United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial St, Suite 300
Concord, NH 03301-5087
http://www.fws.gov/newengland

In Reply Refer To: FERC Nos. 1892, 1855 and 1904
TransCanada Hydro Northeast Inc.
Connecticut River
COMMENTS ON STUDY REPORTS

July 14, 2016

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Dear Secretary Bose:

This responds to study reports filed by TransCanada Hydro Northeast Inc. (TC) on May 16, 2016 as part of the relicensing of the Wilder, Bellows Falls and Vernon projects, located on the Connecticut River in New Hampshire and Vermont. On June 1, 2016, TC held meetings to discuss the filed study reports with agencies and other interested parties. On June 14, 2016, TC submitted its study report meeting minutes to the Federal Energy Regulatory Commission (FERC). TC provided filed seven study reports with FERC. The U.S. Fish and Wildlife Service (Service) reviewed the study reports and meeting minutes and offers the following comments.

Study 17 Upstream Passage of Riverine Fish Species Study Report

Objectives of this study include: (1) identify the use by riverine and diadromous fish species and temporal distribution of upstream passage through the Wilder, Bellows Falls, and Vernon fish ladders; (2) monitor the operation of the ladders from ice-out to ice-in to assess ladder use; and (3) identify potential operating windows during the open-water period appropriate for riverine and diadromous fish passage.

EXECUTIVE SUMMARY

The dates of video recording at each Project are listed in the second paragraph but are later contradicted when each Project is discussed individually. Specifically, in the first paragraph Normandeau Associates, Inc. (Normandeau; consultant to TC) states that video recording at Wilder extended from April 15, 2015 to January 7, 2016." However, in the fourth paragraph Normandeau states "Fish passage was recorded throughout the monitoring period from May 12, 2015 through shutdown on January 7, 2016." Does one represent the set of dates over which video monitoring spanned and the other indicate the time period fish were actually observed? Normandeau should clarify this apparent discrepancy.

In the last paragraphs of the Executive Summary, Normandeau concludes that there is little benefit to operating the ladders for resident species due to low net upstream passage counts. The Service does not believe that net upstream passage is the only relevant metric to analyze. Assessing the total upstream and downstream counts puts the net counts into a more appropriate context. In addition, the ladders were designed for Atlantic salmon. Therefore, the ladders are not optimally designed for riverine species which could be one reason for the high number of counts in the downstream direction (i.e., these could represent fallback).

3.0 METHODOLOGY

3.2 Monitoring

Fish passage monitoring began as early as April 15, 2015 for all three sites, however white sucker and walleye move during early April through May. Therefore, at least a portion of the white sucker and walleye runs may have been missed in this study. While the intent of the study was to document species that may utilize the ladder during the early spring for spawning migrations, high flow precluded the Vernon ladder opening until May 5, 2015. However, in 2016 Vernon was opened on April 15, and the Vermont Fish and Wildlife Department (VTFWD) has data which may be able to fill in this data gap. The Service recommends that TC contact VTFWD to request its Salmonsoft files for the period April 15 through June 30, 2016. TC should review the files and document how many white sucker and walleye used the ladder during this period. This will provide an indication of what percentage of those runs may have been missed in 2015 as a result of the delayed start of monitoring at Vernon.

4.0 RESULTS AND DISCUSSION

4.1.1 Species Assemblage

On page 8 of the report, Normandeau states "The high number of both upstream and downstream movements relative to the net upstream passage count suggests milling in the counting window pool that resulted in multiple recordings of the same fish." However, since fish were not individually marked as part of this study, it is not known if the recordings were in fact the same fish. Therefore, we recommend removing this statement from the study report. While there may be some back and forth movement or milling about (particularly for certain species such as trout), quantifying this type of passage behavior on an individual basis would require an entirely different study design than what was used. Another plausible explanation could be that different individual fish are using the ladder to pass downstream than those that used it to move upstream.

Graphs displaying daily net upstream passage counts and cumulative passage with water temperature are provided for each Project. In addition to plotting cumulative passage by individual species, please plot cumulative passage for: (1) all species; (2) diadromous species; and (3) resident species in three separate plots.

4.1.3 Diel Periodicity

Daily periodicities of fish use of the Wilder, Bellows Falls, and Vernon fish ladders were plotted as the number of upstream and downstream movements and net upstream passage by hour of day for each species observed. Net upstream passage should not be displayed as a stacked bar chart on top of upstream movement counts, as the resultant graph could be misinterpreted (i.e., for Figure 4.1-10, the data could be interpreted that there was net upstream movement of two Atlantic salmon when in fact it was only a single salmon). Instead, TC should graph net upstream passage as a linear function on the existing graphs, maintaining upstream and downstream counts as well as hour of day.

4.1.4 Fish Passage and River Flows

Normandeau states that, when calculating the ratio of passage flow to station flow at Wilder, Unit 3 discharge was applied to passage and not generation because it serves as the fish passage system attraction flow. While we understand that Unit 3 flow should not be counted twice in the calculation, assigning it to fish passage flow results in a high ratio (average of 45 percent) which does not fully represent the dual role Unit 3 plays.

4.2.1 Species Assemblage

On page 23 of the report, Normandeau states "Similarly, in Study 16 (Sea Lamprey Spawning Assessment) although attempts were made to collect fish for tagging from the Bellows Falls fish ladder, abundances were insufficient to feasibly collect there, so all tagged specimens were collected from the Vernon fish ladder and released in the Bellows Falls impoundment having not used the Bellows Falls fish ladder." From this statement it is unclear if the lamprey collected from the Vernon fish ladder and subsequently placed in the Bellows Falls impoundment were included in the Vernon passage counts or not. TC should clarify this issue.

