of the Oak Creek facility

On page 21 of its Notice, NYSDEC states “The Alternative Technology Report also claims that CWW may be an “available” technology for satisfying 6 NYCRR§704.5 at Indian Point based on the recent requirement for the Oak Creek Power Plant in Milwaukee, Wisconsin to install and operate 9.5 mm CWW screens 7,000 ft offshore in the waters of Lake Michigan. The State of Wisconsin selected 9.5 mm CWW screens as BTA for impingement but made no similar claim for entrainment reductions. In fact, any entrainment reductions realized at the Oak Creek plant will be attributed to the location of the intake, not from the CWW technology.

The Alternative Technology Report only referred to the CWW system at Oak Creek Power Plant to support the fact that CWW technology is currently in use at a facility with an intake flow capacity comparable to the Indian Point Stations:

“Oak Creek Power Plant in Milwaukee, Wisconsin operates the largest installation of CWW screens. It has four operating Units online that generate a total of 1135 MWe. The Oak Creek CWW screen system includes an offshore intake system situated approximately 6000-7000 ft from the shoreline at a depth of approximately 43 ft. According to Oak Creek (see Attachment 1, Section 6), the CWW system became operational in January 2009 and is designed to operate year round. The offshore intake system uses twenty-four (24) 8-ft diameter CWW screens with a slot size of 0.375 inches to filter a flow rate of 1,560,000 gpm (see Attachment 1, Section 6). The total intake flow rate at Oak Creek is comparable to the total intake flow rate at IPEC Units 2 and 3. The CWW screen system at Oak Creek was designed to provide a through-screen velocity at or below 0.5 fps and the system was oversized by approximately 16% (3 additional screens) to provide a margin against fouling. Johnson Screens, a leading CWW screen manufacturer, supplied Oak Creek’s CWW screens. The entire screen assemblies are manufactured from copper-nickel alloy.” (Alternative Technology Report, page 54)

As noted in Attachment 1, Section 6 of the Alternative Technology Report, the full intake flow capacity at Oak Creek will be utilized after two new units are completed:

“Currently [as of 11/19/2009] four units are online and generate a total of 1,135 Mwe. These units were commissioned between 1959 and 1967. Two additional units are being constructed and will each generate 615 Mwe. .... The intake system is operating at 60% capacity since the 2 new units are not online.”

The Alternative Technology Report did not claim that the CWW technology at Oak Creek supported the proposition that CWW would reduce entrainment, as alleged in the Notice.

Furthermore, listed below is a summary (based on excerpts from the Findings of Fact, Conclusions of Law and Order, Case No. IH-05-06, State of Wisconsin Division of Hearings and Appeals, July 10, 2006).<sup>69</sup> of key facts and conclusions that lead the State of Wisconsin to make the determination that the CWW intake at Oak Creek Power Plant was BTA for entrainment, and that allowed the State of Wisconsin to issue Wisconsin Electric a WPDES permit for Oak Creek Power Plant.

“Wisconsin Electric caused studies to be conducted in 2002 and 2003 to assess the relative abundance of entrainable fish larvae and eggs at both the proposed offshore and the existing intake onshore locations. (Tr. 457; Exs. 18, 20). The studies concluded that in 2002 and 2003 there were fewer entrainable organisms offshore as compared to onshore. (Tr. 525, 560, 563; Ex. 57).” (Findings of Fact, page 6)

“The calculation baseline for entrainment was derived from the densities of organisms found at the existing OCPP shoreline intake during the 2002 and 2003 studies. Densities of organisms found in the bottom stratum of water in the intake canal were used to

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<sup>69</sup> In the Matter of the Petition for Contested Case Hearing Regarding WPDES Permit No. WI-0000914-07-0 issued to Wisconsin Electric Power Company for the Oak Creek Power Plant and Elm Road Generating Station located in Oak Creek, Wisconsin

establish the calculation baseline. This calculation baseline was then compared to the densities of organisms found in the vicinity of the proposed CWIS during the 2002 and 2003 studies. Using the comparative densities between the two sites, the entrainment reduction was 93% for 2002 densities and 73% for the 2003 densities. An alternative calculation to adjust for the fact that the 2002 and 2003 sampling was done only during nighttime hours (referred to as the “Case II” calculation), yielded no change in the entrainment reduction of 93% for 2002, but a decrease in the 2003 reduction percentage from 73% to 63%. (Tr. 559-60).” (Findings of Fact, page 7)

