TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 18
American Eel Upstream Passage Assessment

Supplement to Study Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

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List of Abbreviations

CRWC	Connecticut River Watershed Council
°C	Degrees Celsius
FERC	Federal Energy Regulatory Commission
FWS	U.S. Department of the Interior – Fish and Wildlife Service
ILP	Integrated Licensing Process
NHDES	New Hampshire Department of Environmental Services
NHFGD	New Hampshire Fish and Game Department
RSP	Revised Study Plan
TransCanada	TransCanada Hydro Northeast Inc.
TU	Trout Unlimited
USR	Updated Study Report
VANR	Vermont Agency of Natural Resources
VDEC	Vermont Department of Environmental Conservation
VY	Vermont Yankee Nuclear Power Plant

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1.0 INTRODUCTION

This document provides supplemental results from observations made during 2016 as part of the American Eel Upstream Passage Assessment (ILP Study 18) conducted originally in 2015 in support of Federal Energy Regulatory Commission (FERC) relicensing efforts by TransCanada Hydro Northeast Inc. (TransCanada) for the Wilder Hydroelectric Project (FERC Project No. 1892), Bellows Falls Hydroelectric Project (FERC No. 1855), and the Vernon Hydroelectric Project (FERC No. 1904).

The June 29, 2016 Study Plan Determination issued by FERC on the study report that was filed March 1, 2016 stated:

"A primary objective of Study 18 was to determine where eels concentrate and evaluate the effectiveness of using traps to collect eels from these areas as a means for providing upstream passage. Concentrations of eels were identified at the Vernon Project (80 eels) and a study of the potential to trap eels in the fishway as a means to provide upstream passage during periods when the fishway does not operate would be consistent with the study objectives. Because this information is needed for staff's analysis and development of license articles (section 5.9(b)(5)), we recommend that TransCanada proceed with the proposed eel trapping in the Vernon fishway during 2016."

2.0 STUDY GOALS AND OBJECTIVES

As stated in the Revised Study Plan (RSP), the goal of this study was to provide baseline data on the presence of American Eels attempting to move upstream of the Wilder, Bellows Falls, and Vernon projects and the locations where they congregate while attempting upstream passage.

The goal of the 2016 supplemental effort was to collect information on upstream migrating eels at Vernon when the Vernon fish ladder was not operating. During the 2015 study, the fish ladder was operated continuously for Study 17 (Upstream Passage of Riverine Fish Species Assessment) throughout the American Eel migratory season.

Objectives for the 2016 supplemental effort were to:

- conduct systematic surveys of eel presence/abundance at Vernon tailrace and spillway locations in order to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures; and
- collect eels with a site-specifically designed temporary eel ramp trap installed near the upstream fishway entrance, an area that had been identified from the 2015 surveys and from upstream passage data collected in 2015 in Study 17 as the primary area of potential eel concentration, to assess whether eels can be collected and passed in substantial numbers.

2.1 Study Area

The 2016 study area included the Vernon tailrace and spillway locations. Systematic surveys were conducted in the spillway area, especially where significant leakage flow existed.

3.0 METHODOLOGY

3.1 Systematic Surveys

Visual surveys were conducted weekly at night, on foot or from a boat downstream of Vernon dam, from July 28, 2016 through October 20, 2016. Visual surveys began at least one-half hour after sunset. Complete surveys took approximately 1-2 hours. Surveys were done in areas where eels were likely to congregate below the dam, though survey sites were designed to systematically view virtually all of the spillway face of the dam where it meets the water, as well as specific trickle areas, the log sluice discharge, powerhouse face, fish ladder entrance and eel ramp base area, and a riprapped area downstream of the fishway entrance.

Data collected included location, observation of eels (presence, absence, numbers, and estimated sizes), time and date of observation, notes on weather conditions, and moon phase. Eel lengths were estimated and classified as <10 cm (<4 inches), 10-20 cm (4-8 inches), or >20 cm (>8 inches). Note that this varied from the length classification used in 2015 (0-6 inches, 6-12 inches, 12-18 inches, and >18 inches) to conform to the classification system used at Turners Falls and Holyoke dams. Other data that were recorded included notes on project operations during sampling such as spill gates that were open. There were no high flows greater than the project's maximum generating capacity, but the trash/ice sluice was operated on occasion during the 2016 study. Survey locations were similar to those surveyed in 2015 (see Figure 4.1-1), except that survey site 15 (fish ladder) was not surveyed because the fish ladder was dewatered on July 18, 2016 and remained dry for the entirety of the 2016 eel survey period.

3.2 Temporary Eel Ramp Trap

Site selection for installation of a temporary eel ramp trap was made during a site visit / consultation of TransCanada and Normandeau with staff from FWS, VFWD, and USGS on July 20, 2016. The eel ramp design was based on the Haro (2013) generic temporary eel ramp trap design modified for the site (Figure 3.2-1).