4.5 Post-Season Fish Ladder Inspection Results

A mid-year assessment of the Wilder fish ladder was conducted by TC on September 23, 2015. This assessment was undertaken based on problems identified during a site visit by Service hydraulic engineer Brett Towler on September 4, 2015. On page 65 of the report, Normandeau states, "An observed inconsistency in water height over a number of weirs suggested some weir orifices might be blocked, causing water to pool higher than designed. The fish ladder was subsequently shut down, an inspection conducted, debris removed (maintenance personnel enter the fish ladder to remove debris), and the fish ladder put back into operation. The inspection found three areas where debris load likely altered normal operation. These were the same suspect areas identified during the FWS site visit. These problem areas were not identified during the previous week's routine inspection. Discussion with the working foreman revealed that a heavy debris load in the forebay was passed through the trash/ice sluice (next to the fish ladder exit) just a few days before the FWS site visit."

While the problems identified during the mid-year assessment may have been due to the debris passed through the trash/ice sluice, we don't know for certain how long the passage issues occurred prior to being discovered by Mr. Towler; it may have been several days or it could have been much longer. At a minimum, the ladder was not functioning properly for several weeks during a time when data from the other ladders indicate at least some species were passing (e.g., eels, bass and sunfish); therefore, passage rates recorded in this study are potentially not a reflection of the true passage rate potential at Wilder.

Study 19 American Eel Downstream Passage Assessment Study Report

Objectives of this study were to quantify the movement rates, timing and route selection of adult silver eels passing downstream past the Wilder, Bellows Falls and Vernon projects and to assess the mortality and injury of silver eels passing through each turbine type at each project.

4.0 METHODS

4.3 Turbine Survival Methodology

4.3.6 Assessment of Injuries

In the guidelines for classifying injuries in Table 4.3.6-1, it states that fish with no visible maladies that die within one hour of recapture are classified as a "non-passage related minor injury." The basis for making that decision seems highly subjective. It is unclear what a "non-passage related minor injury" could be, since after passing through the turbine, the eels are quickly retrieved. We can think of no non-turbine-induced causes of injuries to large eels during this short period of time spent in a deep tailrace before recapture. It is also unclear how reasonable it is to classify an eel's condition as "minor injury" if it died while being held for less than an hour.

There is also a criterion that states that an eel with multiple injuries is classified by the worst of its injuries. This is acceptable if an eel suffers minor and major injuries, but if an eel suffers a number of "minor" injuries such as scraping, eye bulging and partially hemorrhaged eye, it seems reasonable to classify these multiple maladies as significant enough for a "major injury" designation.

4.4 Methods Specific to Each Project

4.4.1 Wilder

Turbine mortality testing of Wilder Unit 3 was suspended when it was determined that most of the Unit 3 discharge fed into the fish ladder attraction flows and eels that passed through Unit 3 were becoming stuck in the attraction water system. Without the evaluation of Unit 3, which has unique properties such as a small diameter and high speed runner, we will need to make inferences about turbine mortality through this unit based on the results of other turbine mortality studies done at other projects. Additionally, we have concerns about passage of eels through Unit 3 irrespective of turbine survival, as the use of Unit 3 discharge for fishway attraction flows puts any downstream migrants that pass through Unit 3 at additional risk. Screening of this intake to prevent any eel entrainment into Unit 3 and the associated fishway attraction water system will need to be considered.

5.0 RESULTS AND DISCUSSION

5.1 Route Selection and Residence

5.1.3 Wilder

Table 5.1.1-3 summarizes the number of eels that passed via each route and the proportion of river flow passed through that route. Based on data summarized in Figure 5.1.1-3, eel passage at Wilder was predominantly during hours of darkness with all passages between 5:00 p.m. and 5:00 a.m. As such, only flow data during the hours eels passed should be considered in the calculation of flow proportions to various routes depicted in Table 5.1.1-3.

In addition, these pooled data do not provide a good sense of what options eels may have had as they approached the station. Since individual eel track information is available, providing data broken out by eel distribution among passage routes based on actual flows through available routes at the time of passage would provide better insight into the factors leading to route selection.

This issue was raised at the June 1, 2016 meeting where John Ragonese of TC stated that they would review the data and develop a metric including a way to present the data and would consult with the agencies prior to running any analysis. The response at the meeting is accurately presented in the Meeting Summary and states that TC will provide more detailed information on individual fish and will consult with interested parties on how that data will be presented. We concur with that approach.

These same comments also apply to the assessment of passage route data versus flow data at Bellows Falls and Vernon.

5.1.2 Bellows Falls

Results of migration and routing studies at Bellows Falls indicated that only 28 of the 45 eels, or only 62 percent of those that passed Wilder were detected approaching Bellows Falls. There is no information provided regarding the ultimate fate of the 17 eels that did not arrive at Bellows Falls. However, lacking that information, we note that the arrival data corroborate the turbine survival studies showing a 62.2 percent survival rate through Wilder.

5.1.3 Vernon

Results of migration and routing studies at Bellows Falls indicated that 44 of the 65 eels, or 68 percent of those released at and passed Bellows Falls were detected approaching Vernon. As stated above, we have no information on the fate of eels that passed Bellows Falls. Based on turbine survival rates alone, a higher percentage of Bellows-released eels would have been expected to reach Vernon. The report should include an evaluation of what may be the cause of unexpectedly low numbers of eels released at Bellows Falls that arrived at Vernon.

