Wilder, Bellows Falls, and Vernon Project Relicensing

Updated Study Results Meeting: March 08, 2018

Agenda

9:30 – 9:45	Introduction - *John Ragonese*
9:45 – 11:00	Study 18 - 2017 continuation of American eel upstream passage assessment at Vernon Dam - *Steve Leach*
	Study 21 - 2017 assessment of adult American shad downstream route selection at Vernon Dam - *Steve Leach, Christian Gagne*
11:00 – 11:15	Break
11:15 – 12:15	Study 2/3 – Erosion supplemental data report - *John Field*
12:15 – 12:45	Lunch - provided
12:45	Review modifications being made to Vernon dam for 2018 upstream fish passage season
	Studies 9 and 24 – Instream flow, and co-occurring mussels – update of ongoing consultation

FOR TELECONFERENCE OR DIAL-IN PARTICIPANTS

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Study 18

American Eel Upstream Passage Assessment

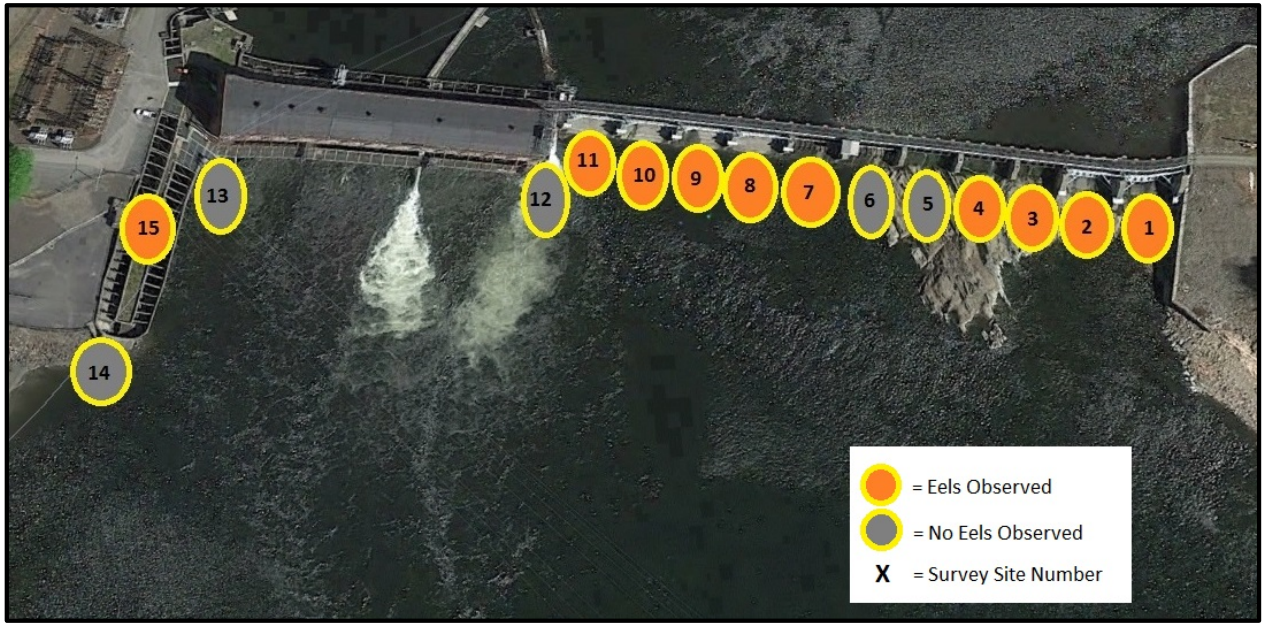
Study 18
American Eel Upstream Passage Assessment

Reporting

- GRH supplemented study 18 with continued surveys, June 1 through November 6, 2017
- Methodology consistent with 2016
  - Visual surveys June 1 through November 6
  - Installation of temporary eel ramp trap near the fish ladder entrance, June 1 through November 8
- Report filed February 9, 2018

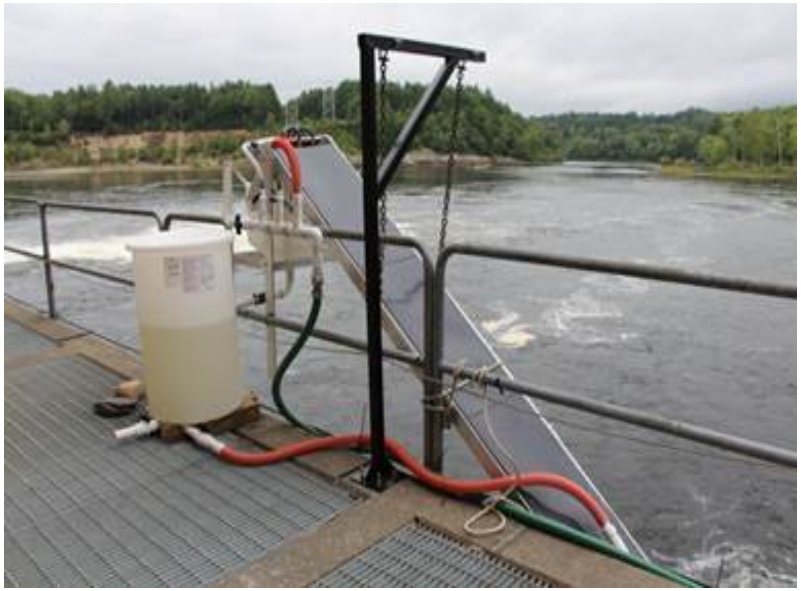
Visual Surveys

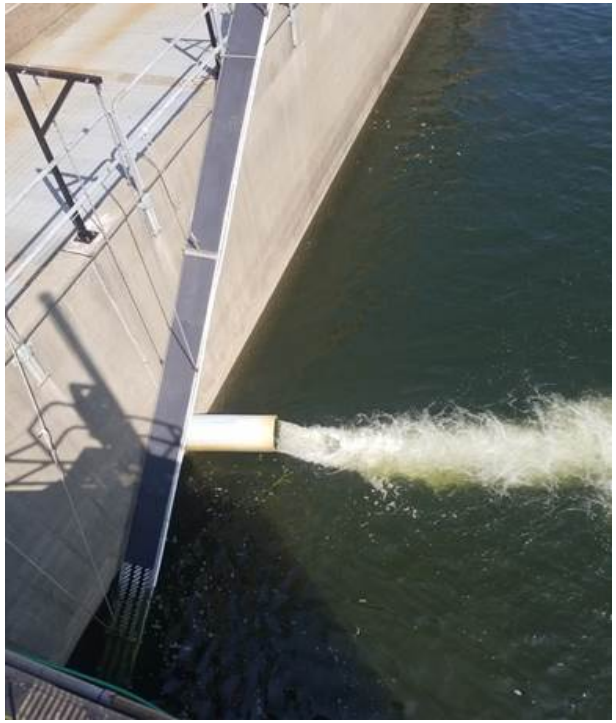
- 148 eels were observed in 2017 during weekly surveys over 23 weeks
  - 80 eels were observed in 2015 over 25 weeks and 70 eels observed in 2016 over 13 weeks
- A majority (70.9%) of all observations of eels occurred between June 14 and July 19
- Site No. 15 (fishway) and No. 8 (floodgate) had the most frequent positive observations (55.4%, and 14.2% of total observed)



Ramp Trap Collection

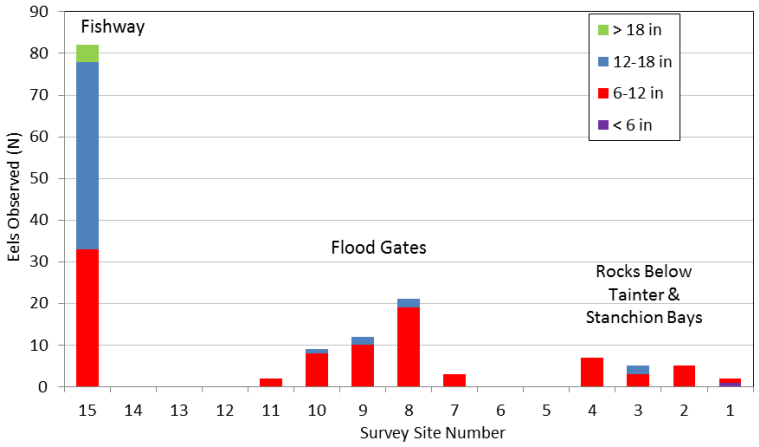
- 123 eels were collected from the ramp trap from July 5 to September 19
- The majority (71.5%) were collected on August 21 (n=43) and August 23 (n=45), 2 weeks after the dewatering of the fishway





Fishway Dewatering Observation

- The fishway was dewatered on August 7, 2017
- ~115-120 eels were counted moving through the orifice of the first weir downstream of the counting room and lengths were estimated (N=43) from video
- Lengths ranged from 7 to 22 inches and averaged around 13 inches, the majority (56%) were 12 -18 inches, similar to visual survey results for the fishway monitoring site (#15, 55%)
- That suggests that larger eels use the fish ladder more than some other sites, perhaps due to their relative ability to navigate the velocities there



Study Conclusions

- No large aggregations of eels staging in pools or attempting to ascend wetted structures of the dam were observed
- At most, 15 eels were observed in any one survey period at any one site
- Eels observed in the rock outcrop most closely represented migratory behavior since they had ascended wetted surfaces to arrive from the tailwater elevation
- Eels observed at the floodgates appeared to exhibit resting/hiding behavior, not necessarily migratory behavior
- The Vernon temporary eel ramp trap, operated during late spring, summer and fall, collected 123 eels

