United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

September 30, 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 August 1, 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 August 25, 2016, TC held a meeting 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 filed 11 study reports with FERC. The U.S. Fish and Wildlife Service (Service) reviewed the study reports and offers the following comments on four of these reports and on the Final Tributary and Backwater Fish Access and Habitat Study Report, filed on June 17, 2016. We have no comments on the other seven August 1, 2016 reports.

Study 10 Fish Assemblage Study – Revised Final Report

The objectives of this study were to: (1) document fish species occurrence, distribution, and relative abundance within project impoundments, tailwaters, and downstream riverine sections; (2) compare historical records of fish species occurrence in the project-affected areas to the results of this study; and (3) describe the distribution of resident/riverine and diadromous fish species within the reaches of the River and in relationship to data gathered by related studies, State agencies' surveys, and other information as available.

5.0 Results and Discussion

Figure 5.4-2 should be graphed so that all of the included data is clear. One option is to alter the y-axis so that it contains a break, allowing the reader to view high and low values for each species and discern between percent composition within impoundments, riverine reaches, and the Bellows Falls bypass reach.

Study 13 Tributary and Backwater Fish Access and Habitats

The objective of this study was to conduct a field assessment of a subset of tributaries and backwaters to identify and assess the effects of project-related water level fluctuations on fish access, available habitat, and water quality.

6.0 Assessment of Project Effects

For this study, depths greater than 0.5 feet were assumed to provide adequate access for fish to enter into tributaries and backwater areas from the mainstem Connecticut River and vice versa. However, recently published Federal guidelines of nature-like fishways require a minimum channel depth of 1.5 feet, 2.5 feet, and 1.75 feet for rainbow smelt, brook trout, and juvenile salmonids respectively (Turek et al. 2016). Thus, the defined criteria, considering all depths greater than 0.5 feet, is a very low threshold depth for access, especially when combined with the 50 percent-of-day criterion discussed below.

<u>6.1.2 Assessment of Project Effects on Water Surface Elevation</u>

This section states that "this revised report includes the requested evaluation of study sites during the spring spawning period to identify periods of time with < 0.5 feet of water depth for one hour or more (the minimum model time step) as well as for 12 hours or more as originally proposed. The 12-hour criterion … is considered reasonable for quantifying adverse project effects as fish approaching from the mainstem would have adequate access under this criterion for no less than 50% of the total time…while the < 0.5 feet of access at any time is considered the most conservative condition."

The Service does not agree that the 12-hour criterion is reasonable to quantify adverse project effects. For fish, especially for those making time-sensitive spawning migrations, limiting access to tributaries and backwaters up to 50 percent of the time can substantially impact spawning success as a result of delays and stranding.

7.0 Study Conclusions

This section states that "while some study sites showed occasional or frequent project effects, these sites comprise a small fraction of all available fish habitat in tributaries and backwaters within the basin." However, the sample design was established to randomly select a subset of streams of various stream orders within project-affected areas. Therefore, sample streams were meant to represent the entire population of streams that could be affected by project operations.

The study concludes that "normal project operations have little to no effect on fish ability to access tributaries." However, Table 6.1.2-3 indicates that over 40 percent of the sites frequently had water depth less than 0.5 feet. This is a substantial portion of sites with access issues, during a time when fish make spawning migrations into tributaries. Considering the biological importance of low-order streams, which provide valuable spawning and rearing habitat, these data indicate a significant impact when taking into account the total number of streams that likely have project-related access issues.

Studies 14 and 15 Resident Fish Spawning in Impoundments and Riverine Sections – Final Report

The objective of this study was to characterize spawning habitat, identify spawning periodicity, and assess the potential effects of project-related water level fluctuations on spawning success of resident fish species. The study area included 29 sites within project impoundments and 24 sites within riverine reaches.

4.0 Methodology

4.2.2 Minimum Depth Criteria

This section states that "dewatering and egg or nest failure was assumed to occur when the water surface elevation dropped below the elevation of an egg mass or active nest. Yellow perch eggs are encapsulated within a moist, gelatinous mass, and brief periods of exposure did not appear to affect viability." We strongly suggest that this statement on viability be removed, as the critical time period of dewatering that does not impact viability is not known for this species (as described in the New Hampshire Fish and Game Department's [NHFGD] April 29, 2016 comment letter).

5.0 Results and Discussion

5.1.3 Water Visibility

Water visibility was noted as having an effect on most spawning surveys (excluding egg-block sampling), due to the visual nature of identifying and observing adult spawners, egg masses, or constructed nests. The report states that "this factor necessarily biases the spawning assessment towards shallower habitats that are more vulnerable to dewatering, since deeper and less vulnerable eggs and nests were likely present, but largely undetected due to limitations in visibility. Consequently, estimates of project effects on egg or nest sites are conservative and likely to be over-estimated." The Service notes that these biases or over-estimations are assumed and are not supported by any data that demonstrates the existence or amount of spawning by various species in deeper areas.

5.2.3 Northern Pike and Chain Pickerel

Backwater surveys to collect northern pike and chain pickerel were conducted at 12 study sites from April 28 to July 2. Despite a high level of effort and observations of approximately 21 northern pike and 34 chain pickerel, none of the observed fish appeared to exhibit spawning behavior. Based on a literature review, a wide range of spawning temperatures for this species were identified, which may or may not be applicable to the Connecticut River. The NHFGD previously provided details of northern pike spawning under the ice and large pike being caught at both Study Site 14-VB-039 and 14-VB-050 soon after ice out each spring. Therefore, it is the Service's position that spawning most likely occurred prior to the start of Study 14 and 15 surveys.