Study 22 Downstream Migration of Juvenile American Shad at Vernon Study Report

The objectives of this study were to assess project operation effects on the timing, route selection, migration rates and survival of juvenile shad migrating past the Vernon Project.

3.0 METHODS

3.3 Turbine Survival

In this section, Normandeau notes that "sample size requirements can be adjusted upwards or downwards to achieve desired statistical precision level if the initial assumption deviates significantly during the course of the study." The consultant chose a threshold of greater than 95 percent survival for controls to aid in determining study sample size needs. The study results showed lower control survival during the delayed assessment and concluded, "only the 1hr survival estimate was deemed reliable." The report then states "similar high juvenile American shad mortality rates have occurred during the delayed assessment period in other Hi-Z tag studies conducted on the Susquehanna and Connecticut rivers."

If it was known that control mortalities would be "high" based on past studies, why was a value of 95 percent survival selected? Safe and effective fish passage should include an understanding of survival beyond a one hour period. Monitoring of fish longer than one hour following a turbine passage event is intended to measure mortality due to effects that may not be evident in the period of one hour. The lack of this information prevents a full evaluation of turbine-induced impacts.

4.0 RESULTS

4.1 Route Selection

A total of 284 tagged juveniles released upstream arrived at the Vernon Station/Dam. However, a total of 43 (or 15.1 percent) of the fish that arrived were never confirmed as passing. The report notes that the fate of these fish is unknown and those data are discussed no further. The data for these fish should not be dismissed and it should be considered that they may indicate indirect project-related effects, including predation. Information such as where the last known detection in the immediate project area was, whether they were concentrated in certain areas, or whether they were last detected among a variety of areas will provide valuable insight and should be described in the report.

Radio tagged fish released upstream provide an opportunity to examine the number of those fish detected at the most downstream detection station (upstream of Stebbins Island) relative to the documented passage route through the station. We recommend that TC report the numbers of shad that passed through turbine versus non-routes relative to how many of those fish were subsequently detected the below-project antenna. These calculated proportions could then be compared to and contrasted with both the balloon-tag derived turbine mortality and through-project survival estimates.

A continuous time series of river discharge is needed to place the reporting of radio tagged fish passage by river flow in a meaningful management context. Figure 4.1.3-5 shows radio-tagged passage by total project discharge which does not take into account that river conditions were variable over time.

4.2 Run Timing

The design, methods, data, results, and conclusory statements appear reasonable and supported. They also serve to further support the findings on radio tagged fish route use/timing (i.e., delay), with the acknowledgment that the ability to determine "delay" is not reliably possible with the limited single beam sonar.

4.3 Turbine Survival

On page 60, Normandeau states that all the Unit 4 fish were recaptured alive, yet the next sentence states, "the number of fish assigned dead for Unit 4 was 15." The first sentence should be revised to clarify that, of those released fish that were subsequently recovered downstream, all were recovered alive.

Table 6.3-3 of the desktop analyses for Vernon Station impingement, entrainment, and survival (Study 23) identifies survival of 1 to 3 inch juvenile American shad from "EPRI source" data (1997) as ranging from 93.9 to 95.4 percent, with "calculated survival potential" ranging from 89.1 to 98.2 percent. However, in Figure 4.2.3-2 of this report it shows that during the reported peak period of outmigration, juveniles ranged in size from 85 mm to 110 mm (or 3.0 to 4.3 inches); with a reported mean length of 97 mm (3.8 inches). It would be more representative of actual fish passing Vernon station to report in Study 23 the anticipated survival of juvenile shad up to 4 inches. With this modification, the Study 23 report and Table 6.3-3 would better reflect site-specific conditions at Vernon and the expected decreased survival rates for larger juveniles.

We note that in a presentation at the 2012 Fish Passage Conference at the University of Massachusetts, Paul Heisey of Normandeau Associates stated that at the Conowingo Project, juvenile shad 1-hour survival was 89.9 percent and 48-hour survival was 91.2 percent for treatment/turbine passed fish. We are concerned that the controls often exhibit mortality of a magnitude that creates a situation that precludes estimating 48-hour survival (due to exceedance of an "allowable" control mortality threshold). Further, even when control mortality is within acceptable levels (like the Conowingo example), survival of treatment fish appears to improve over time after adjusting for control survival (sometimes even exceeding 100 percent). This results in survival estimates that are biologically questionable at best. While these types of studies provide useful data on immediate survival through turbines, new methods need to be investigated for assessing long-term survival and/or increasing survival of control fish.

Study 23 Fish Impingement, Entrainment and Survival Study Report

Objectives of this study include: (1) identifying routes of fish movement past each project and the risk of injury/mortality associated with each route; (2) analyzing target species for factors that may influence vulnerability to entrainment and mortality; (3) assessing the potential for impingement and entrainment and estimating survival rates for target species; (4) estimating turbine passage survival rates; and (5) estimating total project survival considering all passage routes for American shad and river herring at the Vernon Project and for American eel, Atlantic salmon, and sea lamprey at all three projects.

3.1 Wilder

In Table 3.1-1 the calculated approach velocity for units 1 and 2 is given as 2.5 feet per second (fps), while later in the document the specified velocity is 4.3 fps. Based on an intake area of 1,314.4 square feet and a turbine capacity of 5,650 cfs, the approach velocity should be 4.3 fps. Therefore the error in the table should be corrected.