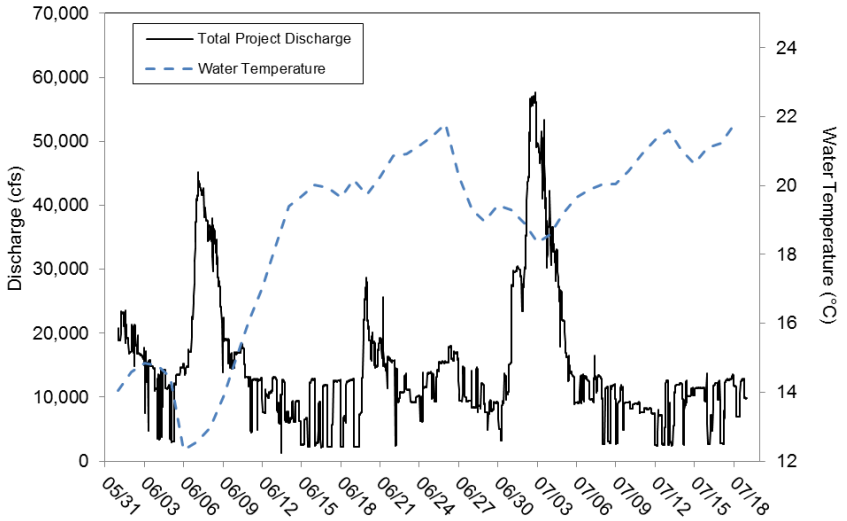
Study 21
American Shad Telemetry Study

Study Supplement

- GRH conducted a 2017 supplement to study 21 in response to concerns that the number of adult shad for which a downstream passage route could be determined in 2015 was too low to draw reasonable conclusions
- The goal was to characterize downstream passage route selection, passage efficiency, and passage timing/residency at Vernon
- Report filed 2/15/18

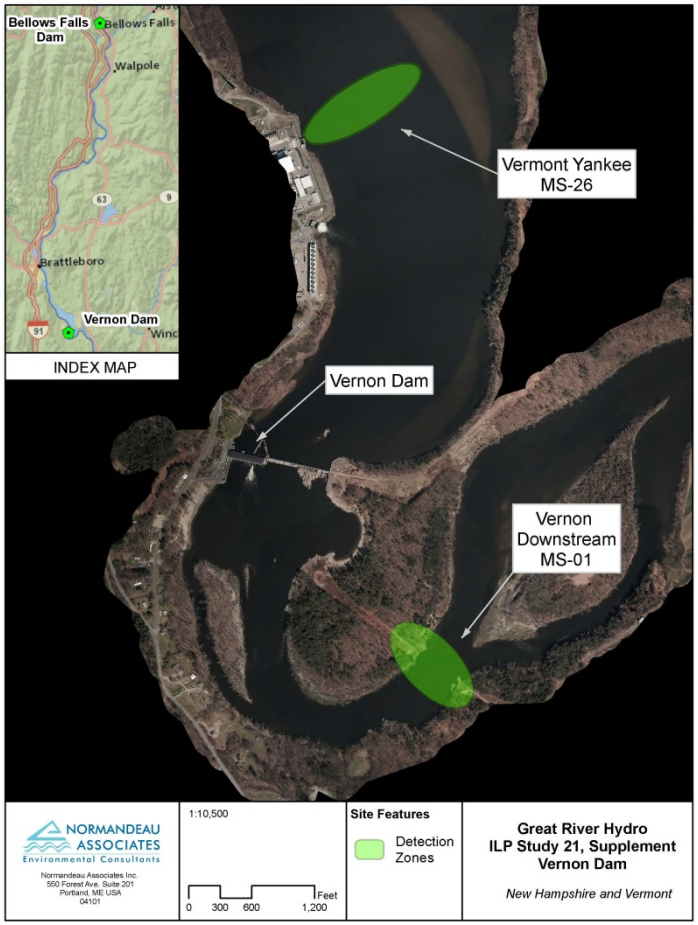
Collection, Tag, and Release

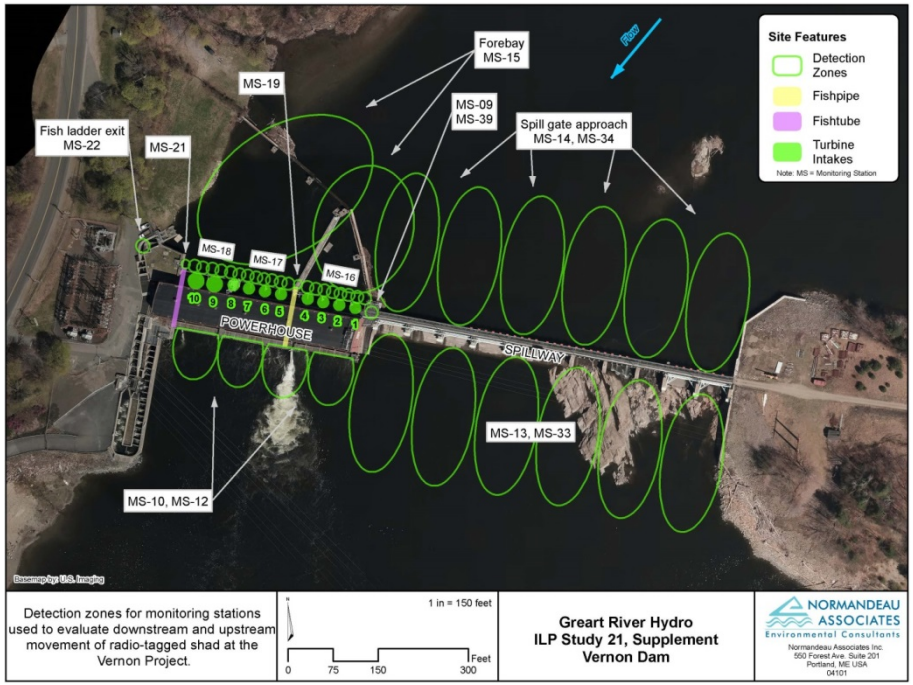
- 99 adult shad collected from Vernon fish way trap, tagged, transported to Old Ferry for release: 5/30 (N=25), 6/11 (N=30), 6/13 (N=44)
- Radio telemetry array augmented for better resolution (spill gate approach, spillway, east fish pipe, former construction bypass), fewer frequencies (2), individual line data (non-CRTO)
- Tracking by foot to verify departure from release, and air (1) and boat (6) from VY to Westminster / Bellows Falls to verify upstream locations



Total project discharge and daily mean water temperature at Vernon

Study 21
American Shad Telemetry Study





Monitoring stations and conceptual detection zones used to evaluate downstream movement of radio-tagged American Shad at Vernon

Availability to Study

- 63 fish detected upstream at VY (64%)
- 61 fish detected in study area (62%)
- 13 did not pass
    - 6 returned upstream
    - 5 stationary in forebay
    - 2 last detected in forebay
- 48 fish available for route of passage assessment

Passage Route Selection

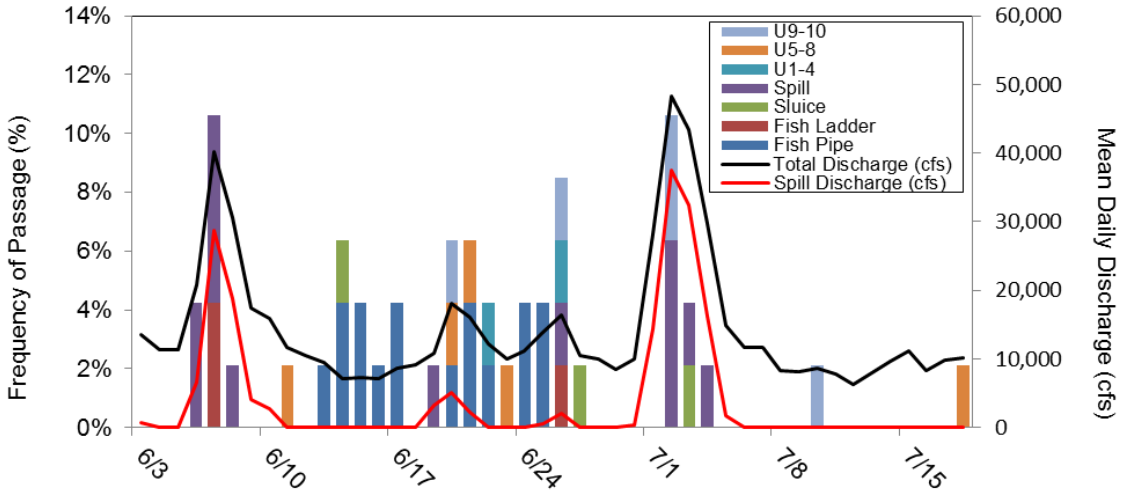
- Of 48, the majority of passage (N = 23) occurred when all 10 units were in operation
- Most of those (N = 21) occurred when at least one spill gate was open
- Prevalent operational scenario was all units operating (33% of the study period)