5.2.4 Yellow Perch

Within this section, it is estimated that "the percentage mortality of Yellow Perch egg masses observed in shallow margins of backwater habitats vulnerable to project effects ranged from 0% in the VB-050 backwater to 99.9% in the BB-019 (Black River) backwater (Figure 5.2-6), with an average overall mortality rate of 56%." The Service requests that the proportion of the total number of egg masses that were subject to any dewatering be included in the report as previously requested by the Vermont Department of Fish and Wildlife.

6.0 Assessment of Project Effects

6.4 Project Effects Modeling

The report suggests that it is possible that northern pike and chain pickerel responded to periods of high, uncontrolled flow by spawning in inundated fields and riparian habitats that are normally dry during periods of controlled flow, citing McCarraher and Thomas (1972). We recommend that this language be removed, as these comments are speculative and there were no observations of this behavior during either study. Further, the McCarraher and Thomas (1972) paper discusses northern pike habitat selectivity preferences for specific aquatic floristic associations in the sandhill region of Nebraska and therefore this reference is likely not entirely applicable to the Connecticut River.

7.0 Study Conclusions

Overall, Study 14 and 15 conclusions are echoed in TC's March 1, 2016 Updated Study Report – Response to Comments letter. Of concern are the references in both documents to walleye and white sucker being species that spawn upstream of project influences or in mainstem reaches deeper than sampled by egg blocks (>10-12 feet). Since white sucker spawn in rocky shallows or in moderate currents, while walleye have been observed spawning in shallow depths of rivers (Langdon et al. 2006), we do not agree with this conclusion. TC's letter states that Studies 14 and 15 were biased towards shallower habitats, and the lack of data pertaining to target species was a result of unobserved spawning, and spawning took place and was documented for species in the same "species group," which have similar habitat preferences and spawning periodicity. It is the

Service's position that each target species has unique life history characteristics and spawning behavior, and therefore we do not agree that species in the same "species group" can be lumped together as suggested by TC.

While the Service understands the effort that went into these studies and that environmental conditions pertaining to high flows and poor water clarity made it difficult to achieve all study goals, we believe that there is not enough data to assess potential project-related effects for 8 of the 13 study species (62 percent) because limited (walleye: one egg; white sucker: 62 eggs from just two sites; largemouth bass: five nests); or no data (back crappie, northern pike, chain pickerel, spottail shiner, golden shiner) was collected. Thus, we recommend that Studies 14 and 15 be repeated in 2017 for walleye, white sucker, largemouth bass, black crappie, northern pike, chain pickerel, spottail shiner, and golden shiner. Given that project operations have the potential to adversely affect spawning behavior of these species, either due to flow or impoundment level fluctuations, it is imperative that robust spawning data are gathered for use in the analysis of project impacts.

Study 16 Sea Lamprey Spawning Assessment – Final Report

The objectives of this study include: (1) identify suitable spawning habitat within project-affected areas; (2) use radio telemetry to document where sea lampreys spawn within project-affected areas; (3) conduct surveys at spawning sites to document suitability; (4) collect physical habitat data where lamprey nests occur; and (5) assess potential effects of project operations on spawning habitat.

4.0 Methodology

4.4 Data From Other Studies

In this section, TC identifies where data from other studies were used to complete Study 16. With respect to water level logger data, site-specific loggers were deployed only where nest capping was done. For other active nest sites, water level logger data from Studies 14/15 were used, even though the loggers were located varying distances from the actual survey sites. The report notes this, yet does not explain how (or if) using off-site loggers affected data analysis/model output. Analysis of this issue should be conducted and results should be provided in an updated report.

4.5 Nest Dewatering Calculations

Dewatering analysis was done for each site, except those deemed to have insufficient habitat. The term "insufficient" should be defined. Further, in Section 5.2.1, descriptions of those same sites use the term "unsuitable." TC should use consistent terminology when describing the site characteristics.

5.0 Results and Discussion

5.2 Habitat Assessment

Sites WL-004, BT-006 and VT-014 had no documented nesting activity but were deemed by TC to have suitable habitat. Analyses of observed and modeled water surface elevations were completed for these sites, with the results reported in Appendices C, E and F. Given that project effect analyses were completed for these sites, it is unclear why the results were not reported in Table 5.2-3.

While we understand that the analyses were based on elevations of observed nests for those sites where active spawning was identified, at sites WL-004 and BT-006 (as depicted in Figure C-3 of Appendix C), the high and low elevations of suitable habitat were collected and could be used as a surrogate for nest elevations. Figure C-3 shows that a portion of suitable habitat was dewatered periodically in 2015. Comparing 2015 data to the five model years (Appendix F), it can be seen that the change in water surface elevations was much greater in all five model years relative to those documented in 2015. This indicates that, on average, more of the suitable habitat would be exposed at higher frequencies and duration than indicated by the 2015 data presented in Figure C-3. It is also unclear why the high and low elevations of suitable habitat were not presented on Figure C-16 (site VT-014).

As noted in our comments under Section 5.2.1 below, four sites were determined by TC to have insufficient habitat. These sites were excluded from project effects analyses. Given that the narrative descriptions of these sites in Section 5.2.1 suggest there was suitable habitat at all four sites, the Service requests that TC include them in the project effects analyses (similar to what was done for sites WL-004, BT-006 and VT-014, as presented in Appendices C, E and F) or provide an explanation as to why they should be excluded.