3.3 Vernon

In Table 3.3-1 the calculated approach velocity for units 1 through 4 is given as 1.4 fps; however, that number appears to be based on an intake area of 764.4 square feet and a turbine capacity of 1,100 cfs. First, we note that the maximum hydraulic capacity listed for units 1 through 4 in the Pre-Application Document (PAD) was 1,465 cfs, not 1,100 cfs. Normandeau should verify which capacity figure is correct. Second, the calculation uses the full rack area. In order to determine the maximum approach velocity, the minimum wetted rack area should be used (in this case that would be the rack area at elevation 212.0 Mean Sea Level; MSL). Using the capacity listed in the PAD and the minimum licensed pond level of 212 feet MSL results in an approach velocity of 2.08 fps. Using that same elevation but the lower maximum capacity of 1,100 cfs results in an approach velocity of 1.56 fps.

4.4 Project Approach Velocities

As noted earlier, the maximum turbine discharges listed in the report differ from those specified in the PADs for the three projects. Normandeau should verify that the discharges listed in Table 4.4-1 are the correct ones.

5.2 Entrainment

In the report, Normandeau states that one of the primary factors reducing entrainment potential at Wilder is the relatively deep intakes; however, deep intakes likely increase the entrainment potential for American eels. While there may be low numbers of obligatory migrants (e.g., eels) currently, this will not be the case once upstream eel passage is implemented at the projects.

For Bellows Falls, one of the factors listed as reducing entrainment potential is the lack of a natural shoreline due to the elongated power canal. However, the power canal itself may increase entrainment potential for species utilizing the habitat it provides.

5.2.2 Qualitative Assessment of Entrainment Potential

According to Normandeau, qualitative assessments of entrainment potential of target fish species and life stages were derived using a multi-step ranking based on habitat and life history, swim speeds, and empirical data from comparable hydroelectric locations. Although Normandeau identifies species requiring downriver movement as being the most susceptible to entrainment, adult eels are only given a rating of medium at all three projects and adult shad are ranked as high/medium for the Vernon Project (Tables 5.2-4 through 5.2-6) for the Habitat and Life History factor.

Likewise, for the factor of swim speed relative to approach velocity, in all cases adult American eel and adult shad are rated as having a low entrainment potential, presumably because their swimming abilities generally exceed the approach velocities. While the scientific literature may support that these species/life stages have the physical ability to avoid becoming entrained at the project intakes, the "Low" rating does not account for the behavior of obligatory migrants to follow the dominant flow. That is to say, just because they can avoid entrainment does not mean they will, if the prevailing flow field is through the intakes. In fact, results from the radio telemetry studies clearly show that adult eels exhibit high entrainment and adult shad exhibit medium entrainment levels (Wilder eels: 93 percent; Bellows Falls eels: 82 percent; Vernon eels: 77 percent; Vernon adult shad: 43 percent). Therefore, unless the rack spacing at the intakes physically precludes entrainment, we recommend the tables be adjusted to reflect more realistic rankings for these two factors.

6.1 Blade Strike Probabilities

Table 6.1-1 provides predicted survival of entrained fishes based on Franke et al. (1997) for the Wilder Project. According to the table, the input used for turbine efficiency was 73.3 percent for both the Kaplan and Francis turbines. While this efficiency matches the maximum discharge efficiency of the vertical Francis turbine provided in Table 3.1-2, it differs from the maximum discharge efficiency of the Kaplan turbines (79.1 percent per Table 3.2-1). We request that Normandeau explain the basis for using the chosen turbine efficiency.

Additionally, we request that Normandeau provide an explanation as to why survival was only predicted for maximum discharge efficiency versus peak efficiency. It would be informative to compare predicted survivals between the two efficiencies. Further, survival should be predicted for the turbine(s) that provides the existing minimum flow release at each project (using the efficiency of the turbine at that flow).

Finally, a more detailed explanation should be provided for the Correlation Factor applied to the equation (either 0.1 or 0.2). Based on our review of Franke et al. (1997), it appears that a lambda of 0.1 may be appropriate for Kaplan turbines but model results for Francis turbines, which were assigned a lambda equal to 0.2 based on Kaplan turbine results because no other reliable estimation method was available, showed that poor correlation between measured and calculated survival.

6.2 EPRI Source Data

In assessing turbine passage survival, Normandeau relied on data provided in Winchell et al. (2000), which is a subset of the EPRI (1997) survival data. It would be helpful if the report included the Winchell et al. data as an appendix. Table 6.2-1 summarizes survival rates reported in Winchell et al. (2000) by size class for axial (e.g., Kaplan) and radial (i.e., Francis) flow turbines with runner speeds less than 300 rpm. While in some cases fish size may be more important than species for assessing fish survival potential, clearly this is not the case for all species. For example, it has been documented in a number of studies (including TransCanada's Study Report 19) that actual survival of American eels through Francis turbines is much higher than would be predicted by the Franke et al. (1997) equation. Further, no sites in the EPRI database assessed survival of adult American shad or any similar-sized fish (i.e., fish within the size interval 15.1 inches to 20 inches). Therefore, calculating a mean survival for fish greater than 12 inches may do little to inform what the actual expected survival would be for a particular species.

We also note that nearly 20 years has passed since the EPRI report was released. There likely have been a number of empirical turbine survival evaluations in the intervening years that could be used to update and recalculate mean survival rates. Further, the paucity of data for particular species of interest (e.g., adult American shad and adult American eel) speaks to the need for additional empirical studies and underscores the importance of TransCanada having undertaken such studies at its facilities.

