## STATE OF VERMONT ENVIRONMENTAL COURT

)

In Re: Entergy Nuclear Vermont Yankee ) Discharge Permit ) Permit Number: 3-1199 )

DOCKET NO. 89-4-06 Vtec

## <u>CONNECTICUT RIVER WATERSHED COUNCIL et al.'s</u> <u>REQUEST FOR FINDINGS</u>

Appellants Connecticut River Watershed Council, Trout Unlimited (Deerfield/Millers

349 Chapter), and Citizens Awareness Network (Massachusetts Chapter) (collectively "CRWC"

or "Appellants") respectfully submit this Request for Findings, and accompanying post-trial

Memorandum of Law.

# ENVIRONMENTAL AND NATURAL RESOURCES LAW CLINIC

Patrick A. Parenteau, Esq. David K. Mears, Esq. Benjamin Rajotte, Esq. (admission pending) Environmental and Natural Resources Law Clinic Vermont Law School PO Box 96 South Royalton, VT 05068 (802) 831-1630

Attorneys for Appellants Connecticut River Watershed Council Trout Unlimited (Deerfield/Millers 349 Chapter) Citizens Awareness Network (Massachusetts Chapter)

Dated: October 9, 2007

# TABLE OF CONTENTS

| I.   | INTF   | RODUCTION   | 1  |  |
|------|--|---|----|--|
| II.  | HISTORY OF VERMONT YANKEE<br>OPERATION AND PERMITTING                  |   |    |  |
|      | A.   | Design and Initial Operation (1973-78)  | 2  |  |
|      | B.   | 1978 Demonstration  | 3  |  |
|      | C.   | Project SAVE (1981-85)  | 4  |  |
|      | D.   | Experimental Discharge (1986-90)  | 5  |  |
|      | E.   | 1990 Demonstration  | 5  |  |
|      | F.   | Permits (1991-2001)   | 6  |  |
|      | G.   | 2004 Demonstration and Application<br>for Permit Amendment                            | 6  |  |
|      | H.   | Permit Amendment (2006)   | 7  |  |
| III. | BALANCED INDIGENOUS POPULATION AND<br>REPRESENTATIVE IMPORTANT SPECIES |   |    |  |
|      | A.   | General Regulatory Framework  | 8  |  |
|      | B.   | Connecticut River Habitat   | 10 |  |
|      | C.   | RIS Methodology   | 11 |  |
|      | D.   | Thermal Shock   | 14 |  |
|      | E.   | Warmwater Species Included in RIS   | 15 |  |
|      | F.   | Coolwater Species Included in RIS   | 18 |  |
|      | G.   | Coldwater and Coolwater Species Not Included in RIS                                   | 19 |  |
| IV.  | HYDROTHERMAL MODELING AND<br>DOWNSTREAM EFFECTS                        |   |    |  |
|      | A.   | The Hydrothermal Model  | 23 |  |
|      | B.   | Comparison of the 1978, 1990, and 2004<br>Demonstrations Regarding Downstream Effects | 26 |  |
| V.   | CUM  | CUMULATIVE AND SYNERGISTIC EFFECTS  |    |  |

## TABLE OF CONTENTS (cont'd)

| VI.   | SUBSTANTIAL DECLINE IN AMERICAN SHAD<br>POPULATION AND ADVERSE EFFECTS ON<br>LIFE STAGES |                                       |      |
|-------|--|---------------------------------------|------|
|       | A.   | Spawning Behavior                     | . 48 |
|       | B.   | Temperature and Reproductive Success  | . 51 |
|       | C.   | Bioenergetics                         | . 52 |
|       | D.   | Larval Development                    | . 54 |
|       | E.   | Juvenile Rearing                      | . 55 |
|       | F.   | Juvenile Outmigration                 | . 56 |
|       | G.   | Shad Collapse and Restoration Efforts | . 58 |
|       | H.   | Observations on the River             | . 60 |
|       | I.   | Turners Fall Dam                      | . 61 |
|       | J.   | Limits to Thermal Tolerance           | . 64 |
|       | K.   | Chronic Effects                       | . 73 |
| VII.  | ADVERSE EFFECTS ON LIFE STAGES OF<br>ATLANTIC SALMON                                     |                                       |      |
| VIII. | THE  | TURNERS FALLS DAM PASSAGE HYPOTHESIS  | . 84 |
| IX.   | THE  | STRIPED BASS PREDATION HYPOTHESIS     | . 88 |
| X.    | VER  | MONT WATER QUALITY STANDARDS          | . 92 |
| APPE  | NDIX   |                                       | . 95 |

#### I. <u>INTRODUCTION</u>

Appellants respectfully request the findings of fact set forth below. They are cited as "R.F." in the accompanying Memorandum of Law. The following is intended to clarify them:

The trial transcript is abbreviated as "Trial Tr.," and the transcript of the crossexamination of Appellants' rebuttal testimony is abbreviated as "Rebuttal Tr." Each testifying witness' last name is provided in parenthesis for identification.

References to "Prefiled" by Appellants' experts generally refer to their respective <u>Reports To Accompany Pre-filed Testimony</u> serving as Appellants' prefiled testimony. This term also applies to Entergy's prefiled submissions. References to "Rebuttal" by Appellants' experts refer to their Revised Rebuttal Testimony dated August 24, 2007.

References to exhibits correspond to the exhibits set forth in the parties' individual and joint exhibit lists. Some requests for findings refer to scientific articles cited or discussed in prefiled or rebuttal testimony. These articles are generally listed within the bibliographies or text of the prefiled submissions or affidavits that are cited in the requests for findings; they are referenced here by naming the lead author or authors, followed by publication year.

An appendix follows these requests for findings. The appendix contains a table listing some of the evidence that was excluded by the Court in prior rulings and Appellants' grounds for its admissibility. Appellants have respectfully submitted some requests for findings, where indicated by an asterisk for identification, drawing in whole or part from evidence in this table.

"Entergy" refers to Cross-Appellant Entergy Nuclear Vermont Yankee, LLC and any predecessor or related entities where applicable; it is also meant to refer to any of Entergy's consultants, experts, agents, and others acting on its behalf in performing, evaluating, or otherwise playing a role in this Section 316(a) Demonstration, and vice versa. These requests for findings are generally meant to address both the Section 316(a) Demonstration at issue and any

- 1 -

other evidence in this action, for purposes of applying the controlling law.

## II. HISTORY OF VERMONT YANKEE OPERATION AND PERMITTING

#### A. <u>Design and Initial Operation (1973-78)</u>

 In early 1973, the U.S. Atomic Energy Commission issued Vermont Yankee ("Vermont Yankee," or the "plant" or "facility") an operating license. Jt. Ex. 5, 1990
 Demonstration, at 1; Jt. Ex. 3, 2004 Demonstration, at 230.

2. Vermont Yankee installed cooling towers designed to dissipate directly to the atmosphere all or some of the heat added to the circulating water from cooling the condenser. Jt. Ex. 5, 1990 Demonstration, at 1. Pursuant to its license, the plant operated in closed cycle cooling mode pending determinations concerning possible environmental impacts from thermal discharge to the Connecticut River ("Connecticut River" or the "river"). Jt. Ex. 5, 1990 Demonstration, at 1; Jt. Ex. 3, 2004 Demonstration, at 230.

3. For the first two years of operation (1972-73), Vermont Yankee used only the closed cycle mode of condenser cooling. Jt. Ex. 5, 1990 Demonstration, at 1.

4. In order to obtain data about the environmental impact of its discharge, state and federal agencies allowed Vermont Yankee to discharge heated effluent into the Connecticut River concurrent with an intensive biological and hydrological testing program ("Phase Studies"). Jt. Ex. 6, 1978 Demonstration, at 1-1; Jt. Ex. 5, 1990 Demonstration, at 1; Jt. Ex. 3, 2004 Demonstration, at 230.

5. There were a series of such studies between 1974 and 1978. Jt. Ex. 6, 1978 Demonstration, at 1-2, 1-3, 1-5; Jt. Ex. 5, 1990 Demonstration, at 1.

6. Concurrent with these open cycle testing programs was the implementation of the Federal Water Pollution Control Act Amendments of 1972 (hereinafter referred to as the "Clean

- 2 -

Water Act" or "Act"). Jt. Ex. 6, 1978 Demonstration, at 1-3.

7. The Clean Water Act requires that steam electric generating stations have the best available control technology, which is interpreted as some form of closed cycle cooling. Jt. Ex. 6, 1978 Demonstration, at 1-3.

## B. <u>1978 Demonstration</u>

8. As a result of the Phase Studies and pre-operational studies, Vermont Yankee submitted a § 316(a) demonstration in 1978 (the "1978 Demonstration"). Jt. Ex. 6, 1978 Demonstration; see also Jt. Ex. 5, 1990 Demonstration, at 1.

9. Vermont Yankee used the <u>Interagency 316(a) Technical Guidance Manual and</u> <u>Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements</u> <u>Manual</u> by the Environmental Protection Agency, Office of Water Enforcement, Permits Division, Industrial Permits Branch (draft May 1, 1977) (the "1977 Guidance") to format the 1978 Demonstration. ANR Ex. 13, 1977 Guidance; Jt. Ex. 6, 1978 Demonstration, at 1-3.

10. The 1978 Demonstration incorporated elements of the "Type I" and "Type II" demonstrations from the 1977 Guidance. ANR Ex. 13, 1977 Guidance; Jt. Ex. 6, 1978 Demonstration, at 1-4.

11. Based on the 1978 Demonstration, Vermont Yankee was granted a NPDES permit in 1978 to discharge condenser cooling water to the Connecticut River during the winter period of October 15 through May 15 (the "Winter Period") according to the following criteria:

- the temperature at Station 3 during open cycle operation shall not exceed 65°F;
- the rate of temperature change at Station 3 shall not exceed 5°F per hour; and
- the increase in temperature above ambient at Station 3 shall not exceed 13.4°F.

Jt. Ex. 5, 1990 Demonstration, at 1-3, Jt. Ex. 3, 2004 Demonstration, at 230.

12. During the summer period of May 16 through October 14 (the "Summer Period") the plant operated in the closed cycle mode. Jt. Ex. 5, 1990 Demonstration, at 1; Jt. Ex. 3, 2004 Demonstration, at 230.

#### C. <u>Project SAVE (1981-85)</u>

13. In 1981 Vermont Yankee proposed a program to the Vermont Department of Water Resources for evaluating alternate operational condenser cooling modes during the Summer Period. Jt. Ex. 5, 1990 Demonstration, at 3.

14. In 1981 Vermont Yankee proposed a program and study plan to the Vermont
Agency of Natural Resources ("ANR") for evaluating the effects on aquatic resources of open
and hybrid cycle cooling as an alternative to closed operation during the Summer Period. Jt. Ex.
3, 2004 Demonstration, at 232.

15. The goal of this program, known as "Project SAVE" (an acronym for "Save Available Vermont Energy"), was to maximize Vermont Yankee's energy production without objectionable environmental impact. Jt. Ex. 5, 1990 Demonstration, at 3.

 Project SAVE's experimental studies were applied for under section A1.6(1) of Vermont Yankee's NPDES Permit No. VT0000264. Jt. Ex. 5, 1990 Demonstration, at 3.

17. Three species of fish were part of the initial Project SAVE effort: smallmouth bass, walleye, and white perch. However, due to high mortality of tagged white perch and low returns of tagged walleye, the program was modified to concentrate on smallmouth bass. Jt. Ex. 5, 1990 Demonstration, at 3-4.

18. The smallmouth bass is a non-native warmwater species, introduced in the 1800s.Trial Tr. 428 (Mattson).

19. During the early years of Project SAVE (1982 to 1985), Vermont Yankee was

- 4 -

operated in either open or hybrid mode for various time periods during the Summer Period. Jt. Ex. 5, 1990 Demonstration, at 4; Jt. Ex. 3, 2004 Demonstration, at 232.

20. The goals of Project SAVE were reassessed in 1985, since the then current NPDES permit would expire in January 1986. Jt. Ex. 5, 1990 Demonstration, at 5.

21. Project SAVE was reassessed in 1985 in part due to a revision of the Vermont Water Quality Standards that changed the habitat designation of this reach of the Connecticut River from warmwater to coldwater fish habitat. Jt. Ex. 3, 2004 Demonstration, at 232.

22. The Vermont coldwater fish habitat temperature standards limited the increase in water temperature due to the Vermont Yankee discharge to 1°F above ambient. Jt. Ex. 3, 2004 Demonstration, at 232.

#### D. Experimental Discharge (1986-90)

23. Under the renewed 1986 NPDES permit, temperature standards for the Winter Period of October 15 through May 15 remained the same; however, a new 1°F temperature increase for the Summer Period was permitted. Final Discharge Permit No. 3-1199 (beginning Jan. 9, 1986), at 1-2; Jt. Ex. 5, 1990 Demonstration, at 5; Jt. Ex. 3, 2004 Demonstration, at 233.

24. The renewed NPDES permit allowed for a five-year experimental program instead of requiring year-to-year authorization from the ANR. Final Discharge Permit No. 3-1199 (beginning Jan. 9, 1986); Jt. Ex. 5, 1990 Demonstration, at 5.

25. In 1986, Vermont Yankee underwent an extended outage to replace pipes in the containment building. Open or hybrid operation continued in 1987. Jt. Ex. 5, 1990 Demonstration, at 5.

#### E. <u>1990 Demonstration</u>

26. Relying upon data attained as part of Project SAVE, as well as the previous information used in the 1978 Demonstration, Vermont Yankee submitted a § 316(a)

- 5 -

demonstration to accompany its petition for alternate temperature standards for the Summer Period (the "1990 Demonstration"). Jt. Ex. 5, 1990 Demonstration, at 6.

On January 1, 1991, Vermont Yankee received a renewed NPDES permit set to expire on December 31, 1995. Final Discharge Permit No. 3-1199 (beginning Jan. 1, 1991), at 1;R. Jones Prefiled, at 10.

28. The 1991 NPDES permit allowed open or hybrid cycle mode during the Summer Period. The permit allowed for an increase in ambient temperature at Station 3 of 2°F (if Station 7 was above 63°F) to 5°F (if Station 7 was below 55°F). Final Discharge Permit No. 3-1199 (beginning Jan. 1, 1991), at 6; R. Jones Prefiled, at 10.

29. Ambient river temperature is monitored at Upstream Station 7, a location 3.5 miles upriver of Vermont Yankee on the Vermont shore. The actual change in river temperature due to Vermont Yankee is monitored at Downstream Station 3, located 0.65 miles downstream from Vernon Dam and 1.4 miles downstream from Vermont Yankee. Jt. Ex. 3, 2004 Demonstration, at 13.

#### F. <u>Permits (1991-2001)</u>

30. Pursuant to permits issued in 1991 (as set forth above), and 1996, and 2001, Vermont Yankee operates under year-round open or hybrid mode. Final Discharge Permit No. 3-1199 (beginning Jan. 1, 1991), at 6; Final Discharge Permit No. 3-1199 (beginning Mar. 21, 1996), at 4-5; ANR Ex. 3, Discharge Permit No. 3-1199 (beginning July 11, 2001), at 4-5; see also R. Jones Prefiled, at 10.

## G. 2004 Demonstration and Application for Permit Amendment

31. On February 20, 2003 Vermont Yankee requested an amendment to the existing thermal effluent limitations, to allow it to increase the temperature of the Connecticut River by

- 6 -

1°F during the Summer Period at Station 3. ANR Ex. 7, Draft Amended NPDES Permit Fact Sheet (Oct. 2005), at 2; ANR Ex. 9, Draft Amended NPDES Permit Fact Sheet (revised Mar. 2006), at 2.

32. In April 2004, Vermont Yankee submitted a final § 316(a) Type III demonstration in connection with its request for a 1°F increase in thermal discharge temperatures (the "2004 Demonstration"). Jt. Ex. 3, 2004 Demonstration, at 5.

#### H. <u>Permit Amendment (2006)</u>

33. On March 30, 2006, Entergy received an amendment to its existing NPDES permit that split the Summer Period into two parts. The first part of the Summer Period runs from May 16 to June 15, and the effluent limits are identical to the 2004 permit. However, the second part of the Summer Period, from June 16 to October 14, allows for an additional 1°F increase when ambient river temperatures are between 55°F and 78°F. Jt. Ex. 1, 2006 Amended Discharge Permit, at 4-5.

34. Vermont Yankee actually requested the permit amendment for the entire Summer Period of May 16 through October 14, and ANR granted it for the time period of June 16 through October 14. Jt. Ex. 1, 2006 Amended Discharge Permit, at 4-5; ANR Ex. 7, Draft Amended NPDES Permit Fact Sheet (Oct. 2005), at 2; ANR Ex. 9, Draft Amended NPDES Permit Fact Sheet (revised Mar. 2006), at 4; Trial Tr. 396 (Mattson).

35. The March 30, 2006 amended permit also contains a provision that states that the river temperature should not exceed 85°F as a result of the Vermont Yankee discharge. Jt. Ex. 1, 2006 Amended Discharge Permit, at 5.

36. On March 31, 2006, Entergy's existing NPDES permit expired. Jt. Ex. 1, 2006 Amended Discharge Permit, at 1.

37. Vermont Yankee's application for a renewed permit is pending.

- 7 -

## III. BALANCED INDIGENOUS POPULATION AND REPRESENTATIVE IMPORTANT SPECIES

## A. <u>General Regulatory Framework</u>

38. EPA regulations define the terms "balanced, indigenous community" ("BIC") and

"balanced, indigenous population" ("BIP") as follows:

[A] biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species and by a lack of domination by pollution tolerant species. Such a community may include historically non-native species introduced in connection with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications. Normally, however, such a community will not include species whose presence or abundance is attributable to the introduction of pollutants that will be eliminated by compliance by all sources with section 301(b)(2) of the Act; and may not include species whose presence or abundance is attributable to alternative effluent limitations imposed pursuant to section 316(a).

39. The 1977 Guidance further defines BIC as set forth below:

a. It "consists of desirable species of fish, shellfish, and wildlife, including

the biota at other trophic levels which are necessary as a part of the food chain or

otherwise ecologically important to the maintenance of the community." ANR Ex. 13,

1977 Guidance, at 74.

b. "In keeping with the objective of the Act, the community should be

consistent with the restoration and maintenance of the biological integrity of the water."

ANR Ex. 13, 1977 Guidance, at 74.

c. "For purposes of a 316(a) demonstration, distribution and composition of the indigenous population should be defined in terms of the population which would be impacted by the thermal discharged caused by the alternative effluent limitation proposed under 316(a)." ANR Ex. 13, 1977 Guidance, at 74.

d. "A determination of the indigenous population should take into account all

impacts on the population except the thermal discharge. [T]hen, the discrete impact of the thermal discharge on the indigenous population may be estimated in the course of a 316(a) demonstration." ANR Ex. 13, 1977 Guidance, at 74.

e. "In order to determine the indigenous population which will be subject to a thermal discharge under an alternative 316(a) effluent limitation, it is necessary to account for all non-thermal impacts on the population such as ... entrapment and entrainment effects of any withdrawal of cooling water through intake structures under the alternative 316(a) effluent limitation." ANR Ex. 13, 1977 Guidance, at 74.

40. Further, under the 1977 Guidance a "community" is generally defined as "any assemblage of populations living in a prescribed area or physical habitat; it is an organized unit to the extent that it has characteristics additional to its individual and population components, and functions as a unit through coupled metabolic transformations." ANR Ex. 13, 1977 Guidance, at 75.

41. EPA regulations define "representative important species" ("RIS") as "species which are representative, in terms of their biological needs, of a balanced, indigenous community of shellfish, fish and wildlife in the body of water into which a discharge of heat is made." 40 C.F.R. § 125.71(b).

42. The 1977 Guidance further defines RIS as follows:

"Representative, important species are those species which are: representative, in terms of their biological requirements, of a [BIC] of shellfish, fish, and wildlife in the body of water into which the discharge is made. Specifically included are those species which are:

- 1. Commercially or recreationally valuable (i.e., within the top ten species landed by dollar value);
- 2. Threatened or endangered;
- 3. Critical to the structure and function of the ecological system (e.g.,

habitat formers);

- 4. Potentially capable of becoming localized nuisance species;
- 5. Necessary in the food chain for the well-being of species determined in 1-4; or
- 6. Representative of the thermal requirements of important species but which themselves may not be important."

ANR Ex. 13, 1977 Guidance, at 78-79.

43. Macroinvertebrates are defined, for purposes of the 1977 Guidance, as synonymous with aquatic macroinvertebrates. ANR Ex. 13, 1977 Guidance, at 77.

#### B. <u>Connecticut River Habitat</u>

44. The Connecticut River is designated as a Class B "cold water fish habitat." See Vermont Water Quality Standards, at app. A, <u>Fish Habitat Designation</u>, subsec. B ("All waters not designated as warm water fish habitat by subsection A are hereby designated as cold water fish habitat for purposes of these rules."); see also <u>id.</u> § 3-04; D. McCullough Prefiled, at 27; Trial Tr. 906 (Cox); Trial Tr. 741 (Burnham).

45. The Connecticut River does not have a seasonal limitation. Trial Tr. 907 (Cox).

46. In 1985, the revised Vermont Water Quality Standards were being implemented by the Vermont Water Resources Board. Jt. Ex. 5, 1990 Demonstration, at 5.

47. As part of these new standards, the habitat designation of the Connecticut River near Vernon was changed from a warmwater to coldwater fish habitat. Jt. Ex. 5, 1990 Demonstration, at 5; see also Vermont Water Quality Standards, at app. A, <u>Fish Habitat</u> <u>Designation</u>, subsec. B.

48. As described by Dr. McCullough, the Connecticut River once supported a larger composition and relative abundance of coldwater and coolwater species, including Atlantic salmon and brook trout, as well as coolwater species such as American shad, yellow perch, and

fallfish. D. McCullough Prefiled, at 7-8; Trial Tr. 1214 (McCullough).

49. The 1990 Demonstration noted that the coldwater designation in 1985 was in response to "the restoration goals of for anadromous fish, Atlantic salmon (<u>Salmo salar</u>) and American shad, to the Connecticut River." Jt. Ex. 5, 1990 Demonstration, at 5.

50. The designation was made to facilitate the restoration of Atlantic salmon and American shad. D. McCullough Prefiled, at 10; see also Trial Tr. 953 (Cox).