The ramp framework was constructed from 6063 aluminum channel, 37 feet long, 18.5 inches wide, and 3.5 inches high. The framework supported Milieu elver ramp climbing substrate (http://www.milieuinc.com/products) and was covered, except for the bottom 8 feet, with 0.25-inch thick PVC sheet. The substrate was composed of a molded ABS plastic tray with three sections (overall width of 18 inches) with staggered 1-inch diameter PVC vertical studs. The ramp was installed at an angle of approximately 36 degrees parallel to the downstream face of the dam with its base adjacent to the corner formed by the fish ladder entrance. At minimum tailwater elevation the base of the ramp terminated less than one foot from the wall, and at tailwater elevation five feet higher than minimum, it terminated approximately 7 feet from the wall. The ramp was supported by two davits

mounted on the dam deck, and secured to the wall near its base with an angle bracket. The overshoot at the top of the ramp fell to a drop-off hopper designed to funnel eels to a 32-gallon collection tank with standpipe. The collection tank was designed to allow for reintroduction of water to the ladder via a standpipe. The climbing substrate was wetted by three 0.5-inch diameter flexible hoses, and a fourth hose provided additional water to the drop-off and collection hopper. Attraction water was introduced near the base of the ramp via a 1-inch diameter pipe that was perforated along the lower 6 feet. The overall expected flow rate was 0.08-0.1 cfs (35-50 gpm) supplied by a continuous duty submersible pump. An additional attraction flow was introduced by splashing down the wall adjacent to the ramp base supplied by a second submersible pump.

The eel ramp was operated continuously from September 6 to November 4, 2016 under VFWD Scientific Collection Permit #S-2016-CG and NHFGD Scientific License #F2016-108.

After installation and initial operation, a second site visit was conducted by TransCanada with Dr. A. Haro of USGS on September 21, 2016. That visit resulted in minor improvements to climbing flow volumes and attraction flow position as well as the closure of the fish ladder entrance gate to potentially prevent eels bypassing the eel ramp in favor of the fishway entrance area.

Figure 3.2-1. Vernon temporary eel ramp trap.

4.0 RESULTS AND DISCUSSION

4.1 Systematic Surveys

Over the 13 weeks of surveys, seventy eels were observed at Vernon dam (Table 4.1-1, Figure 4.1-1). The greatest number observed in a single survey was 25 eels on August 18. Eels were observed at nine of 17 survey sites. The greatest number of eels (summed for all surveys) were observed at site #3 (N = 19), which included leakage from stanchion bay 1 through a bedrock outcrop; site #8 (N = 17), which included the apron of tainter gate #3 and the submerged flood gate below it (where most of the count was observed); and site #13, (N = 11), the fish ladder entrance area (Table 4.1-1).

Generally, eels were observed at three discernible site types: the fishway entrance (site #17), an area in the vicinity of the submerged flood gates below three tainter gates and one of the hydraulic panels (sites #7-10), and in the bedrock outcrop below the hydraulic panels and stanchion bays (site #3, 5, and 6) (Table 4.1-2). Collectively, eels were most frequently observed in the submerged flood gates, where 34 eels were observed (49% of the total). As noted during 2015 surveys, researchers felt that eels observed in that location did not appear to be seeking flow or otherwise actively migrating at the time of observation, but instead appeared to be seeking refuge in the submerged structures. Overall, 23 eels (33% of the total) were observed in the bedrock outcrop and because the area was characterized by rivulets of running water and an increase in elevation, those eels appeared to be actively migrating.

Table 4.1-1. Numerical data for Vernon eel observations in 2016[a].

Date	Site Number[b]																	Total by Date
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15[c]**	**16**	**17**	
7/28	0	0	0			0	2	1	0	1	0	0	0	0	.	0	0	4
8/1	0	0	0	0	0	0	0	3	0	0	0	0	2	1	.	0	0	6
8/11	0	0	0	0	0	0	1	1	4	0	0	0	3	0	.	0	0	9
8/18	0	0	6	4	0	0	0	7	3	1	0	0	4	0	.	0	0	25
8/25	0	0	6	0	0	1	0	0	1	1	0	0	2	0	.	0	0	11
9/1	0	0	5	0	0	0	0	1	0	1	0	0	0	0	.	0	0	7
9/8	0	0	0	0	0	0	1	1	0	0	0	0	0	0	.	0	0	2
9/15	0	0	2	0	0	0	0	0	0	0	0	0	0	0	.	0	0	2
9/19	0	0	0	0	0	0	0	1	0	0	0	0	0	0	.	0	0	1
9/27	0	0	0	0	0	0	0	1	0	0	0	0	0		.		0	1
10/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0
10/13	0	0	0	0	0	0	1	0	0	0	0	0	0	0	.	0	0	1
10/20	0	0	0	0	0	0	0	1	0	0	0	0	0	0	.	0	0	1
Total by Site	**0**	**0**	**19**	**4**	**0**	**1**	**5**	**17**	**8**	**4**	**0**	**0**	**11**	**1**	**.**	**0**	**0**	**70**

a. Survey site numbers can be referenced to site numbers in Figure 4.1-1.

b. Sites not visited during a given date due to safety concerns are marked by shaded cells.

c. Site (fish ladder) not surveyed during 2016 because fish ladder was dewatered.