5.2.1 Summary of Spawning Habitat

In previous sections of the report, sites WL-003, BT-031, VT-040 and VT-046 all are described as having "insufficient" or "unsuitable" habitat, yet the narrative descriptions of these sites appear to confirm that suitable substrate was present (although for some sites, like Site WL-003, it is unclear if the suitable habitat was within the project-affected area or not).

- WL-003: "A limited bar of suitable habitat ranging from sand to cobble with low embeddedness in sand…occurred approximately 0.25 miles upstream of the tributary mouth. No nests were identified in that area…"
- BT-031: "A small area of potentially suitable habitat was located approximately 1 mile upstream…That area was investigated and characterized with a dominant substrate of low to moderately embedded gravel…but was very small and appeared to be subject to continuous exposure during low tributary flow periods. One possible nest was identified in the supplemental low-water surveys…"

- VT-040: "Coarse substrate was available beginning in the vicinity approximately one mile upstream of the mouth of the West River in the vicinity of the Interstate 91 Bridge. That habitat was characterized as highly embedded gravel….No nests were identified at this site."
- VT-046: "A small bar characterized as highly embedded gravel…occurred just downstream of the Vermont highway 142 Bridge, however no evidence of sea lamprey spawning was identified there."

In addition to the narrative descriptions, Table 5.2-2 shows that the four "insufficient habitat" sites had suitable substrate and/or embeddedness (i.e., they had similar substrate and embeddedness as sites with active nests). TC should explain the basis of its determination of "insufficient" or "unsuitable" habitat at these sites.

6.0 Assessment of Project Effects

Section 6.1 Water Level Fluctuation and Nest Exposure

TC lists several potential mitigating factors to consider when evaluating the risk of nest exposure. Below we provide responses to some of those factors.

1. One factor listed is that nests may not constitute the sole rearing habitat. TC goes on to cite Smith and Marsden (2009) in support of this rationale, stating "Only a small portion of eggs are deposited in nests or remain there once deposited. This may reflect a bet-hedging spawning strategy that Sea Lamprey have evolved so that a small percentage are protected in the nest while the majority is essentially broadcast which could help ensure that some portion of the eggs are located in favorable habitat, such as the interstitial spaces in the substrate."

   We have reviewed the referenced paper and can find no mention of this bet-hedging hypothesis. Results of their research showed that in the laboratory, eggs hatched on both silt and gravel substrate and predation rates did not differ between the two substrate types. However, in their field investigations, eggs deposited in depositional areas had near zero viability relative to eggs hatched in gravel. Likewise, predation rates were much higher over silt substrate versus gravel substrate, leading to the conclusion that depositional areas are "inhospitable environments for egg incubation" (Smith and Marsden 2009).

   Smith and Marsden (2009) ascribe the high proportion of eggs dislodged from sea lamprey nests to stream discharge (not to any bet-hedging strategy), hypothesizing that in low discharge years, eggs may be transported short distances to suitable gravel substrate which could result in high survival and large year-classes; alternatively, in high discharge years, eggs may be transported farther, settling out into depositional areas with silt substrate, leading to high mortality due to predation or suffocation.

Based on the conclusions of Smith and Marsden (2009), the Service's position is that conditions in the nest are best suited for successful egg hatching and survival and conditions that promote egg retention in the nest (including flows within the operational control of the projects) should be examined.

2. Another mitigative factor identified by TC is that not all lamprey nests may have been occupied (i.e., were not "active" nests with eggs and/or larvae in them) and an unoccupied nest that becomes exposed does not constitute a detrimental effect. This argument may or may not be true. It could be that the nest is unoccupied because of abandonment in response to fluctuating water levels due to project operations. Nest abandonment could constitute or equate to a detrimental effect, because even though there is no direct impact on incubating eggs, abandonment could represent lost production potential if spawning lampreys had to construct another nest in sub-optimal habitat.

3. A third mitigative factor identified by TC is that ammocoetes have been shown to survive some dewatering (Liedtke et al. 2015). We believe stakeholders have previously pointed out that the subject study was directed at nests containing eggs, not burrowed ammocoetes. TC has provided no data relative to the survival rates of dewatered eggs.

6.3 Scour and Flushing

As in section 6.2, this section contains TC's description of potential mitigating factors to project effects based on degradation, scour and deposition. One of the factors identified is that deposition of sediments likely is not detrimental and may be protective. Again TC uses Smith and Marsden (2009) to support this contention, stating that the authors "found that Sea Lamprey eggs incubated in fine silt survived at a higher rate than those incubated without substrate" and "that suffocation by silt may not be a major factor influencing mortality of lamprey eggs." In fact, while results of Smith and Marsden's (2009) laboratory experiments did show higher egg survival on silt and sand versus gravel, the field trials revealed that no eggs survived to hatch on silt. Further, the authors conclude that "Our field studies indicate that eggs deposited on silt substrate are more vulnerable to predation, drift, or both than are eggs deposited on gravel." Clearly there appears to be a distinction that should be made between eggs incubated in silt (which field trials indicate does not result in hatch success) and silt and sand that may settle over a lamprey nest during the course of the spawning season, a factor not addressed in Smith and Marsden (2009).

6.4 Conclusions

Based on nest elevation analysis using both empirical water level logger data from 2015 as well as hydrologic data from five representative water years, TC determined that, of the 16 nests where spawning activity was verified, three sites did not experience project effects, nine sites experienced moderate project effects (where some, but not all identified nests, were dewatered periodically during normal operations), and four sites experienced project effects (where all nests were dewatered periodically during normal operations).