## C. <u>RIS Methodology</u>

A BIP does not allow focus on one species to the exclusion of other species. Trial
 Tr. 1205 (McCullough).

52. Any "determination of no prior appreciable harm is also dependent upon the way that the RIS is designated and interpreted." D. McCullough Rebuttal, at 2.

53. The RIS species selected as part of the 2004 Demonstration consists of the following: American shad; Atlantic salmon (parr and smolts); spottail shiner; fallfish; white sucker; smallmouth bass; largemouth bass; yellow perch; and walleye. Jt. Ex. 3, 2004 Demonstration, at 10.

54. The 1990 and 1978 Demonstrations included many of the same species and omitted others. American shad and Atlantic salmon, for instance, were also part of the RIS in the 1990 and 1978 Demonstrations, while those demonstrations did not include largemouth bass. Jt. Ex. 5, 1990 Demonstration, at iii, 40-57; Jt. Ex. 6, 1978 Demonstration, at 11-37 - 11-59.

55. The 2004 Demonstration does not provide a comparison of historic composition of the BIP. M. Mattson Prefiled, at 26-27; D. McCullough Rebuttal, at 2.

56. The BIP interpreted in the 2004 Demonstration is weighted toward thermally tolerant species, and thereby creates a means to reverse engineer a temperature criterion for the river that favors warmwater species to the exclusion of the less tolerant species. D. McCullough

- 11 -

Rebuttal, at 2-3 (citing ANR Ex. 13, 1977 Guidance, at 74).

57. The native species such as Atlantic salmon and brook trout are coldwater species. The American shad and yellow perch are coolwater species. D. McCullough Rebuttal, at 1; M. Mattson Prefiled, at 26. The smallmouth and largemouth bass and walleye are warmwater species. See Jt. Ex. 3, 2004 Demonstration, at 10 tbl. 2-1; D. McCullough Rebuttal, at 1.

58. "The Connecticut River represents the southernmost extent of Atlantic salmon in New England and as such is most sensitive to thermal perturbations. A population of any fish species (e.g., Atlantic salmon) at the edges of its distribution is most susceptible to further changes in its environmental conditions because its existing conditions often tend to be more frequently above its optimal. Any natural or human-caused factor that further alters these critical environmental conditions, such as thermal regime, will increasingly weaken the ability of the population to be maintained in its native habitats." D. McCullough Prefiled, at 26.

59. The 1977 Guidance requires that the RIS identify the most thermally sensitive species and give such species special consideration. Trial Tr. 506 (Mattson).

60. Atlantic salmon is the most thermally sensitive species on the RIS. Trial Tr. 506 (Mattson); see also Jt. Ex. 249, CRASC, <u>Strategic Plan for the Restoration of Atlantic Salmon to</u> <u>the Connecticut River</u>, discussed in D. McCullough Rebuttal, at 5.

61. The 2004 Demonstration did not give special consideration to Atlantic salmon in the RIS analysis, except for the fact that it is on the RIS. D. McCullough Prefiled, at 7-8, 26-27;D. McCullough Rebuttal, at 16; Trial Tr. 506-07 (Mattson).

62. Dr. Mattson admitted that he did not look for thermal tolerances that would optimize the use of the river by Atlantic salmon. "[W]e did not." Trial Tr. 507 (Mattson).

63. Following Entergy's submission of the 2004 Demonstration, fisheries biologists

- 12 -

representing the New Hampshire Fish and Game Department, the U.S. Fish and Wildlife Service, and the Vermont Fish and Wildlife Department met to review the report. These agencies found numerous concerns and inadequacies in the 2004 Demonstration. Jt. Ex. 72, Ltr. from K. Cox to B. Kooiker (July 9, 2004), at 1.

64. A letter from Mr. Cox to Mr. Kooiker concludes that several analyses were not conducted as the agencies intended, and critical information requested was not provided. Jt. Ex.
72, Ltr. from K. Cox to B. Kooiker (July 9, 2004), at 4.

65. These reviewing agencies determined that the trend analysis relied upon in the 2004 Demonstration appeared highly variable and may lack statistical power to detect truly significant trends. Jt. Ex. 72, Ltr. from K. Cox to B. Kooiker (July 9, 2004), at 2. Dr. Mattson's method has low statistical power to evaluate changes in the RIS. D. McCullough Rebuttal, at 5.

66. The New Hampshire Fish and Game Department, the U.S. Fish and Wildlife Service, and the Vermont Fish and Wildlife Department also believed that the Entergy needed to further address (i) the effect of the thermal plume under the proposed temperature limits on salmon and shad, and (ii) retrospective and predictive effects of the thermal discharge on the RIS and habitat availability in the less than one mile of river between the Vernon Station and the Station 3 monitoring site. Jt. Ex. 72, Ltr. from K. Cox to B. Kooiker (July 9, 2004), at 3.

67. Further evaluation of the depletion of shad and salmon species in the area affected by Vermont Yankee's discharge, including the limited area designated by Entergy as affected by its discharge, is required. See also D. McCullough Rebuttal, at 6-7.

68. The 2004 Demonstration's conclusion that there will be "no meaningful change" in predicted habitat is ambiguous, and the New Hampshire Fish and Game Department, the U.S. Fish and Wildlife Service, and the Vermont Fish and Wildlife Department did not fully agree that

- 13 -

there will not be significant adverse effects on predicted habitat changes affecting year-round resident RIS. Jt. Ex. 72, Ltr. from K. Cox to B. Kooiker (July 9, 2004), at 2.

69. Dr. Mattson does not provide information on age and size class distribution in his trend analyses. Without this basic information it is impossible to draw meaningful conclusions about trends. There is a substantial difference in environmental quality reflected by communities comprised of diverse age and size classes versus those where abundance is comprised principally of young of the year. D. McCullough Rebuttal, at 7.

70. In addition, Entergy's upstream-downstream comparison also does not provide information about changes in the RIS because the comparison of pool and riffle communities is improper. Trial Tr. 1156 (McCullough).

71. The fish and macroinvertebrate species in the pool community of Vernon Pool, compared to the riffle communities of Vernon Pool, are different. D. McCullough Prefiled, at 29.

72. Entergy's failure to recognize this difference renders its comparison invalid. TrialTr. 1156 (McCullough).

#### D. <u>Thermal Shock</u>

73. Thermal shock can occur with sudden exposure to higher temperature and lower temperature. Trial. Tr. 1259 (McCullough). Thermal shock thresholds are relative to temperatures fish are exposed to before being subjected to higher temperatures. Trial Tr. 1258 (McCullough). Whereas avoidance temperature is the temperature at which fish will swim away from the heat. Trial Tr. 1259 (McCullough).

74. Even if a fish can avoid an avoidance temperature, thermal shock can still occur. Trial Tr. 1262 (McCullough). A fish, acting normally, cannot always avoid temperatures that will cause thermal shock. Trial Tr. 1264 (McCullough).

- 14 -

75. After receiving the thermal shock, smolts can be highly vulnerable to predation while attempting to recover. D. McCullough Prefiled, at 18 (citing Coutant, 1973).

76. Effects of thermal shock are various, and do not necessarily include death. Trial Tr. 1259 (McCullough).

77. The 2004 Demonstration does not analyze the risk of thermal shock to thermally sensitive fish species occurring at the levels of its proposed thermal discharge, nor on the effects on those species if it were to occur. D. McCullough Prefiled, at 18-19.

#### E. <u>Warmwater Species Included in RIS</u><sup>1</sup>

78. Largemouth bass, which are included in the RIS, are a warmwater, heat tolerant species. Trial Tr. 896 (Cox); D. McCullough Prefiled, at 27.

79. Further support for the classification of largemouth bass as a warmwater species comes from Scott and Crossman (1973), who state: "The largemouth bass, with its tolerance for high temperature and slight turbidity, its fast growth rate, and fish diet have made it a favourite for stocking warmwater farm ponds for food and sport." D. McCullough Prefiled, at 27 (citing Scott and Crossman, 1973).

80. Largemouth bass and smallmouth bass are not indigenous, but were introduced to the Connecticut River. D. McCullough Prefiled, at 27. The 2004 Demonstration describes largemouth bass as a piscivorous (predacious), non-native species introduced to the Connecticut River in the 1860s. Jt. Ex. 3, 2004 Demonstration, at 202; D. McCullough Prefiled, at 28.

81. As stated by Dr. McCullough, "review of the temperature requirements for several of the key coldwater and coolwater fish species shows that current temperatures in the Connecticut River far exceed growth optima of Atlantic salmon, brook trout, American shad, and

1

See separate sections setting forth requests for findings with respect to American shad and Atlantic salmon.

yellow perch." D. McCullough Prefiled, at 14.

82. The largemouth bass is at the opposite end of the temperature spectrum from salmon smolt, which represents the most thermally sensitive life stage of one of the RIS. Trial Tr. 885-86 (Cox).

83. ANR acknowledged that it is "difficult" to optimize conditions for both salmon smolt and largemouth bass within the same water body. Trial Tr. 886 (Cox).

84. It is a permit requirement for Entergy that there be an Environmental Advisory Committee ("EAC") to advise ANR. The EAC's role is advisory in nature, and it consists of a member of ANR's Fish and Wildlife Department, Department of Environmental Conservation, and the counterparts in both Massachusetts and New Hampshire, as well as the U.S. Fish and Wildlife Service. Trial Tr. 701 (Carpenter). The EAC makes "important recommendations," and "the agency relies on [the recommendations]" and "makes decisions based on some of those recommendations." Trial Tr. 701 (Carpenter).

85. Full evaluation of chronic effects is essential to understand impact on Atlantic salmon, including risks from a wide range of other chronic effects such as the ability to reproduce, spawn, swim, avoid predators, and maintain level of smoltification. D. McCullough Rebuttal, at 5, 7-8.

86. Fully supporting the biological requirements of Atlantic salmon requires maintenance of optimum or preferred temperatures. D. McCullough Rebuttal, at 16; D. McCullough Prefiled, at 27-28.

87. For Atlantic salmon, a temperature of approximately 64.4°F would represent an optimum growth temperature. Optimum growth temperatures of brook trout are 54.3 to 59.7°F.
D. McCullough Prefiled, at 7 (citing McCullough, 2001).

- 16 -

88. Reducing or eliminating the amount of warmwater species in the current RIS list would maximize the goals of the salmon restoration program. Trial Tr. 887 (Cox).

89. "It is not feasible to simultaneously optimize the temperature regime of the river near Vernon Pool for both Atlantic salmon and largemouth bass. Averaging the temperature requirements of these two species would not satisfy either species' needs." D. McCullough Prefiled, at 27.

90. Juvenile shad may face predation by smallmouth and largemouth bass, large numbers of which are located in Vernon Pool or downstream. R. Jones Prefiled, at 16-17; see also Trial Tr. 891 (Cox).

91. Vermont Yankee's thermal discharge has been occurring throughout the year since 1991. R. Jones Prefiled, at 5-6.

92. "[C]hanges have occurred" in the Connecticut River. R. Jones Prefiled, at 6.

93. Warming from Vermont Yankee's discharge in the Winter Period provides for a habitat in which largemouth are able to increase in their abundance. R. Jones Prefiled, at 5-6.

94. The increased abundance of largemouth bass increases the risk of predation. D. McCullough Rebuttal, at 16.

95. The year-round water temperatures, from the combined effect of the Winter Period and the Summer Period, create a synergistic effect that favors the bass. R. Jones Prefiled, at 5-6.

96. "Cold winter temperatures "limit the ability of the smallmouth bass to dominate a waterbody. They are also able to maintain much higher food consumption rates with each degree of temperature increment. A means of limiting predation on salmon smolts in the Columbia River basin is lowering the river temperature. Consumption is directly related to temperature so

- 17 -

that more smolts will be consumed with increasing temperatures." D. McCullough Rebuttal, at 3.

97. \* Because Vermont Yankee discharges large volumes of hot water during the winter, the bass populations far downstream of Vermont Yankee are not impacted by the normal cold winter conditions that would limit their abundances. D. McCullough Rebuttal (pre-redaction), at 3.

98. Largemouth bass in particular present a predation threat to juvenile shad and salmon. D. McCullough Prefiled, at 24.

99. The bass and walleye species in the RIS are a "source of mortality for juvenile salmon and shad, which have already been reduced to critically low numbers in the Connecticut River between Bellows Falls and Holyoke dams." D. McCullough Rebuttal, at 4. ANR views the walleye as probably feeding to some extent on salmon smolts. Trial Tr. 891 (Cox).

100. For these reasons, the bass and walleye listed in the RIS are more properly viewed as "nuisance" species, as defined in the 1977 Guidance, that interfere with restoration of the salmon and shad. D. McCullough Rebuttal, at 4; ANR Ex. 13, 1977 Guidance, at 77 (defining "nuisance" species).

## F. <u>Coolwater Species Included in RIS</u>

101. Fallfish and yellow perch have similar thermal tolerances. Both species are on the low end of the continuum of tolerance to thermal increases. D. McCullough Prefiled, at 7-8.

102. The thermal increases caused by Vermont Yankee are also not healthy for yellow perch, a coolwater species. The yellow perch growth optimum is 74°F according to the 2004 Demonstration. Jt. Ex. 3, 2004 Demonstration, at 186; D. McCullough Rebuttal, at 15.

103. Kitchell (1977) identified a growth optimum 71.6°F. The temperature-growth curve in the Kitchell study indicates a "very steep decline in growth with increasing temperature."D. McCullough Rebuttal, at 15 (citing Kitchell, 1977).

- 18 -

104. For most of the summer period, maximum daily temperatures appear to exceed the optimum growth temperature for yellow perch. Adding further to the ambient temperature via the amended permit "would be damaging to the population viability and strength relative to the warmwater species." D. McCullough Rebuttal, at 15; see also McCullough Prefiled, at tbl. 1.

105. The disease susceptibility of yellow perch also increases above a threshold of about 79°F. D. McCullough Rebuttal, at 15; see also McCullough Prefiled, at tbl. 1.

## G. Coldwater and Coolwater Species Not Included in RIS

#### Brook Trout

106. Brook trout are native to the Connecticut River watershed. Trial Tr. 512 (Mattson); D. McCullough Prefiled, at 7, 27; Trial Tr. 1176 (McCullough); R. Jones Prefiled, at 15.

107. The RIS used in the 2004 Demonstration did not include the brook trout. Jt. Ex.3, 2004 Demonstration, at 10; see also Trial Tr. 512 (Mattson).

108. Brook trout have been found in the Vernon reach of the Connecticut River. Trial Tr. 512 (Mattson); see also Trial Tr. 1268-70 (McCullough) (citing Merriman and Thorpe, 1976).

109. They have been observed in the Connecticut River after November 1975. D. McCullough Prefiled, at 7, 27; R. Jones Prefiled, at 15; Trial Tr. 1037 (Deen); Trial Tr. 1176 (McCullough).

110. The Vermont Water Quality Standards definition of "existing use" is "a use which has actually occurred on or after November 28, 1975, in or on waters, whether or not the use is included in the standard for classification of the waters, and whether or not the use is presently occurring." V.W.Q.S. § 1-01(B)(18).

111. Brook trout should have been included in the RIS. D. McCullough Rebuttal, at 2-5.

- 19 -

112. "To sustain a healthy population, brook trout must fully utilize the entire Connecticut River basin and freely migrate among tributaries. Adverse thermal conditions in the mainstem could sever this connectivity, fragment habitat, and isolate the individual populations, reducing the viability of the brook trout within the Upper Connecticut River." D. McCullough Rebuttal, at 2-5.

113. The 1977 Guidance requires that the most thermally sensitive species in the local area should be identified and their importance given special consideration. ANR Ex. 13, 1977 Guidance, at 37; Trial Tr. 506 (M. Mattson).

114. Brook trout is a coldwater species. D. McCullough Prefiled, at 7; Tr. 512(Mattson). They have a lower thermal tolerance than do Atlantic salmon smolts. Trial Tr. 513(Mattson).

115. There have been significant restoration efforts for brook trout throughout the Connecticut River basin, though brook trout are not listed in the RIS. D. McCullough Prefiled, at 27.

116. Dr. McCullough points out that absence of evidence is not necessarily evidence of absence in terms of brook trout abundance. Given the inhospitable temperature conditions that exist in Vernon reach, it is not surprising that a native coldwater species would not be found in large numbers. Rebuttal Tr. 10-11 (McCullough).

117. The 2004 Demonstration characterizes "brook trout as being represented by largemouth bass as an RIS." Jt. Ex. 3, 2004 Demonstration, at 202; see also D. McCullough Prefiled, at 27.

118. The thermal tolerance limits of largemouth do not represent the limits associated with brook trout. D. McCullough Prefiled, at 27.

- 20 -

119. Optimum growth temperatures of brook trout are 54.3°F to 59.7°F. D.McCullough Prefiled, at 7 (citing McCullough, 2001).

120. Habitat in the mainstem near Vermont Yankee is currently unsuitable for brook trout. Trial Tr. 1177 (McCullough). Based on natural behavior of trout populations, brook trout would migrate through the Connecticut River mainstem. Trial Tr. 1101- 1102 (McCullough).

121. The 2004 Demonstration states that largemouth bass represents brook trout, and concludes that the interaction of largemouth bass with the existing and proposed Vermont Yankee thermal limits embodies the concept of RIS. Jt. Ex. 3, 2004 Demonstration, at 202.

122. The temperature tolerances of brown and rainbow trout are closer to those of the Atlantic salmon and American shad (when compared to the temperatures tolerances of largemouth and smallmouth bass). Rebuttal Tr. 66 (McCullough). The 2004 Demonstration does not include rainbow or brown trout as an RIS. Jt. Ex. 3, 2004 Demonstration, at 8.

123. Comparable with bass, brown and rainbow trout are recreationally important species. Rebuttal Tr. 65 (McCullough).

#### Native Predators

124. There is no native piscivore listed as an RIS. Only the exotic smallmouth and largemouth bass and walleye are included. Jt. Ex. 3, 2004 Demonstration, at 10 tbl. 2-1.

125. American eel is a native piscivore but not included in the RIS. Rebuttal Trial Tr.69-70 (McCullough).

126. "If native predators are to be protected, then the RIS is deficient." D.McCullough Rebuttal, at 3.

#### Dwarf Wedge Mussel and Tessellated Darter

127. In 1990 the dwarf wedge mussel was listed as endangered under the Endangered Species Act. 50 C.F.R. Pt. 17, 55 Fed. Reg. 9447-01 (Mar. 14, 1990), available at 1990 WL

- 21 -

326308 (F.R.); R. Jones Prefiled, at 16.

128. "The tessellated darter is a fish species that has consistently been collected from the lower Vernon Pool." R. Jones Prefiled, at 16. The dwarf wedge mussel depends on the tessellated darter for its survival. R. Jones Prefiled, at 16.

129. Currently, there only about twenty known small populations of dwarf wedge mussel, including one in the Connecticut River from the Ottauquechee River to the Weathersfield Bow near Claremont, New Hampshire. R. Jones Prefiled, at 16.

130. In its larval stage the wedge mussel will attach to its host species and metamorphose into the juvenile stage. Although the nearest known population of the wedge mussel is relatively far north of the Vermont Yankee," as explained by Dr. Jones, the wedge mussel depends for its survival on the tessellated darter as a host species. R. Jones Prefiled, at 16.

131. Specifically, wedge mussels "are species-specific and will only live if they find the correct host. In its larval stage the wedge mussel will attach to its host species and metamorphose into the juvenile stage. This particular wedge mussel depends on 2 [specific] host species: the tessellated darter and the mottled sculpin." R. Jones Prefiled, at 16.

132. In 1993, the U.S. Fish and Wildlife Service approved a recovery plan for the wedge mussel that calls for the attempt to reestablish populations throughout its historical range including the Connecticut River. R. Jones Prefiled, at 16 (citing U.S. Fish and Wildlife Service, <u>Dwarf Mussel Recovery Plan</u>, at 23 (Feb. 8, 1993)).

133. "Reestablishing a population in or near (upstream or downstream) the Vernon Pool would require proper environmental conditions (temperature, etc.) and the presence of one of the host species." R. Jones Prefiled, at 16.

#### <u>Macroinvertebrates</u>

134. Macroinvertebrates are small organisms including insects, mollusks, crustaceans,

- 22 -

snails, and other organisms. Trial Tr. 440 (Mattson); Trial Tr. 773 (Burnham).

135. A macroinvertebrate community exhibits a wide range of species with different tolerances to different stressors. Trial Tr. 774;4-6 (Burnham).

136. Stressors include temperature, along with sediments, hydrological alterations, and nutrients. Trial Tr. 814 (Burnham).

137. Dr. Mattson combines all species of the macroinvertebrate community to a gross taxonomic classification that obscures thermal tolerance variation. D. McCullough Rebuttal, at 2;M, Mattson Prefiled, at 80; Jt. Ex. 3, 2004 Demonstration, at 82.

138. As stated by Dr. Burnham of ANR, he did no field or laboratory experiments to determine the effects of the discharge on macroinvertebrates. Trial Tr. 728 (Burnham). He also performed no studies "looking at the effects of temperature on the biological community." Trial Tr. 736 (Burnham).

139. The 1977 Guidance recommends including macroinvertebrates. ANR Ex. 13,1977 Guidance, at 59.

140. Entergy did not include macroinvertebrates in the RIS for the 2004 Demonstration. Jt. Ex. 3, 2004 Demonstration, at 10.

141. Entergy improperly compares the macroinvertebrate community in the Lower Vernon Pool with the downstream community. D. McCullough Rebuttal, at 2.

## IV. HYDROTHERMAL MODELING AND DOWNSTREAM EFFECTS

### A. <u>The Hydrothermal Model</u>

142. Entergy uses a hydrothermal model developed by Dr. Swanson (the "Swanson model"). Jt. Ex. 4, <u>Hydrothermal Modeling of the Cooling Water Discharge from the Vermont</u> Yankee Power Plan to the Connecticut River, Final Report ("Swanson model"); see also R. Jones Prefiled, at 13.

143. The Swanson model relies on simulated temperatures, not actual temperatures. R.Jones Prefiled, at 11; Jt. Ex. 4, Swanson Model, at 25, 65-72.