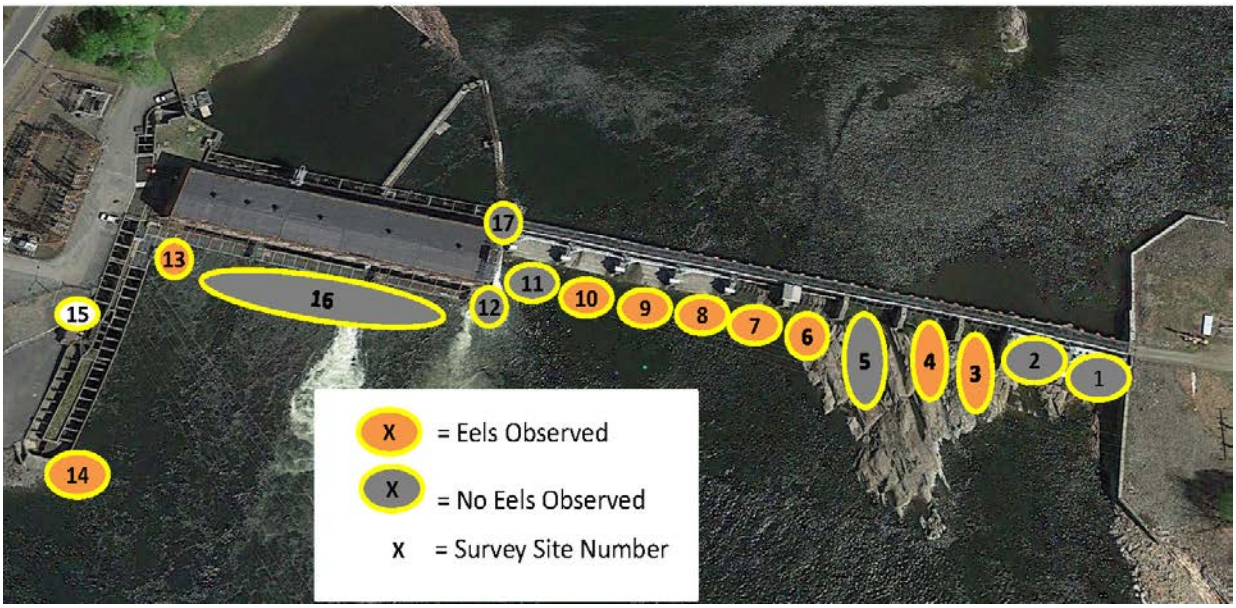

Figure 4.1-1. Vernon nighttime visual survey sites, 2016.

Table 4.1-2. Distribution of eel size classes observed by site and major location type at Vernon dam, 2016.

		Fishway Entrance and Below Fishway		Flood Gates Below Tainter Gates & Hydraulic Panels				Rocks Below Hydraulic Panels & Stanchion Bays			Total
Site Number:		**14**	**13**	**10**	**9**	**8**	**7**	**6**	**4**	**3**	
Size Class	<10 cm (4 in.)	0	0	0	0	0	0	0	0	1[a]	1
	10-20 cm (4-8 in.)	0	1	1	0	7	1	0	2	10	23
	>20 cm (8 in.)	1	10	3	8	10	4	1	2	8	46
Total		**12**		**34**				**24**			**70**

a. Eel size may have been underestimated due to visual distortion from flowing water and water depth.

4.2 Temporary Eel Ramp Trap

The temporary eel ramp trap was operated continuously from September 6 to November 4, 2016 and was checked daily, Monday through Friday for catch with the exception that during the first week of operation it was checked daily per stipulation of the VFWD Scientific Collection Permit.

Only one eel was collected from the ramp trap, on September 23. It was 276 mm (10.9 inches) long and weighed 38 g (1.3 oz.). After processing, the eel was

released to the Connecticut River upstream of Vernon dam from the canoe portage access.

Although catch was limited to one eel, it is important to note that the ramp trap was not installed until September. It is possible that most eel upstream migratory activity had occurred earlier in the season (i.e., during the anadromous fish passage season / fish ladder operational period), as was observed during 2015. Therefore, the catch rate may be representative of eel abundance at Vernon dam. Prior to installation of the eel ramp 89% of all eels observed during nighttime surveys (N=62) had already been recorded. During the period of ramp operation, only eight eels were observed in seven weekly nighttime observations.