While TC raises a number of what it deems mitigating factors, we do not fully accept these as discussed above. The fact remains that results indicate project operations impact sea lamprey spawning through fluctuating water surface elevations which periodically dewater lamprey nests. What we do not know is the overall proportion of available habitat affected by project operations. The 2015 data indicate that up to 81 percent of identified nest sites were dewatered at some point during the spawning season. As TC notes in the report, the model analysis does not reflect specific conditions observed in 2015 (which was an unusually wet June, leading to higher-than-average water surface elevations); thus, using the model is problematic in terms of assessing actual project effects. The Service does not disagree. It is possible that in a more typical water year, lamprey nest sites would have been located in different areas (including different tributaries), which could then make them either more or less susceptible to project-induced effects such as dewatering. Unless the study is repeated over multiple years under varying hydrologic conditions, there is no way to know for sure, and we must rely upon the data presented in the report.

Study 21 American Shad Telemetry Study - Appendices A though E

The objectives of this study include: (1) characterizing the effect of project operations on behavior, approach routes, passage success, survival, and residency time of adult American shad as they move through the Vernon Project during upstream and downstream migration; and (2) characterizing whether project operations affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the project-affected river reach downstream of Vernon Dam and river reach from Vernon Dam to Bellows Falls Dam.

We have numerous concerns regarding the American Shad Telemetry Study Report, including: (1) agreed upon details of the study goals and objectives were not addressed; (2) there is a lack of clarity of reported methods and data; (3) there is limited data presentation; and (4) there is very limited results description, data analyses, or discussion as specified in the Revised Study Plan and approved by FERC.

Representativeness of 2015 River Flows

An overarching concern for the Service is the representativeness of environmental conditions during the study, their effects on obtained data, and the ability to subsequently address Study Plan goals and objectives. River discharge has implications on several identified goals and objectives, especially as observed in the month of June and early July in 2015.

The Pre-Application Document (PAD) for the project provides station exceedance curves for the period 1972-2011. For the month of June, river flow exceeded station capacity 12-13 percent of the time and river flow exceeded station capacity approximately 8 percent of the time in July. Hourly Vernon Station operations data show that spill at the project for the month of June 2015 occurred 65.5 percent of the time (472 of 720 hourly measures). The mean reported discharge of those hourly spill events is 6,904 cfs. For the month of July, spill occurred 57.0 percent of the time (110 of 193 hourly measures) in 2015. The mean discharge level of those hourly spill events is 6,854 cfs. As such, the frequency of flows exceeding station capacity for June 2015 was five times greater than the long-term statistics cited in the PAD, and for July, the frequency of flows in excess of station capacity were seven times the long-term statistics cited in the PAD.

The Shad Study had several study components, including upstream passage, downstream passage, and spawning, all of which can be affected by river discharge and project operations We believe the frequency, timing, duration, and magnitude of these spill events require specific analysis relative to the impact of these events on results and conclusions. The non-representative flow conditions may also result in insufficient information upon which to draw conclusions and a second year of study may be needed. However, that determination cannot be made based on the type and level of analyses conducted to date and the results that were presented in the current report, as more complete data analysis and a thorough interpretation of the results are needed.

Upstream Passage Evaluation

Effective fish passage includes the attraction or guidance of the fish to the fishway entrance and approach rate (or "near field" behavior as defined in the report), entry into the fishway and success in passing upstream through the ladder into the headpond. The study report fails to provide adequate data or analysis to demonstrate effective passage as described below.

Entrance Forays

The evaluation of upstream passage was designed to provide data, analyses and results to: "characterize effects if any of project operations on behavior, approach routes, passage success, survival…during both upstream and downstream migrations…assess near-field attraction to, and entrance efficiency of the Vernon fish ladder" and assess "the effects of project operations on upstream passage…"

At the August 25, 2016 meeting, the term "foray" that was used in the report was defined by Normandeau Associates staff as an event that starts when a shad enters the near-field area of the fishway entrance, and ends when it leaves that area, irrespective of the number of times the fish enters or leaves the fishway entrance. Therefore "forays" into the ladder are inclusive of both fish that were outside the fishway entrance and those that had entered the fishway. Analysis based on this broad definition of "foray" confounds the data related to behavior at the entrance. More specific information is needed to understand how near-field conditions in the tailrace and fish ladder entrance conditions affect entry into the ladder under varied operational conditions during the period of time a tagged fish was present in the ladder entrance area.

Actual attempts to enter the fishway entrance and drop outs occurring multiple times would, based on the report analysis, result in a single "foray" over an extended period when unit operations can change. Each entrance attempt needs to be evaluated individually to assess whether different operational conditions affect entry. Multiple entries indicate a problem within the fishway that should be identified and corrected. Lumping entries obscures behavior details and potentially masks the extent of passage problems.

Time-to-Event Analysis

Data collected during fish passage studies at hydroelectric projects reflect a wide range of operational and environmental conditions which require appropriate considerations in data analyses to avoid misrepresenting the data or drawing misleading conclusions. Following the March 2016 Updated Study Report meeting, there was no discussion about alternative approaches TransCanada could take to analyze the telemetry data. Therefore, the Service's May 2, 2016 letter to FERC on the March-issued study report included a request, detailing the need, rationale, and benefits of using the "time-to-event analyses" approach described in Castro-Santos and Perry (2012) to best understand project effects. This method uses continuously recorded data (e.g., turbine discharge, spill discharge and receiver detections) at user-defined time intervals. For example, the analysis may assess data from telemetry receivers at 15 minute intervals, grouped by area of management interest, with operational data also at 15-minute time intervals. This approach avoids biases inherent in simple, proportional examination of the data. We note that data already collected by TC is conducive to time-to-event analysis. Further, Normandeau Associates has performed this analysis on a similar telemetry study on the Kennebec River.