144. The Swanson model is limited to Lower Vernon Pool. It does not evaluate the downstream effect of Vermont Yankee's discharge. Trial Tr. 97-98, 109 (Swanson); Jt. Ex. 4, Swanson Model, at 25, 28-29. As the modeling report states, its "focus of the study was on the lower Vernon Pool"; the "study area of interest" was Vernon Pool above the Vernon Dam. Jt. Ex. 4, Swanson Model, at 25, 28-29.

145. Entergy assumes that the temperature at Station 7 (located approximately 3.5 miles upstream from the discharge point) is an accurate estimate of the "ambient" water temperature at the discharge point. Jt. Ex. 104, CRWC Comments, at 13.

146. Entergy has not estimated the full geographic extent of its thermal discharge on heating river water downstream of Vermont Yankee. R. Jones Prefiled, at 12; D. McCullough Prefiled, at 31-32. The 2004 Demonstration does not discuss the extent of Vermont Yankee's thermal influence downstream of Lower Vernon Pool.

147. Dr. Swanson admitted that the discharged heat continues downstream. He did not model the effect of Vermont Yankee's thermal discharge moving down the river. Trial Tr. 98 (Swanson).

148. The Swanson model treats Vernon Dam as an "open boundary." Therefore, the model does not consider that the dam directs water flow at different depths to different locations through selected openings (e.g., gates) in the dam. Jt. Ex. 4, Swanson Model, at 26, 28.

149. Additionally, selective impoundment and the release of water at different temperatures or oxygen content is a common issue when considering ecological impacts of dams.

- 24 -

R. Jones Rebuttal, at 15 (citing Dortch, 1997).

150. Here, Connecticut River flows are highly controlled by hydroelectric generation activities upstream and downstream of Vermont Yankee. Jt. Ex. 3, 2004 Demonstration, at 11.

151. Vernon Dam has an operational (hydroelectric) capacity of about 10,000 cubic feet per second of flow rate and all river flow below this level is controlled by the hydroelectric facility. Jt. Ex. 4, Swanson Model, at 2; R. Jones Rebuttal, at 15.

152. As shown in figure 2 to Dr. Jones' rebuttal testimony, this means that when river flow is at 10,000 cubic feet per second or less, all water will discharge through the powerhouse, fish pipe or fish ladder (if operating) – all on the Vermont side of the dam. R. Jones Rebuttal, at 15, 30 fig. 2.

153. According to the Swanson Model, many of the highest water temperatures measured in the thermal plume during the August 2002 calibration of the model were at stations E5/E6, located adjacent to the New Hampshire shore and near Vernon Dam. Jt. Ex. 4, Swanson Model, at 6, 11; R. Jones Rebuttal, at 15.

154. If the water in Lower Vernon Pool (stratified by temperature due to the thermal plume and atmospheric heating) is being selectively discharged from the Vermont side of the dam, this can result in an impoundment (storage) of the warmer water from the thermal discharge in Lower Vernon Pool, resulting in water temperatures in Vernon Pool being warmer than those modeled, and water temperatures in upper Turners Falls Pool being cooler than those modeled. R. Jones Rebuttal, at 15.

155. The Swanson model does not evaluate how the thermal effects (in either Vernon Pool or upper Turners Falls Pool) may be influenced by selective discharges of impounded and stratified water in Lower Vernon Pool. R. Jones Rebuttal, at 15.

- 25 -

156. The Swanson model does not consider the location of the outflows from the dam in relation to the thermal plume. R. Jones Rebuttal, at 15.

157. The outflow from the dams in relation to their own measurements show that the highest temperatures in the plume were measured at the thermostes closest to the New Hampshire shore and nearest the dam – the opposite side of the river from where the water flows out of the dam. R. Jones Rebuttal, at 15.

158. Dr. Swanson did not know the temperature gradient in Lower Vernon Pool in 1990. Tr. Trial 104 (Swanson).

159. As admitted by Dr. Swanson, in conducting the hydrothermal modeling he did not "look at what the combined temperature distribution effect in Vernon pool was of the existing discharge and the proposed discharge in comparison with the temperature gradients [he] would have seen in Lower Vernon Pool prior to 1991." Tr. Trial 104 (Swanson).

160. Dr. Swanson agreed that both (i) his modeling is not infallible, and (ii) a model's fallibility depends on the assumptions made and the degree of its calibration and testing. Trial Tr. 110 (Swanson).

161. Dr. Swanson is not an expert on temperature effect on fish or other acquatic biota, and did not offer an opinion on those subjects.

162. Dr. Swanson offered no testimony on the effects of temperature on the species in question. Trial Tr. 295 (Swanson).

#### B. Comparison of the 1978, 1990, and 2004 Demonstrations Regarding Downstream Effects

163. Knowing the full extent of the thermal discharge is the only way to begin to fully understand the potential impact of Vermont Yankee's thermal discharge on American shad and other species downstream in Turners Falls Pool and below. R. Jones Rebuttal, at 6.

- 26 -

164. \* Dr. Jones relies on the July 2, 2007 letter from the U.S. Geological Survey

Silvio O. Conte Anadromous Fish Research Laboratory in part for the need for further study. The

letter, written by two fish biologists who specialize in the study of anadromous species

(particularly American shad) in the Connecticut River states:

The most important information with which to address thermal effects on any of the Connecticut River flora or fauna is the extent of the thermal influence of the plant. The further downstream this influence extends, the more opportunities to affect the river's ecology.

R. Jones Rebuttal (pre-redaction), at 6-7; CRWC Ex. 26, Ltr. from S Garabedien to D. Deen (July 2, 2007), at Response to Question 12.

### 1978 Demonstration

165. The 1978 Demonstration shows that the thermal influence of Vermont Yankee's discharge extends past Turners Falls, at least to Holyoke, which Entergy reported in its 1978 and 1990 Demonstrations. Jt. Ex. 6, 1978 Demonstration, at 5-14 - 5-15; Jt. Ex. 5, 1990

Demonstration, at 59; R. Jones Prefiled, at 18.

166. Specifically, Vermont Yankee discharged heated thermal effluent, with the approval of the Vermont Water Resources Board, from September 1976 through May 1977, overlapping with the end and the beginning of the current summer discharge period. Jt. Ex. 6, 1978 Demonstration), at 1-3; R. Jones Rebuttal, at 2.

167. This experimental discharge was a basis for the 1978 Demonstration's analysis of the downstream extent of the thermal influence of the discharge. Jt. Ex. 6, 1978 Demonstration, at 5-14 - 5-15; R. Jones Rebuttal, at 2-3.

168. The May to June 1977 discharge is the only study of the full extent of Vermont Yankee's discharge that appears in any of the § 316(a) demonstrations. Jt. Ex. 6, 1978Demonstration, at 5-14 - 5-15; R. Jones Rebuttal, at 2-3.

169. This study included dye tracing of heated water down the Connecticut River,
coupled with measurements of water temperature 50 miles downstream of Vernon Dam. Jt. Ex.
6, 1978 Demonstration, at 5-14 - 5-15; Jt. Ex. 5, 1990 Demonstration, at 59.

170. The dye study was conducted during May to June 1977 and showed that a volume of water took 4 days to travel 50 miles when river flow through Vernon Dam was fluctuating between 1,200 and 10,000 cubic feet per second. Jt. Ex. 6, 1978 Demonstration, at 5-11 - 5-19;
R. Jones Rebuttal, at 2-3.

171. The 1978 Demonstration estimated that a volume of water would take 2.5 days to travel 50 miles at a river flow rate of 10,000 cubic feet per second. Jt. Ex. 6, 1978 Demonstration, at 5-14 - 5-15; R. Jones Rebuttal, at 2-3.

172. The 1978 Demonstration provides the only detailed field/modeling data in the trial record of the full extent of Vermont Yankee's thermal discharge. R. Jones Rebuttal, at 6.

173. The methodology and results are summarized in chapter 5 of the 1978 Demonstration. To summarize, the 1978 Demonstration found that, with an ambient water temperature of 60° F, 40% to 70% of the heat discharged into the river was still present 50 miles downstream. Jt. Ex. 6, 1978 Demonstration, at 5-14 -5-15; R. Jones Rebuttal, at 2-3.

#### 1990 Demonstration

174. The 1990 Demonstration reaffirmed the conclusion of the 1978 Demonstration on the extent of the downstream effect of the discharge to Holyoke. Jt. Ex. 5, 1990 Demonstration, at 59; R. Jones Prefiled, at 6, 18; see also D. McCullough Prefiled, at 10-11.

#### 2004 Demonstration

175. The 2004 Demonstration's predictive analysis does not consider the likely full geographic extent of the thermal discharge's effects. R. Jones Rebuttal, at 1-7; see also Trial Tr.

- 28 -

414-15 (Mattson).

176. Dr. Mattson focuses on Lower Vernon Pool. Trial Tr. 414 (Mattson); R. Jones Rebuttal, at 1-6.

177. Dr. Mattson's analysis of the downstream extent of Vermont Yankee's thermal discharge is limited to monitoring results from Station 2 and two supplemental sources. Trial Tr. 414-15 (Mattson); D. McCullough Rebuttal, at 5; R. Jones Rebuttal, at 1-7.

178. The two supplemental sources are a 1985 simulation discussed in Entergy's Analytical Bulletin #13, and water temperature measurements from Station 7 and Turners Falls Dam from May 15 to 24, 2001. R. Jones Rebuttal, at 1-2 (citing Jt. Ex. 137, Analytical Bulletin #13; M. Mattson Prefiled, at 44-45).

179. The only results regarding the extent of Vermont Yankee's thermal discharge that Dr. Mattson reports in his pre-filed and live testimony are that the Station 7 (ambient upstream) temperatures were lower than the Turners Falls (downstream) temperatures both during the outage and operational periods of Vermont Yankee. M. Mattson Prefiled, at 45; Trial Tr. 537 (Mattson); R. Jones Rebuttal, at 3.

180. Dr. Mattson does not provide information on the relative differences in the paired comparisons during the outage and operational periods. His analysis does not address whether the temperatures differences at Station 7 and Turners Falls Dam remained constant or changed between the outage and operational periods. R. Jones Rebuttal, at 3.

181. Additionally, Dr. Mattson apparently compared temperatures at the two sites from the same time – despite the fact that the relevant comparison for this type of study should be the temperature change of the same volume of water as it moves from Station 7 to Turners Falls Dam. R. Jones Rebuttal, at 3.

- 29 -

182. Operative questions not addressed by Dr. Mattson include whether that volume of water became heated by Vermont Yankee's thermal discharge, and if so how quickly did it lose that heat. R. Jones Rebuttal, at 3.

183. The dye study mentioned above, related to the 1978 Demonstration, was designed to answer questions of that nature. It is the only study of the full extent of Vermont Yankee's discharge that appears in any of the 316(a) demonstrations. R. Jones Rebuttal, at 2-4.

184. Subsequent to his prefiled and direct testimony, Dr. Mattson's rebuttal testimony discussed comparing May 15 to 19, 2001 (during a Vermont Yankee outage) and May 20 to 24, 2001 (post-outage) temperatures upstream at Station 7 and downstream at Turners Falls Dam. M. Mattson Rebuttal, at 2-3; R. Jones Rebuttal, at 3-6.

185. That analysis provides no evidence of the degree to which the temperatures between Station 7 and Turners Falls Dam differ during periods of outage and operation. M. Mattson Rebuttal, at 2-3; R. Jones Rebuttal, at 3-6.

186. While Turners Falls Dam is only  $\approx 20$  miles from Vernon Dam, slower flow would presumably delay the movement of any heated water from Vermont Yankee to Turners Falls Dam. As discussed by Dr. Jones, without studies to suggest otherwise, it is impossible to rule out that the 5-day period of May 20 - 24, 2001 was too short to detect the extent of the changes in river temperature. R. Jones Rebuttal, at 4-5.

187. Dr. Mattson provides no information on other relevant factors that may influence the temperature difference between Station 7 and Turners Falls Dam. The river flow rate (and the Vernon Dam discharge rate), as well as the atmospheric temperatures from May 15 to 24, 2007, are all factors that will influence water temperature differences at the two measurement sites. R. Jones Rebuttal, at 4. 188. Additionally, in direct examination, Dr. Mattson stated "[w]hen preparing a [Section 316(a)] demonstration, we create a hierarchy of evaluating the scientific literature when multiple sources are present." Trial Tr. 431 (Mattson); R. Jones Rebuttal, at 7.

189. According to his testimony, all thermal effects data was from "peer review and scientific literature." Trial Tr. 431 (Mattson); R. Jones Rebuttal, at 7. Highest priority was given to data "from the river system and even from the specific portion of the river system when available." Trial Tr. 431-32 (Mattson); R. Jones Rebuttal, at 7.

190. Dr. Mattson does not include the possibility of Entergy conducting studies on thermal effects in and downstream of Lower Vernon Pool. As stated by Dr. Jones, the sitespecific results that would come from such studies would be vital to understanding thermal effects in and downstream of Lower Vernon Pool. R. Jones Rebuttal, at 7.

191. \* When data is not available from the specific portion of the river system or even from the broader river system, Mattson turns to a second tier of studies from anywhere in the region and, if necessary, anywhere in the species' geographic range. R. Jones Rebuttal (preredaction), at 7; Trial Tr. 432 (Mattson).

192. Dr. Barnthouse stated in his affidavit that "temperatures within the discharge plume never exceed either the legal tolerance limit or the avoidance limit for American shad." Ent. Ex. 4, L. Barnthouse Aff., at ¶ 27.

193. The statement quoted above by Dr. Barnthouse is contradictory to the statement quoted from the 2004 Demonstration. R. Jones Prefiled, at 14.

194. The 2004 Demonstration states that the "typical range" in temperature of the heated effluent during the warmer summer months is approximately 80°F to 90°F, with a worst-case maximum of "about 100°F." Jt. Ex. 3, 2004 Demonstration, at 11; R. Jones Prefiled, at 14.

- 31 -

195. Dr. Mattson provides no information on the amount of the actual heated discharge from Vermont Yankee from May 20 to 24. When Vermont Yankee is operational, it can still be operating in closed or hybrid cooling mode. Jt. Ex. 3, 2004 Demonstration, at 11. Depending on ambient river temperature and river flow, conditions may also be such that Vermont Yankee would be required to discharge only a fraction of the total heat it would under other conditions. None of this critical information is provided. R. Jones Rebuttal, at 5.

196. In fact, Entergy provides evidence that we should not expect to see a significant increase in "Station 7 to Turners Falls Dam" temperatures during May 20 to 24, 2001 because Vermont Yankee was apparently not discharging heated effluent or was only doing so at a limited rate at that time. R. Jones Rebuttal, at 5.

197. This can be seen in the top graph in figure 3-6d of the 2004 Demonstration that shows the measured Station 3 minus Station 7 temperatures from mid-May to mid-October 2001, and apparently includes the operational period from May 20 to May 24. Jt. Ex. 3, 2004 Demonstration, at 34 fig. 3-6d; R. Jones Rebuttal, at 5.

198. While the difference between Station 3 and Station 7 temperatures during this period varies between  $\approx$  3-4°F, there is no way of knowing how that compares to the May 15 to 19 temperature difference because temperatures are not shown. Jt. Ex. 3, 2004 Demonstration, at 34; R. Jones Rebuttal, at 5.

199. According to the 2004 Demonstration, the measured temperatures at Station 3 are almost always higher than those at Station 7 (by as much as 4°F); regardless of whether Vermont Yankee is discharging heated effluent. Jt. Ex. 3, 2004 Demonstration, at 25-26, R. Jones Rebuttal, at 5-6. Looking at the top graph of Demonstration's figure 3-6d, the interesting comparison would have been the effects at Turners Falls Dam from increased temperatures

- 32 -

experienced at Station 3 during early June, when there was a large difference between Station 3 and Station 7 temperatures. R. Jones Rebuttal, at 6.

200. In the 2004 Demonstration, Entergy also acknowledges that the increased temperature of the river is fully mixed top to bottom, bank to bank, by the time river flow gets to Station 3. Jt. Ex. 3, 2004 Demonstration, at app. 3, <u>Thermal Modeling of the Cooling Water</u> <u>Discharge form the Vermont Yankee Power Plant to the Connecticut River</u>.

201. Entergy restricts its concern for warming the Connecticut River to the short distance from Vermont Yankee to just below the Vernon Dam tailrace. Yet the river-warming effects continue a great distance downstream and add to a background temperature that exceeds temperatures favorable for coldwater species. D. McCullough Prefiled, at 31. In this respect, Entergy has not done the necessary hydrothermal modeling that would inform them about the spatial extent of their heated effluent. D. McCullough Rebuttal, at 5.

202. A completed study on the Willamette River that used a state-of-the-art temperature model (CE-QUAL-W2) found that temperature deviations caused by a temperature increase can travel at least 175 miles downstream. The Willamette River is a river with the same drainage area as the Connecticut River and subject to all the same physical processes for heating and cooling. D. McCullough Rebuttal, at 5.

203. As testified by Dr. McCullough, "heating of the Connecticut River by hot water discharge from Vermont Yankee very likely causes a temperature increase that travels far downriver and adds to the overall cumulative temperature increase along the length of the river." D. McCullough Prefiled, at 10-11.

204. ANR recommended that a study "be designed to compare the behavior of smolts released in several test lots upstream of the discharge point (e.g., below Bellows Falls dam), as

- 33 -
well as below Vernon dam (e.g., Station 3)." D. McCullough Prefiled, at 29-30.

205. This letter reveals concerns of the discharge affecting "the physiological fitness of smolts necessary to their being prepared for life in the marine environment." D. McCullough Prefiled, at 29-30.

206. A comparison of smolt releases above versus below Vernon Dam does not evaluate the extent to which both releases are exposed to prolonged levels of elevated temperatures downstream of the dam. These effects were only contemplated by ANR to be examined a short distance downstream. D. McCullough Prefiled, at 30.

207. Dr. Barnthouse stated that shad spawning and juvenile abundance declined both in the habitats exposed to Vermont Yankee's thermal discharge and those not exposed (e.g., spawners in Holyoke Pool downstream of Vernon Pool). Ent. Ex. 4, L. Barnthouse Aff., at ¶ 44; see also Trial Tr. 254-55 (Barnthouse); D. McCullough Rebuttal, at 16-17;

208. \* Dr. Barnthouse based his opinions on the assumption that the thermal plume does not extend downstream. Ent. Ex. 4, L. Barnthouse Aff., at ¶ 42; D. McCullough Prefiled, at 32.

209. Dr. Barnthouse's opinions on this subject are based on a flawed upper incipient lethal temperature ("UILT") value for American shad and the presumption that if UILT and avoidance temperatures are not present that there would be no source of shad failure.<sup>2</sup> D. McCullough Rebuttal, at 16-17.

210. Energy depletion caused by thermal stress reduces the distance that shad can migrate upstream before exhaustion and death. This factor would also interfere with the capability of the shad to recover from spawning, begin eating again, and migrate back to the

2

See separate section on American shad with respect to their UILT and avoidance temperatures.

ocean in order to return to spawn in a future year. D. McCullough Rebuttal, at 17.

211. Dr. Barnthouse's conclusion also presumes that fish responses to changes in annual thermal discharges would be virtually instantaneous. Population responses are more complex and can involve progressive changes moving through several generations, but can also be characterized at times by abrupt collapses. D. McCullough Rebuttal, at 17.

212. Additionally, migration of adults and juveniles still occurs within the mainstem, an area affected by Vermont Yankee discharges. D. McCullough Prefiled, at 32.

213. Dr. Barnthouse did no studies of his own. He simply received the same data as did Drs. Jones and McCullough and reached different conclusions. Trial Tr. 295 (Barnthouse).

214. Dr. Barnthouse based his conclusion on general qualitative information on thermal discharge, unaccompanied by exact annual history of thermal discharge by month or year. D. McCullough Rebuttal, at 17.

215. Dr. Jones based his opinion in part on the 1978 and 1990 Demonstrations, which conclude that heated effluent continues downstream as set forth in the request for findings with respect to the Swanson model. Jt. Ex. 6, 1978 Demonstration, at 5-14 to 5-15; R. Jones Rebuttal, at 2-3.

216. Such analysis of annual history of thermal discharge by month or year was also not provided in the 2004 Demonstration. D. McCullough Rebuttal, at 17.

217. The hypotheses by Entergy's experts ("Hypothesis 2" by Dr. Mattson and "Hypothesis 1" by Dr. Barnthouse) are explicitly limited to declines in American shad numbers "upstream of Vernon Dam" (i.e., Vernon Pool) and do not consider the possible effects of the thermal discharge on American shad <u>throughout</u> Vermont Yankee's thermal influence downstream of Vernon Dam. Ent. Ex. 4., L. Barnthouse Aff., at ¶ 20; and Ent. Ex. 3, M.

- 35 -

Mattson Aff., at ¶¶ 24-28; R. Jones Prefiled, at 12.

218. Heat from Vermont Yankee's discharge has to go somewhere. Trial Tr. 847 (Cox).

219. As explained by Dr. Jones: "We know that Vermont Yankee's thermal discharge can warm the water at least as far as Holyoke Dam." R. Jones Prefiled, at 12.

220. That is 58 miles downstream of Vermont Yankee, and downstream of Turner
Falls Dam, as acknowledged in Entergy's 1990 Demonstration. Jt. Ex. 5, 1990 Demonstration, at
59; R. Jones Prefiled, at 12.

221. In addition, the downstream effects of Vermont Yankee's thermal discharge are a possible cause of the poor passage rate at Turners Falls. Given the potential reach of Vermont Yankee's thermal discharge, Entergy should study its effect on the biotic community (including American shad) at least down to Holyoke Dam. R. Jones Prefiled, at 12.

222. There is no indication that Entergy has ever conducted such studies. Because Entergy's experts (Drs. Mattson and Barnthouse) analyzed the question of whether the decline of the American shad <u>in Vernon Pool</u> was caused by Vermont Yankee's thermal discharge, they do not consider the effects of this extended thermal influence. R. Jones Prefiled, at 12.

223. In the 2004 Demonstration, Entergy did not study how much Vermont Yankee raises water temperature in the Connecticut River below Station 3 (only 1.4 miles downstream of Vermont Yankee) or how far downstream the effect lasts. R. Jones Prefiled, at 6.