As part of its relicensing studies, FirstLight collected and subsequently released nearly 6,000 juvenile eels upstream of Turners Falls dam in 2014 (Kleinschmidt and Gomez and Sullivan, 2016). Although it is unknown how many eels pass the Turners Falls Project undetected, the low abundance observed at Vernon suggests that incidental passage is not substantial. Therefore, the influence that the experimental passage of eels in 2014 (without subsequent experimental passage in 2015 and 2016) may have had on observations of eels at Vernon in 2015 and 2016 is also unknown.

4.3 Size Classes of Observed Eels

In visual surveys, eels classified in the largest size group, >20 cm (>8 inches) dominated observations with collectively 66% of the total (Table 4.1-2, Figure 4.3-1). Eels classified as the 10-20 cm (4-8 inches) group accounted for 33% of the total. One eel was classified in the smallest group, <10 cm (<4 inches), however that classification is questionable for two reasons. Based on observations made at Vernon and farther downstream in the Connecticut River, generally, larger eels are anticipated to be observed at Vernon under current conditions and estimating length of eels in visual observations is inherently difficult.

In observations made at Vernon during 2015, 100% of eels observed were classified as >4 inches (30% were classified as 6-12 inches, 66% were classified as 12-18 inches, and 4% were classified as >18 inches). Approximately 20 river miles (RM) downstream of Vernon at the Turners Falls Project, eels were estimated to be 200-300 mm (8-12 inches) in observations made during 2014 (Kleinschmidt and Gomez & Sullivan, 2015). Specific upstream eel passage was done at Turners Falls in that year as part of FirstLight's relicensing studies, but was not done in 2015 or 2016. Approximately 55 RM downstream of Vernon, at Holyoke dam, the first dam on the Connecticut River, 92% of eels collected and passed upstream were classified as >10 cm (4 inches) in 2015 (Normandeau, 2016).

The dispersion and rate of upstream migration of juvenile eels in the Connecticut River has not been documented, but it is unlikely that the size distribution observed at Vernon would reflect that of the first dam on the River. Sheppard (2015) reported multiple sizes and age classes, and a shift in the overall size distribution of yellow-phase American Eels migrating upstream past multiple dams in Maine rivers. In Rhode Island, Oliveira (1997) reported restricted movement by juvenile American Eels from their initial collection sites, and annual growth rates of approximately 30 mm/year. White and Knights (1997) found that, upstream of the

head of tide, the number up immigrating eels decreased rapidly and the average size and age increased, and that the effect of manmade barriers was greater than distance alone.

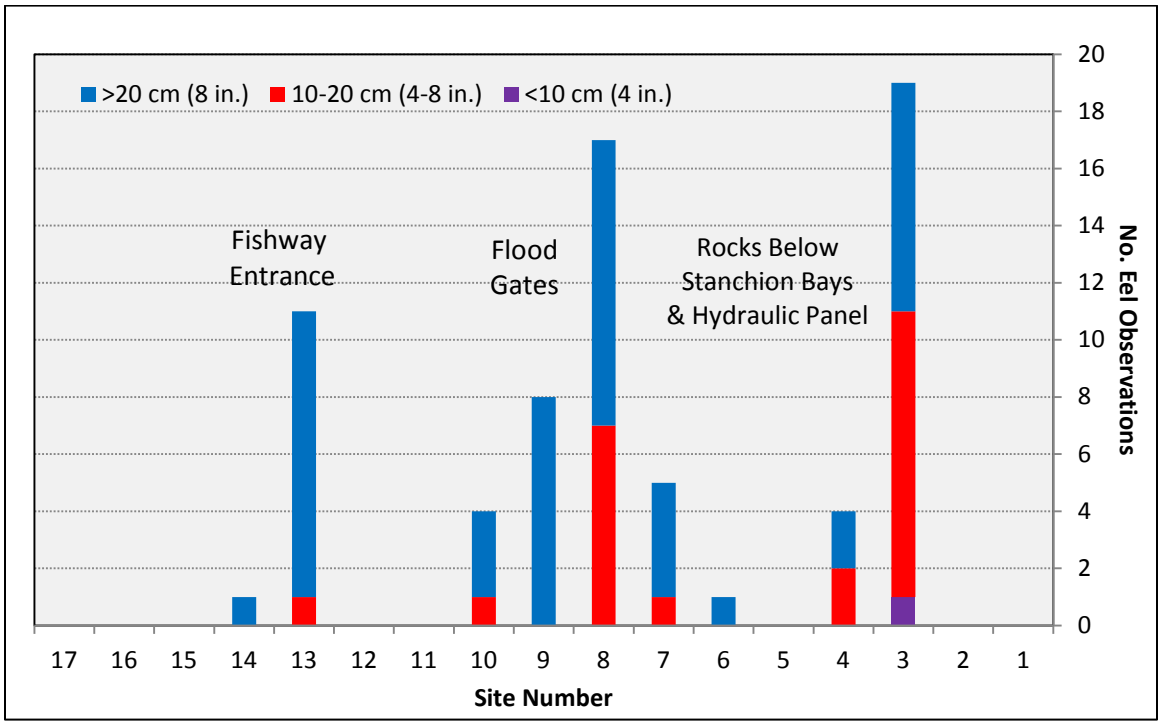

Figure 4.3-1. 2016 Vernon eel observations by site number and size class.