“Wisconsin Electric submitted a confidence interval analysis of the 2003 data and concluded that there was a 98% probability that the entrainment reduction would be greater than 60% under the assumption that the nighttime sampling densities would be replicated during the day. When recalculated based on assumptions that there would be increased organisms present during daytime hours, this “confidence interval analysis” resulted in a 73% probability of achieving the 60% entrainment standard. (Tr. 562-63; Ex. 38).” (Discussion, page 21)

“The confidence interval analysis presented by Wisconsin Electric provided the DNR with a reasonable basis upon which to conclude that the proposed intake may reasonably be expected to meet the 60% entrainment reduction standard. The Phase II rule does not contemplate that an applicant show conclusively that it will achieve entrainment standards, but rather requires a showing that the facility “can reasonably be expected” to meet such standards. See 40 C.F.R. § 125.98(b)(1)(iv). The statistical confidence interval presented by Wisconsin Electric makes a sufficient showing that the facility may be reasonably expected to meet entrainment standards.” (Discussion, page 22)

“The proposed cooling water intake structure can reasonably be expected to meet the 60% entrainment reduction standard of the Phase II rule. 40 C.F.R. §125.98(b)(1)(iv).” (Conclusions of Law, page 34)

The statements establish the fact that the BTA decision for entrainment at Oak Creek was based on differences in densities of entrainable organisms at the offshore

location of the CWW intake in comparison to densities at the shoreline Base case intake. Furthermore, it documents the fact that the BTA determination was granted because Oak Creek demonstrated the offshore CWW intake could reasonably be expected to reduce entrainment by 60%.

## VII. Endangered and threatened species, species of concern

On page 21 of its Notice, NYSDEC states “ The historical biological data for the Indian Point facilities confirms that the operation of Units 2 and 3 harm (“take”) both shortnose sturgeon and Atlantic sturgeon by impinging them on the CWISs screens or entraining them in the CWISs.”

Also on page 21 of its Notice, NYSDEC further states “Given that Entergy is seeking an additional 20-year license to operate Units 2 and 3, and the previous history of unauthorized “take” of both shortnose sturgeon and Atlantic sturgeon it is reasonable to conclude that the Indian Point facilities continue to cause mortality to the sturgeon species in the Hudson River.”

First, as discussed in Section II of this response, in 34 years of River-wide fisheries monitoring (1974-2008), only two (2) sturgeon larvae have ever been found in the Indian Point region among 13,868 ichthyoplankton samples collected there during the larval period, and no sturgeon eggs or larvae have ever been collected in entrainment samples from Units 2 and 3. Therefore, there is no evidence that any sturgeon eggs or larvae have ever been entrained at Unit 2 or Unit 3.

Second, although sturgeon were occasionally observed in the daily impingement samples collected from 1974 through 1990 at Unit 2 and Unit 3, cooling water withdrawal and discharge at Indian Point occurs under a Biological Opinion, issued by the National Marine Fisheries Service (which administers the Endangered Species Act), stating that the operation of Indian Point during licensing period would not pose a threat to recovery of the shortnose sturgeon in the Hudson River. Moreover, annual impingement monitoring for sturgeon and other fish species was discontinued after installation of the Ristroph Screens and Fish Return System at Indian Point Unit 2 and Unit 3 in late 1990 with the concurrence of NYSDEC. The Ristroph Screens and Fish Return System were designed and installed as a condition of the Hudson River Settlement Agreement under the supervision of Riverkeeper's then-expert Dr. Ian Fletcher's, and the

subject of a published, peer-reviewed study<sup>70</sup> in which Dr. Fletcher concluded “further refinements to the Ristroph family of screens are possible, of course, but I do not believe that improvements beyond those reported here are apt to bring about greatly enhanced reductions in fish kills”. In other words, the Ristroph Screens and Fish Return System installed and operated at Indian Point Unit 2 and Unit 3 is a state-of-the-art system capable of avoiding impingement mortality of sturgeon. Finally, installation of the CWW system, as proposed, would meet or may exceed the Department-approved current configuration in terms of mizinimizing impingement mortality, and therefore assures acceptably low impingement mortality of sturgeon during the license renewal period. Submerged CWW screens of an appropriate slot size to protect the eggs, larvae, and juveniles of all fish and shellfish at the site were considered by EPA to be among the design and construction technologies selected in the federal rule (voluntarily suspended).

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<sup>70</sup> Fletcher, R.I. 1990. Flow dynamics and fish recovery experiments: water intake systems. Transactions of the American Fisheries Society 119: 393-415.