224. \* Without knowing this, we cannot know how much the Vermont Yankee discharge is contributing to the ecosystem shift described above. R. Jones Prefiled, at 6.

225. Entergy also did not study the role of Vermont Yankee's discharge in various life stages of American shad and other species in Vernon Pool itself. R. Jones Prefiled, at 12.

- 36 -

### V. <u>CUMULATIVE AND SYNERGISTIC EFFECTS</u>

226. Mr. Burnham, the ANR expert on compliance with Vermont Water Quality Standards, had not read 40 C.F.R. § 125.73(c)(2) before being asked to do so in court. Trial Tr. 760 (Burnham).

227. Section 127.73(c)(2) states: "In determining whether or not prior appreciable harm has occurred, the Director shall consider the length of time in which the applicant has been discharging and the nature of the discharge."

228. The 2004 Demonstration does not take into account the various cumulative and synergistic factors that affect the BIP and species' functions. D. McCullough Prefiled, at 25, 36.

229. Studies that emphasize the effects from one factor, such as temperature, do not adequately predict the detrimental effect temperature may have when combined with other water quality factors. D. McCullough Prefiled, at 25.

230. The 2004 Demonstration does not evaluate the correlation between temperature and dissolved oxygen (i.e., the hotter the water, the lower the dissolved oxygen). Trial Tr. 299 (Barnthouse).

231. Temperature affects the amount of dissolved oxygen in a water column. The warmer the water, the less dissolved oxygen there is. Trial Tr. 463 (Mattson); Trial Tr. 299 (Barnthouse); see also D. McCullough Prefiled, at 25.

232. Low dissolved oxygen has been noted in the Connecticut River (Moss, 1976); D.McCullough Prefiled, at 25.

233. Low dissolved oxygen can make the effects of high temperature more severe than expected under normal dissolved oxygen conditions. D. McCullough Prefiled, at 25 (citing McCullough, 1999; Materna, 2003).

234. The recovery of Atlantic salmon is dependent on reducing the array of sources of

- 37 -

thermal impacts, together with addressing other linked key habitat elements such as dissolved oxygen and sediment substrate quality. D. McCullough Prefiled, at 10.

235. The available data shows a sharp decline in the American shad population in the vicinity of Vermont Yankee, and the Atlantic salmon population is showing no signs of achieving the goal of restoration to its native habitat in the river. R. Jones Prefiled, at 6.

236. \* The 2004 Demonstration does not evaluate the cumulative impact of continuous discharges on the Connecticut River BIP and RIS. Entergy does not take into account the consequences of the temperature increases it has already been granted during the summer. Entergy does not take into account the likely problems caused by winter temperature increases that undoubtedly do affect spawning success, simply because the proposed new increase is devoted to summertime. D. McCullough Prefiled, at 36.

237. Dr. Barnthouse agrees that it is necessary to consider cumulative effects when evaluating temperature effects on a river. Trial Tr. 295 (Barnthouse).

238. For instance, the historical increases of Vermont Yankee's thermal discharge are already in excess of optimum growth temperatures and levels that yellow perch are likely to avoid. D. McCullough Prefiled, at 36.

239. As stated by Dr. McCullough, even though a 1°F additional temperature increase is itself lower than the sum of prior increases, the effect is still negative. More precisely, the 2°F to 5°F increase allowed in 1991 could likewise be subdivided into multiple increases of 1°F. D. McCullough Rebuttal, at 9.

240. Subdividing previous temperature variances into one degree increases makes the end result no less important to the dependent species when their spawning optima, growth optima, feeding limits, migration thresholds, and disease thresholds are exceeded. D.

- 38 -

McCullough Rebuttal, at 9.

241. The chronic effects that may already exist throughout the Connecticut River would be exacerbated downstream of the Vermont Yankee discharge point with further temperature increases. D. McCullough Prefiled, at 33.

242. Dr. Barnthouse did not consider chronic thermal effects. Rather, he focused on acute lethal and avoidance temperatures.<sup>3</sup> D. McCullough Prefiled, at 33.

243. As set forth by Dr. Jones, a number of examples from research from the last ten to fifteen years show how changes in water temperature (along with other environmental factors) can cause adverse chronic effects for American shad in the Connecticut River and other rivers. R. Jones Rebuttal, at 14 (citing Facey, 1986; Leach, 1999; O'Leary, 1986); see also R. Jones Affidavit (June 15, 2006), at ¶¶ 7-10.

244. These studies represent some of the most current and best science on what are the relevant "indicator temperatures" for various life history stages of American shad. The most recent reference listed in the 2004 Demonstration for American shad "indicator temperatures" is from 1985 and most are from the 1970s. Not only did Entergy not perform studies that were necessary, but it also did not consider studies that had already been done which bear directly on the requirements of Section 316(a). R. Jones Rebuttal, at 13-14.

245. Dr. Mattson defines "indicator temperatures" in his prefiled testimony as the "water temperatures that coincide with life cycles events, such as spawning or migration, or represent the water temperature for optimum growth or larval development." M. Mattson Prefiled, at 36; R. Jones Rebuttal, at 13.

246. Dr. Mattson did not explain how such "indicator temperatures" are actually

<sup>&</sup>lt;sup>3</sup> The 2004 Demonstration also does not fully consider chronic thermal effects. Additional requests for findings specifically concerning the thermal effects of the cumulative and historic discharge are set forth in the separate sections discussing American shad and Atlantic salmon.

incorporated into the predictive analysis of the effects of Vermont Yankee's thermal discharge on any species, including American shad. R. Jones Rebuttal, at 13-14.

247. Species can generally tolerate less than optimum temperatures in their habitat, although usually with noticeable adverse effects such as increased disease, increased susceptibility to predation, and decreased reproductive output over the lifespan of an individual.R. Jones Prefiled, at 5-6.

248. Many of these effects, such as lifetime reproductive success, can only be measured over an entire lifespan of an individual fish. R. Jones Prefiled, at 5-6.

249. As testified by Dr. McCullough, a comprehensive analysis of the thermal effects on fish must include consideration of all the chronic impacts as well as acute impacts. D. McCullough Prefiled, at 11.

250. Acute effect temperatures can have some specific applications relative to entrainment in cooling water, but for general application to the riverine environment and full consideration of life cycle impacts, chronic effects analysis is far more important. D. McCullough Prefiled, at 11.

251. \* Dr. Jones agrees with a letter from the U.S. Department of Interior that stated "[e]ven if the impact was SMALL, the fact that the resource . . . is declining argues strongly for mitigation measures. In this instance, the obvious mitigation would be to require [Vermont Yankee] to operate in closed-cycle mode year-round, which would greatly reduce impacts associated with impingement, entrainment and thermal effluent." R. Jones Prefiled, at 4-5 (discussing Ltr. to M. Lesar from A. Raddant in response to NRC dSEIS (Mar. 6, 2007)).

252. The failure to take these chronic effects into account undermines the opinions of Drs. Mattson, Barnthouse, and Coutant. Dr. Mattson relies solely on the use of the

- 40 -

"exclusionary" temperatures (UILT and avoidance). M. Mattson Prefiled, at 45-47; Trial Tr. 547-48 (Mattson); D. McCullough Rebuttal, at 7.

253. This is an inadequate means to ensure protection of the community, including in particular its most sensitive members. D. McCullough Rebuttal, at 7.

254. As testified by Dr. McCullough, relying simply on gross abundance trends by RIS species as a means to observe chronic effects in action does not detect significant changes in composition and abundance, especially for those species present in low numbers. The size of the abundance change required to statistically prove an effect can be very large. D. McCullough Rebuttal, at 7-8 (citing Ham and Pearsons, 2000)

255. Full consideration of a wide range of chronic effects is necessary for "full protection" of the community. EPA has recognized the significance of evaluating chronic effects while emphasizing optimum growth temperatures as a key indicator. D. McCullough Rebuttal, at 7-8 (citing Materna, 2001).

256. Chronic effects such as ability to reproduce, spawn, swim, avoid predators, maintain level of smoltification must also be fully considered for the same reasons, but were not in the 2004 Demonstration. D. McCullough Rebuttal, at 7-8.

257. In this case, there are already thermal impairments caused by a combination of environmental factors and stressors, including the existing discharge. A further increase of 1°F would worsen these conditions. D. McCullough Rebuttal, at 7-8.

258. Vermont Yankee's thermal discharges contribute significantly to the composition and relative abundance of the current fish community. D. McCullough Prefiled, at 28.

259. The river's natural thermal potential is more suited to coolwater fish, as noted by Downey (1990): "The fish community near Vernon was characterized as a coolwater fish

- 41 -

community." D. McCullough Prefiled, at 28 (Downey, 1990).

260. Full examination of the brief trend in fish sampling data would require examining the data above the dam and below the dam independently, because upstream-downstream comparisons do not account for differences between pool and riffle habitat types. D. McCullough Prefiled, at 29.

261. Significant shifts in fish community types will be unlikely observed using Entergy's narrow fish sampling data. A longer time series is required. D. McCullough Prefiled, at 29.

262. Cumulative heating effects to the Connecticut River have progressively shifted this river from a coldwater fishery to one dominated by warmwater species in terms of abundance. D. McCullough Prefiled, at 29-30.

263. The Vermont Yankee discharge has contributed to shifting a coolwaterwarmwater community further toward the warmwater end of the spectrum where coldwater species are mere remnants, eliminating much hope of restoring the beneficial use for which the river is designated. D. McCullough Prefiled, at 29.

264. The discharge has pushed temperatures beyond optimal levels for many of the key life stages of native coldwater and coolwater fish species, and imposed a multitude of chronic thermal impacts. D. McCullough Prefiled, at 26.

265. As water temperature rises, the habitat in the river undergoes significant changes, the composition of the biological community gradually shifts towards more heat-tolerant species, and the populations of indigenous species dependent on lower temperatures decline and eventually disappear. R. Jones Prefiled, at 5.

266. Species can tolerate less than optimum temperatures in their habitat, although

- 42 -

usually with noticeable adverse effects such as increased disease, increased susceptibility to predation, and decreased reproductive output over the lifespan of an individual. R. Jones Prefiled, at 5-6.

267. Many of these effects, such as lifetime reproductive success, can only be measured over an entire lifespan of an individual. However, as the range of temperatures move farther away from the optimum, and as exposure time increases, the effects become more pronounced. The closer the temperature comes to the upper-bound tolerance levels (e.g., for acute lethality) the greater the risk that temperatures will cause dramatic and more immediate drops in survival, reproduction, or other important life history traits. R. Jones Prefiled, at 5-6.

268. Atlantic salmon in the Connecticut River are subject to furunculosis, one of the most common diseases to affect this species in freshwater. This bacterial disease is stimulated by elevated temperatures. D. McCullough Prefiled, at 17 (citing Bakke, 1998, Fay, 2006).

269. The link between temperature and disease was not considered in the 2004 Demonstration. Trial Tr. 810 (Burnham).

270. Identifying biological changes in fish communities at a certain location (e.g., above Vernon Pool) is very difficult when degradation occurs in increments. D. McCullough Prefiled, at 30.

271. This is especially true because the fish communities along the Connecticut River continuum have been so heavily perturbed for decades, significant thermal impact has already occurred, and there is a headward invasion of warmwater species. Any restoration endpoint is difficult to infer when the biological baseline is already heavily disturbed. D. McCullough Prefiled, at 30.

272. Combined with other sources of heat and pollutants, as well as many other

- 43 -

stresses on the river, the biological community is changing and native species are being driven out of the river above Vernon. D. Deen Prefiled, at 7.

273. Entergy has not examined the combined effect of Vermont Yankee's discharge, heating of the Vernon headpool, and other cumulative anthropogenic heat sources in the Connecticut River. D. McCullough Prefiled, at 31-32.

274. Dr. Barnthouse assumes that because Entergy was already granted a thermal discharge allowance in the past, the effects of that discharge, and any small increase in it, must be benign. D. McCullough Prefiled, at 31; Ent. Ex. 4, L. Barnthouse Aff., at ¶¶ 24-45.

275. Vermont Yankee's existing level of thermal impact to the river has already created a baseline condition that is not conducive to maintenance and propagation of native cold and coolwater fish species of the Connecticut River. D. McCullough Prefiled, at 25.

276. This impact, in combination with other anthropogenic cumulative impacts, has created an environment that will lead to continuing low or declining fish populations. D. McCullough Prefiled, at 25.

277. Dr. McCullough finds it highly probable that the increase in the Connecticut River's thermal baseline has significantly reduced the historic productivity of Atlantic salmon, brook trout, American shad, and yellow perch, and that Vermont Yankee is worsening these thermal conditions. D. McCullough Prefiled, at 9, 31.

278. The time period evaluated by ANR in its determination on the effect of a 1°F increase in Vernon Pool was between 1991 and 2002. Trial Tr. 296 19 (Barnthouse); Trial Tr. 435 (Mattson). ANR's conclusion (as described by Cox) that there has been no prior appreciable harm to the BIP was based on an analysis of the trend data between this time period. Trial Tr. 897 (Cox).

- 44 -

279. Dr. Mattson testified that he chose the year 1991 because it was the first year that Vermont Yankee was permitted to discharge at the summer limits, and he picked 2002 because it was the last year of data available for the 2004 Demonstration. Trial Tr. 435 (Mattson).

280. There are thirty years of trend data. Trial Tr. 897 (Cox). The 1990 Demonstration considered twenty years of discharges prior to 1991. Trial Tr. 437-38 (Mattson). There has never been a statistical analysis of that thirty-year data set. Trial Tr. 897 (Cox). This is another example of the methodology limitations of the 2004 Demonstration.

281. The ecological monitoring data collected between 1991 and 2002 was not collected by a uniform method. See Trial Tr. 899 (Cox).

282. Entergy does not take into account any pre-1991 harm because it uses only 1991-2002 data, and focuses only on trends at single points in the mainstem (i.e., not comparing community composition above and below the discharge). D. McCullough Rebuttal, at 6-7.

283. Entergy's trend analysis also assumes that if there was pre-1991 harm, it would appear between 1991 and 2002. It is possible that the prior harm resulted in the current community composition, except that thermal impact to American shad is likely adding to the difficulty of maintaining this species in the Connecticut River. D. McCullough Rebuttal, at 6-7.

284. Entergy appears to use 1998-2002 as a historical baseline period for comparison with future conditions. This is not a true historical baseline because it does not take into account the long-term cumulative increases that had already occurred throughout the Connecticut River system. D. McCullough Prefiled, at 31.

285. The U.S. Department of Interior has stated that "the full extent of Vermont Yankee's thermal effluent impact cannot be determined until a thorough evaluation of the entire data set is conducted, including pre-operational data and data collected under different permit

- 45 -

limits." R. Jones Prefiled, at 15-16 (citing attachment 1 thereto, Ltr. from A. Raddant to M. Lesar (Mar. 6, 2007)).

286. Additionally, ANR did not factor all sources of potential mortality in evaluating Entergy's proposed discharge. Trial Tr. 895 (Cox). For instance, for salmon smolt, a source of mortality may be acute lethal effects on smolt that come into close contact with the discharge at the point that the discharge enters the river. Trial Tr. 894 (Cox). Entrainment or impingement in connection with the intake structure is another contributor to their mortality. Trial Tr. 891 (Cox).

287. \* The majority of the world's experts on climatology predict significant warming of the earth's atmosphere due to greenhouse gas emissions. Projections for future water temperature conditions are tightly coupled with future climatic patterns. NASA published a study in the April 2007 issue of the American Meteorological Society's Journal of Climate, based upon use of the general circulation model employed by the Intergovernmental Panel on Climate Change (IPCC) showing that New England can expect summer temperatures by 2080 to average summer highs of 37.8-43.3°C (100-110°F) unless carbon dioxide (CO<sub>2</sub>) levels are stabilized. This study indicated that summer high temperatures would be accompanied by drought conditions. D. McCullough Prefiled, at 25 (citing Armando Duke, <u>NASA Forecasts Hotter Summers for East</u> <u>Coast</u>, at http://www.axcessnews.com/user.php/articles/print/id/10963, last visited Oct. 5, 2007).

288. Water temperature has been increasing for the past twenty-five years in the Connecticut River system, principally by human impact. D. McCullough Prefiled, at 26.

289. Dates of first capture and median capture of Atlantic salmon have shifted by 0.5 days per year expressed over this twenty-five-year period. This shift has likely been produced by global climate warming patterns. D. McCullough Prefiled, at 26 (citing Juanes, 2004)

290. \* In 1989 Connecticut's state climatologist predicted that air temperatures in the

- 46 -

state would increase by 5.4°F by 2050. D. McCullough Prefiled, at 25 (citing Miller, 1989).

291. As global warming increases, it will become important to reduce other sources of heat. Elimination of unnecessary sources of stream heating is a recommended means of reducing warmwater diseases affecting coldwater species. D. McCullough Prefiled, at 18.

292. \* High water temperature and reduced river flows caused by this predicted drought tend to be coupled. Increased periods of drought that do occur even periodically can have population effects that last for years. D. McCullough Prefiled, at 26 (citing Rob Neumann, Dep't of Nat. Resources Mgmt. and Engineering, Univ. of Conn., <u>Impacts of Drought on Fish</u>, available at http://www.ctiwr.uconn.edu/DroughtArticles/Neumann.htm, last visited Oct. 5, 2007).

293. \* Populations do not rebound in the mechanistic manner implied by Barnthouse's simplistic risk assessment model. D. McCullough Prefiled, at 26; Ent. Ex. 4, L. Barnthouse Aff., at ¶¶ 50, 69-76.

294. \* The State of Connecticut has a drought preparedness plan (2003) due to the probability of drought conditions. D. McCullough Prefiled, at 26.

295. The threat of continuing global climate change further magnifies the importance of taking all opportunities to reduce, rather than add to, temperatures of the river to maintain native fish populations. D. McCullough Prefiled, at 26.

296. As stated by ANR in how it intends to apply Vermont Water Quality Standards: "[W]e have not quantitatively in any way considered climate change in our decision at this point." Trial Tr. 781 (Burnham).

# VI. SUBSTANTIAL DECLINE IN AMERICAN SHAD POPULATION AND ADVERSE EFFECTS ON LIFE STAGES

#### A. <u>Spawning Behavior</u>

297. American shad ("American shad" or "shad") is an anadromous species native to the Connecticut River. Jt. Ex. 5, 1990 2004 Demonstration, at 45; see also Trial Tr. 426 (Mattson); Ent. Ex. 4, L. Barnthouse Aff., at ¶¶ 9-10.

298. American shad is a coolwater species. D. McCullough Prefiled, at 7.

299. Shad is a key indicator species for the overall health of the biological community in the Connecticut River. R. Jones Prefiled, at 16-17.

300. Shad is listed as an RIS in the 2004 Demonstration. Jt. Ex. 3, 2004

Demonstration, at 8.

301. Adult shad enter the Connecticut River in early April. Trial Tr. 838 (Cox).

302. Shad spawn as they move upstream. Trial Tr. 842 (Cox). Shad are broadcast spawners, meaning that they release eggs in the water column. Trial Tr. 960 (Cox); R. Jones Prefiled, at 17.

303. Most spawning occurs in the Connecticut River from mid-May through mid-June.CRWC Ex. 25, Savoy and Crecco (2004), at 409.

304. The Connecticut River's temperature from Vernon Dam downstream to Massachusetts is important because that reach of the river is good habitat for spawning. Trial Tr. 855-56 (Cox). As recognized by ANR, it is important to know what the temperatures are in Turners Falls Pool and whether Vermont Yankee's discharge had an effect on those temperatures. Trial Tr. 850 (Cox).

305. In their upmigration, adult shad must pass three dams: Holyoke, Turners Falls, and Vernon – to get to the historic limitation range at Bellows Falls. CRWC Ex. 25, Leggett

(2004) at 391, 409; Trial Tr. 922-23 (Cox).

306. Adult American shad arrive at Holyoke Dam during the month of April to early May. Trial Tr. 838 (Cox). Holyoke Dam is 86 river miles from the mouth of the Connecticut River. M. Mattson Prefiled, at 15.

307. Adult American shad arrive at Turners Falls Dam between mid-April and mid-May, estimated to be around a week or two before they arrive at the Vernon Dam. Trial Tr. 838 (Cox). Turners Falls is 123 river miles from the mouth of the Connecticut River. M. Mattson Prefiled, at 15.

308. Adult American shad arrive at Vernon Dam in approximately mid-May, estimated to be around a week or two after they arrive at Turners Falls Dam. Trial Tr. 838 (Cox). Vernon Dam is 142 river miles from the mouth of the Connecticut River. M. Mattson Prefiled, at 14.

309. The Vernon fishway is a submerged fishpipe located "in the center of the river," and "certainly will be affected by the plume." Trial Tr. 91-92 (Swanson).

310. Bellows Falls is 280 river miles from the mouth of the Connecticut River and is the historic upper most range of the American shad. CRWC Ex. 25, Leggett (2004), at 391; CRWC Ex. 25, Savoy and Crecco (2004), at 409; Trial Tr. 922-23 (Cox).

311. Entergy's expert (Swanson) testified that the hottest part of the plume flows into the Vernon Fish Ladder and extends over to the fishway. Trial Tr. 92 (Swanson).

312. By the time the shad arrive in the Vernon-area, spawning has already begun and continues through the third week of June. Trial Tr. 840 (Cox).

313. Shad spawn in Turners Falls Pool and Vernon Pool. Trial Tr. 841 (Cox).

314. Water temperature is an important cue to shad spawning. Trial Tr. 329 (Barnthouse); Trial Tr. 840, 842 (Cox).

315. Shad will spawn in a range of temperatures from 57°F to 70°F. The optimum temperature for adult shad to spawn is 65°F. Jt. Ex. 3, 2004 Demonstration, at 157; Trial Tr. 840 (Cox); Trial Tr. 978 (Deen).

316. Photoperiod also affects spawning. Most spawning occurs at night or on overcast days. CRWC Ex. 25, Savoy and Crecco (2004), at 409. Temperature along with photoperiod triggers migration and spawning in many species of fish including American shad and Atlantic salmon. D. Deen Prefiled, at 2. Photoperiod, a lengthening or shortening of day length, and the amount of light, plays a role in spawning. Trial Tr. 924 (Cox).