4.4 Environmental Conditions

4.4.1 Water Quality

Water temperature and dissolved oxygen values were collected weekly from the eel ramp trap collection hopper. Additionally, water temperature loggers were deployed near the base of the ramp from September 8 – November 9, 2016 (Figure 4.4-1). The majority of eel observations occurred at the end of July and during August, coincident with the highest observed water temperatures. All eel observations occurred while water temperatures exceeded 15.4°C, 97% (68 of 70) of which occurred when temperatures exceeded 20°C. Overall, 63% (44 of 70) of the eels were observed when water temperature was >25°C (Figures 4.4-2).

4.4.2 Precipitation and Dam Discharge

For many diadromous fish species, including American Eel, periods of significant precipitation that lead to higher levels of river discharge can correlate with increased migration volume (Welsh and Liller, 2013). The 2016 season was characterized as drought conditions, and no significant rain events occurred during July, September, or October. In September, precipitation was only 56% of the 10-

year average. Two rain events occurred during August that cumulatively resulted in higher than average precipitation (Table 4.4-1), though spill conditions never occurred at Vernon during the season. During August, the period of the season with the highest precipitation, the greatest number of eels, 51 (73% of cumulative total), were observed (Figure 4.4-3).

Although precipitation, and therefore project discharge, was relatively low and the number of eels was low, the proportional number of eels observed throughout the season appeared to track increased project discharge (Figure 4.4-4).

4.4.3 Lunar Illumination

Lunar illumination has been suggested as having a potential to contribute to a covariate relationship with hydraulic conditions to influence eel upstream migration once water temperatures are above an appropriate temperature threshold. Past studies have concluded that low light conditions tend to promote eel movement, but even with higher levels of lunar illumination, low light conditions in the water can persist from a variety of factors such as increased cloud cover and turbidity (Welsh and Liller, 2013). Weekly eel observations are presented with daily percent lunar illumination in Figure 4.4-5. Eel observations were distributed across all moon phases. Peak eel observation occurred with approximately 50% illumination during a waning moon in August. As noted in Section 4.4.2, the peak observations appear to be associated with increased discharge, and given the relatively few eels observed during the study, there was no clear relationship between lunar illumination and observations of relative eel abundance.

Table 4.4-1. Monthly total precipitation at Vernon during July – October, 2016 with 10-year average monthly precipitation (TransCanada data).

	Jul.	**Aug.**	**Sep.**	**Oct.**
2016 (inches)	3.07	5.99	2.09	3.13
10 YR Avg. (inches)	4.10	4.40	4.05	4.56
% of 10 YR Avg.	75	136	56	68