Study 21
American Shad Telemetry Study

Final Disposition	Downstream Passage Route	Number	% of Number Passed
Did not return from upstream	-	38	-
Approached but did not pass	-	13	-
Returned upstream	-	7	-
Unknown		1	
Stationary in Forebay	-	5	-
Passed downstream of Vernon	Turbine Units 1-4	2	4.2
	Turbine Units 5-8	5	10.4
	Turbine Units 9-10	5	10.4
	Fish tube	0	0.0
	Fish ladder	3	6.3
	Fish pipe	16	33.3
	Sluice gate	3	6.3
	Spillway	13	27.1
	Former construction bypass	0	0.0
	Unknown	1	2.1
Subtotal (approaching Vernon)		61	-
Subtotal (passing Vernon)		48	-
Total		99	-

Forebay Residency

- Median time from release to return to Vernon was 7.8 d
- Majority of returns (86%) occurred during June
- Median forebay residency (initial detection to time of passage) was 11.69 h
- Median adjusted residency was 4.72 h

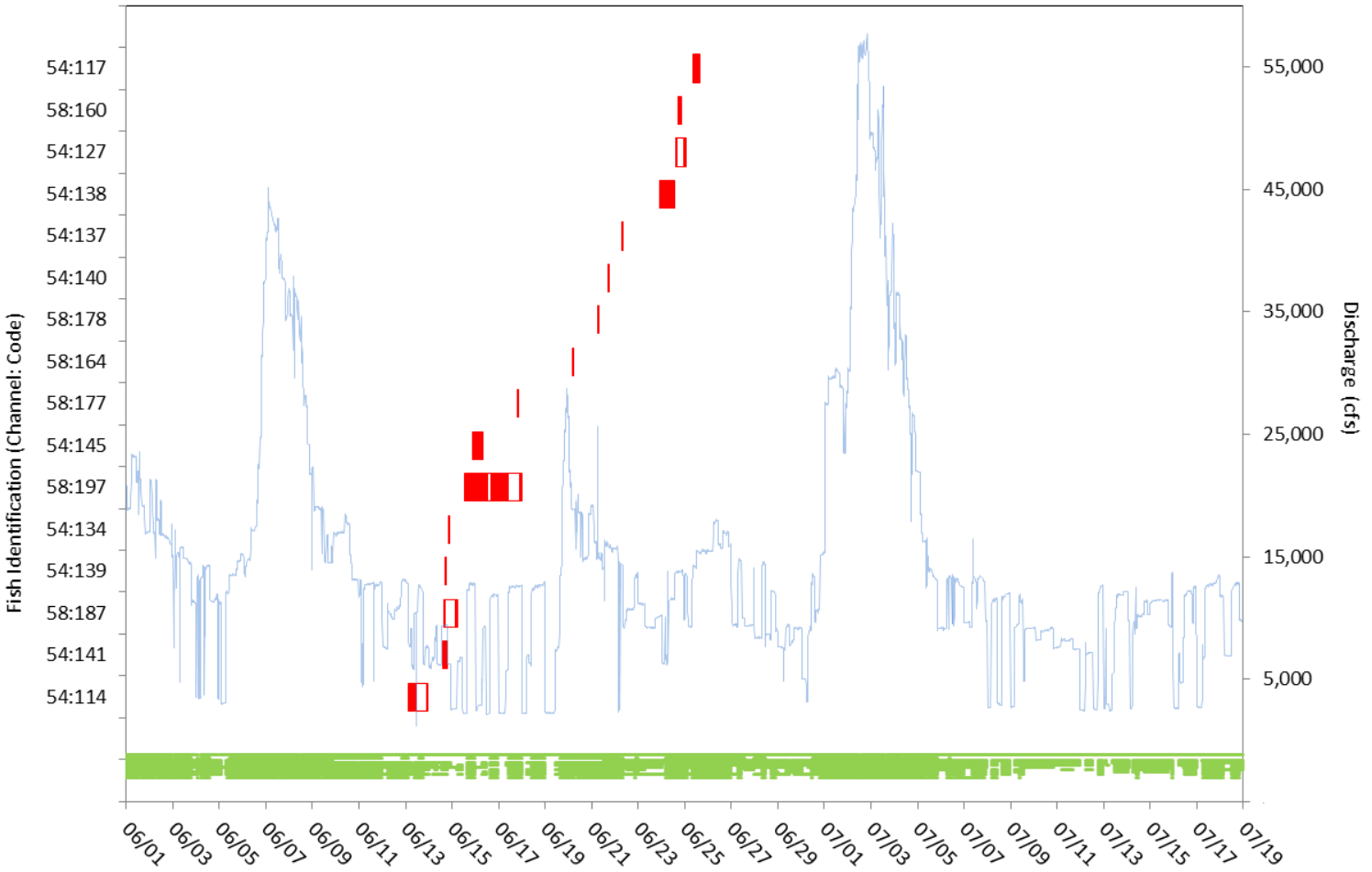


Temporal distribution of downstream passage of radio-tagged American Shad at Vernon

Study 21
American Shad Telemetry Study

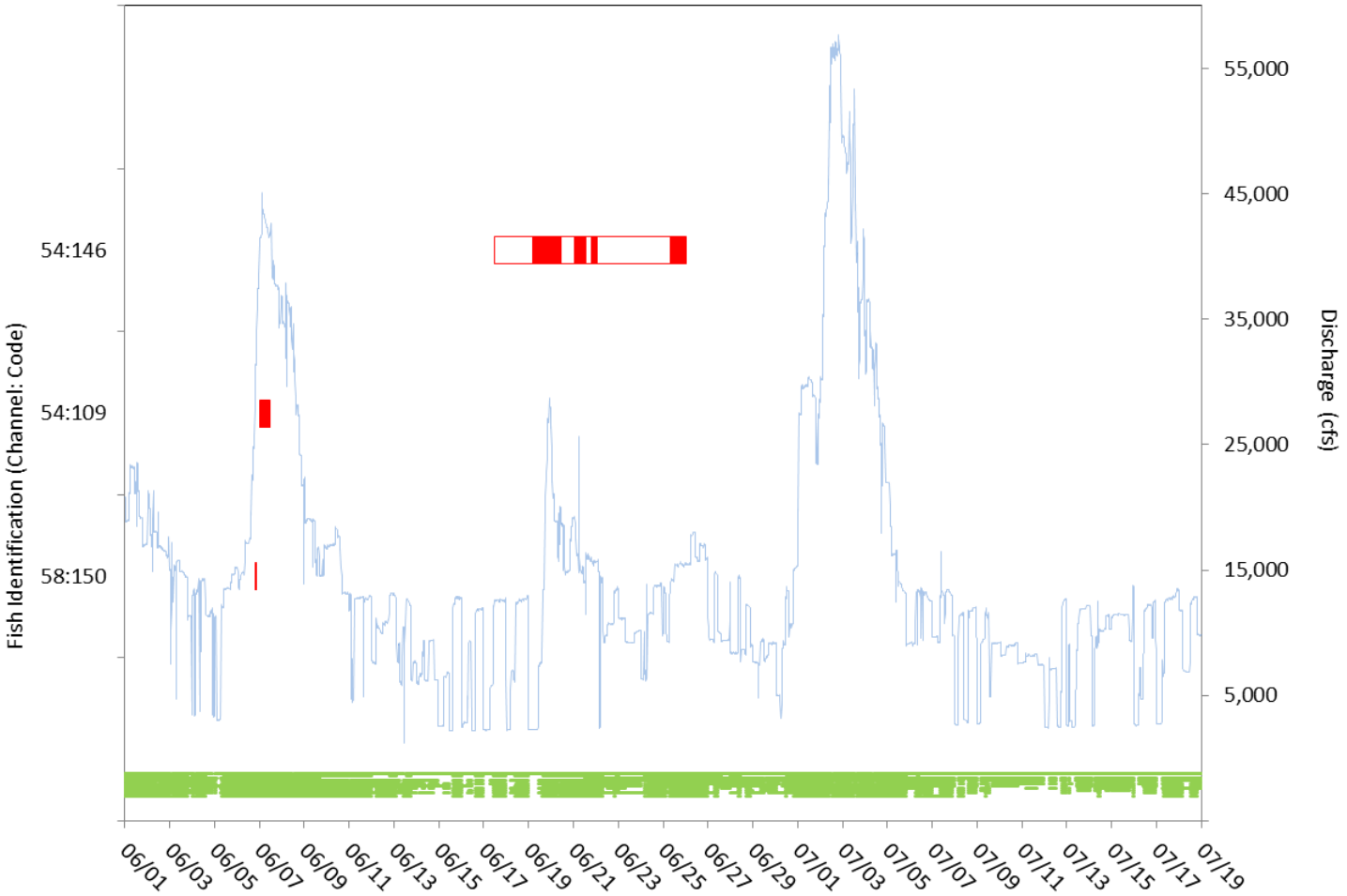
Downstream Passage Route	Residency	Forebay Residency (hours)						
		N	Min	Max	Mean (SD)	25th Percentile	Median	75th Percentile
East Fish Pipe	Unadjusted	16	0.10	45.38	9.41 (11.97)	0.35	3.50	14.40
	Adjusted		0.10	25.93	6.24 (8.22)	0.35	2.03	7.41
Fish Ladder	Unadjusted	3	0.28	215.33	76.22 (98.5)	6.67	13.06	114.20
	Adjusted		0.28	75.23	29.52 (32.74)	6.67	13.06	44.15
Units 1-4	Unadjusted	2	13.30	13.96	13.63 (0.33)	13.47	13.63	13.80
	Adjusted		13.30	13.96	13.63 (0.33)	13.47	13.63	13.80
Units 5-8	Unadjusted	5	0.21	110.59	32.21 (39.9)	10.67	16.57	23.01
	Adjusted		0.21	19.53	12.28 (6.69)	10.67	14.43	16.57
Units 9-10	Unadjusted	5	0.30	21.65	5.54 (8.19)	0.48	0.94	4.32
	Adjusted		0.30	21.65	5.54 (8.19)	0.48	0.94	4.32
Sluice	Unadjusted	3	0.41	156.30	76.69 (63.69)	36.88	73.35	114.83
	Adjusted		0.41	155.33	76.36 (63.28)	36.88	73.35	114.34
Spill	Unadjusted	13	0.01	426.30	78.12 (122.62)	0.12	0.43	74.00
	Adjusted		0.01	67.85	13.8 (23.85)	0.12	0.43	15.41
Unknown	Unadjusted	1	263.32					
	Adjusted		247.27					
All	Unadjusted	48	0.01	426.30	43.84 (84.9)	0.32	11.69	29.13
	Adjusted		0.01	247.27	20.01 (43.46)	0.33	4.72	15.70