317. If the temperatures in Turners Falls Pool reached 70°F during the upstream migration of adult shad, the fish will initiate spawning there. Trial Tr. 840, 842 (Cox). Mr. Cox further testified that it is a possibility that shad would be spawning in Turners Falls Pool if the temperatures exceed 70°F the shad would be spawning there. Trial Tr. 850 (Cox); see also Jt. Ex. 3, 2004 Demonstration, at 157; Trial Tr. 329 (Barnthouse).

318. The temperature in Turners Falls Pool exceeds 70°F during the shad spawning season. Trial Tr. 842 (Cox).

319. Simulated temperatures in the Lower Vernon Pool exceed 85°F based on Dr.Swanson's hydrothermal simulations. Trial Tr. 864 (Cox).

320. ANR did "not specifically or directly" evaluate the potential effect of Vermont Yankee's thermal discharge on upstream migration of shad in lower Turners Pool. Trial Tr. 846 (Cox).

321. Adult shad begin returning to the sea when the water temperature reaches 72°F.Only 30% to 40% of the fish will survive the downstream migration to sea. D. Deen Prefiled, at7.

322. Adult shad arrive at Bellows Falls Dam as late as early July. D. Deen Prefiled, at2.

323. When the population size of an anadromous fish species declines in a river system or a region, increased access to potential spawning areas of suitable temperatures is essential. R. Jones Prefiled, at 8.

324. \* Decreased spawning in the Holyoke to Bellows Falls range of the Connecticut River (the "Upper Connecticut River") conflicts with the stated goal of restoring the American shad population to its historic range as far as Bellows Falls. R. Jones Prefiled, at 8.

## B. <u>Temperature and Reproductive Success</u>

325. Shad can be repeat spawners. Trial Tr. 841 (Cox). If an adult shad survives its first migration up the Connecticut River to spawn and returns back to the ocean, there is a 30% to 40% chance that it could return to the Connecticut River and spawn again. D. Deen Prefiled, at 7.

326. There has been a reduction in the proportion of repeat spawners – both males and females – throughout the historic range of American shad in the Connecticut River. CRWC Ex.
25, Leggett (2004), at 398-99; Trial Tr. 841 (Cox).

327. Increased water temperatures affect egg deposition by reducing the number of spawning shad overall and eliminate the most fecund (the largest females with the most number of eggs) individuals from the overall population. D. McCullough Prefiled, at 16-17.

328. When temperatures impair the success of repeat spawning, overall productivity of the population goes down D. McCullough Prefiled, at 16.

329. The success of each summer's spawning period (i.e., the total number of juveniles) is dependent on the number of females. R. Jones Prefiled, at 17.

330. Evidence shows a decrease in the fecundity (the fertility) of female shad in

- 51 -

Vernon Pool compared to those in the Turners Falls Dam Pool. R. Jones Prefiled, at 4.

331. Shad counts and juvenile shad abundance began to decline five years after initiation of increased summer discharge in 1991. Trial Tr. 260 (Barnthouse).

332. \* Shad may have evolved to follow a migratory pattern that allows greater behavioral response to environmental fluctuations than salmon (which seem to rely more on the length of the day). This is possibly due to shad tending to spawn soon after entering the River while salmon spawn in far tributaries. This work points to the need to consider whether warming water temperature, in part due to Vermont Yankee's thermal discharge, is causing Connecticut River shad to migrate less and spawn earlier. R. Jones Prefiled, at 8.

333. The 2004 Demonstration does not evaluate whether increases in water temperature are causing Connecticut River shad to migrate less and spawn earlier. R. Jones Prefiled, at 8.

### C. <u>Bioenergetics</u>

334. As water temperature increases, more energy must be expended. Trial Tr. 839-40 (Cox). This is known as the principle of bioenergetics. Higher water temperatures increase the level of stress and reduce spawning success of migrating adults. R. Jones Prefiled, at 4, 7-8.

335. Shad do not feed while in migration. Trial Tr. 838 (Cox); CRWC Ex. 25, Leggett(2004), at 396.

336. The prevailing view is that shad are not as strong swimmers as Atlantic salmon.Trial Tr. 839 (Cox). Shad expend more energy on migration than other species, such as Atlantic salmon. R. Jones Prefiled, at 7.

337. Addition of heat from Vermont Yankee increases the energetic costs of swimming through the Vernon tailrace and Lower Vernon Pool. R. Jones Prefiled, at 8.

338. Increased energetic costs of swimming means less energy for other activities (e.g.,

feeding, spawning, and avoiding predators) and results in increased stress. R. Jones Prefiled, at 8.

339. Dr. Mattson acknowledged energetic stress can increase the "cost of doing business" for fish in terms of "energy expended swimming or eating [or] completing their life," and the risk of energetic stress on fish that "remain in an area of an increased temperature zone." Trial Tr. 570-71 (Mattson).

340. \* Higher water temperature "increases the costs of doing business" for shad in the Connecticut River, especially for those attempting to reach Vernon Pool. R. Jones Prefiled, at 7 (citing Leonard, 1999).

341. Depletion of shad energy reserves can impair their motivation to continue migrating upstream. Trial Tr. 842 (Cox). Individuals of the population simply may not have the energy needed to migrate further upstream beyond Turner's Falls Dam. D. McCullough Prefiled, at 22.

342. If migration depletes the energy reserves of migrating shad, the combination of the distance, passage at the dams, fallback during dam passage attempts, and heat stress during migration would very conceivably impair survival. D. McCullough Prefiled, at 22.

343. A 1981 study (Glebe and Leggett) indicated that the shad expended 40% to 60% of "their total energy reserves to migrate from the sea to the spawning areas to spawn," which at the time of the study occurred principally below Enfield Dam below Holyoke Dam). CRWC Ex. 25, Leggett (2004), at 396.

344. Thermal stress downstream of Vernon Dam would make travel increasinglyenergy intensive and reduce the success of adult shad, including females, in passing Vernon Dam.D. McCullough Prefiled, at 17; R. Jones Prefiled, at 8. The distance traveled to Vernon Dam, thedam passage exertion, and the temperature are sufficient to cause energy depletion as suggested

- 53 -

by the Leggett study (2004). D. McCullough Prefiled, at 22 (citing Leggett, 2004).

345. Thermal stress would also reduce the probability of repeat spawning. D.McCullough Prefiled, at 17.

346. Studies on Connecticut River shad have hypothesized that the increased distance traveled by American shad migrating above Holyoke Dam depletes the energy reserves of the migrating fish and reduces their survival. L. Barnthouse Prefiled, at 20.

347. The 2004 Demonstration does not evaluate the effect of shad energetics relative to Vermont Yankee's discharge or proposed discharge. R. Jones Prefiled, at 7.

### D. Larval Development

348. 63°F to 70°F is the optimal temperature range for egg incubation for shad. Trial Tr. 854-55 (Cox).

349. Shad lay their eggs in the water column and do not build a nest like salmon do. The eggs settle down to the bottom. Trial Tr. 960-61 (Cox).

350. Eggs that would be spawned or broadcast above the area of the plume drift downstream with the current. Trial Tr. 961 (Cox).

351. Exposing eggs to upper limit incubation temperatures (i.e., 70°F) would either tend to kill the eggs from heat stress or disease, or cause early emergence, which could lead to poor survival in juvenile stages. D. McCullough Prefiled, at 35.

352. An episodic increase in temperature from 68°F to 77°F over 48 hours reduces survival of yolk-sac and feeding stage larvae of American shad. R. Jones Prefiled, at 7 (Leach and Houde, 1999).

353. The temperature shock that results from an increase of 68° F to 86° F kills all larval shad. R. Jones Prefiled, at 7 (Leach and Houde, 1999).

354. Increased water temperatures in Turner's Falls Pool could have an impact on egg

incubation. Trial Tr. 855 (Cox).

355. Entergy has not conducted any field or laboratory studies to evaluate the effects of their thermal discharge on egg and larval development or viability in Lower Vernon Pool or Turners Falls Pool. R. Jones Rebuttal, at 14-15.

## E. Juvenile Rearing

356. The Swanson model simulates temperatures between 80°F and 90°F in Lower Vernon Pool during the Summer Period. Trial Tr. 864 (Cox); Jt. Ex. 3, 2004 Demonstration, at 11; R. Jones Prefiled, at 14.

357. 100°F is the maximum temperature that thermal models have estimated the temperature in the Lower Vernon Pool, within the thermal plume from the discharge, during the warmer summer months. Jt. Ex. 3, 2004 Demonstration, at 11; R. Jones Prefiled, at 14.

358. 70°F is the optimal rearing temperature for juvenile shad. Trial Tr. 864 (Cox).

359. The adverse temperatures produced in Vernon Pool downstream of Vermont Yankee would provide extremely adverse juvenile rearing conditions for the shad juveniles that may attempt to rear there. D. McCullough Prefiled, at 16.

360. There is no continuous monitoring of actual temperatures in Lower Vernon Pool, within the thermal plume from the discharge. Trial Tr. 863 (Cox).

361. Suitable spawning and rearing habitat exists in Lower Vernon Pool above the thermal discharge. Trial Tr. 960 (Cox).

362. Juvenile shad are actually living in an area of increased temperature (within the monitored area). Trial Tr. 256 (Barnthouse).

363. Temperature may also affect growth, development, and outmigration of juvenile shad. Trial Tr. 318 (Barnthouse).

364. Entergy has not conducted any field or laboratory studies to evaluate the effects of their thermal discharge on juvenile rearing or viability in Lower Vernon Pool or Turners Falls Pool. R. Jones Rebuttal, at 10.

### F. Juvenile Outmigration

365. Juvenile shad outmigration period is early September to mid November. Trial Tr.867 (Cox).

366. Temperature is a factor in the outmigration of juvenile shad. Trial Tr. 867 (Cox);Trial Tr. 318 (Barnthouse); R. Jones Rebuttal, at 10.

367. The water temperature cue for beginning outmigration by juvenile shad is approx 66°F. As a threshold of 66°F is reached, the behavioral tendency of juveniles to maintain position against the current in low light or at night is decreased and they begin to drift downstream. R. Jones Prefiled, at 7.

368. Increases in water temperature can delay outmigration of juvenile shad. Trial Tr.867 (Cox).

369. Laboratory studies suggest that effects may occur on shad from late migration.Trial Tr. 323 (Barnthouse).

370. Late migration adversely affects shad physiology. D. McCullough Prefiled, at 2223. Negative physiological effects on juvenile shad from delayed outmigration include
impairments to the adaptive process that allows juveniles to become adapted to a saltwater
environment. Trial Tr. 868 (Cox).

371. Late migration and seawater entry increase mortality of American shad. Delays in downstream migration of juvenile shad, from physical barriers (e.g., dams and fish ladders) and thermal stresses (i.e., temperature increases), impairs shads' ability to make the physiological

- 56 -

adaptations required for life in salt water and causes increased mortality. R. Jones Prefiled, at 7.

372. The EAC raised concerns about juvenile shad outmigration during the permit amendment review process. Trial Tr. 709 (Carpenter).

373. No studies to determine the effect of the Vermont Yankee discharge on juvenile shad outmigration from Lower Vernon Pool were done in connection with the Vermont Yankee 2004 Demonstration. Trial Tr. 869-70 (Cox).

374. Dr. Mattson does not consider the possible effects of thermal discharge on juvenile migration and survival, which can contribute to changes in future adult populations, and by focuses just on thermal discharge during the adult shad spawning migration. R. Jones Rebuttal, at 19-20.

375. The U.S. Fish and Wildlife Service recommended that the amended permit contain a condition requiring studies on juvenile shad outmigration. The U.S. Fish and Wildlife Service determined that the 2004 Demonstration lacked information regarding the potential impact the thermal effluent may have on migrating Atlantic Salmon under the existing or proposed conditions. Jt. Ex. 109, Clarification of Position, Ltr. from M. Moriarity to J. Wennberg (Mar. 21, 2006), at 1.

376. CRASC also recommended studies on effects of discharge on juvenile outmigration. In a letter to the Vermont Agency of Natural Resources, the Connecticut River Salmon Commission ("CRASC") stated that it could not support Vermont Yankee's requested temperature variance until studies were performed that were specifically designed to evaluate the conditions at Vermont Yankee. Jt. Ex. 100, Comments on Vermont Yankee Proposed Amended NPDES Permit (Dec. 6, 2005), at 1.

377. The U.S. Geological Survey Silvio O. Conte Anadromous Fish Research

- 57 -

Laboratory also recommended studies on juvenile outmigration, a recommendation on which Dr. Jones drew on in part for his opinion on the need for such further studies. R. Jones Rebuttal (pre-redaction), at 6-7; CRWC Ex. 26, Ltr. from S. Garabedien to D. Deen (July 2, 2007), at Responses to Questions 11-12.<sup>4</sup>

378. ANR did not accept these recommendations. Trial Tr. 870 (Cox).

## G. <u>Shad Collapse and Restoration Efforts</u>

379. In 1981 a fish ladder was installed at Turners Falls Dam. R. Jones Prefiled, at 9.

380. In 1983 improvements to Turners Falls Dam fish passage facility results in an upward trend for American shad passage numbers at Turners Falls Dam. R. Jones Prefiled, at 9.

381. Shad returns to Vernon Dam steadily increased between 1981 and 1995. R. Jones Prefiled, at 9-10.

382. In 1991, Vermont Yankee was granted a variance allowing increased thermal discharge into the Connecticut River from May 15 to October 15. Final Discharge Permit No. 3-1199 (beginning Jan. 1, 1991), at 6; R. Jones Prefiled, at 10.

383. Shad counts and juvenile shad abundance began to decline five years after initiation of the increased summer discharge in 1991. R. Jones Prefiled, at 10; Trial Tr. 260 (Barnthouse).

384. The average age of sexual maturity for shad is five years. Trial Tr. 334 (Barnthouse).

385. The total number of adult American shad passing through Connecticut River dams from 1991 to 2006 is represented in the table below. The maximum passage number appears in bold and the percentage of shad that passed in subsequent years relative to the

<sup>&</sup>lt;sup>4</sup> CRWC is mindful of the Court's ruling that the letter from the U.S. Geological Survey Silvio O. Conte Anadromous Fish Research Laboratory ("Conte Letter") itself is inadmissible, but has allowed Dr. Jones to rely on it in support of his opinions. See Appendix.

maximum passage number:

| Year   | Downstream of<br>Holvoke | Holyoke | Turner Falls | Vernon               |  |  |  |  |  |  |
|--|--------------------------|---------|--------------|----------------------|--|--|--|--|--|--|
| 1991   | 1.195, 920               | 520.000 | 54.656       | 37.197               |  |  |  |  |  |  |
| 1992   | 1,628,039                | 720,000 | 60,089       | 31,155               |  |  |  |  |  |  |
| Adult shad population as percentage of maximum (in bold above) |                          |         |              |                      |  |  |  |  |  |  |
| 1993   | 46%                      | 47%     | 17%          | 9.8%                 |  |  |  |  |  |  |
| 1994   | 20%                      | 25%     | 6.2%         | 7%                   |  |  |  |  |  |  |
| 1995   | 19%                      | 26%     | 31%          | 42%                  |  |  |  |  |  |  |
| 1996   | 41%                      | 38%     | 31%          | 51%                  |  |  |  |  |  |  |
| 1997   | 41%                      | 42%     | 15%          | 20%                  |  |  |  |  |  |  |
| 1998   | 40%                      | 44%     | 18%          | 22%                  |  |  |  |  |  |  |
| 1999   | 29%                      | 27%     | 11%          | 14%                  |  |  |  |  |  |  |
| 2000   | 26%                      | 31%     | 4.3%         | 2.2%                 |  |  |  |  |  |  |
| 2001   | 47%                      | 38%     | 2.5%         | 4.5%                 |  |  |  |  |  |  |
| 2002   | 42%                      | 52%     | 4.8%         | 1.0%                 |  |  |  |  |  |  |
| 2003   |                          | 40%     | n.a.         | 0.7%                 |  |  |  |  |  |  |
| 2004   |                          | 27%     | 3.5%         | 1.8%                 |  |  |  |  |  |  |
| 2005   |                          | 16%     | 2.5%         | 0.5%                 |  |  |  |  |  |  |
| 2006   |                          | 22%     | 2.5%         | 0.4%                 |  |  |  |  |  |  |
| Average  | 35%                      | 34%     | 12%          | 17%                  |  |  |  |  |  |  |
|  |                          |         |              | (including 1992)     |  |  |  |  |  |  |
|  |                          |         |              | 13%                  |  |  |  |  |  |  |
|  |                          |         |              | (not including 1992) |  |  |  |  |  |  |

#### Table 1

R. Jones Prefiled, at 19-20 & tbl. 1 (data from Ent. Ex. 3, M. Mattson Aff., at ex. 6 thereto).

386. Table 1 set forth immediately above shows the declines over time in the size of the American shad population at the river mouth, Holyoke Dam, Turners Falls Dam, and in the Lower Vernon Pool. R. Jones Rebuttal, at 22; R. Jones Prefiled, at 19-20 & tbl. 1.

387. Table 1 shows the American shad population has declined at different rates in different parts of the river from their peaks in the early 1990s to the near present. R. Jones Rebuttal, at 22; R. Jones Prefiled, at 19-20 & tbl. 1.

388. Table 1 shows that the shad population at Holyoke Dam declined 58%, to only42% of its 1992 maximum. R. Jones Rebuttal, at 22-23; R. Jones Prefiled, at 19-20 & tbl. 1.

389. Table 1 shows that the shad population at the Turner's Falls Dam declined 97.5%,

to only 2.5% of its 1992 maximum. R. Jones Prefiled, at 3, 19-20 & tbl. 1.

390. Table 1 shows that the shad population in the Lower Vernon Pool declined 99%, to only 1.0% of its 1991 maximum. R. Jones Rebuttal, at 23; R. Jones Prefiled, at 19-20 & tbl. 1.

391. As represented in Table 1, in 2003, the year before completion of the 2004 Demonstration, the total number of counted adult shad entering Vernon Pool was only 268 - a99.3% reduction from the population high of 37,197 in 1991. R. Jones Prefiled, at 11.

392. \* Based on this 99.3% decline of shad population over roughly a single decade, since Vermont Yankee increased its thermal discharge, Dr. Jones concluded that there has been more than appreciable harm to the American shad population in Vernon and Turners Pools that is not explained by any river-wide decrease in the American shad population. R. Jones Prefiled, at 11.

393. The drop in population of shad entering Turners Falls Pool is greater than we would expect from the river-wide decline. R. Jones Rebuttal, at 23.

394. If the American shad decline was attributable to Vermont Yankee's thermal discharge, that would be evidence of prior appreciable harm. Trial Tr. 458-59 (Mattson).

## H. <u>Observations on the River</u>

395. It is well known among trout fishers that when the Connecticut River water temperature goes above the level of 65°F that shad stop feeding. D. Deen Prefiled, at 2.

396. \* It has been noticeable in recent years that the river near Turners Falls Dam does not freeze over at all. D. Deen Prefiled, at 9.

397. Vernon Dam crosses the river between Vernon, Vermont and Hinsdale, New Hampshire. There is a fish ladder on the Vermont side that has proven to be effective at passing fish. D. Deen Prefiled, at 3.

398. The next dam above Vernon is at Bellows Falls. Bellows Falls is the historic limit of the upstream migration of the American shad. Historically, shad were not strong enough swimmers to make it over Bellows Falls. D. Deen Prefiled, at 3.

399. Atlantic salmon, being stronger swimmers, historically have gone furtherupstream, as far as the Ammonoosuc River at Woodsville, New Hampshire. D. Deen Prefiled, at3.

400. Beginning in the late 1990s, Mr. Deen observed a sharp decline in the number of shad returning to the Bellows Falls reach of the river. Once the shad stopped returning to Bellows Falls, he guided anglers successfully below Turners Falls Dam. D. Deen Prefiled (testimony to accompany prefiled report), at 3.

401. By 2000, he had stopped taking clients to fish for shad at Saxtons River altogether because the returns of shad above Vernon were too low to guarantee any success. D. Deen Prefiled (testimony to accompany prefiled report), at 3.

402. The fishing at Turners Falls has remained reliable despite the drop in over all returns to the river. Numbers have remained at sufficient levels to allow for reliable fishing for his clients. D. Deen Prefiled (testimony to accompany prefiled report), at 3.

# I. <u>Turners Falls Dam</u><sup>5</sup>

403. The relationship between shad and passage at Turners Falls Dam is poorly understood. ANR Ex. 15, Cox Prefiled, at 19.

404. Subtle differences between the water in a fish ladder and that in the tailrace or forebay of a dam can affect the rate of passage at each dam. D. McCullough Prefiled, at 23.

405. Passage success depends upon the interaction of factors including river flow rate

<sup>&</sup>lt;sup>5</sup> Requested findings with respect to Entergy's claim that shad declines are attributable to Turners Falls Dam and not Vermont Yankee are set forth in that section.

and river temperature. Warmer-than-normal water temperatures can delay upstream migration in anadromous fish (Farrell, 1997), and delayed migration can reduce spawning success (Rand and Hinch, 1998). R. Jones Prefiled, at 17-18 (citing Farrell, 1997; Rand and Hinch, 1998).

406. Studies to evaluate the effect of temperature on shad passage at Connecticut River dams have not been performed. Trial Tr. 851-53 (Cox).

407. Dr. Jones draws in part upon a letter from the Silvio O. Conte Anadromous Fish Research Laboratory in his conclusion that shad passage at Turners Falls Dam declined between 1990 and 2006. Trial Tr. 1334 (R. Jones); CRWC Ex. 26, Unsigned Ltr. from Garabedien to Deen, July 2, 2007, at 2.

408. In cross examination, Dr. Jones was asked whether he was "really sure what Conte Lab means when they state that shad passage at Turners Falls Dam declined between 1990 and 2006," to which he answered affirmatively and stated that the biologists at the Silvio O. Conte Anadromous Fish Research Laboratory analyzed dramatic declines in shad passage since 1990 that could not be explained by expected variability.<sup>6</sup> Trial Tr. 1334 (Jones).

409. As separately explained by Dr. Jones, the statements by Dr. Mattson that passage at Turners Falls Dam is the cause of the decline in the shad population is unfounded because there is "no evidence at all of any changes in the structure or operation of this facility that would explain the decline." R. Jones Rebuttal, at 20.