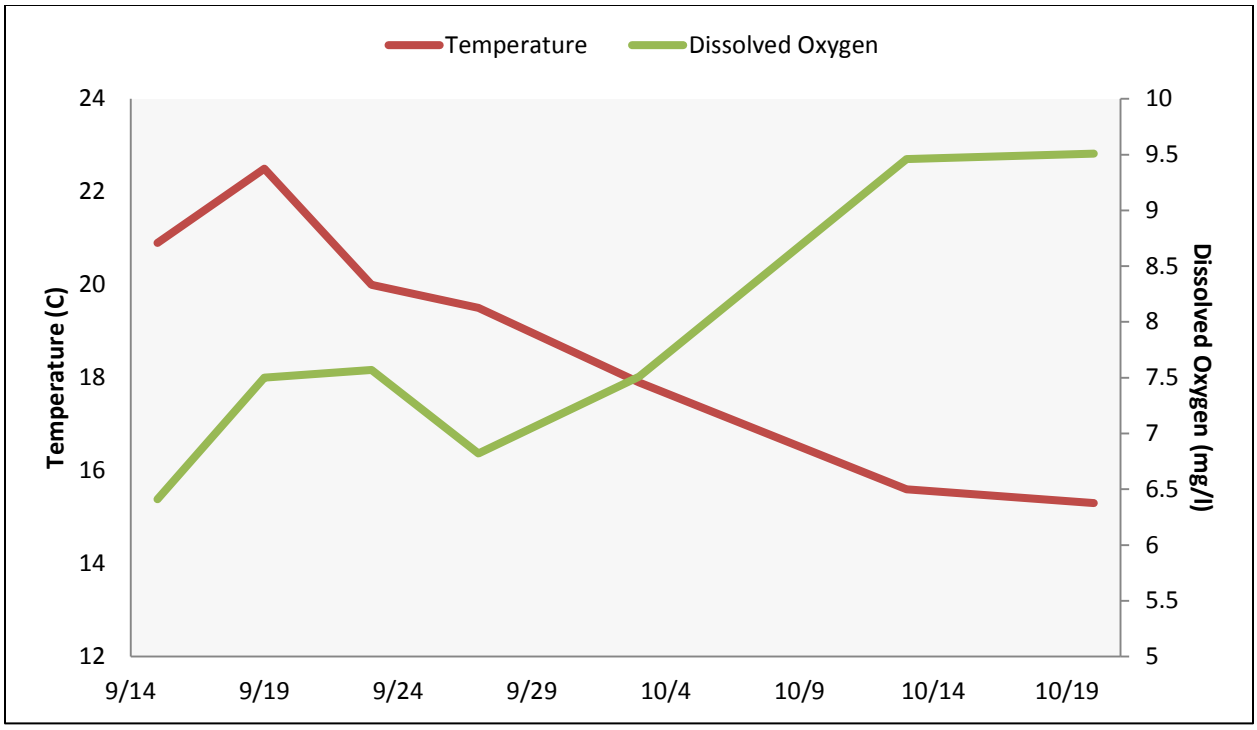

Figure 4.4-1. Vernon eel ramp trap collection tank temperature (^{O}C) and dissolved oxygen (mg/L), 2016.

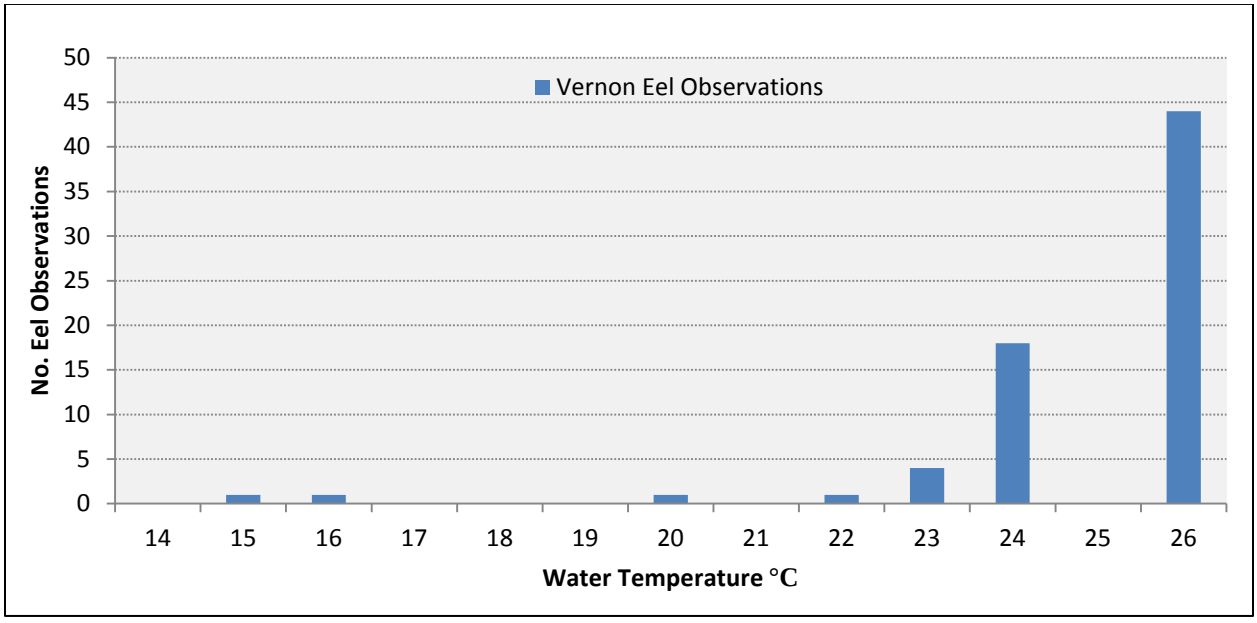

Figure 4.4-2. Number of eels observed in Vernon visual surveys by water temperature, 2016.