As part of Study 21, TC was to examine and report on how operational conditions relate empirically to fish successfully locating the near-field fishway attraction flow, entering the fishway, and passing the fishway to the headpond. This includes information on failures in each of these steps, which provide important insights into the impacts of project structures and operations on successful passage, ways to minimize impacts, and additional information and evaluation needs. The approach of using proportional fish passage measures, including binning documented passage conditions for tagged fish at the instant of passage, is inadequate for examining various operational and environmental effects that the fish encountered over the period of time they were in the study area(s). Tagged fish were not exposed to a set of constant project and environmental conditions from the time of arrival in the tailrace to a later time-specific passage event, such as ladder entry. The study report (Table 5.3-3) notes the average time from arrival in the tailrace to entrance in the area of ladder attraction flow was 2 days 13 hours with a range of 22 minutes to 10 days. The supplemental hourly operations data shows all the conditions fish experience such as turbine units operated, rates of turbine discharge, and spill discharge change in a relatively short time step. This information highlights the inadequacy of only looking at the data of a specific operational or behavioral variable at the instant a fish made an important passage transition, such as from attraction flow (near field) into the ladder entrance.

Castro-Santos and Perry's (2012) time-to-event analysis method uses fish passage rates rather than proportions and binned instantaneous event/conditions to account for time-varying project effects. It also allows for consideration that each individual tagged fish is present for variable periods of time in study areas as they approach, enter or fail to enter the ladder and pass. Attempts to reduce the data into components of x number of shad passing under a series of binned operational options do not account for how many fish were present in each of those reported binned options, changes the fish encountered from varying arrival times (early morning, mid-day, or late day) relative to operations, the number of attempts they make to pass, the duration of their exposures to various conditions and the subsequent passage outcomes, whether successes or failures.

The time-to-event approach would allow all observations to be included as identified variables shift over time, allowing for assessment of how the tagged fish responded at each decision point like at fishway entry (number of attempts, time to enter, successful entry, failures, subsequent attempts). For example, did fish experiencing lower discharge conditions, and therefore greater proportional fishway attraction flow, demonstrate increased rates of entry in less time and did that increase affect success in passing to the exit of the ladder? These are all examples of what can be addressed by using the "time-to-event" analytical approach. We note that FirstLight Power has agreed to use this approach in evaluation of telemetry data from similar studies at the Northfield Mountain Pumped Storage and Turners Falls projects.

Results and Discussion

The fishway attraction water system (AWS) is shut off at night, yet tagged fish were noted as entering the fishway when the AWS was off. This finding reinforces the conclusion from another Connecticut River shad study that shad do not cease upriver movement at night (Dr. Ted Castro-Santos, U.S.G.S., personal communication). It is important to understand how variable unit operations and generation flows relate to both day and night fishway entries and the subsequent success or failure to pass. These evaluations would best be described by a rate-based analysis.

It is possible that, given the extensive period of high spill, the measures of residency time of fish in the tailrace moving upstream may have been reduced by some measurable quantity or in relation to changing operations, or conversely may have been more prolonged under lower flow operations. This factor should be analyzed and would be best evaluated by the rate-based approach.

We also have concerns with the data and conclusions provided by TC and presented in the report and its appendices. For example, TC identified 70 radio-tagged and PIT-tagged (dual-tagged) fish in the study area. Of these, eight shad appear from the telemetry data to have only reached Stebbins Island, four were detected by FirstLight (FL) telemetry to be in their study area at the same time as TC noted detections and one fish (#27-47) had conflicting detections between the TC and FL databases. Additionally, two dual-tagged fish (# 27-164 and 8-172) were detected in the fishway with PIT antennas but not by any radio receivers. Lastly, the report is not clear on the type of radio-tag receiver used at each receiver location, which has implications for the use of the "continuous record time out" (CRTO) option that Lotek receivers allow. The Orion receivers maintain a full period of record. The Study Plan did not identify the use of the CRTO feature, which has potential implications to data analysis. Receiver locations, types and settings need to be explicitly identified in the report.

Downstream Passage

At the August 25, 2016 TC report review meeting, the Service noted the omission of any survival data or discussion in the report regarding upstream or downstream passage mortality, as required in the Study Plan. The Study Plan objectives were to "characterize project operational effects on post-spawn downstream migration route selection, passage efficiency, downstream passage timing/residence, and survival related to Vernon Project." Failure to provide this analysis is a significant deviation from the Study Plan and must be rectified in a revised report.

As noted in our comments on the upstream passage evaluation, the proportional passage approach used for the downstream analyses, binned by intervals like river discharge at the instant of passage, does not fully describe project operational effects The rate-based approach should be used. As an example, the only information on residency time of outmigrants in the project forebay is reported in a single sentence (page 40 of report) that notes a median residency time upstream of Vernon of just under 10 hours. Given limited data, it is important to understand the variable conditions each tagged fish experienced when it reached the dam and how these conditions subsequently influenced its: (1) route selection(s); (2) delay before passing; and (3) survival. There is no way of knowing from the report how many different tagged fish were present among defined binned table results, when and where tagged fish were present and for how long, and whether there are any additional substantive results to inform our understanding of project effects. Rather, only the reported "passage events" at the exact moment that passage occurred was summarized.

The current report provides no account or analyses to address the following questions: (1) did fish arrive at the dam or forebay disproportionately at higher as opposed to lower river discharges; (2) did fish that arrived in higher flows, or with changing status of spill gate use, behave differently, use different routes, pass more quickly or slowly, or have different fates than those not exposed to such conditions; and (3) under spill and no spill conditions, and under varied operations, what were the differences in time of residency, route selection, passage, and ultimate fates? Determining passage rates and accounting for varying rates of river discharge, unit discharge and the other variables should be more fully examined to understand the interaction with project effects.