Study 21
American Shad Telemetry Study



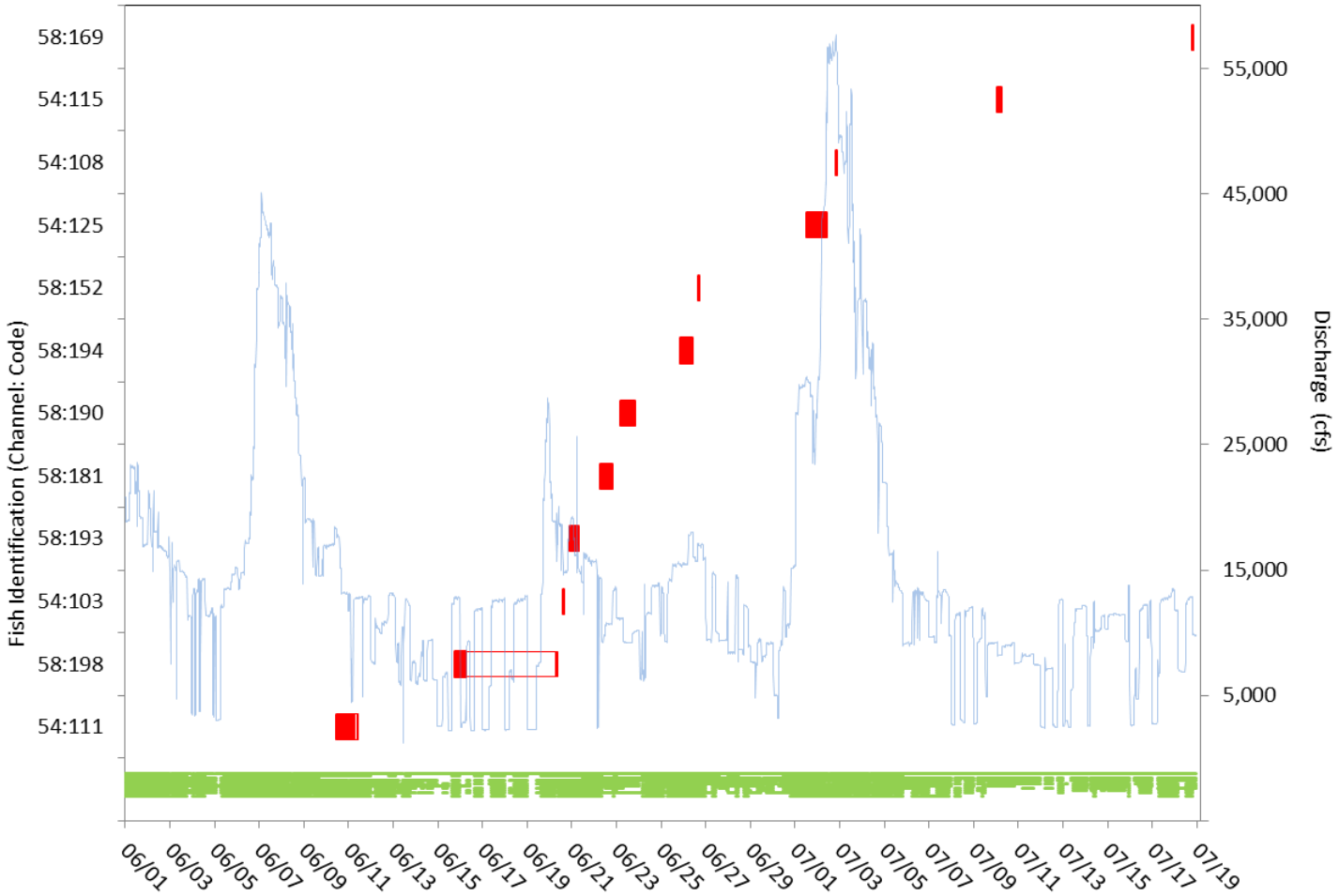
Forebay residence of radio-tagged adult shad emigrating past Vernon dam through the east fish pipe

Study 21
American Shad Telemetry Study



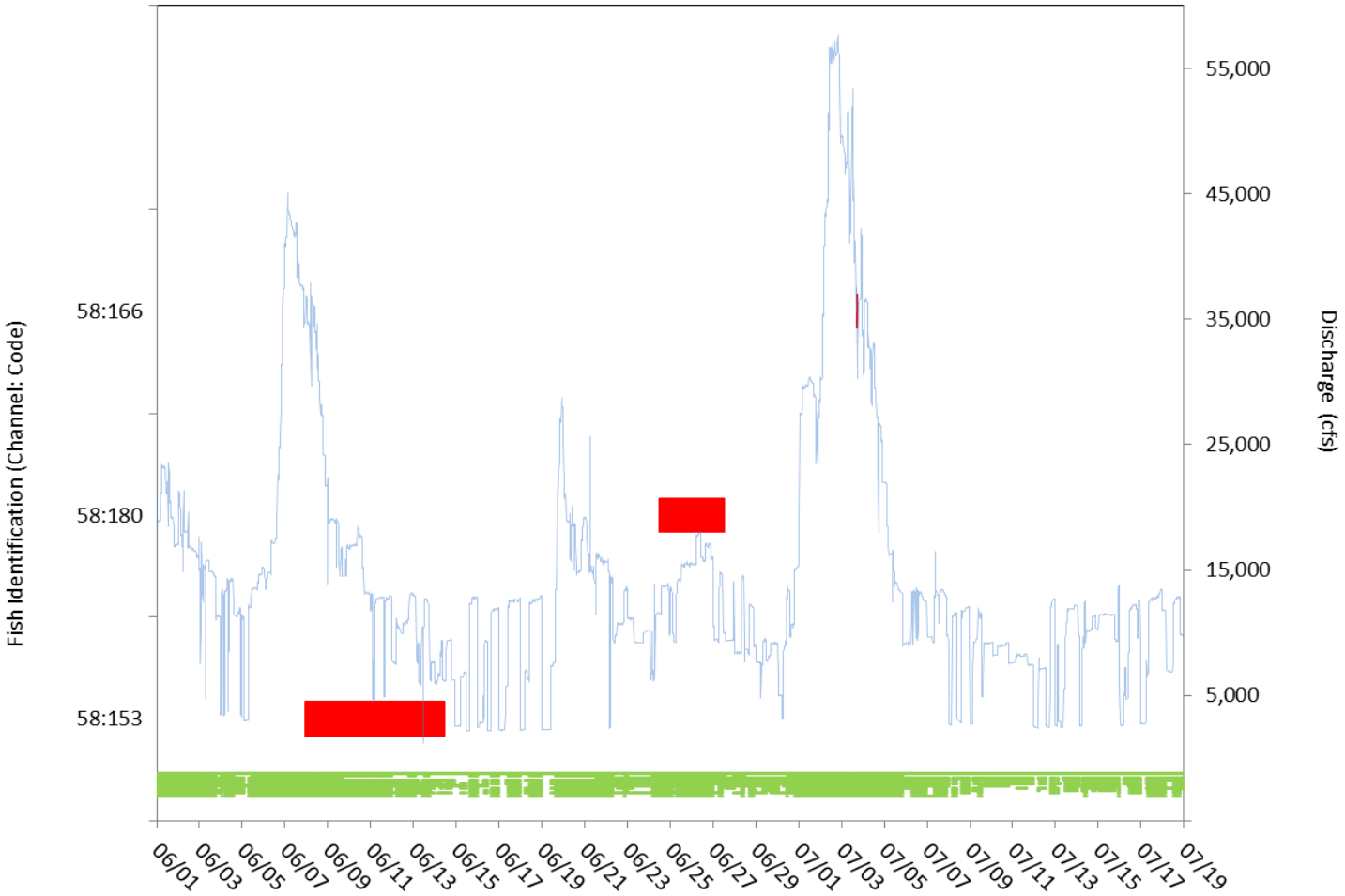
Forebay residence of radio-tagged adult shad emigrating past Vernon dam through the fish ladder