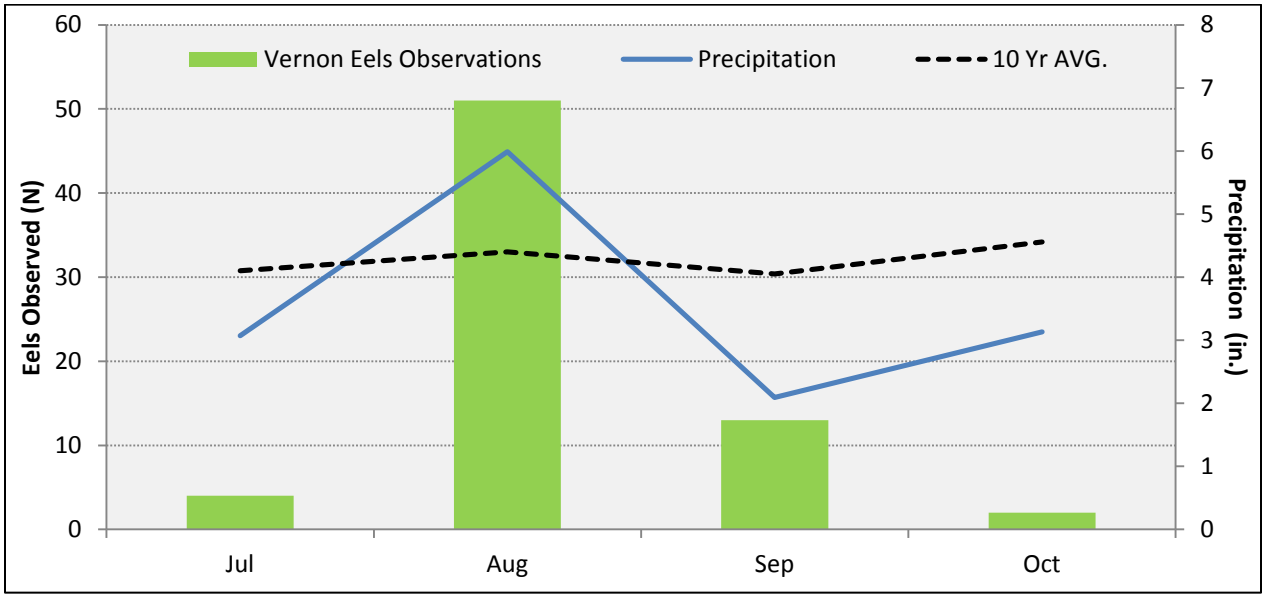

Figure 4.4-3. Monthly total observations (bars) with total precipitation (solid line) and 10-year average precipitation (dashed line) at Vernon, 2016.

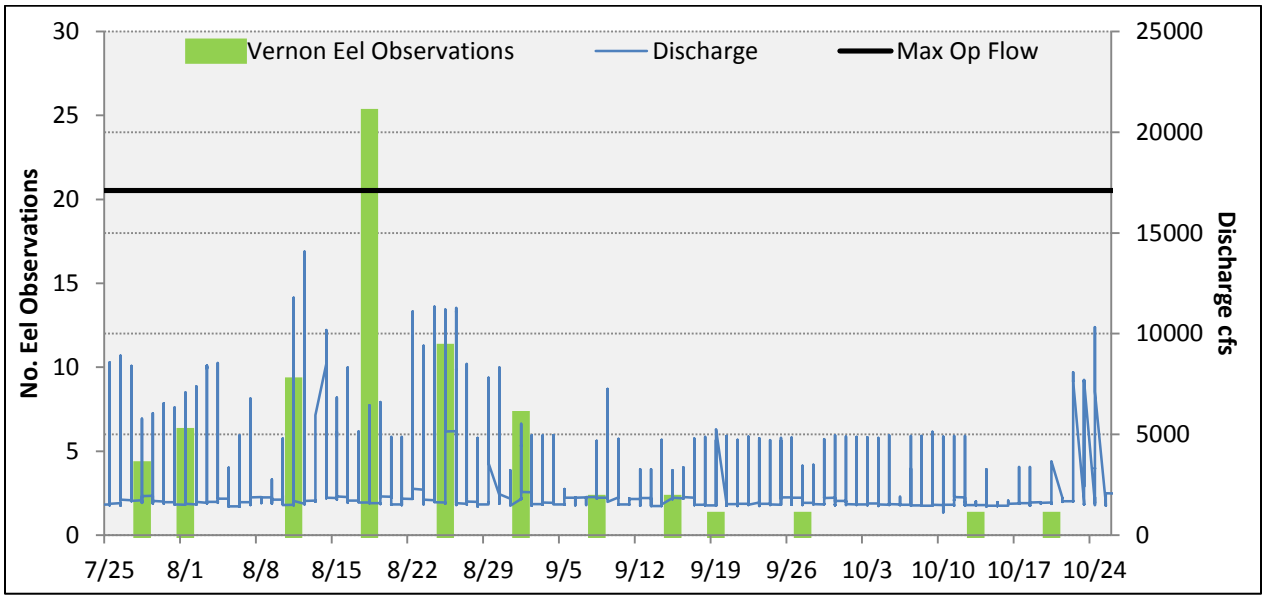

Figure 4.4-4. Vernon discharge (blue line) with eel observations (bars) and maximum generating capacity (black line), 2016.