6.3 Potential Survival through Turbines

The Service believes this assessment is flawed for the reasons discussed under sections 6.1 and 6.2 above (at least with respect to adult eels and shad). In addition, it is unclear whether the values presented under the heading "Percent Survival by Fish Size" based on EPRI source data are the ranges for all species within that size range or in fact are the ranges for that particular species (we assume it is the former but clarification would be appreciated). It also is unclear whether the data represent the entire EPRI database or only those sites where control survival was less than 10 percent (the criteria used in Winchell et al. 2000).

We recommend the data in Tables 6.3-1 through 6.3-3 be broken out by turbine type.

7.0 Total Project Survival

This section of the report estimates total project survival at each facility for target diadromous species based on both empirical data collected as part of Studies 19, 21 and 22 and the impingement, entrainment and survival analyses conducted as part of Study 23 (where empirical data are lacking).

Total project survival at Wilder was estimated at 53.5 percent. This low survival is driven by the high entrainment of eels into units 1 and 2 and the relatively low survival through those units. While results from the Francis turbines at Bellows Falls would suggest higher survival through Unit 3 at Wilder than the Franke et al. (1997) estimate of 24.8 percent, the fact that this unit's flow goes into the auxiliary water system for the fish ladder (which includes a perforated screen) likely means that few eels would survive under the current configuration as noted above in our comments on Study 19.

As mentioned above, the three low speed vertical Francis units at Bellows Falls had much higher eel survival rates than would be expected from the Franke et al. (1997) estimated range. While estimated survival through the other passage routes (trash/ice sluice and spillway) was lower, the high rate of entrainment through the units led to an overall through-project survival estimate of 94.4 percent.

Similarly, at Vernon, the Francis units had substantially higher eel survival rates than the Kaplan units. However, even given that most eels used the Kaplan turbines as a passage route, overall through-project survival was estimated to be 91.6 percent. This estimate was driven, in part, by the high estimated survival rate of eels that used the fish pipe (100 percent).

Through project survival of adult shad at Vernon was not estimated. Although Table 7.1-4 lists survival rates, these were based on detection downstream of the various passage routes of shad fitted with radio telemetry tags as part of Study 21. Pursuant to Study 21, survival was to be assessed through the motion sensing capabilities of the radio telemetry tags; however, it is our understanding (based on information provided by FirstLight at a stakeholder meeting to discuss the radio telemetry data analyses) that there were problems with the motion sensing aspect of the tags and therefore, their use in determining survival was questionable.

Further, at the recent Fish Passage 2016 conference, a paper was presented that showed dead eels released downstream of a dam traveled from 20 to 30 kilometers downstream[1]; this finding suggests that mere detection of tagged fish downstream of a dam does not in and of itself document survival.

Given the potential problems with using the motion sensing capabilities of the radio telemetry tags to determine survival, as well as the recent research regarding the mobility of tagged dead eels, the Service believes Tables 7.1-1 through 7.2-2 should be revised to exclude any survival estimates based on telemetry detection alone.

---

[1] Presentation by F. Kreische et al. at the Fish Passage 2016 conference titled: "Analyzing small-scale movements in the downstream migration of European eel: a radio telemetry study." June 22, 2016, University of Massachusetts, Amherst, MA.

In particular, we are concerned with using these estimates for adult shad. As can be seen in Table 7-1 below, while the balloon tag survival estimates for juvenile shad fall within the range of survival estimates via Franke et al. (1997), the 100 percent survival rates listed for adult shad based on telemetry detection are much higher than those calculated using the Franke et al. equations.

Table 7-1. Summary of empirical and literature-based entrainment and survival estimates for the different passage routes at each project, by turbine type.

Project	Turbine	Calculated Intake Velocity	Species	Life Stage	Qualitative Entrainment Potential	Actual Entrainent per TC Studies	Calculated Survival per Franke et al. [1]	Actual Survival per TC Studies
Wilder	Unit 2	4.3	Eel	Adult	H/M	units 1&2: 71%	45-92%	62%
	Unit 3	1.4	Eel	Adult		22%	24.80%	N/A
	Trash sluice		Eel	Adult		7%		67%[3]
	Bypass		Eel	Adult		0%		
Bellows Falls	Units 1-3	2.2	Eel	Adult	H/M	82%	52-76%	98%
	Trash sluice		Eel	Adult		13%		83%
	Spill into bypass		Eel	Adult		5%		80%
Vernon	Units 1-4	1.4	Eel	Adult		6%	24-65%	94%
	Units 5-8	2.5	Eel	Adult	H/M	43%	18-86%	81%
	Units 9/10	2.1	Eel	Adult		28%	41-71%	98%
	Fish pipe		Eel	Adult		18.80%		67%[3]
	Fish tube		Eel	Adult		0.90%		67%[3]
	Trash sluice		Eel	Adult		2.70%		67%[3]
	US Fishway		Eel	Adult		0.90%		67%[3]
Vernon	Units 1-4	1.4	Shad	Adult		16%	43-74%[2]	100%[4]
	Units 5-8	2.5	Shad	Adult	H/M	20%	39-89%[2]	100%[4]
	Units 9/10	2.1	Shad	Adult		7%	56-76%[2]	100%[4]
	Fish pipe		Shad	Adult		25%		100%[4]
	Fish tube		Shad	Adult		0%		
	Trash sluice		Shad	Adult		0%		
	US Fishway		Shad	Adult		0%		
	Spillway		Shad	Adult		20%		100%[4]
	Unknown		Shad	Adult		11%		100%[4]
Vernon	Units 1-4	1.4	Shad	Juvenile		13%	90-95.3%	92%
	Units 5-8	2.5	Shad	Juvenile	H	42%	89-98.2%	95%
	Units 9/10	2.1	Shad	Juvenile		20%	92-96%	95%
	Fish pipe		Shad	Juvenile		9%		100%[5]
	Trash sluice		Shad	Juvenile		9%		100%[5]
	Fish tube		Shad	Juvenile		2%		100%[5]
	US Fishway		Shad	Juvenile		0.40%		100%[5]
	Attraction pipe		Shad	Juvenile		1%		100%[5]
	Unknown		Shad	Juvenile		3%		100%[5]