Study 21
American Shad Telemetry Study



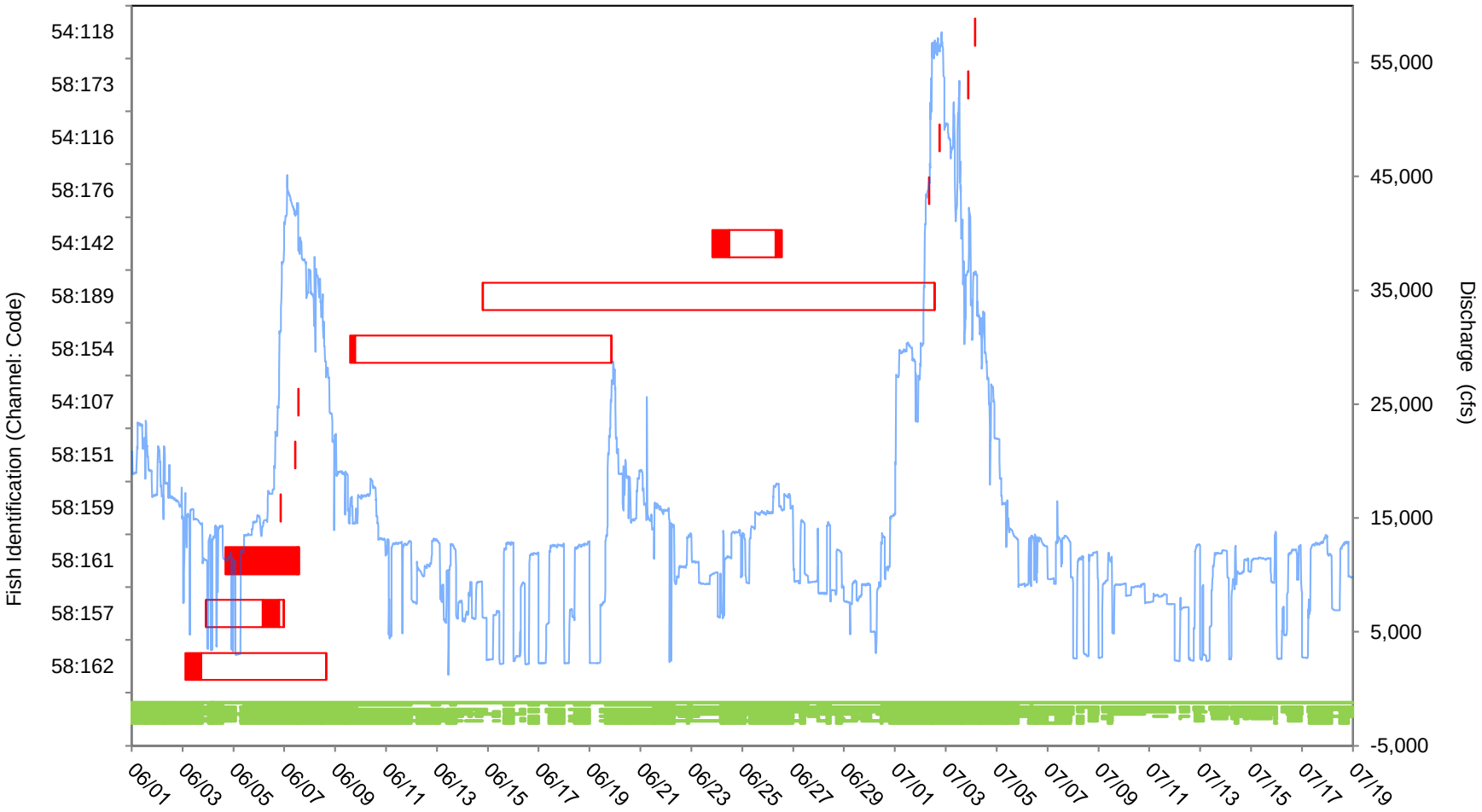
Forebay residence of radio-tagged adult shad emigrating past Vernon dam through the hydroelectric units

Study 21
American Shad Telemetry Study



Forebay residence of radio-tagged adult shad emigrating past Vernon dam through the debris sluice

Study 21
American Shad Telemetry Study



Forebay residence of radio-tagged adult shad emigrating past Vernon dam through the spillway

Conclusions

- Dominant route of passage (34%) was the east fish pipe
- High flows facilitated outmigration, spill conditions are episodic but typical in the outmigration season – spill gates contribute passage route for a relatively large proportion (27%)
- Collectively, 25% passed via units (10.4% / 10.4% / 4.2%)
- Tagged shad tended to move past project quickly, overall adjusted median residency time was 4.72 h

Study 2 / 3
Riverbank Transect Study
Riverbank Erosion Study

Supplement
Riverbank Transect
Riverbank Erosion Study

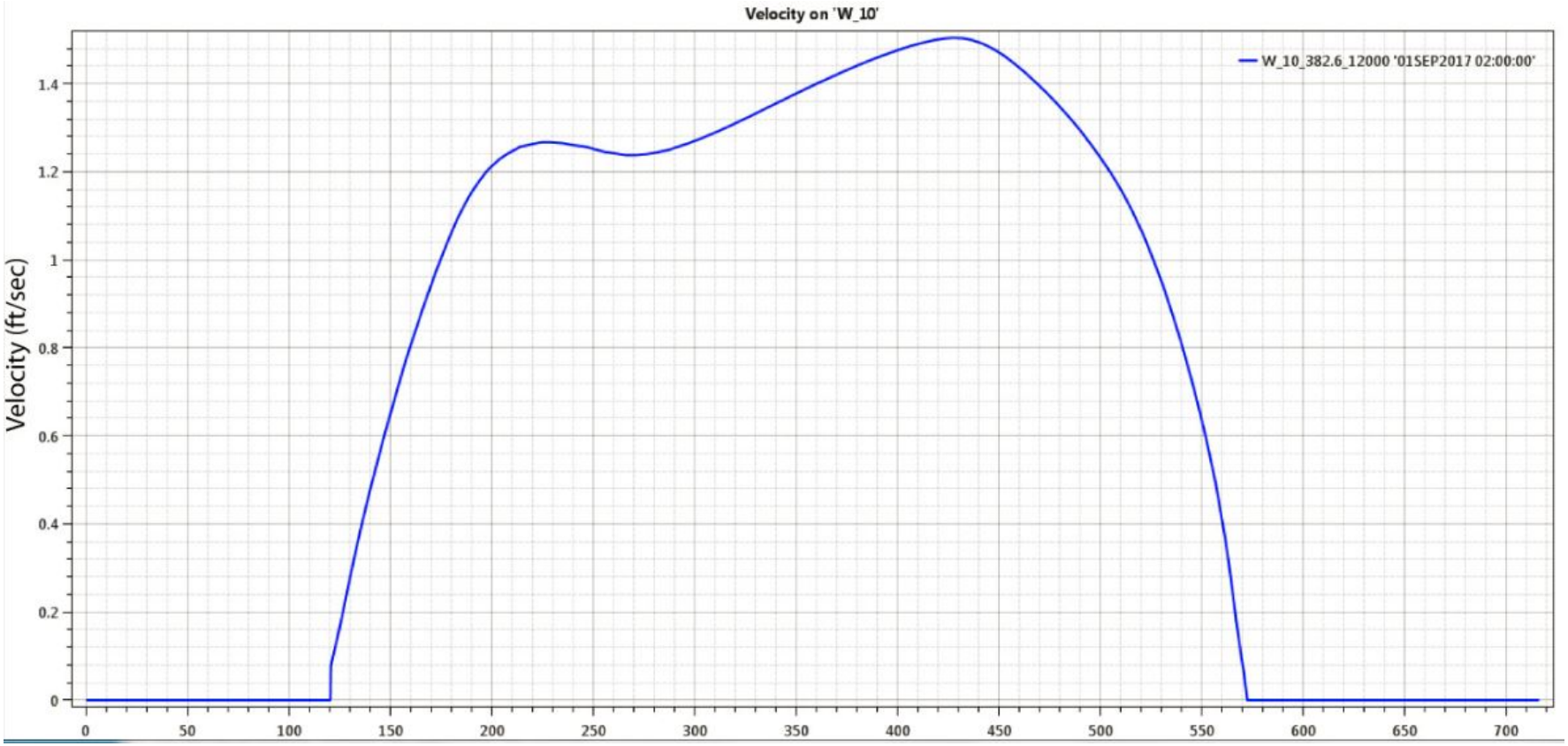
FERC July 21, 2017 Study Determination

- Analyze critical shear stress and near-bank velocity at 21 monitoring sites
- Correlate with water surface elevations corresponding to minimum flow, average project operating ranges, and maximum hydraulic capacity
- Describe erosion and other features associated with each water surface elevation

Methodology Employed

- 2D hydraulic modeling to establish flow velocity and shear stress at 21 sites
- Sediment sampling and grain size analysis to establish threshold entrainment values
- Compare modeled values with threshold values needed to initiate sediment transport
- Consideration of other factors influencing sediment entrainment results