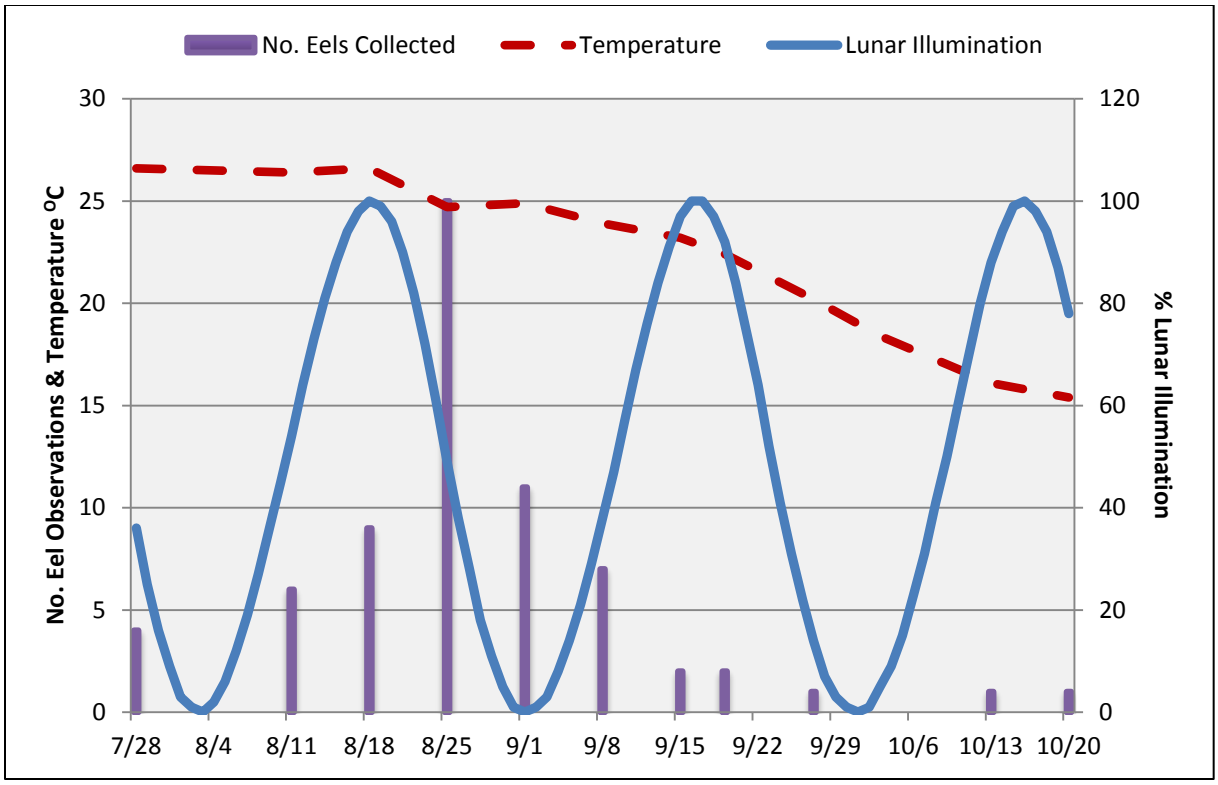

Figure 4.4-5. Periodicity of Vernon eel observations (bars) with range of daily water temperatures (dashed line) and lunar illumination (solid line), 2016.

5.0 STUDY CONCLUSIONS

Systematic surveys of eel presence/abundance at the Vernon tailrace and spillway in 2016 did not identify any large aggregations of eels staging in pools or attempting to ascend wetted structures of the dam. However, most eels were observed in the vicinity of the fish ladder and in the leakage flow from stanchion bay gates that drain through the rock outcrop. Those eels observed in the rock outcrop most closely represented migratory behavior since they had clearly ascended wetted surfaces to arrive from the tailwater elevation to the observation points. It is important to stress the term relative, however. The greatest number of eels observed in any one survey period at any one site was seven eels observed in and around the submerged flood gate below tainter gate #3, where eels appeared to exhibit resting/hiding behavior rather than active migration behaviors such as seeking and climbing.

During the 2016 survey period, the overall abundance of eels, as evidenced by visual surveys, was too low to draw many conclusions. The influence that the experimental passage of eels in 2014 (without subsequent experimental passage in 2015 and 2016) downstream at Turners Falls Dam may have had on observations of eels at Vernon in 2015 and 2016 is unknown.

Although the Vernon temporary eel ramp trap collected only one eel, as noted in Section 4.2, that one eel represented 12.5% of the number of eels observed during the period that the ramp was operated. The ramp trap was operated during late summer and fall. Observations reported from 2015 and 2016 suggested that most eel upstream migratory behavior at Vernon could have occurred before this time in 2016, although different conditions each year would likely have differing results. Therefore, the 2016 results should not be construed as necessarily indicative of the effectiveness of the ramp to collect eels.

6.0 LITERATURE CITED

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