[1] estimate based on fish size, not species

[2] estimate halfway between 15" and 30" Franke estimates, given shad length of 18 to 20 inches

[3] Survival estimate based on telemetry detection from Study 19

[4] Survival estimate based on telemetry detection from Study 21

[5] Survival estimate based on telemetry detection from Study 22

Study 24 Dwarf Wedgemussel and Co-Occurring Mussel Study: Development of Delphi Habitat Suitability Criteria (Delphi HSC Study Report)

This report summarizes the activities and results of the Delphi panel of experts that was convened in order to develop habitat suitability curves (HSCs) for dwarf wedgemussels. Once completed and agreed upon, these HSCs will be used in the instream flow study analysis to determine project effects.

In our May 2, 2016 letter to FERC providing comments on study reports that TC issued on March 1, 2016, we identified several concerns we had with how the Delphi process had proceeded up to that point in time. Those concerns included: (1) the small number of Delphi panelists; (2) the fact that one of the panelists was the person that developed the background information and expert panelist questionnaire; and (3) apparent overrepresentation of panelists associated with TC.

Given those concerns, the Service recommended that TC provide all of the materials related to the Delphi process, including:

- the criteria that were used for expert selection;
- the list of experts who were solicited and why;
- names of the five panelists mentioned at the September 14, 2015 meeting;
- names of the current panelists;
- a copy of the questionnaire that was developed and sent to panelists;
- round 1 and 2 data values;
- HSI curves developed so far; and
- reviewer feedback.

This information was requested so that we could assess the status of the Delphi panel deliberations and potentially recommend additional panelists to help achieve consensus on the remaining issues. Further, we recommended against allowing the panel to proceed with developing curves for parameters where consensus could not be achieved.

In a May 31, 2016 letter responding to stakeholder comments, TC addressed some of the concerns identified by the Service and others:

- With respect to the criteria used to select panelists, TC stated that the Delphi HSC Study Report includes the criteria used.
- Regarding the panelist who also played a role in initiating the Delphi process, TC states that the panelist did not develop the Delphi questionnaire but did develop the background information and the list of potential panelists.
- In response to the concern over failure to reach consensus, TC stated that by the third round of review consensus was reached.
- With respect to the materials requested in our May 2, 2016 letter, TC stated that those materials were included in the Delphi HSC Study Report.

We have reviewed the Delphi HSC Study Report and find that it does not include all of the requested materials.

3.0 METHODS

3.3 Selection of Delphi Participants

We had asked for the criteria used to select expert panelists. Normandeau's report does not describe the criteria used; rather, it only lists the qualifications of the potential panelists. While the Service does not dispute that the five potential panelists listed are highly qualified, our concern is that the initial list was restricted to those five individuals. Based on peer-reviewed published literature alone, this list could have been greatly expanded. For example, Kelly Maloney of the U.S. Geological Survey, Leetown Science Center has conducted research on the dwarf wedgemussel (DWM), as have David Michaelson (life history, habitat), Tim King (genetics), Kristine Shaw (genetics), Art Bogan (phylogeny, evolution), Dave Smith (statistics/modeling, structured decision making), and Barry Baldigo (habitat). In addition, Tamara Pandolfo did her dissertation research on DWMs (habitat) and there are a number of people who have extensive experience surveying for DWMs, including Steve Johnson and Dan Geiger.

Had more experts been identified at the start of the process, there likely would have been more panelists participating in the Delphi process.

It also bears noting that Crance (1987) states, "A panel consisting of about 10 experts is probably ideal, but more than 10 may be used if desired."

3.4 Selection of Candidate Variables and HSC Curves

The Service supports evaluation of the seven variables listed. In addition, recent literature suggests an association between water temperature and presence of DWMs (positive relationship between DWM and groundwater influence; Rosenberry et al. 2016).

3.6 Panelist Responses and HSC Revisions

According to Normandeau, Delphi "rounds" were repeated until each panelist indicated that all HSC curve revisions were "acceptable" to them, with "acceptable" not necessarily indicating complete agreement. According to Crance (1987), "The exercise is terminated when a consensus or an acceptable level of agreement has been reached on the curves." What constitutes an acceptable level of agreement is not defined in either the report or Crance (1987).

4.0 RESULTS

Normandeau states that the Delphi process concluded after three rounds, with unanimous agreement on four variables and majority agreement on the three remaining variables. However, only two panelists commented and agreed to the third round curves for bed shear stress, relative shear stress and shear velocity.