410. The most dramatic declines in the American shad population in this region began after 1995. D. McCullough Rebuttal, at 5. Indeed, from 1990 to 1992, the number of shad counted passing upstream at Turners Falls Dam increases. Trial Tr. 1226, 1332 (Jones).

411. As demonstrated in Table 2 below, depicting exhibit 6 of Dr. Mattson's affidavit

<sup>&</sup>lt;sup>6</sup> Dr. Mattson later relied upon documents generated by biologists associated with the Silvio O. Conte Anadromous Fish Research Laboratory.

(reproduced below), the significant shad declines occurred after 1995:

River

#### Table 2

Annual number of spawning American shad entering the Connecticut River (Column 2) and passing upstream at Holyoke Dam (Mile 86), Turners Falls Dam (Mile 123) and Vernon Dam (Mile 142) during each year that the Vernon Dam Fish ladder was in operation, 1981-2006.

|                            | Downstream |         |               |        |  |
|----------------------------|------------|---------|---------------|--------|--|
| Year                       | of Holyoke | Holyoke | Turners Falls | Vernon |  |
| 1981                       | 909,270    | 380,000 | 200           | 97     |  |
| 1982                       | 939,330    | 290,000 | . 11          | 9      |  |
| 1983                       | 1,574,460  | 530,000 | 12705         | 2597   |  |
| 1984                       | 1,231,110  | 500,000 | 4333          | 335    |  |
| 1985                       | 727,560    | 480,000 | 3885          | 833    |  |
| 1986                       | 748,440    | 350,000 | 17858         | 982    |  |
| 1987                       | 587,520    | 280,000 | 18959         | 3459   |  |
| 1988                       | 647,640    | 290,000 | 15787         | 1370   |  |
| 1989                       | 979,440    | 350,000 | 9511          | 2953   |  |
| 1990                       | 816,480    | 360,000 | ~27908        | 10894  |  |
| 1991                       | 1,195,920  | 520,000 | 54656         | 37197  |  |
| 1992                       | 1,628,039  | 720,000 | 60089         | 31155  |  |
| 1993                       | 749,227    | 340,000 | 10221         | 3651   |  |
| 1994                       | 325,558    | 181,000 | 3729          | 2681   |  |
| 1995                       | 303,973    | 190,000 | 18369         | 15771  |  |
| 1996                       | 667,137    | 276,000 | 18485         | 18884  |  |
| 1997                       | 659,478    | 299,000 | 9216          | 7384   |  |
| 1998                       | 651,358    | 316,000 | 10527         | 8151   |  |
| 1999                       | 475,095    | 194,000 | 6756          | 5083   |  |
| 2000                       | 427,381    | 225,000 | 2590          | 800    |  |
| 2001                       | 773,114    | 273,000 | 1520          | 1666   |  |
| 2002                       | 686,662    | 375,000 | 2870          | 356    |  |
| 2003                       |            | 287,000 |               | 268    |  |
| 2004                       |            | 191,290 | 2092          | 653    |  |
| 2005                       |            | 116,511 | 1500          | 167    |  |
| 2006                       |            | 154,772 | 1500          | 133    |  |
| Turners ladder opened 1980 |            |         |               |        |  |
| Vernon ladder opened 1981  |            |         |               |        |  |

Ent. Ex. 3, M. Mattson Aff., at ex. 6 thereto; see also R. Jones Prefiled, at 19-20 & tbl. 1 (using these figures to provide a table of the percentage of shad that passed Connecticut River dams relative to the maximum passage numbers set forth for 1991-92).

412. Dr. Barnthouse stated that it is impossible to know what the secondary peak in 1995-96 would have been without discharge. He stated: "You're asking me about an alternate universe now. Because the discharge was there so there is literally no way to know what the return would have been if there had been no discharge." Trial Tr. 339 (Barnthouse).

413. Under Dr. Barnthouse's methodology, a lack of a peak in adult shad five years after a previous peak is evidence of an adverse effect by the thermal discharge. Trial Tr. 260

(Barnthouse).

## J. Limits to Thermal Tolerance

#### Acute Lethality

414. Dr. Mattson claims that the proposed 1°F increase proposed is <u>de minimis</u> for species such as American shad on the basis that avoidance temperatures and the UILT are not exceeded. M. Mattson Prefiled, at 10-11.

415. Dr. McCullough states that UILT values are based upon seven-day exposures to temperatures killing 50% of a test population. D. McCullough Rebuttal, at 9.

416. Different acclimation temperatures will result in different estimates of UILT. R.Jones Rebuttal, at 9 (citing Marcy, 1972).

417. The 2004 Demonstration does not perform a full UILT and avoidancetemperature. Trial Tr. 1128 (McCullough); D. McCullough Prefiled, at 34; R. Jones Prefiled, at13.

418. The "lethal temperature" that Entergy uses for American shad, and cited in the 2004 Demonstration, is from a paper by Moss (1970). R. Jones Rebuttal, at 7 (citing Moss, 1970); Jt. Ex. 3, 2004 Demonstration, at app. 2, A2-2 (citing Moss, 1970). See Sanford A. Moss, <u>The Response of Young American Shad to Rapid Temperature Changes, in Transactions of the American Fisheries Society</u> 99(2):381-384 (1970), cited in Jt. Ex. 3, 2004 Demonstration, at 238 (Literature Cited), R. Jones Prefiled, at 21 (Literature Cited).

419. The 2004 Demonstration based a UILT of 90.5°F for American shad on Moss(1970). Jt. Ex. 3, 2004 Demonstration, at app. 2, A2-2 (citing Moss, 1970).

420. Moss (1970) does not establish a UILT for shad. Moss's only mention of a lethal temperature for shad is one sentence in the paper's "Introduction" section (not the "Results"

section). R. Jones Rebuttal, at 7-8 (citing Moss, 1970).

421. Moss characterized his observation regarding the "rapid death" of the test subjects as "preliminary" and "unpublished." R. Jones Rebuttal, at 7-8 (citing Moss, 1970).

422. Dr. Mattson does not define "lethal temperature" as "the temperature at which fatality automatically occurs," but rather as the temperature at which a fish "will be excluded from the waters" and not be subject to "immediate mortality." M. Mattson Prefiled, at 34.

423. Dr. Mattson's defines UILT as "the temperature at which half of the test subjects die when exposed to it." M. Mattson Prefiled, at 34.

424. The observation that juvenile shad experienced "rapid mortality" appears to be based on 100% mortality rate although Moss does not state what the actual mortality rate was. R. Jones Rebuttal, at 8.

425. Marcy (1972) sought to confirm a previous field experiment in which juvenile shad were transferred from ambient water at approximately 66°F to thermal effluent that reached approximately 90°F. R. Jones Rebuttal, at 8 (citing Marcy, 1972).

426. All of the fish in the Marcy experiment died after four to six minutes of exposure to the 90°F effluent. R. Jones Rebuttal, at 8 (citing Marcy, 1972).

427. From the design of the Marcy experiment, it is impossible to know if 100% mortality would not have occurred at a lower temperature with longer exposure. R. Jones Rebuttal, at 8-9 (citing Marcy, 1972).

428. Marcy (1976) confirmed these immediate lethal effects of rapid increases in water temperature to 90.5 °F in field experiments. R. Jones Prefiled, at 13 (citing Marcy, 1976, reprinted 2004).

429. All of the fish in this experiment died after four to six minutes of exposure to the

90° F effluent. R. Jones Rebuttal, at 8 (citing Marcy, 1972).

430. The acute temperature considered to be "relatively" safe, by National Academy of Sciences ("NAS") established methodology, has been the UILT -2°C (safety factor). D. McCullough Prefiled, at 34 (citing NAS, 1972).

431. The Moss study does not assert that water temperatures less than 90.5°F are not lethal to shad; only that Moss observed rapid death of juvenile shad when water temperature was rapidly raised from between 75.2°F and 82.4°F to 90.5°F in the laboratory. R. Jones Prefiled, at 13 (citing Moss, 1970).

432. The Moss study does not describe the longer-term lethal effects or the chronic adverse effects of water temperatures less than 90.5°F. These effects may include a reduced probability of successful migration and successful adaptation to the marine environment. R. Jones Prefiled, at 13 (relying in part on CRWC Ex. 5, R. Jones Aff., at ¶¶ 10-13); R. Jones Rebuttal, at 19 (same).

433. Given that a rapid increase to 90.5°F causes acute lethality, it is likely that longer exposure at lower temperatures could also result in death or other adverse developmental, behavioral, and physiological responses that would affect recruitment in the shad population. R. Jones Prefiled, at 13.

434. While the assumed UILT in the 2004 Demonstration was estimated for juvenile shad only, Entergy uses it for all life stages of shad – eggs to adults. R. Jones Rebuttal, at 9.

435. The role of Vermont Yankee's discharge in various life stages of American shad (and other species) in Vernon Pool has not been examined and remains unresolved. R. Jones Prefiled, at 13; R. Jones Rebuttal, at 19.

436. Dr. Mattson describes UILT as "derived from laboratory experiments in which

- 66 -

fish are removed from a temperature to which they are acclimated and placed in a range of other temperatures that typically result in a range of survival from 100% to 0%," with UILT determined by the "temperature at which half of the test subjects die when exposed to it." M. Mattson Prefiled, at 34.

437. Reliable and age-specific UILT estimates are required to protect each of the life stages of the American shad in and downstream of Lower Vernon Pool. R. Jones Rebuttal, at 9.

438. More recent studies of the effects of elevated water temperature on American shad demonstrate that temperatures less than 90.5°F adversely affect shad physiology or are lethal to other life stages of American shad. R. Jones Prefiled, at 13 (relying in part on Jones Aff (June 15, 2006), at ¶¶ 7 -9, citing Facey and Van Den Avyle, 1986, Leach and Houde, 1999).

439. New studies should be done to assess the potential effects of Vermont Yankee's thermal discharge on American shad and to estimate exclusionary and indicator temperatures for all life stages under temperature, river flow, and other environmental factors found in and downstream of Lower Vernon Pool. R. Jones Rebuttal, at 13.

440. Entergy did not do the studies necessary to determine what effect the proposed discharge would have on preferred temperatures for all life stages of American shad and other species within the Connecticut River watershed. R. Jones Prefiled, at 13-14.

#### Avoidance Temperature

441. The 2004 Demonstration provides 86°F as the avoidance temperature for American shad. Jt. Ex. 3, 2004 Demonstration, at 163 & app. 2, A2-2 (citing Marcy, 1976); see also M. Mattson Prefiled, at 46 (citing Jt. Ex. 3, 2004 Demonstration, at app. 2, A2-2); R. Jones Rebuttal, at 7; R. Jones Prefiled, at 14.

442. The Marcy study (1972, results reported in 1976) has the same defects as set forth

- 67 -

in the requested findings above with respect to acute lethality. R. Jones Rebuttal, at 9 (citing Marcy, 1972).

443. This Marcy study provides no information on river flow rates or the extent of the thermal plume that juvenile shad were exposed to. R. Jones Rebuttal, at 9 (citing Marcy, 1972).

444. River flow rate is important because juvenile shad are usually less than 10 cm long and are unlikely to be able to avoid high currents. R. Jones Rebuttal, at 10.

445. \* This is a probable reason for their relatively high rate of impingement on Vermont Yankee's water intake screens. R. Jones Rebuttal (pre-redaction), at 10.

446. Additionally, high river flow rates occur in Lower Vernon Pool when Vernon Dam discharges water at a high rate. R. Jones Rebuttal, at 10.

447. This Marcy study also does not discuss the possible effect that thermal avoidance temperature may have in disrupting outmigration of juveniles in later summer and fall. R. Jones Rebuttal, at 10 (citing Marcy, 1972).

448. It is known that juvenile shad tend to use the downstream current during outmigration and that the timing of outmigration is keyed to river temperature. R. Jones Rebuttal, at 10 (citing O'Leary and Kynard, 1986).

449. The Marcy study states that it was designed to "define their [juvenile American shad] temperature limit under the conditions existing in the lower Connecticut River." R. Jones Rebuttal, at 10-11 (citing Marcy, 1972).

450. It does not consider the link between thermal effluent temperature and the ecology of the American shad under conditions in and downstream of Lower Vernon Pool. R. Jones Rebuttal, at 11 (citing Marcy, 1972).

451. The Marcy study conducted at the site of the Connecticut Yankee Nuclear Power

Plant. The differences in the variables at issue in the Connecticut Yankee and Vermont Yankee sites mean that Entergy should have performed separate study of avoidance temperatures specific to species in the Connecticut River watershed affected by Vermont Yankee. R. Jones Rebuttal, at 11-13.

452. The Marcy study was conducted at the Connecticut Yankee site only sixteen miles upstream of Long Island Sound and "well below the major shad spawning areas." R. Jones Rebuttal, at 11 (citing Marcy, 1972; Marcy, 1976).

453. The potential effects of Connecticut Yankee's thermal discharge were largely limited to the early upstream migration of adults to their spawning areas, and to the final leg of the downstream migration of juveniles and surviving adults to the ocean. R. Jones Rebuttal, at 11.

454. Vermont Yankee is in the Upper Connecticut River, approximately 143 miles from the ocean, within a mile of Vernon Dam. R. Jones Rebuttal, at 11; M. Mattson Prefiled, at 14.

455. This means that Vermont Yankee's thermal discharge can affect the early upstream migration of adults and the late downstream migration of juveniles and adults. R. Jones Rebuttal, at 11.

456. \* This also means that it can affect all freshwater life stages of the American shad.R. Jones Rebuttal (pre-redaction), at 11.

457. The natural and human-caused river topology at the site of Connecticut Yankee is far different than for Vermont Yankee. R. Jones Rebuttal, at 11.

458. Salt water extends as far as two miles south of Connecticut Yankee. R. Jones Rebuttal, at 12.

- 69 -
459. The average annual daily flow at Haddem Neck, immediately downstream of Connecticut Yankee, is approximately 17,000 cubic feet per second; whereas the river flow immediately downstream of Vermont Yankee, is not regulated by a dam (e.g., flow rates through Vernon Dam vary from 1,250 cubic feet per second to over 13,000 cubic feet per second). R. Jones Rebuttal, at 12.

460. Near Connecticut Yankee, tidal flow averages 15,000 cubic feet per second, but may be as high as 22,000 cubic feet per second. There is no tidal effect at Vermont Yankee. R. Jones Rebuttal, at 12.

461. Cooling water at Connecticut Yankee was discharged into a canal that flows 5,500 feet before entering the river. There is no such canal at Vermont Yankee. R. Jones Rebuttal, at 12.

462. Unlike Connecticut Yankee, Vermont Yankee is located within a mile upstream of Vernon Dam. Due to the location of the fish ladder and fish pipe on the Vermont side of Vernon dam, migrating adult and juvenile shad must swim directly through the plume. R. Jones Rebuttal, at 12 (citing Jt. Ex. 201, Analytical Bulletin #77).

463. Additionally, the thermal discharge heats downstream water to at least Holyoke Dam, making it impossible for any shad migrating upstream or downstream through Vernon Pool and Turners Falls Pool to avoid the effects of the plume. R. Jones Rebuttal, at 13; Jt. Ex. 6, 1978 Demonstration, at 5-14 - 5-15; Jt. Ex. 5, 1990 Demonstration, at 59; R. Jones Prefiled, at 6, 18; see also D. McCullough Prefiled, at 10-11.

464. The "avoidance behavior" measured by the Marcy study was also limited to vertical (downward) movement of 1.5 meters or less. There is no evidence that this avoidance behavior is sufficient to move out of harmful temperatures in or near Lower Vernon Pool. R.

- 70 -

Jones Rebuttal, at 10 (citing Marcy, 1972).

465. The testing in the Marcy study was limited to caged shad and did not test for avoidance or lethal thermal effects on free-swimming shad. R. Jones Prefiled, at 14.

466. The avoidance temperature of American shad, as relied upon in the 2004 Demonstration, is above the preferred temperature levels for successful propagation of shad published in the Marcy study. D. Deen Prefiled, at 7 (citing Marcy, 1972; Jt. Ex. 3, 2004 Demonstration, at 163).

467. Marcy used only shad collected from a part of the river that was not affected by thermal discharge ( $\approx$ 75°F), and he immediately transferred the shad into cages located in the thermal discharge ( $\approx$ 86°F), allowing no time for temperature acclimation. R. Jones Prefiled, at 14.

468. In contrast to the shad used in Marcy's study, the shad in the vicinity of Vermont Yankee are already exposed to high temperatures (>80°F). R. Jones Prefiled, at 14.

469. Marcy's work does not address the important question of whether shad will avoid additional potentially harmful temperature increases to 86°F or higher if they already live in warmer water and are not exposed to a rapidly changing temperature gradient. R. Jones Prefiled, at 14.

470. Further research needs to be conducted to determine accurate estimates for shad thermal tolerances, including avoidance temperature. R. Jones Prefiled, at 14; Trial Tr. 868-70 (Cox).

471. Shad living in warmer waters may not avoid potentially harmful temperature increases, a concern supported by the Moss laboratory study that demonstrated that shad would avoid rapid temperature changes of about 8°F over about 4 feet, but showed no avoidance of rapid

- 71 -

changes of 1.8°F. R. Jones Prefiled, at 14.

472. The 2004 Demonstration relies on a hydrothermal modeling study instead of the real-time monitoring of temperatures in Lower Vernon Pool where American shad (and other species) must deal with the greatest temperature increases. R. Jones Prefiled, at 12.

473. \* To reach their conclusion that their thermal discharge is not a cause in the decline in the American shad population in and downstream of Vernon Pool, Entergy simply overlaps the results of their thermal modeling study with the literature values for American shad thermal tolerance. I have mentioned the inadequate nature of the thermal tolerance estimates above and will do so in more detail below when discussing Problem 3. R. Jones Prefiled, at 12.

474. The thermal modeling study does not estimate temperatures below Vernon Dam, but, instead, bases estimations on up-field measurements taken from a limited part of the Lower Vernon Pool (and not the part closest to the discharge) from only June 25 - July 9 and August 1 -23, 2002. R. Jones Prefiled, at 12.

475. Where it is possible to do both laboratory experiments and field studies, doing both is the preferred method of assessing ecological impacts. Trial Tr. 304 (Barnthouse).

476. The EAC has proposed studies to determine the effect of the Vermont Yankee discharge on outmigrating juvenile shad from Lower Vernon Pool. Vermont Yankee has not completed or undertaken these studies. Trial Tr. 869-70 (Cox).

477. The Marcy study demonstrates that a field study of the effects of thermal discharge on the behavior of juvenile shad is possible. Trial Tr. 311 (Barnthouse).

478. The Zydlewski and McCormick study shows that it is possible to conduct a laboratory experiment on juvenile shad. Trial Tr. 318 (Barnthouse).

479. It is possible to do a laboratory experiment on the effects of temperature on shad

- 72 -

energetics, analyzing increased oxygen consumption and respiration rate, and temperature effect on dissolved oxygen levels. Trial Tr. 316-17 (Barnthouse).

480. The distribution of a population of any fish species under field conditions will invariably be more restricted than what might be predicted from its thermal tolerance limits. This effect can be seen in a figure from Lessard and Hayes (2003) (fig. 14). D. McCullough Prefiled, at 24-25.

481. A population can achieve its greatest survival and growth rate in the stream zone where it finds its optimum growth temperatures. D. McCullough Prefiled, at 24-25.

482. As maximum daily temperatures increase above the optimum growth range, the population density continues to decline until density reaches zero. The point in a downstream direction where the population's distribution terminates is typically at a temperature less than the UUILT. D. McCullough Prefiled, at 24-25 & figs. 7-8.

483. A population's distribution limit can be reached well before it reaches a maximum daily temperature that produces acute effects that kill it. The chronic effects, such as inability to effectively compete for food, lethargy, increased susceptibility to predation, inability to defend territory, increased disease incidence, etc. cause a species to be displaced or suffer unsupportable mortalities. D. McCullough Prefiled, at 25

### K. <u>Chronic Effects</u>

484. Entergy has not investigated the impacts to adult and juvenile shad from chronic exposure to sub-lethal temperatures. D. McCullough Prefiled, at 33.

485. "It is not possible to claim no prior harm when chronic effects of thermal discharges were never examined." D. McCullough Rebuttal, at 7.

486. A chronic temperature criterion is needed because the temperature increase in the Connecticut River downstream of the Vermont Yankee facility produces an extended exposure.

- 73 -

D. McCullough Prefiled, at 34.

487. The 2004 Demonstration reports that 70°F is the indicator temperature value for optimum growth. Jt. Ex. 3, 2004 Demonstration, at 163.

488. The 2004 Demonstration relied on Connecticut Yankee shad studies for thermal effects data. Trial Tr. 454 (Mattson).

489. In direct testimony, Dr. Barnthouse stated: "I would expect the behavior of juvenile American shad in the vicinity of the Vermont Yankee plume to be very similar to the behavior in the vicinity of the Connecticut Yankee plume. And it is the exact same fish, the same species. The plumes both come from nuclear power plants. I presume they have similar thermal characteristics. I would not expect to see a very different result." Trial Tr. 313 (Barnthouse); R. Jones Rebuttal, at 24.

490. The natural and human-caused river conditions at Connecticut Yankee and Vermont Yankee are not similar. R. Jones Rebuttal, at 24.

491. Dr. Barnthouse's statement that shad found near the two plumes are the "exact same fish" is a key biological unknown for the Connecticut River shad population. R. Jones Rebuttal, at 24.

492. It is well known that there are genetic differences among shad populations for a range of life-history characteristics that make them adapted to specific environmental conditions.R. Jones Rebuttal, at 24 (citing CRWC Ex. 25, Leggett (2004), at 392).

493. Such differences include river-specific homing behavior, the frequency of repeat spawners, migration energetics, and fecundity. There is also evidence of genetic differentiation among shad within a river for such traits as early versus late spawners. R. Jones Rebuttal, at 24-25 (citing Limburg, 1996).

494. Shad found in Turners Falls and Vernon Pools may not be the "same exact fish" as those that spawn downstream, meaning that they may have evolved distinct biological adaptations for longer migrations, as well as for spawning and development in the different environmental conditions historically experienced in these more upstream areas. R. Jones Rebuttal, at 25.