Studies 2 and 3
Riverbank Transect Study, Riverbank Erosion Study



Studies 2 and 3
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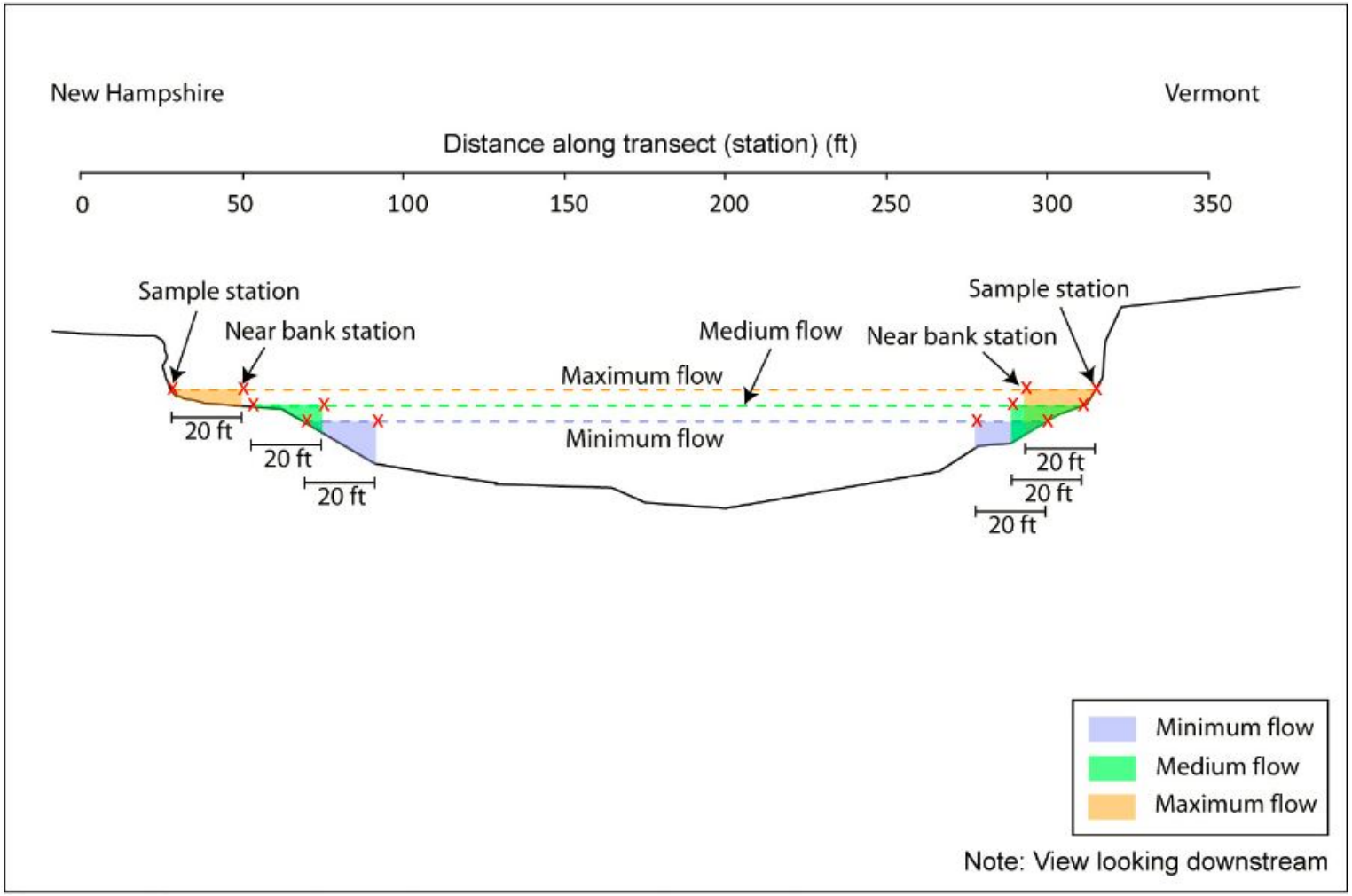


Studies 2 and 3
Riverbank Transect Study, Riverbank Erosion Study

Comparison of measured values and critical threshold values

- If τ / τ_c or $V/V_c > 1$, then entrainment possible
- If τ / τ_c or V/V_c , 1, then entrainment not possible

Studies 2 and 3
Riverbank Transect Study, Riverbank Erosion Study

WR09 - Hartwell (New Hampshire)									
Sample characteristics									
Sample elevation (NAVD88 ft)	290.5 (minimum)			293.7 (medium)			297.0 (maximum)		
Sample ID	WR09-1			WR09-2			WR09-3		
Morphological feature	Beach			Bank			Bank		
Sediment composition	Sandy silt			Silt with clay			Silt		
D50 grain size (mm)	0.0547			0.0130			0.0221		
Stratigraphy	Not applicable - below bank			Colluvium			Colluvium		
Erosion features	None			Topple block			Topple block		
Presence/character vegetation	None			Moderate herbaceous cover			Thick herbaceous cover		
Presence of seeps	Dry, upslope seepage			Dry, upslope seepage			Dry, upslope seepage		
Other characteristics	Abundant tree roots			Abundant roots			Abundant roots		
Model parameters and outputs									
Dam elevation (NAVD88 ft)	290.2			290.2			290.2		
Model flow (cfs)	700	5000	12000	700	5000	12000	700	5000	12000
Sample station (ft)	186	186	186	181	181	181	172	172	172
Near bank station (ft)	207	207	207	202	202	202	192	192	192
Velocity (ft/sec)	0.123	1.471	3.023	Dry	1.414	2.952	Dry	Dry	2.605
Shear stress (lb/ft^2)	0.0002	0.025	0.092	Dry	0.024	0.088	Dry	Dry	0.069
Threshold analysis									
Threshold velocity (ft/sec)	2.0	2.0	2.0	3.75	3.75	3.75	3.75	3.75	3.75
Velocity threshold passed	No	No	Yes	No	No	No	No	No	No
Critical shear stress (lb/ft^2)	0.032	0.032	0.032	0.012	0.012	0.012	0.020	0.020	0.020
Shear stress threshold passed	No	No	Yes	No	Yes	Yes	No	No	Yes

Studies 2 and 3
Riverbank Transect Study, Riverbank Erosion Study

W07 - Tullando (New Hampshire)									
Sample characteristics									
Sample elevation (NAVD88 ft)	382.6 (minimum)			382.9 (medium)			384.4 (maximum)		
Sample ID	W07-1			W07-1			W07-2		
Morphological feature	Beach			Beach			Bank		
Sediment composition	Silty fine sand			Silty fine sand			Fine sand		
D50 grain size (mm)	0.2438			0.2438			0.3399		
Stratigraphy	Not applicable - below bank			Not applicable - below bank			Colluvium		
Erosion features	None			None			Notching		
Presence/character vegetation	None			None			Moss		
Presence of seeps	None			None			None		
Other characteristics	Leaning tree at base of bank			Leaning tree at base of bank			Leaning tree at base of bank		
Model parameters and outputs									
Dam elevation (NAVD88 ft)	382.6			382.6			382.6		
Model flow (cfs)	700	5000	12000	700	5000	12000	700	5000	12000
Sample station (ft)	1255	1255	1255	1253	1253	1253	1250	1250	1250
Near bank station (ft)	1276	1276	1276	1273	1273	1273	1271	1271	1271
Velocity (ft/sec)	0.067	0.473	1.074	Dry	0.433	0.993	Dry	Dry	0.946
Shear stress (lb/ft^2)	0.0001	0.003	0.017	Dry	0.003	0.015	Dry	Dry	0.014
Threshold analysis									
Threshold velocity (ft/sec)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Velocity threshold passed	No	No	No	No	No	No	No	No	No
Critical shear stress (lb/ft^2)	0.062	0.062	0.062	0.062	0.062	0.062	0.058	0.058	0.058
Shear stress threshold passed	No	No	No	No	No	No	No	No	No

Other Considerations

- Published critical shear stress values are often significantly underestimated
- Modeled velocity and shear stress values used are higher than location of sampling
- Bank shape, vegetation, obstructions and other features that would increase critical shear stress/velocity values or decrease modeled values not accounted for in analysis

Conclusions

- While some localized entrainment possible at selected sites at upper end of project operating range, the vast majority of sites show no entrainment possible as the result of project operations

- High flows necessary to entrain large volumes of sediment and sustain cycle of erosion

Vernon Fish Ladder Modifications

Improve evaluation of American Eel migration up the fish ladder through modest physical improvements intended to significantly reduce multiple counts of eels.

Improve American Shad migration through fish ladder by eliminating potential delays at ladder entrance (entrance weir) and the “180° Turn” at visitor window.

Concern: Entrance weir not following tailrace closely enough, or consistently enough while maintaining the approximately 1 ft of flow over the weir gate.

Investigation:

- Mid-station reference elevation sensor not precise enough for the fish ladder entrance location

Modification:

- Re-established reference elevation to just outside fish ladder
- All “metritape” level sensors replaced with pressure transducers
- Mid-tailrace monitoring location moved to just outside of the fish ladder entrance

Concerns:

1. At counting window, eels are counted more than once or not at all
   - Swim within or just above grading on counting window floor
   - Swim through grading on regulating pool walls