The fact that there was not consensus (or even agreement) on three of the seven Habottta Suitability Criteria (HSC) variables is very concerning. As we noted in our May 2, 2016 comments, if agreement cannot be reached among the panelists then we recommend adding panelists and continuing with subsequent rounds until agreement on the curves is reached. This is particularly important given the very small number of panelists involved. Additionally, because the anonymity of the experts is maintained in the report, it is not clear whether either of the panelists who did agree on the curves has particular expertise in the hydraulic parameters being assessed. Again, enlarging the Delphi panel will help ensure there is sufficient expertise among the group to adequately inform curve development and increase the likelihood of achieving consensus.

4.8 Other Topics

In this section of the report Normandeau explains how it anticipates using the curves in the hydraulic habitat model to assess project effects: "...it is expected that a process similar to "effective habitat analysis" will be employed when modeling habitat over a range of peaking flows...This method fixes a specific location's combined suitability,...to the minimum value over the range of modeled flows....if a specific location yields a combined suitability of zero....that location will remain at zero suitability, even if conditions are suitable at other flows."

While this description may be accurate, it also could be somewhat misleading. A more thorough explanation can be found in the Instream Flow Study Report for the Catawba-Wateree Project (FERC No. 2232; DTA 2005):

> For the Catawba-Wateree River, a range of peaking flows was compared to a range of minimum flows....The range of peaking flows and minimum flows were entered into RHABSIM and cell detail reports were generated for all non-mobile life stages of concern. The reports contained a WUA value for each cell, transect, and life stage. With the aid of a program written by DTA, "Dual Flow Analyzer," the comparison of WUA for different flows was compiled into condensed matrices that showed the resulting effective habitat for paired flows. Graphs were then created showing a comparison of different peaking curves. The HABEF program (Milhous 1991) was the primary quantitative method used by the IFST for assessing the effects of peaking operations on fisheries habitat. The HABEF was developed to examine the cell-by-cell effects of fluctuating stream flow levels on microhabitat availability for organisms having limited mobility. The underlying concept of the Dual Flow Analysis is that when flows are fluctuating, a specific habitat cell is only suitable for a non-mobile organism as long as the conditions (i.e., depth and velocity) remain (at that specific cell) within the organism's habitat preferences throughout the range of flows experienced by the organism. Effective habitat is calculated for each cell by comparing the suitability of the cell at each of two stream flows. In the overall comparison of the two discharges, a cell may be more suitable at a higher flow than at a lower flow, or vice versa. The HABEF only records the lower (or effective) of the two paired values of the cell (e.g., overlapping habitat). If the habitat value is zero at either

the low or high flow, it is not counted. The effective composite suitability is then multiplied by the cell's surface area for the calculation of weighted usable area.

DTA's description clarifies that a location will be given a suitability of zero if one of the flows in that particular dual flow combination is zero, regardless of whether the other flow assessed results in suitable habitat. This is an important distinction, as the point of "effective" or "dual flow" analysis is to evaluate what combination of flows results in the greatest quantity of persistent habitat.

4.9 Next Steps

Normandeau states that the draft HSC curves reflect the expert opinion of three panelists. Actually, only four of the seven curves reflect the opinion of three panelists, with the remaining three curves reflecting the opinion of two panelists.

According to Normandeau, the curves developed through the Delphi process will be evaluated, tested, and possibly modified based, in part, on preliminary modeling and analyses. As explained above, the Service does not support moving forward with curve evaluation and testing at this point in time. Following are our recommendations as to how the study should proceed from this point forward:

1. Normandeau should attempt to add experts to the existing panel (preferably at least three more) in an effort to achieve consensus on the seven identified parameters. This likely will mean at least one or two more rounds of review.
2. Once consensus has been achieved on the HSC parameters, TC should convene a meeting of the Aquatics Workgroup to discuss the curves and obtain feedback on the curves as well as on the proposed analyses the curves would be used for within the hydraulic model (e.g., habitat time series, dual flow, habitat persistence, etc.).
3. Based on that feedback, Normandeau should finalize the curves and conduct initial model testing. Results of these tests should be presented to the Aquatics Workgroup to obtain feedback prior to moving forward with full model runs.

Appendices A through C: Delphi Round Summaries

Depth

The initial depth HSC sent out to panelists has a suitability of 1.0 for depths from approximately 5 feet out to 20 feet. However, based on the supporting citations, it appears that optimal depths should be much shallower; of the five references, only one identifies DWM as being found at depths in excess of 3 feet. Therefore, it appears that the data collected during earlier phases of Study 24 may be disproportionately influencing curve development. Following is a summary of the Study 24 field survey results:

- Survey work conducted in 2011 and 2013 detected DWMs at about one quarter of the sites located in the Wilder and Bellows Falls impoundments, whereas none were found in the free flowing sections between impoundments. Where they were found, they were almost always at very low densities (typically one per site in the Bellows Falls impoundment). While the Phase 1 Study 24 Report states that nearly all DWMs were found in water depths of 6 to 20 feet in areas with light to moderate flow velocities, no supporting tabular data are provided. Had those data been provided, it may have been possible to identify whether DWM Catch Per Unit Effort (CPUE) had any association with water depth and velocity at each site.

- In 2014, 20 transects were surveyed. Depth data were collected for the 6 DWMs observed. Five of the 6 DWMs were found at depths from 8.8 feet (2.7 meters) to 13.5 feet (4.1 meters). The sixth DWM was found at a depth of 1.9 feet (0.6 meters). An additional 9 DWMs were observed off-transect but depth was not measured at those locations. Only a single DWM was collected during the quantitative mussel survey around Chase Island. That individual was found in water 1.6 feet (0.5 meters) deep.