495. The 2004 Demonstration does not consider these physiological differences. SeeR. Jones Rebuttal, at 24-25.

496. Most of the eighty technical bulletins prepared between 1984 and 2003 provide no results of studies on the effects of increasing water temperature on the physiology or behavior of shad. R. Jones Prefiled, at 11 (citing Analytical Bulletins listed in Jt. Ex 3, 2004 Demonstration, at app. 1 (Jt. Exs. 125-204, Analytical Bulletins #1-80)).

497. \* Six of the Analytical Bulletins provide information on the results of a study between 1990 to 1995 of female maturity and extent of spawning. These reports may provide evidence of an adverse effect of thermal discharge on the spawning success of American shad in upstream of Turners Falls. R. Jones Prefiled, at 11.

498. The only other study of the physiology of shad conducted by Vermont Yankee, since 1991, was a preliminary two-year study in 1991 and 1992 (before the start of the decline in the shad population) that estimated the variation in energetics among American shad in Vernon Pool and Turner Falls Pool. R. Jones Prefiled, at 11-12

499. This preliminary study had a high degree of experimental error and could not detect anything less than a 20% difference in energy content between females in the Vernon pool and the Turners Falls pool. R. Jones Prefiled, at 12.

500. None of studies analyzed the variation in physiology as a function of water

temperature. R. Jones Prefiled, at 12.

501. The record shows no studies of the energetics of American shad conducted since 1992, nor any studies of the sexual maturity of females since 1995 – both prior to the beginning of the most dramatic declines in the American shad population. R. Jones Prefiled, at 12.

502. If shad are exposed to a river environment that has been cumulatively warmed and where there are few options for retreat to more healthy temperatures upstream, the shad may be able to escape temperatures that would be lethal with brief exposures, but they would not be able to retreat to temperature regimes with no harmful chronic effects. D. McCullough Prefiled, at 33.

503. If shad are exposed to a river environment that has been cumulatively warmed and where there are few options for retreat to more healthy temperatures upstream, the shad may be able to escape temperatures that would be lethal with brief exposures, but they would not be able to retreat to temperature regimes with no harmful chronic effects. D. McCullough Prefiled, at 33.

504. Genetic studies of shad spawning upstream and downstream in the Connecticut River, in addition to detailed ecological and physiological studies of the short-term and long-term effects of the water temperatures, and the interaction of temperature with other environmental factors such as food and water flow, are needed to determine the possible evolutionary and genetic impact of Vermont Yankee's thermal discharge on shad. R. Jones Prefiled, at 9.

505. Similar studies should also be conducted for other native fish species that are either in decline or, as is the case with the Atlantic salmon, have failed to be restored. R. Jones Prefiled, at 9. Recovery of Atlantic salmon, for instance, depends on reducing the array of sources of thermal impacts, together with addressing other linked key habitat elements such as

- 76 -

dissolved oxygen and sediment substrate quality. D. McCullough Prefiled, at 10.

506. Relying on UILT is not a reliable means for determining how a species will adapt to temperature increases. Trial Tr. 1142 (McCullough).

507. \* The studies used by Entergy are not the standard UILT (upper incipient lethal temperature) methodology commonly accepted for estimating the high range of temperature to which a species should be exposed. R. Jones Prefiled, at 14.

508. The 2004 Demonstration states that the typical range in temperature of the heated effluent during the warmer summer months is approximately 80 to 90°F, with a very infrequent worst-case maximum of about 100°F. R. Jones Prefiled, at 14; Jt. Ex. 3, 2004 Demonstration, at 11.

509. \* The claim that water temperatures in Lower Vernon Pool never exceed 90.5°F (Barnthouse Affidavit, ¶ 27) is contradicted by this statement. R. Jones Prefiled, at 14

# VII. ADVERSE EFFECTS ON LIFE STAGES OF ATLANTIC SALMON

510. Atlantic salmon ("Atlantic salmon" or "salmon") is an anadramous species native to the Connecticut River. Jt. Ex. 3, 2004 Demonstration, at 8.

511. Salmon is a migratory species. Trial Tr. 426 (Mattson).

512. Atlantic salmon is a coldwater species. Trial Tr. 429 (Mattson); Trial Tr. 833

(Cox); D. McCullough Prefiled, at 7; D. McCullough Rebuttal, at 2-3.

513. The Connecticut River watershed is historic habitat for Atlantic salmon. D. McCullough Prefiled, at 2.

514. Salmon is one of the RIS, and the subject of a major restoration effort under the same program for shad as described above. Trial Tr. 422-24 (Mattson)

515. As with shad, restoration of Atlantic salmon is a high priority for states and the

federal government. Jt. Ex. 249, Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River (July 1, 1998), at 1.

516. As part of this restoration effort, salmon are introduced into the Connecticut River from the Penobscot River. Trial Tr. 223 (Coutant).

517. These fish are adapted to a cooler temperature regime than the Connecticut River. Trial Tr. 223 (Coutant); Trial Tr. 833 (Cox).

518. The Connecticut River is at the southern limit of the Atlantic salmon range. Trial Tr. 224 (Coutant).

519. Atlantic salmon enter the Connecticut River at about the same time as shad, around April 1. Trial Tr. 871 (Cox).

520. The Connecticut River mainstem provides rearing habitat for juvenile salmon.Trial Tr. 833-34 (Cox); D. McCullough Prefiled, at 15; D. McCullough Rebuttal, at 7.

521. Dr. McCullough concludes that if it were not for cumulative effects of river heating and dam effects, it is likely that the mainstem habitat suitable for Atlantic salmon rearing would also expand. D. McCullough Prefiled, at 15; Trial Tr. 1244-45 (McCullough).

522. When salmon are forced to inhabit waters with high average or maximum temperatures (i.e., temperatures between the level resulting in low growth and those that begin to kill fish directly), loading stresses accumulate. D. McCullough Prefiled, at 21.

523. Swanson's model simulates temperatures that exceed preferred spawning temperatures for adult salmon in Lower Vernon Pool. R. Jones Prefiled, at 11; Jt. Ex. 4, Swanson Model, at 25, 65-72.

524. Because actual temperatures are not monitored, they may be higher than simulated temperatures. R. Jones Prefiled, at 11; Jt. Ex. 4, Swanson Model, at 25, 65-72.

525. As more energy is diverted to respiration at higher temperatures, less is available for growth and other necessary functions (including gamete development, swimming, predator avoidance, disease resistance, recovery, and healing). D. McCullough Prefiled, at 21.

526. The 2004 Demonstration has no evaluation of effect of temperature on gamete viability for Atlantic salmon. Trial Tr. 1141 (McCullough).

527. When insufficient energy is available for important body processes, mortality may occur from accumulated stress, or else poor gamete production and viability can cause poor reproduction success in the next generation. D. McCullough Prefiled, at 21.

528. As indicated by the Kitchell study (1977), as river temperatures increase, the amount of suitable habitat for salmonids decreases. Trial Tr. 1114 (McCullough).

529. \* The concern over the potential adverse impact of Vermont Yankee's thermal discharge on salmon is shared by many and is a concern recently raised by the U.S. Department of Interior when it stated that, "Vermont Yankee's thermal effluent and the locations of the discharge within the Vernon impoundment could contribute significantly to the cumulative impact on Atlantic salmon smolts migrating from upstream tributaries." R. Jones Prefiled, at 15-16 (citing attachment 1 thereto, Ltr. from A. Raddant to M. Lesar (Mar. 6, 2007)).

530. The avoidance temperature for Atlantic salmon is 78°F, and the 2004 Demonstration states that the avoidance temperature for Atlantic salmon as 78°F under its "temperature selection rationale." Jt. Ex. 3, 2004 Demonstration, at app. 2, A2-3; see also D. McCullough Rebuttal, at 12.

531. Under the proposed permit amendment, Entergy would be allowed to further increase the temperature by a maximum of 2°F at Station 3 if Station 7 is measured at above 78°F. Jt. Ex. 1, 2006 Amended Discharge Permit, at 5; ANR Ex. 7, Draft Amended NPDES Permit Fact

- 79 -

Sheet (Oct. 2005), at 3; ANR Ex. 9, Draft Amended NPDES Permit Fact Sheet (revised Mar. 2006), at 2-3.

532. A temperature range above 78°F is above the avoidance temperature for adult salmon attempting to migrate above Vernon Dam. Jt. Ex. 3, 2004 Demonstration, at app. 2, A2-3; see also D. McCullough Rebuttal, at 12-13.

533. Water temperature above 73.4°F inhibits spawning migrations. D. McCullough Prefiled, at 22 (citing Elson, 1969; DeCola, 1970; Danie, 1984; Hawkins, 1989; Shepard, 1995; Fay, 2006).

534. In terms of fecundity, viability of Atlantic salmon eggs will decrease in the prespawning stages if females are subject to high temperatures. D. McCullough Prefiled, at 16.

535. Roughly 70% of the spawning habitat for the Atlantic salmon lies above Vernon Dam. Trial Tr. 871-72 (Cox).

536. Exposing eggs to upper limit incubation temperatures would either tend to kill the eggs from heat stress or disease or cause early emergence, which could lead to poor survival in juvenile stages. D. McCullough Prefiled, at 35.

537. The smolt is a key life stage of the Atlantic salmon. Trial Tr. 872 (Cox).

538. \* There is evidence that the existing discharge may have caused appreciate harm to salmon smolts in Vernon Pool and further studies must be conduct before any determination can be made with regard to Entergy's request for a further temperature increase. R. Jones Prefiled, at 4.

539. The smoltification process in Atlantic salmon is generally similar to the process for shad. Since they spend a significant portion of their life cycle out at sea, and are hatched and reared in a freshwater environment, smolts have to be able to make that change to allow them to

- 80 -

osmoregulate once they get into the ocean. Trial Tr. 872 (Cox).

540. De-smoltification operates like a biological clock, where if the salmon smolts do not leave at a certain time the process starts to reverse itself. Trial Tr. 873 (Cox).

541. Temperature has an impact on the smoltification process. Trial Tr. 872-73 (Cox).

542. De-smoltification of Atlantic salmon smolts has been observed in the Connecticut River during the latter portion of their run due to increasing water temperatures. Loss of smolt characteristics makes smolts more vulnerable to osmotic stress in the estuary, which makes smolts more vulnerable to predation. D. McCullough Rebuttal, at 14.

543. The revised starting date of June 15 for the Summer Period does not fully protect outmigrating smolts from effects of thermal loading. D. McCullough Prefiled, at 14.

544. That date also still impairs adults. As explained by Dr. McCullough, adults migrating during the early to late summer must be able to avoid disease, recuperate after spawning to be able to spawn in the future, and not succumb to the extreme bioenergetic stress of migration under high temperature conditions. D. McCullough Rebuttal, at 6.

545. Temperatures above 68°F are known to enhance the incidence of warmwater diseases that can lead to mortality of the juveniles or adults. D. McCullough Rebuttal, at 15.

546. It is known from numerous studies that adults are more temperature sensitive than juveniles. That is, UILTs for adults would be lower than those for juveniles. D. McCullough Rebuttal, at 15.

547. Dr. Coutant, Entergy's fisheries biologist, testified to the Atlantic salmon based on his Pacific salmon experience. Trial Tr. 159 (Coutant).

548. The optimum growth temperature for juvenile Atlantic salmon has been reported as 59°F to 66.2°F. D. McCullough Prefiled, at 12-13; D. McCullough Rebuttal, at 13; see also Jt.

- 81 -

Ex. 3, 2004 Demonstration, at app. 2, A2-3 (listing optimum temperature for Atlantic salmon juvenile growth as 59°F to 66°F).

549. These temperatures are exceeded during the latter part of the salmon smolt migration. D. McCullough Rebuttal, at 13.

550. Under existing permit conditions, Vermont Yankee is already approved to exceed growth temperatures. D. McCullough Rebuttal, at 13; see also ANR Ex. 3, Discharge Permit No.3-1199 (beginning July 11, 2001), at 4-5.

551. As posed by Dr. McCullough, if ambient temperatures are 63°F, it appears that Vermont Yankee could make the temperature for entire river 67°F (by increasing temperatures by 3°F, and before May 16 by another 1°F). ANR Ex. 3, Discharge Permit No. 3-1199 (beginning July 11, 2001), at 4-5; D. McCullough Rebuttal, at 13.

552. This exceeds optimum growth temperature. D. McCullough Rebuttal, at 13.

553. Also, because temperatures continue to increase downstream given the heightened baseline created by Vermont Yankee, temperatures become even more adverse (elevated above optimum) downstream than they would have been without the Vermont Yankee discharge. D. McCullough Rebuttal, at 13.

554. Vermont Yankee's proposed discharge will likely also impair Atlantic salmon feeding. The Atlantic salmon feeding limit has been reported as approximately 78°F. D. McCullough Rebuttal, at 14 (citing Elliot, 1991).

555. 78°F is the threshold at which feeding ceases. Even below this temperature, feeding may not occur in an uninhibited manner. As mentioned, under the proposed discharge, this limit would be exceeded. D. McCullough Rebuttal, at 14.

556. Chronic and sub-lethal effects include reduced juvenile growth, increased

incidence of disease, reduced viability of gametes in adults prior to spawning, increased susceptibility to predation and competition, and suppressed or reversed smoltification. D. McCullough Prefiled, at 12 (68 Fed. Reg. 197, 58757-90 (Oct. 10, 2003).

557. Because Vermont Yankee's thermal discharge has the potential to impact rearing and spawning in the Connecticut River mainstem, further analysis of these impacts is necessary.D. McCullough Prefiled, at 16.

558. According to the meeting minutes of CRASC from June 26, 1997, "[t]he 1996 run lasted from April 23 to August 7, with three additional salmon captured or observed in October."
D. McCullough Rebuttal (Aug. 7, 2007), at 14 (citing CRASC, <u>Minutes of Meeting</u> (June 26, 1997), available at http://www.fws.gov/R5CRc/crasc\_minutes\_06261997.pdf, last visited Oct. 5, 2007.

559. The window of smolt outmigration period identified by CRASC is roughly April 1 to June 15, though the June 15 date is not exact and depends on where the smolt are coming from within the tributaries. Trial Tr. 874 (Cox).

560. If adult salmon migration extends into August in the Connecticut River, and the avoidance temperatures listed in the 2004 Demonstration are as low as 78°F for Atlantic salmon and the UILT is 82°F, the existing thermal discharges pose risks for migrating juveniles during the summer period. D. McCullough Rebuttal (Aug. 7, 2007), at 14.

561. Additionally, migration timing for both anadromous adults and smolts is tightly coupled to the temperature regime set up in the migration pathways and natal habitats.

562. Progressive temperature increases that cause late summer and fall temperatures to remain high longer and spring temperatures to become elevated earlier cause both delayed spawning for fall spawners and necessitate earlier downstream migration to avoid rising late

- 83 -

spring temperatures. D. McCullough Prefiled, at 22.

563. Altered ocean entry dates can interfere with timing of food availability and proper early temperature needs in the estuary and offshore environment. D. McCullough Prefiled, at 22.

## VIII. THE TURNERS FALLS DAM PASSAGE HYPOTHESIS

564. Drs. Barnthouse and Mattson pose hypotheses for causes of shad decline with respect to Turners Falls Dam. Ent. Ex. 4., L. Barnthouse Aff., at ¶¶ 69-76; and Ent. Ex. 3, M. Mattson Aff., at ¶¶ 43-49.

565. The rate of decrease in the adult shad population in Turners and Vernon Pools is at least 10 times greater than that at Holyoke and below. R. Jones Prefiled, at 11.

566. There is no evidence that changes in facilities at Turners Falls Dam between 1991 and 2002 are responsible for shad predation. R. Jones Rebuttal, at 20. This conclusion is further based on and supported by each of the following sources set forth below.

567. During the first three years of operation (between 1980 and 1982), the Turners Falls Dam facility was largely ineffective, passing fewer than 700 shad per year while at least 295,000 had passed Holyoke Dam. R. Jones Prefiled, at 3, 10, 18, 19-20 & fig. 1 (citing Timothy J. Sullivan, <u>Evaluation of the Turners Falls Fishway Complex and Potential Improvements for</u> <u>Passing Adult American Shad</u> ("Sullivan") (Feb. 2004), at 48-49).

568. In 1983, following modifications to Cabot and Spillway Fishways, passage numbers rose significantly.<sup>7</sup> R. Jones Prefiled, at 3, 10, 18, 19-20 & fig. 1 (citing Sullivan, 2004).

<sup>&</sup>lt;sup>7</sup> This modification is further explained in the Sullivan (2004) analysis: "Prior to the 1983 passage season, the fishway was modified to replace plunging flow with streaming flow conditions in an attempt to allow fish to orient correctly. This was done by0 increasing the water depth to a minimum of 14 inches over each weir-crest and blocking weir-crests on alternating sides of successive weirs. To help achieve streaming flow, the submerged orifices under each open weir-crest were also completely blocked, while the width of the submerged orifices under the blocked weircrests was reduced from 18 inches to 10 inches. This configuration resulted in a serpentine flow pattern with the main current moving diagonally across each pool." Sullivan (2004), at 48-49.

569. This configuration has not changed since 1983. R. Jones Prefiled, at 3, 10, 18 (citing Sullivan, 2004).

570. There is no evidence "of any changes in the structure or operation of this facility that would explain the decline." R. Jones Rebuttal, at 20.

571. Dr. Jones compared the shad runs over the period of time of 1983 to present. His

analysis is presented in his prefiled testimony. R. Jones Prefiled, at 3, 9-11, 18. He found that

"in the mid-1990s (approximately one shad generation after the Vermont Yankee began their

1991 summer discharge) the passage rates at Turners Falls began a dramatic decline." R. Jones

Prefiled, at 18.

572. Dr. Jones' conclusion is based in part on and supported by the opinions expressed

by the biologists at the Silvio O. Conte Anadromous Fish Research Laboratory in their July 2,

2007 letter. CRWC Ex. 26, Ltr. from S. Garabedien to D. Deen (July 2, 2007).

573. \* As noted by Dr. Jones, in this letter the biologists stated:

Although shad numbers have declined at both Turners Falls and at Holyoke, the proportion of American shad passed at Holyoke that proceed to pass Turners Falls underwent a decline in the mid-1990's. Until 1996, this proportion averaged about 5 percent (5.1%; range: 0.8% - 10.5%). In the 10 years beginning in 1997, however, the proportion passing Turners Falls has averaged less than 2 percent (1.8%; range: 0.6% - 3.6%). The probability of this difference in proportional returns arising by random chance is less than one percent (1%), thus it is highly likely that the observed decrease represents an actual change, and is not simply a result of natural variability. The shad counts at Holyoke are publicly available from the U.S. Fish and Wildlife Service Connecticut River Coordinator's Office.

. . .

We have . . . conducted extensive studies on this fishway complex from 1999 – 2005. During this period we worked closely with personnel of Northeast Utilities (now FirstLight Power Resources), the utility responsible for those operations. In the process of trying to improve passage at Turners Falls, we coordinated several changes to those configurations, none of which had a substantial effect on passage performance through the Turners Falls Fishway Complex. Given these results, and given that FirstLight staff have indicated that no other changes have occurred, it is unlikely that the reduction in passage at Turners Falls can be attributed to changes in configuration or operation of the passage facilities there.

R. Jones Rebuttal (pre-redaction), at 22-23, 25-26; CRWC Ex. 26, Ltr. from S. Garabedien to D. Deen (July 2, 2007), at Responses to Questions 2-3.

574. In his direct testimony, Dr. Mattson said he was not aware of changes made at Turners Falls Dam that could explain the decline in shad. Trial Tr. 567-71 (Mattson).

575. In his rebuttal testimony, Dr. Mattson said that he had become aware of operational changes at Turners Falls Dam that might have an impact on passage. M. Mattson Rebuttal, at 3-7.

576. Dr. Mattson admitted that there was no evidence that the operational changes had in fact affected passage, either positively or negatively. Trial Tr. 675-76 (Mattson).

577. In his rebuttal testimony, Dr. Mattson confirmed that shad counts indicate that "much more efficient passage occurred in the 1990's" and that there were no known changes at Turners Falls Dam during that decade that could account for the steep decline in shad returns over that period. Mattson Rebuttal, at 8.

578. As explained by Dr. Jones, the statements by Dr. Mattson that passage at Turners Falls Dam is the cause of the decline in the shad population is unfounded because there is "no evidence at all of any changes in the structure or operation of this facility that would explain the decline." R. Jones Rebuttal, at 20.

579. Such changes therefore cannot explain the further decline in American shad in Turners Fall Pool and Vernon Pool.

580. Studies of "sexual condition" of American shad females at Vernon Dam begun in

- 86 -

1997 – which seek to measure reproductive potential by applying pressure to the pelvic fins of caught adult shad and estimating the "quantity and appearance of the milt or eggs extruded" (see Analytical Bulletin #70) – employ a subjective approach to estimating reproductive potential and lack analysis of which environmental factors. R. Jones Rebuttal, at 18.

581. The sex ratio information for shad from the late 1980s through the early 1990s shows a heavy skew towards males reaching the Vernon Dam. Trial Tr. 842-43 (Cox). This correlates with the fact that there has been a decline in the number of juvenile American shad in Vernon Pool and upper Turners Falls Pool. Trial Tr. 459, 20-23 (Mattson).

582. The most dramatic declines in the American shad population in this region began after 1995. D. McCullough Rebuttal, at 5. From 1990 to 1992, the number of shad counted passing upstream at Turners Falls Dam increases. Trial Tr. 1226, 1332 (Jones).

583. As demonstrated in the tables presented by Drs. Jones and Mattson (Tables 1 and 2 in the section with respect to American shad), significant shad declines have occurred after 1995, five years after Vermont Yankee's increased thermal discharge.

584. As further set forth in the requests for findings with respect to American shad specifically, the principle of bioenergetics means that as water temperature increases, more energy must be expended. Trial Tr. 839-40 (Cox). Further, the longer that the shad are delayed at Turners Falls Dam, the more energy that they will have to expend. Trial Tr. 839-40 (Cox).

585. Neither Entergy nor ANR considered the effect that the proposed discharge might have on fish passage at Turners Falls Dam.

586. While Mr. Cox was aware of data indicating the additional stress or energetic cost to shad in their ability to negotiate the particular design of the ladder at Turners Falls Dam. Trial Tr. 854 (Cox).