In addition, we have examined the telemetry data records TC provided and have drawn different conclusions on the route selection and fate of a number of test fish based on receiver detection locations, signal power and duration of tag signals (data assessment by Don Pugh). We disagree with route assignments for six of the 40 radio-tagged fish determined to have passed downstream of Vernon. We also identified six fish that did not pass the project that TC listed in Appendix B as passing. TC also listed two fish as not passing (54-20 and 54-197) that actually passed the project. We assign eight fish as having passed by an "unknown route," whereas TC assigned five fish to an "unknown route." We agree on eight of the nine fish TC identifies as having passed in spill conditions.

We provide the rationales for our assigned route of passage, or failure to pass and fate/mortality in Table 1. The fish route assignments and survival of passed fish shown in Table 1 lead us to different conclusions relative to key study goals and objectives. One example is the stated use of the Fishpipe as the "preferred passage route" and the study report states 11 fish used that route, as opposed to our determination that only five used it.

Table 1. Downstream radio-tagged fish route assignments by Don Pugh and TC and rationales for differences in assignments and fate (mortality or not). TC route Fish tube is the same as the Fishpipe located between Units 4 and 5. Fish having different route assignment are highlighted.

FishCode	DP Route	TC Route[A]	Live/Die	Comment
27-165 (A1)	Fishpipe	Fish tube	Live	
27-181 (A1)	Not Down	Unknown	*Upstream Mortality*	There is only 1 detection in the database (in the turbine forebay) and no detections below the dam, and no detections by FirstLight (FL) either by mobile tracking or fixed receivers.
27-182 (A1)	Unknown	Unknown	*Morality*	Passed the Vernon dam on 5/29, was detected four times by NAI mobile tracking from 6/5 to 7/1 downstream of the dam. FL determined 3 times that it was dead (burst timing) between the Vernon dam and NMPS on 6/3, 6/9 and 7/6.
27-184 (A1)	Spill	Spillway	*Mortality*	FL mobile tracking 6/27 between NMPS and TFalls dam – tag burst time.
27-185 A-1)	Not Down	5-8	*Upstream Mortality*	Last upstream detection 5/20, first downstream 6/16, in tailrace until 7/4. No mobile or fixed location detections by FL.
27-186 (A1)	1-4	1-4	Live	
27-188 (A1)	5-8	5-8	*Mortality*	Passed dam on 6/15 and was detected in the tailrace or spillway until 7/5. No mobile or fixed location detections by FL.
27-191 (A1)	1-4	1-4	*Mortality*	Passed dam on 6/15, NAI detected by mobile tracking 6/15 and 6/27 below the dam. FL mobile tracking mortality 7/6 between NMPS and TFalls dam.
27-32 (A1)	Fishpipe	Fish tube	*Mortality*	FL mobile tracked 6/17 as mortality between Vernon dam and NMPS.
44-104 (A1)	Not Down	Fish tube	*Upstream Mortality*	Exited fishway upstream 6/14, detected in forebay 6/16, last record at turbine intake 5-8 on 6/25. No downstream records by either NAI or FL.
44-168 (A1)	1-4	1-4	Live	
44-191 (A1)	Fishpipe	Fish tube	*Mortality*	FL mobile tracked 6/30 as mortality between Vernon dam and NMPS. No fixed FL detections.
44-192 (A1)	5-8	5-8	Live	
44-193 (A1)	9-10	9-10	Live	
44-194 (A1)	Spill	Spillway	Live	
44-195 (A1)	5-8	5-8	*Mortality*	Passed the dam on 6/8, detected in spillway or tailrace from 6/8 to 7/10. No mobile or fixed location detections by FL.
44-198 (A1)	Spill	Spillway	Live	
44-200 (A1)	Spill	Spillway	Live	
44-202 (A1)	Fishpipe	Fish tube	Live	
44-203 (A1)	1-4	1-4	*Mortality*	Passed the dam on 6/5, located in tailrace or spillway until 6/10. NAI mobile tracking on 6/13 notes fish south of spillway and as a mortality. No mobile or fixed location detections by FL.
54-20 (A1)	1-4	Did not pass	*Mortality*	Turbine Intake 1-4 is last upstream detection, spillway is first downstream on 6/14, remote detections in the spillway or tailrace until 7/5, and four NAI manual tracking detections in tailrace in the spillway or tailrace on 6/18, 6/19, 6/27 and 7/1. No mobile detections by FL. Last fixed FL detection 5/27 as fish moved upriver.
54-182 (A1)	Fishpipe	Fish tube	Live	
54-184 (A1)	9-10	9-10	Live	
54-185 (A1)	9-10	9-10	Live	
54-196 (A1)	1-4	1-4	Live	
54-197 (A1)	Unknown	No passage record	*Mortality*	Detections below dam 6/4 to 6/10, detected at Stebbins Island 6/10. NAI mobile detection 0.5 mile below Ashuelot River, 6/27. No mobile or fixed location detections by FL.
54-198 (A1)	Unknown	Unknown	*Mortality*	Passed Vernon dam 6/1, NAI mobile detection 6/27 spillway/tailrace. No FL mobile or fixed detections.
54-199 (A1)	Not Down	Fish tube	*Upstream Mortality*	Fishpipe very low power detection (39) 6/16 4:56 with high power detections later on 16th in forebay and a manual NAI detection on 6/22 in the forebay. No mobile or fixed location detections by FL.
54-200 (A1)	Not Down	Fish tube	*Upstream Mortality*	Forebay detections from 6/7 to 6/19, detected in the forebay after fishpipe detections, no downstream NAI detections. No mobile or fixed location detections by FL.
54-201 (A1)	Unknown	Unknown	*Mortality*	Two mobile FL mortality detections between Vernon dam and NMPS on 6/30 and 7/6.