Given that only 69 DWMs were found over 125 survey sites and that CPUE was very low at all but a few of those sites, it does not seem that sufficient justification exists for concluding that water depth up to 40 feet is optimal for DWMs. In fact, if one assumes that CPUE is related to habitat suitability, then those sites with the highest CPUE and containing multiple size classes represent viable populations with a high probability of persistence and the habitat at those sites could reasonably be assumed to be near optimal. Basing HSC curves on mere presence of DWMs essentially lowers the bar on what truly may be optimal habitat, as those individuals may have been moved there by host fish, flows, etc. and may not be able to persist in that particular location long-term.

Using that premise, we can look at the Lunenburg, Vermont DWM site, where historical (late 1990s) and recent (2015) surveys confirm a healthy DWM population (i.e, CPUEs of up to 30 per observer-hour, multiple size classes). At that site, DWMs have been found at depths of 0.3 to 3 meters. There are other sites that could be examined but they are on tributaries to the Connecticut River, so the Lunenburg site may be the most appropriate to use in developing a Connecticut River HSC curve for DWM (at least in the context of defining optimal suitability).

Water Temperature

On page 3 of the Round 2 summary, Panelist B stated that HSC should be selected that are relevant to project operations and, therefore, the panelist does not see the relevance of including groundwater influence or temperature sensitivity unless there are documented links to project operations. The Service would point out that including substrate as an HSC variable has not been questioned in the subject HSC development as well as in the many substrate curves that have been used for various fish species; yet to our knowledge, demonstration of a link between project operations and substrate has not been required. This is because the intent of this type of instream flow study is to assess how project operations affect habitat suitability; if temperature is one important component of determining suitability for a given species, then its inclusion is warranted. If sufficient data are lacking for that particular parameter then that is a separate issue from its relevance in the analysis (i.e., while we may believe that groundwater influence or some other temperature metric may be appropriate, the site-specific data may not be available).

It is important that the panelists understand the purpose of the hydraulic model and how the curves fit into that analysis; the physical habitat data that were collected throughout the project-affected reach are compared to the HSC curves to quantify suitable habitat and then different analyses are used to determine how project operations affect that habitat spatially and temporally. So, including a temperature metric likely would affect how much, and where, suitable habitat for DWMs exist, which then would influence the extent to which project operations may impact that habitat.

Again, at this point in the process we are not arguing for the inclusion of a temperature metric as a stand-alone HSC curve, primarily due to the fact that TC was not asked to map groundwater seeps as part of this study or the instream flow study; therefore, data are lacking. We only want to clarify that a given parameter need not be directly related to project operations to justify its inclusion in the model.

Round 3 Summary

On Page 2 of the Round 3 summary, a panelist suggests comparing site-specific data to the Delphi curves as a quality-control check. As noted above, there are very few site-specific data to compare; only a handful of DWMs were found in the 2014 surveys (transect-based and quantitative quadrat) and only qualitative information on the depth, velocity and substrate where DWMs were found in the 2011 and 2013 surveys has been made available through TC reports.

Thank you for the opportunity to comment on the study reports. If you have any questions regarding these comments, please contact Mr. John Warner of this office at 603-223-2541.

Sincerely yours,

Thomas R. Chapman
Supervisor
New England Field Office

LITERATURE CITED

Crance, J.H. 1987. Guidelines for using the Delphi technique to develop habitat suitability index curves. U.S. Fish and Wildlife Service Biological Report 82(10.134). 21 pp.

DTA (Devine Tarbell & Associates, Inc.). 2005. Instream Flow Study Report for the Catawba-Wateree Relicensing (FERC No. 2232). 704 pp.

EPRI (Electric Power Research Institute). 1997. Turbine entrainment and survival database – field tests. Prepared by Alden Research Laboratory, Inc. EPRI Report No. TR-108630. 13 pp. (plus two 3.5 inch diskettes), Palo Alto, CA.

Franke, G.F., D.R. Webb, R.K. Fisher, Jr., D. Mathur, P.N. Hopping, P.A. March, M.R. Hendrick, I.T. Laczo, Y. Ventikos, and F. Sotiropolous. 1997. Development of environmentally advanced hydropower turbine system design concepts. Prepared for U.S. Department of Energy, Idaho Operations Office. Contract DE-AC07-94ID13223.

Rosenberry, D.O., M.A. Briggs, E.B. Voytek, and J.W. Lane. 2016. Influence of groundwater on distribution of dwarf wedgemussels (Alasmidonta heterodon) in the upper reaches of the Delaware River, northeastern USA. Hydrol. Earth Syst. Sci. Discuss., doi: 10.5194/hess-2016-187, 2016. 36 pp.

Winchell, F., S. Amaral, and D. Dixon. 2000. Hydroelectric turbine entrainment and survival database: an alternative to field studies. In: Hydrovision 2000: New Realities, New Responses. HCI Publications, Kansas City, MO.

cc: John Rangonese
TransCanada Hydro Northeast Inc.
Portsmouth Hydro Office
One Harbour Place, Suite 330
Portsmouth, NH 03801
CRC, Ken Sprankle (via email)
VTDEC, Jeff Crocker (via email)
VTDEC, Eric Davis (via email)
VTDFW, Lael Will (via email)
NHDES, Greg Comstock (via email)
NHDES, Owen David (via email)
FWS-Gabe Gries (via email)
NHFGD, Matt Carpenter (via email)
CRWC, David Dean (via email)
TNC, Katie Kennedy (via email)
Reading File

ES: JWarner:7-14-16:(603)223-2541

Document Content(s)