- 87 -

587. ANR has not made any determination about the extent to which water temperature is a factor in fish passage at Turners Falls. As stated by Mr. Cox, that "might" be determined in "whatever" investigations may be undertaken in the future. Trial Tr. 854 (Cox).

588. Mr. Cox testified that investigation of passage patterns at Turners Fall Dam is warranted. Trial Tr. 953-54 (Cox).

589. Passage problems for shad at Turners Falls Dam is a confounding variable. Trial Tr. 852 (Cox). Further investigation may determine a need for both improved passage and lower temperatures. Trial Tr. 854 (Cox).

590. However, ANR did "not specifically or directly" evaluate the potential effect of Vermont Yankee's thermal discharge on upstream migration of shad in lower Turners Pool. Trial Tr. 846 (Cox).

#### IX. <u>THE STRIPED BASS PREDATION HYPOTHESIS</u>

591. Dr. Barnthouse testified that he believed that striped bass predation was "a potential factor in the shad decline, but perhaps not established as a more likely than not principle." See Trial Tr. 354 (Barnthouse).

592. Entergy has not shown that striped bass predation is a significant cause of decline in the American shad population in the Connecticut River. R. Jones Prefiled, at 17.

593. Striped bass are in the Connecticut River in the spring. Juvenile shad are there in the fall. CRWC Ex. 25, Savoy and Crecco (2004), at 365; R. Jones Rebuttal, at 26-27.

594. Thus, most striped bass are not found in the Connecticut River when juveniles are present, and (as further set forth below) statistical evidence of striped bass predation on juveniles is weak. CRWC Ex. 25, Savoy and Crecco (2004), at 369-70; R. Jones Prefiled, at 17.

595. The Davis study (2007) cited by Dr. Barnthouse does not support his opinion that

striped bass predation may be a factor in American shad population in Vernon Pool. L.

Barnthouse Prefiled, at 50 (citing Davis, 2007); R. Jones Rebuttal, at 26.

596. The Davis study (2007) supports Dr. Jones' opinion that striped bass predation is not a significant cause of juvenile shad mortality in the Connecticut River. R. Jones Prefiled, at 12.

597. This study confirms the opinion of Dr. Jones that most striped bass are too small to prey upon American shad and that the actual amount of predation is not significant enough to account for the decline in the shad returns to Vernon Dam recorded in the mid-1990s. R. Jones Rebuttal, at 26.

598. In the study, Davis et al. collected 457 striped bass, ranging in size from less than 30 cm to over 100 cm and examined stomach content of many of these. R. Jones Rebuttal, at 26 (discussing Davis, 2007).

599. Results from their study showed:

- Only 7% of the sampled striped bass were greater than 90 cm. R. Jones Rebuttal, at 26 (discussing Davis, 2007, at tbl. 6).
- American shad carcasses were only found in striped bass greater than 90 cm long. R. Jones Rebuttal, at 26 (discussing Davis, 2007, at tbl. 15-16).
- Only 3% of all striped bass collected (and 6% with non-empty stomachs) were found with an American shad carcass in their stomach. R. Jones Rebuttal, at 26.
- While some (greater than 50 cm long) were found with "shad remnants" in their stomachs (e.g., digested scales, bones), it is not known whether the individual striped bass actually killed and ate a shad, or only ate the remnants from a larger striped bass' prey. R. Jones Rebuttal, at 26 (discussing Davis, 2007, at fig. 19).
- These "shad remnants" also accounted for only between 4.3% and 8.3% of the food mass found in the stomachs of striped bass between 50 and 90 cm long. R. Jones Rebuttal, at 26 (citing Davis, 2007, at fig. 19).
- 600. The conclusions of Drs. Mattson and Barnthouse that striped bass predation may

be a cause of the decline in adult shad abundance above Vernon Dam also relies on the study by Savoy and Crecco (2004). Ent. Ex. 4, L. Barnthouse Aff., at ¶¶ 56-68; M. Mattson Aff., at ¶¶ 50-57; R. Jones Prefiled, at 16.

601. That study did not measure the predation rate of striped bass on American shad.R. Jones Prefiled, at 17.

602. The Savoy and Crecco study (2004) showed only a statistical correlation between a growing striped bass population in Long Island Sound and the lower Connecticut River and a declining American shad population in the lower Connecticut River. R. Jones Prefiled, at 16-17. It does not establish a cause-effect relationship between these two trends. R. Jones Rebuttal, at 26-27.

603. Other scientific studies indicate that adult shad are too large to be preyed upon by most striped bass. R. Jones Prefiled, at 17 (citing Hartman, 2000).

604. For example, the diet of striped bass near the mouth of the Connecticut River consists mainly of fish smaller than adult shad. R. Jones Prefiled, at 17 (citing Nelson, 2003).

605. Another study, by Bilkovic (2002) and conducted in the Mattaponi and Pamunkey Rivers of Virginia, failed to demonstrate American shad in the diets of striped bass. D. McCullough Prefiled, at 24 (Bilkovic, 2002).

606. Additionally, Entergy has not presented any evidence to suggest that there is a large enough population of striped basis upstream of Holyoke Dam to have a significant effect on the population of adult American shad upstream of Holyoke. See also R. Jones Prefiled, at 17.

607. Increased energetic costs of swimming means less energy for other activities, which includes avoiding predators, and results in increased stress in spawning. R. Jones Prefiled, at 8.

- 90 -

608. The striped bass population upstream of Holyoke Dam is too small to explain the

fact that the shad population upstream of Holyoke is decreasing at a much faster rate than the

population downstream of Holyoke. R. Jones Rebuttal, at 27.

609. \* This fact is made clear in the letter from the Conte Lab fish biologists:

We are not aware of any data that would suggest that striped bass predation could have caused the decline of shad passage at Turners Falls fishways. Although the population of striped bass in the Connecticut River has increased over the period that populations of shad have been declining, there is no evidence to suggest that this would or could affect the proportion of shad passed at Holyoke that continue on to pass at Turners Falls. This is true principally because very few striped bass are lifted past Holyoke. The average number of striped bass lifted above Holyoke over the past 10 years is 631. By comparison, the number of shad lifted has averaged 242,181. Moreover, most of the striped bass that pass the Holyoke dam are too small to prey on adult American shad. Thus, if striped bass are affecting passage at Turners Falls, this effect is almost certainly occurring below Holyoke dam, and we know of no data that suggest this may be so.

R. Jones Rebuttal (pre-redaction), at 30-31; CRWC Ex. 26, Conte Letter, at Response to

Question 4.

610. The 2004 Demonstration notes only six striped bass passing Vernon Dam (five in

1999, and one in 2001). Jt. Ex. 3, 2004 Demonstration; R. Jones Prefiled, at 17.

611. Dr. Barnthouse acknowledged that striped bass predation is "primarily limited to

below Holyoke Dam." Trial Tr. 352 (Barnthouse).

612. He did not present any evidence showing that striped bass predation would be

more intense above Turners Falls Dam than below. See D. McCullough Prefiled, at 32.

613. Absent a significant population of striped bass above Holyoke, it is not reasonable to assume that predation is a contributing cause in the shad decline that occurred over the 1990s.R. Jones Prefiled, at 17.

### X. <u>VERMONT WATER QUALITY STANDARDS</u>

614. ANR believes "that all the Water Quality Standards do apply to this permit." Trial Tr. 792 (Burnham). Dr. Burnham testified: "In my opinion the aquatic life use criteria and the thermal criteria and the Vermont Water Quality Standards are substantially the critical ones in this case." Trial Tr. 792 (Burnham).

615. ANR considers the Connecticut River to be a "High Quality Water." Jt. Ex. 89, Ltr. from C. Gjessing to E. Zoli (July 11, 2005); Jt. Ex. 1, 2006 Amended Discharge Permit, at 8; Jt. Ex. 110, ANR Responsiveness Summary, at 11-12.

616. Section 1-01(B)(19) defines "full support of uses" as "the achievement of the level of water quality necessary to consistently maintain and protect existing and designated uses."

617. The proposed discharge will not meet the requirements of Section 1-01(B).

618. Section 1-03(A) states that "all waters shall be managed in accordance with these rules to protect, maintain, and improve water quality."

619. The proposed discharge will not meet the requirements of Section 1-03(A).

620. Section 1-01(B)(18) defines "existing use" as "a use which has actually occurred on or after November 28, 1975, in or on waters, whether or not the use is included in the standard for classification of the waters, and whether or not the use is presently occurring."

621. Brook trout have been observed in the Connecticut River after November 1975.D. McCullough Prefiled, at 7, 27; R. Jones Prefiled, at 15; Trial Tr. 1037 (Deen); Trial Tr. 1176 (McCullough).

622. They are an "existing use" within the meaning of Section 1-01(B)(18). See alsoR. Jones Prefiled, at 15.

623. The RIS used in the 2004 Demonstration did not include the brook trout. Jt. Ex.3, 2004 Demonstration, at 10; see also Trial Tr. 512 (Mattson).

624. Section 1-03(B) states that "existing uses of waters and the level of water quality necessary to protect those existing uses shall be maintained and protected." Section 1-03(B) also lists factors that must be considered to determine what "existing uses" to protect.

625. The proposed discharge will not meet the requirements of Section 1-03(B).

626. Section 1-01(B)(28) defines a "mixing zone" as "a length or area within the waters of the state required for the dispersion and dilution of waste discharges adequately treated to meet federal and state treatment requirements and within which it is recognized that specific water uses or water quality criteria associated with the assigned classification for such waters may not be realized."

627. Section 2-04(A)(1) requires that a mixing zone "shall not exceed 200 feet from the point of discharge."

628. Section 2-04(A)(2) lists the permit conditions required to allow discharge of waste within a mixing zone and requires that the Secretary of ANR "shall insure that conditions due to discharges of waste within any mixing zone shall":

- "Not constitute a barrier to the passage or movement of fish or prevent the full support of aquatic biota, wildlife, and aquatic habitat uses in the receiving waters outside the mixing zone" (subparagraph (b));
- "Not kill organisms passing through the mixing zone" (subparagraph (c)); and
- "Protect and maintain the existing uses of the waters" (subparagraph (d)).

629. The proposed discharge will not meet the requirements of Section 2-04(A).

630. Section 3-04(A) further provides that full support of the "aquatic biota" requires

that "high quality aquatic habitat" be "sustained."

631. The proposed discharge will not meet the requirements of Section 3-04(A).

632. Section 3-01(B)(1)(b) provides that "the total increase from the ambient temperature due to all discharges and activities shall not exceed 1.0°F except as provided for" in Section 3-01(B)(1)(d). See also Trial Tr. 788 (Burnham).

633. The proposed discharge does not meet the requirements of Section 3-01(B)(1)(b).

634. Section 3-01(B)(1)(d) provides for alternative permit conditions for thermal discharges which vary from the temperature criteria in Section 3-01(B)(1)(b). See also Trial Tr.

788 (Burnham).

635. The proposed discharge does not meet the requirements of Section 3-01(B)(1)(d) for an alternative temperature limit.

Dated: October 9, 2007 South Royalton, Vermont Respectfully submitted,

ENVIRONMENTAL AND NATURAL RESOURCES LAW CLINIC

By:

Patrick A. Parenteau, Esq. David K. Mears, Esq. Benjamin Rajotte, Esq. (admission pending) Environmental and Natural Resources Law Clinic Vermont Law School PO Box 96 South Royalton, VT 05068 (802) 831-1630

Attorneys for Appellants Connecticut River Watershed Council Trout Unlimited (Deerfield/Millers 349 Chapter) Citizens Awareness Network (Massachusetts Chapter)

# APPENDIX

Appellants respectfully submit this appendix and table below, which corresponds to those requests for findings above that are indicated by an asterisk at the start of the paragraph.

For the most part, this table reflects the Court's rulings of August 20, 2007 on Entergy's objections to Appellants' prefiled rebuttal testimony. For the Court's convenience, Appellants have sought to strikeout text corresponding to the portions stricken by the Court.

CRWC respectfully submits this testimony and evidence, to be considered as part of the Court's findings, on the grounds that its witnesses had foundation and qualification, and testified on matters that were relevant and within the scope of the issues and their expertise, and that the evidence does not constitute hearsay.

With respect to the Conte Letter, Appellants understand the Court's ruling that the Conte Letter itself is inadmissible, but has allowed Dr. Jones to rely on it in support of his opinions. Appellants respectfully proffer it as evidence that should be part of the record.

Appellants take exception to rulings striking this testimony and evidence, such as the Conte Letter referenced in requests for findings, for purposes of appeal should they not be considered as part of the Court's findings. This is submitted without prejudice to Appellants' rights, claims, and defenses.

This table is also provided for the convenience of the Court in consideration of Appellants' requests for findings, in order to more easily identify the Court's prior rulings.

# **Evidence / Testimony**

Because Vermont Yankee discharges large volumes of hot water during the winter, the bass populations far downstream of Vermont Yankee are not impacted by the normal cold winter conditions that would limit their abundances. D. McCullough Rebuttal (pre-redaction), at 3.

Dr. Jones relies on the July 2, 2007 letter from the U.S. Geological Survey Silvio O. Conte Anadromous Fish Research Laboratory in part for the need for further study. The letter, written by two fish biologists who specialize in the study of anadromous species (particularly American shad) in the Connecticut River states: The most important information with which to address thermal effects on any of the Connecticut River flora or fauna is the extent of the thermal influence of the plant. The further downstream this influence extends, the more opportunities to affect the river's ecology. R. Jones Rebuttal (pre-redaction), at 6-7; CRWC Ex. 26, Ltr. from S Garabedien to D. Deen (July 2, 2007), at Response to Question 12.

When data is not available from the specific portion of the river system or even from the broader river system, Mattson turns to a second tier of studies from anywhere in the region and, if necessary, anywhere in the species' geographic range. R. Jones Rebuttal

(pre-redaction), at 7; Trial Tr. 432 (Mattson).

Dr. Barnthouse based his opinions on the assumption that the thermal plume does not extend downstream. Ent. Ex. 4, L. Barnthouse Aff., at ¶ 42; D. McCullough Prefiled, at 32.

Without knowing this, we cannot know how much the Vermont Yankee discharge is contributing to the ecosystem shift described above. R. Jones Prefiled, at 6.

The 2004 Demonstration does not evaluate the cumulative impact of continuous discharges on the Connecticut River BIP and RIS. Entergy does not take into account the consequences of the temperature increases it has already been granted during the summer. Entergy does not take into account the likely problems caused by winter temperature increases that undoubtedly do affect spawning success, simply because the proposed new increase is devoted to summertime. D. McCullough Prefiled, at 36.

Dr. Jones agrees with a letter from the U.S. Department of Interior that stated "[e]ven if the impact was SMALL, the fact that the resource . . . is declining argues strongly for mitigation measures. In this instance, the obvious mitigation would be to require [Vermont Yankee] to operate in closed-cycle mode year-round, which would greatly reduce impacts associated with impingement, entrainment and thermal effluent." R. Jones Prefiled, at 4-5 (discussing Ltr. to M. Lesar from A. Raddant in response to NRC dSEIS (Mar. 6, 2007)).

The majority of the world's experts on climatology predict significant warming of the earth's atmosphere due to greenhouse gas emissions. Projections for future water temperature conditions are tightly coupled with future climatic patterns. NASA published a study in the April 2007 issue of the American Meteorological Society's Journal of Climate, based upon use of the general circulation model employed by the Intergovernmental Panel on Climate Change (IPCC) showing that New England can expect summer temperatures by 2080 to average summer highs of 37.8-43.3°C (100-110°F) unless carbon dioxide (CO<sub>2</sub>) levels are stabilized. This study indicated that summer high temperatures would be accompanied by drought conditions. D. McCullough Prefiled, at 25 (citing Armando Duke, <u>NASA Forecasts Hotter Summers for East Coast</u>, at http://www.axcessnews.com/user.php/articles/print/id/10963, last visited Oct. 5, 2007).

In 1989 Connecticut's state climatologist predicted that air temperatures in the state would increase by 5.4°F by 2050. D. McCullough Prefiled, at 25 (citing Miller, 1989).

High water temperature and reduced river flows caused by this predicted drought tend to be coupled. Increased periods of drought that do occur even periodically can have population effects that last for years. D. McCullough Prefiled, at 26 (citing Rob Neumann, Dep't of Nat. Resources Mgmt. and Engineering, Univ. of Conn., <u>Impacts of</u> <u>Drought on Fish</u>, available at http://www.ctiwr.uconn.edu/DroughtArticles/Neumann.htm, last visited Oct. 5, 2007).

Populations do not rebound in the mechanistic manner implied by Barnthouse's simplistic

risk assessment model. D. McCullough Prefiled, at 26; Ent. Ex. 4, L. Barnthouse Aff.

The State of Connecticut has a drought preparedness plan (2003) due to the probability of drought conditions. D. McCullough Prefiled, at 26.

Decreased spawning in the Holyoke to Bellows Falls range of the Connecticut River (the "Upper Connecticut River") <del>conflicts with the stated goal of restoring the American shad population to its historic range as far as Bellows Falls</del>. R. Jones Prefiled, at 8.

Shad may have evolved to follow a migratory pattern that allows greater behavioral response to environmental fluctuations than salmon (which seem to rely more on the length of the day). This is possibly due to shad tending to spawn soon after entering the River while salmon spawn in far tributaries. This work points to the need to consider whether warming water temperature, in part due to Vermont Yankee's thermal discharge, is causing Connecticut River shad to migrate less and spawn earlier. R. Jones Prefiled, at 8.

Higher water temperature "increases the costs of doing business" for shad in the Connecticut River, especially for those attempting to reach Vernon Pool. R. Jones Prefiled, at 7 (citing Leonard, 1999).

Based this 99.3% decline of shad population over roughly a single decade, since Vermont Yankee increased its thermal discharge, Dr. Jones concluded that there has been more than "appreciable harm" to the American shad population in Vernon and Turners Pools that is not explained by any river wide decrease in the American shad population. R. Jones Prefiled, at 11.

It has been noticeable in recent years that the river near Turners Falls Dam does not freeze over at all. D. Deen Prefiled, at 9.

This is a probable reason for their relatively high rate of impingement on Vermont Yankee's water intake screens. R. Jones Rebuttal (pre-redaction), at 10.

This also means that it can all freshwater life stages of the American shad. R. Jones Rebuttal (pre-redaction), at 11.

To reach their conclusion that their thermal discharge is not a cause in the decline in the American shad population in and downstream of Vernon Pool, Entergy simply overlaps the results of their thermal modeling study with the literature values for American shad thermal tolerance. I have mentioned the inadequate nature of the thermal tolerance estimates above and will do so in more detail below when discussing Problem 3. R. Jones Prefiled, at 12.

Six of the Analytical Bulletins provide information on the results of a study between 1990 to 1995 of female maturity and extent of spawning. These reports may provide evidence of an adverse effect of thermal discharge on the spawning success of American shad in

upstream of Turners Falls. R. Jones Prefiled, at 11.

The studies used by Entergy are not the standard UILT (upper incipient lethal temperature) methodology commonly accepted for estimating the high range of temperature to which a species should be exposed. R. Jones Prefiled, at 14.

The claim that water temperatures in lower Vernon Pool never exceed  $90.5^{\circ}F$  (Barnthouse Affidavit,  $\P 27$ ) is contradicted by [paraphrasing Dr. Barnthouse without exact quotation, as here]. R. Jones Prefiled, at 14

The concern over the potential adverse impact of Vermont Yankee's thermal discharge on salmon is shared by many and is a concern recently raised by the U.S. Department of Interior when it stated that "Vermont Yankee's thermal effluent and the locations of the discharge within the Vernon impoundment could contribute significantly to the cumulative impact on Atlantic salmon smolts migrating from upstream tributaries." (March 2007 Letter of Interior Department to NRC). R. Jones Prefiled, at 15.

There is evidence that the existing discharge may have caused appreciate harm to salmon smolts in Vernon Pool and further studies must be conduct before any determination can be made with regard to Entergy's request for a further temperature increase. R. Jones Prefiled, at 4.

As noted by Dr. Jones, in this letter the biologists stated: Although shad numbers have declined at both Turners Falls and at Holyoke, the proportion of American shad passed at Holyoke that proceed to pass Turners Falls underwent a decline in the mid-1990's. Until 1996, this proportion averaged about 5 percent (5.1%; range: 0.8% – 10.5%). In the 10 years beginning in 1997, however, the proportion passing Turners Falls has averaged less than 2 percent (1.8%; range: 0.6% - 3.6%). The probability of this difference in proportional returns arising by random chance is less than one percent (1%), thus it is highly likely that the observed decrease represents an actual change, and is not simply a result of natural variability. The shad counts at Holyoke are publicly available from the U.S. Fish and Wildlife Service Connecticut River Coordinator's Office

<del>. . . .</del>

We have .... conducted extensive studies on this fishway complex from 1999 2005. During this period we worked closely with personnel of Northeast Utilities (now FirstLight Power Resources), the utility responsible for those operations. In the process of trying to improve passage at Turners Falls, we coordinated several changes to those configurations, none of which had a substantial effect on passage performance through the Turners Falls Fishway Complex. Given these results, and given that FirstLight staff have indicated that no other changes have occurred, it is unlikely that the reduction in passage at Turners Falls can be attributed to changes in configuration or operation of the passage facilities there.

R. Jones Rebuttal (pre-redaction), at 22-23, 25-26; CRWC Ex. 26, Ltr. from S Garabedien to D. Deen (July 2, 2007), at Responses to Questions 2-3.

This fact is made clear in the letter from the Conte Lab fish biologists:

We are not aware of any data that would suggest that striped bass predation could have caused the decline of shad passage at Turners Falls fishways. Although the population of striped bass in the Connecticut River has increased over the period that populations of shad have been declining, there is no evidence to suggest that this would or could affect the proportion of shad passed at Holyoke that continue on to pass at Turners Falls. This is true principally because very few striped bass are lifted past Holyoke. The average number of striped bass lifted above Holyoke over the past 10 years is 631. By comparison, the number of shad lifted has averaged 242,181. Moreover, most of the striped bass that pass the Holyoke dam are too small to prey on adult American shad. Thus, if striped bass are affecting passage at Turners Falls, this effect is almost certainly occurring below Holyoke dam, and we know of no data that suggest this may be so.

R. Jones Rebuttal (pre-redaction), at 30-31; CRWC Ex. 26, Conte Letter, at Response to Question 4.