54-205 (A1)	Unknown	Spillway	Live	Detection in forebay 6/15 5:12 to 5:17, detection in center of turbine discharge 5:17, then at spillway 5:22.
54-49 (A1)	1-4	1-4	*Mortality*	FL mobile tracked 7/6 as mortality between NMPS.and TFalls dam.
54-82 (A1)	Spill	Spillway	*Mortality*	Passed Vernon upstream 5/27, passed down Vernon 6/25, at Stebbins 6/25 until 7/9. No FL mobile detections or fixed location detections after 5/23.
8-161 (A1)	Spill	Spillway	*Mortality*	FL mobile tracked 7/6 as mortality between Vernon dam and NMPS. No FL fixed detections.
8-163 (A1)	Unknown	Fish tube	Live	Detected at fishpipe 6/21, forebay detections after fishpipe, first downstream detection on 6/24 4:52 is east side turbine discharge (weak) then 5:00 at spillway (strong). Detected Stebbins 6/24 5:42. Passed TFalls alive.
8-167 (A1)	Spill	Spillway	Live	
8-186 (A1)	5-8	5-8	*Mortality*	Passed 6/25, NAI manual detections in Spillway 6/27 and 7/1. No mobile or fixed location detections by FL.
8-188 (A1)	5-8	5-8	Live	
8-189 (A1)	5-8	5-8	Live	
8-190 (A1)	Not Down	5-8	*Upstream Mortality*	Detected 5/27 at intake 5-8, next at turbine forebay 6/5 (strong power), then at center turb discharge 6/27. No mobile or fixed location detections by FL.
8-191 (A1)	5-8	5-8	Live	
8-192 (A1)	Unknown	Unknown	Live	
8-193 (A1)	Spill	Spillway	Live	
8-194 (A1)	1-4	1-4	Live	
8-195 (A1)	Spill	Fish tube	Live	Detected 6/22 23:10 at fishpipe, forebay detections until spillway forebay at 6/23 23:10, then spillway at 23:13, Stebbins detection at 23:38.
8-61 (A1)	Unknown	Fish tube	Live	TC lists pass 6/5, NAI mobile detection 6/6 upstream of Rt. 9 bridge (several miles upstream of dam), last upstream detection at turbine forebay 6/7 23:08 and first downstream detections 23:10.

A - TC data appendix labeled the "fishpipe" as the "fish tube" - no fish used the fish tube

We evaluated survival using the telemetry databases provided by TC and FL. We identified 15 mortalities of fish passing downstream of Vernon Station. These assignments were based on identified mortalities in TC's database, the stationary nature of tag signals over time and from mobile tracking by FL where the burst interval was 11 seconds or greater. This information results in an "aggregate" (all routes and conditions from this study) mean project mortality rate of 37.5 percent.

Our evaluation of shad passage survival for each route, shown in Table 2, illustrates that there is substantial mortality of downstream passed shad through turbines and that those turbine routes are the primary passage routes when there is no spill (Table 3). Our evaluation further identifies that fish passed in spill and through the Fishpipe also suffer mortality. These data are absent from the report, despite the fact that passage survival was clearly identified as an objective in the approved Study Plan. We determined the passage mortality rates for units 1-4 and units 5-8, to be 26-57 percent and 11-61 percent respectively. These mortality rates are within the estimated mortality range based on the Franke et al. 1997 calculation TC used in Study Report 23 - Fish Impingement, Entrainment, and Survival. Three fish were determined to have used units 9-10 and all three survived, but we have little confidence in this result, given the low sample size, and we see no supporting information from other sources to suggest that turbine survival could possibly be 100 percent. Study Report 23 reports an estimated survival rate range, converted here to mortality, of 24-44 percent for units nine and ten. Unless additional project-specific mortality data through units nine and ten are collected, we intend to use the Franke et al. 1997 for mortality of fish using those routes.

Table 2. The five utilized routes of fish passing down over the Vernon Dam and the mortality of those fish by route.

	Route						
	Fishpipe	Spill	1-4	5-8	9-10	Unknown	Total
Live	3	6	5	4	3	4	25
Mortality	2	3	3	3	0	4	15
% Mortality	40.0	33.3	37.5	42.9	0.0	50.0	37.5

Table 3. Route of passage for the 16 fish that passed **when there was no spill**, the percent through each route with the unknown route and without (only fish with known passage routes).

Route	#	%	% Units	% w/o Unk.	% Units
1-4	4	25.0		33.3	
5-8	4	25.0	62.5	33.3	83.3
9-10	2	12.5		16.7	
Fishpipe	2	12.5		16.7	
Unknown	4	25.0			

It is important to note that spill-passed fish experienced substantial mortality (33.3 percent). Eighty-five percent of the total amount of spill flow passed through Tainter gates 1 and 2 during the study period (TC hourly operations data, 5/19 to 7/7). These gates are located above large, exposed/dry, rock ledge outcroppings on the eastern portion of the Dam. The Service would not normally recommend the use of a bottom-opening gate, such as a Tainter gate, as the primary route for downstream migrants and, given that these particular gates discharge to an area that is likely to cause injury and mortality, are even less preferable as a passage route.

The above-noted frequency of spill in 2015 has significant effects on Study 21 results. The most obvious is that the high frequency of spill in 2015 may confound the determination of passage results and does not represent typical June and July operational conditions when post-spawn fish are most likely to move downstream. In fact, 60 percent of study fish passed under spill conditions. The higher frequency of spill may also reduce the residency time of outmigrant shad that encounter the project. However, the report does not examine or report data, analyses, or results on the study objective of residency or delay. Rather, the report includes statements like "…most shad passed May 19 to June 25…comparable numbers passed during the day and night," and includes tables of binned operations data or flow data at the time of passage.

In the discussion, the report states "there were no patterns to route selection based on time of day or project discharge flows." This statement is unsupported by data or analysis. The statement that the median residency time in the Vernon forebay of less than 10 hours does not hinder the timing of the migration is at best misleading, given the failure to fully analyze the residency time of fish that arrive in non-spill and lower discharge conditions.

Spawning Surveys

Results

Table 5.6-2 summarizes egg and larvae collection data by habitat type. For the riverine sites, data are only broken down by mesohabitat type, not by substrate. While we understand that substrate was characterized differently in impounded versus riverine segments (via side scan sonar in the former case and by visual observation in the latter case), it still should be possible to identify what the substrate was at a given riverine site, as that information was necessary to conduct the instream flow study. We recommend revising the table accordingly. It also would be helpful to have the data broken down between Bellows Falls riverine and Vernon riverine (rather than lumping both riverine segments together.

During each ichthyoplankton collection event, water quality and velocity data were collected, but not depth. Given that depth is one of the key physical habitat parameters that changes based on project operations, it should have been measured. TC should explain why depth was not measured. We do note that in Section 6.3, TC states that shad were "generally found in…depths between 1.0 and 2.9 meters…" However, the associated spreadsheets (Appendices C and D) only contain depth data for where the ichthyoplankton net was set.

Ichthyoplankton sampling was conducted downstream from where shad were tracked. Using this method, TC may have missed "active" spawning sites with no tagged shad. Since very little splashing was noted at the sampling sites, indicating ongoing spawning, it is not clear whether or not spawning was occurring at the sample sites. Since eggs drift downstream, eggs collected may have been collected from ongoing spawning at that site, but could have drifted from undetermined spawning locations upstream. Given that actual spawning cannot be confirmed at the sample sites, it is difficult to draw conclusions based on the egg collections.

Discussion and Conclusions

The report includes a statement that "Shad eggs and larvae were found throughout the study area in a variety of habitat conditions and flows, which indicates that the entire study reach is suitable for spawning." This statement is not supported by the collected data and is not a reasonable conclusion, based on shad spawning habitat preferences. Since eggs were only collected at 30 percent of the sampling locations, the results do not demonstrate that spawning was widespread (and as noted above, collected eggs do not necessarily come from the sampling location). Since sampling was not randomly distributed across all habitat types, but only occurred at locations where tagged shad were tracked, there is no data to support the statement that the entire study reach is suitable for spawning.

According to the Revised Study Plan, observed effects of project operations on spawning activity were to be classified into three categories: (1) no effect; (2) moderate effect; and (3) adverse effect. "Moderate effect" was defined as "Observable possible effect on normal spawning activity: spawning may have been hindered but eggs were collected." Notwithstanding our question above about asserting that spawning occurred at a specific site based only on the collection of eggs, splashing was not identified at most locations and therefore spawning was only assumed based on a tagged fish presence. Without actual observations or data on actual spawning activity, it is not clear how "moderate effect" could be determined.

It does not appear that any directed testing of operational impacts was conducted; ichthyoplankton samples were collected irrespective of whether the project was generating or not. It was the Service's understanding that on/off multi-unit testing (as was done downstream of the Turners Falls Dam) or a similar methodology would be used to determine if generating conditions influenced spawning behavior.

From figures 6.3-1 and 6.3-2, it is difficult to actually tell what river flow was during each survey event, but Table 5.6-1 clearly shows that only one collection per site was made, which does not allow for comparing spawning behavior under different sets of conditions (at a specific site).

In addition, because flows were unusually high in June of 2015, there were relatively few times when only the minimum flow was being released during the study, adding to the difficulty of discerning potential impacts that typical peaking operations may have on spawning. Figures 6.3-1 and 6.3-2 show overall discharge at Bellows Falls and Vernon relative to station capacities, as well as dates when spawning was or was not observed. Based on those figures, it appears that 12 of the 21 surveys downstream of Bellows Falls Dam and four of nine surveys downstream of Vernon Dam took place under spill conditions. So, essentially half of the data collected does nothing to inform potential project impacts.

To reiterate, the purpose of this study component was to assess operational effects, which requires collecting observations of shad spawning behavior and ichthyoplankton samples over varied operating conditions within a survey night at a given sample site. For instance, the field crew would go to a spawning location and collect an ichthyoplankton sample under full generation. An hour later a unit (or units) would be taken offline and another sample would be collected. This is the general methodology used by FL at the Turners Falls Project (although due to shortnose sturgeon issues, ichthyoplankton was not able to be collected downstream of the dam, so spawning behavior via splash counts was assessed).

Given the level of information collected by TC, the Service does not believe an acceptable project-effects analysis on shad spawning can be completed. However, similar to our response to FL's report, we will postpone a decision as to whether the study should be redone or not until we receive the final Instream Flow report, as the habitat persistence analysis for shad spawning that will be undertaken as part of that study may be sufficient to determine project effects.

Notwithstanding our position on this issue, we do request that TC add discharge/operational data to Appendix C or D.

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.

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