2. Eels can move through mesh on diffuser room floor and not continue up the ladder (end up in make-up-water chamber)

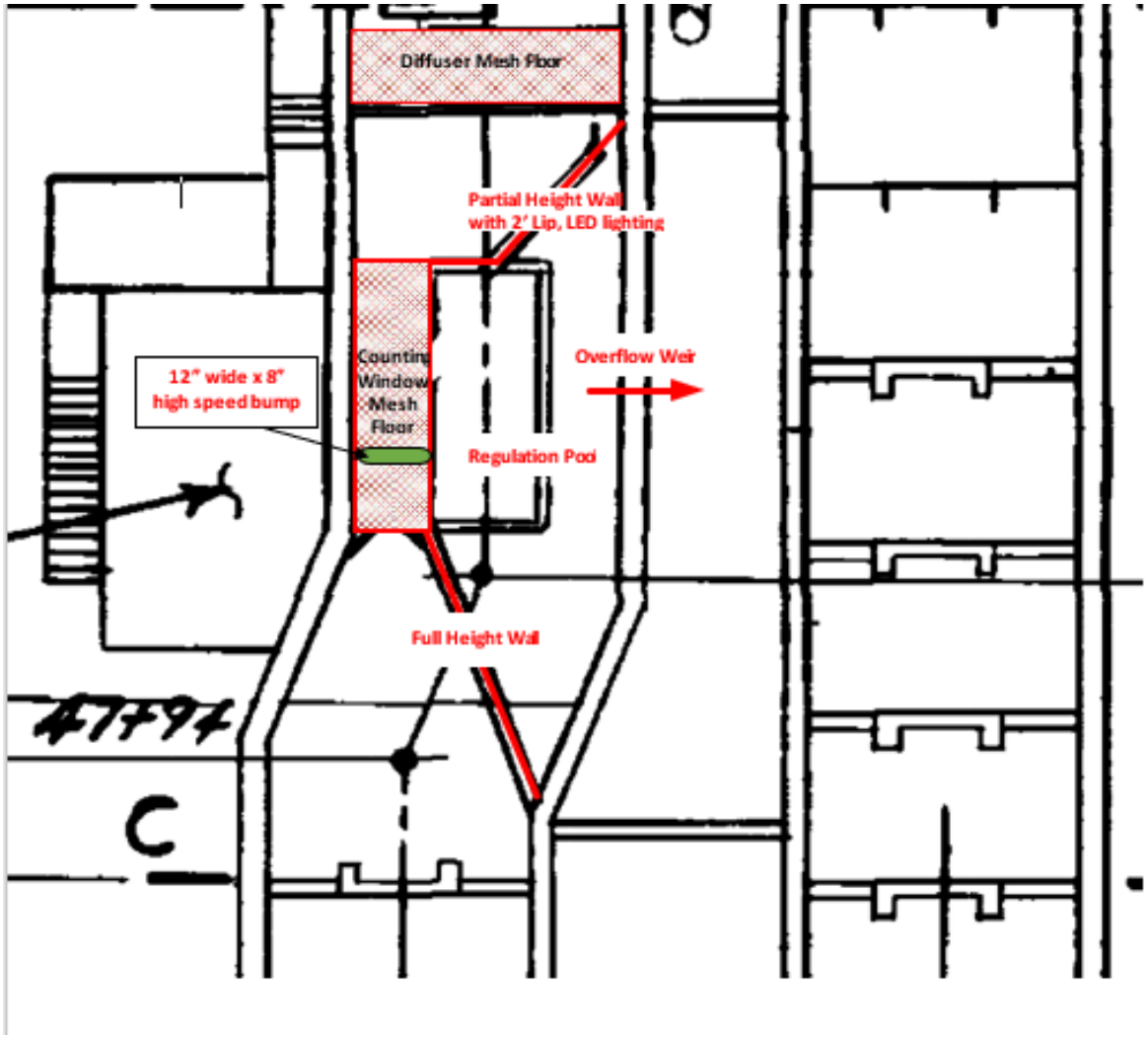
3. Velocity and configuration of exit weir

Concern: Potential shad migration [through] ladder delays at the“180° Turn” at visitor window due to back eddy hydraulics; milling behavior noted.

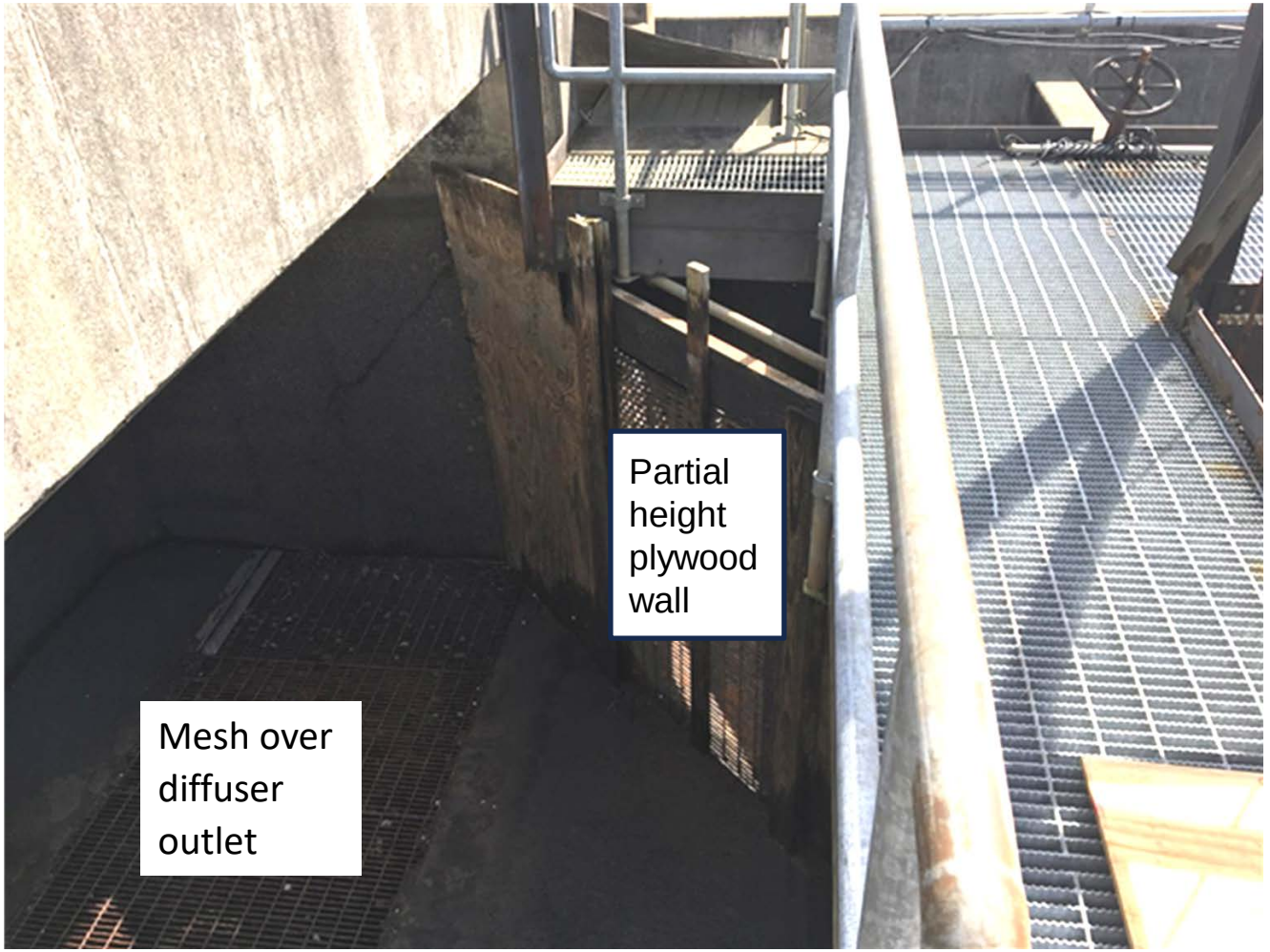
Modification:

- Guidance walls narrowing route through “180° Turn” to be installed

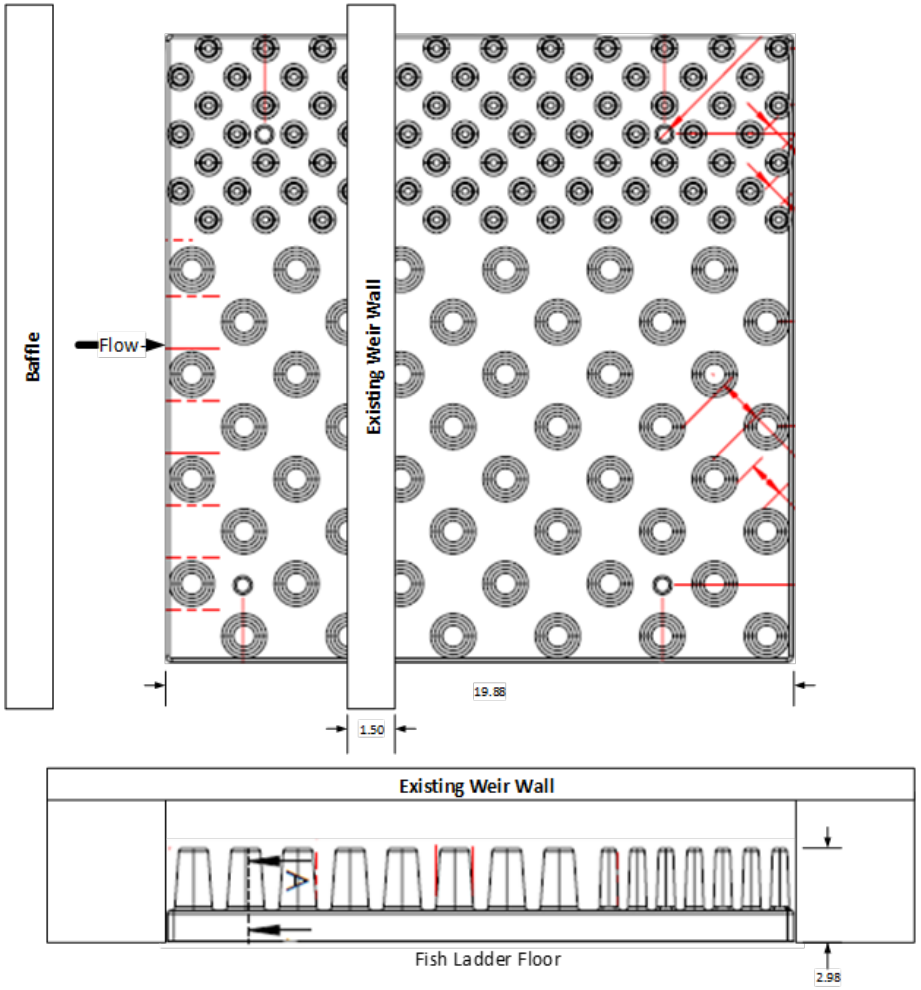
Counting Window / Regulation Pool



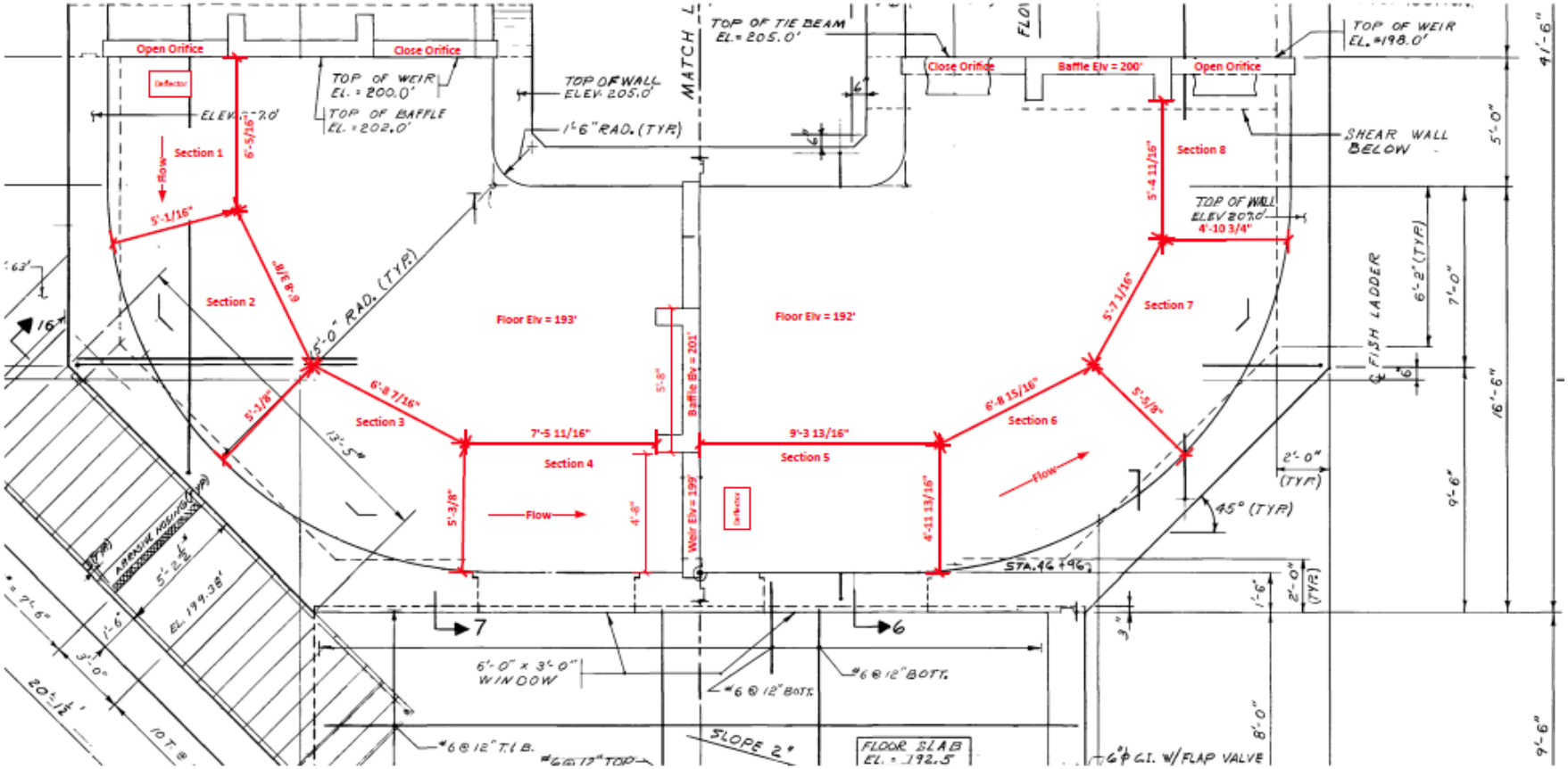
Regulation Pool



Exit Weir


Baffle
Flow
Existing Weir Wall
19.88
1.50
Existing Weir Wall
A
Fish Ladder Floor
2.98

Vernon Fish Ladder Modifications
American Shad


Open Orifice
Close Orifice
Deflector
TOP OF WEIR
EL. = 200.0'
TOP OF BAFFLE
EL. = 202.0'
TOP OF WALL
ELEV. 205.0'
MATCH L
TOP OF TIE BEAM
EL. = 205.0'
1'-6" RAD. (TYP.)
Section 1
Flow
5'-1/16"
6'-5/16"
Section 2
6'-8 3/16"
5'-0" RAD. (TYP.)
Floor Elv = 193'
Floor Elv = 192'
Baffle Elv = 201'
Weir Elv = 199'
5'-1/8"
6'-8 7/16"
Section 3
7'-5 11/16"
Section 4
5'-3/8"
4'-8"
9'-3 13/16"
Section 5
Flow
13'-5"
Close Orifice
Baffle Elv = 200'
Open Orifice
TOP OF WEIR
EL. = 198.0'
SHEAR WALL
BELOW
Section 8
5'-4 11/16"
TOP OF WALL
ELEV 207.0'
4'-10 3/4"
Section 7
5'-7 1/16"
6'-8 15/16"
Section 6
5'-5/16"
FISH LADDER
6'-2" (TYP.)
7'-0"
16'-6"
9'-6"
41'-6"
5'-0"
2'-0" (TYP.)
45° (TYP.)
STA. 16+96
4'-11 13/16"
7
6
6'-0" x 3'-0" WINDOW
#6 @ 12" BOTT.
#6 @ 12" T.&B.
SLOPE 2"
FLOOR SLAB
EL. = 192.5'
6"ϕ C.I. W/FLAP VALVE
8'-0"
3"
1'-6"
EL. 199.38'
5'-2 1/2"
3'-0"
20±1/2'
10 T @

Study 9 Instream flow
and
Study 24 Co-occurring mussels

Status of ongoing consultation

Studies 9 and 24 Instream flow, and co-occurring mussels Ongoing consultation

- **March 6, 2017 Final Study Reports Filed**
- **April 14, 2017 Study Report Meeting/Consultation prior to comment period deadline** – request for additional data and IFIM model results - provided
- **July 24, 2017 Stakeholder consultation** – agency feedback on DWM shear related criteria; Time Series for co-occurring mussels in Vernon; lamprey 2D and lamprey curves; operation and generation scheduling description; future model run scenario development; future meeting schedule proposed.
- **October 10, 2018 Stakeholder consultation** – discussion of preliminary agency model run request; what comprises “inflow = outflow” in these projects; stipulation and priority of model constraints; scenario template; summary of market elements that drive operations; HEC-RAS graphs showing elevation vs. cfs at different nodes and animation of Wilder reservoir fluctuation

Studies 9 and 24 Instream flow, and co-occurring mussels
Ongoing consultation

Stakeholders will meet, further discuss and develop Study 9 habitat based flow or operating scenarios and provide them to GRH

GRH to develop and provide:

- Template for Stakeholders to specify the run
- Output of base case run and existing graphs. *
- Perform an inflow=outflow model run, with other considerations as described above**
- Additional information on elements of operations – potential caveat or carve outs.

* Base Case updated to reflect current price curves (2017 vs 2012); Improved operational accuracy.

** Updated Base Case and inflow=outflow model runs under review; hope to release shortly

Study 25 - Dragonfly and Damselfly Inventory and Assessment – Supplement to Final Study Report
Comment 56

The report appears to not differentiate between odonate species and their habitat preference. No distingtion between species that prefer lotic habitat of the riverine section versus those species that are generalist or select the semi-lotic habitat of the impounded reaches. The importance of making this distinction is that project operations affect the impoundment sections of the river differently than the riverine sections. In general, riverine sites had lower abundance of odonates than the impounded sites. The completion of this type of analysis would allow the resource agencies to determine whether project operations are having a disproportional effect on odonate using riverine sections versus the impounded reaches

- **All potential effects occur in the riverine sections of the project area. Odonate species were found in the impounded sections in addition to riverine sections. The only species which were found exclusively in the riverine sections were *Ophiogomphus rupinsulensis* and *Stylogomphus albistylus*.**
- **literature supports the strong association of *Ophiogomphus rupinsulensis* with lotic habitats.**
- ***Stylogomphus albistylus* is reported in the literature as being associated with smaller water bodies (Paulson, 2011; Nikula et al., 2007), which typically exhibit higher flow velocities.**
- **Although no comparison to other species was made in the Final Study Report, exuviae of *Ophiogomphus rupinsulensis* were found at similar heights to *Gomphus vastus* where exuviae co-occurred, strongly suggesting these species eclose at similar heights.**

- The hypothesis that *Gomphus abbreviatus* may be negatively affected in the riverine sections and is using suboptimal habitat as a result is not supported by the collected data. Study 25 found this species to be more common at the lower impoundment sites than the upper impoundment sites. The upper impoundments have more lotic characteristics and WSE fluctuations are less affected by project operations than in the lower portions of the impoundments.
- Although *Gomphus quadricolor* is often identified as occurring in rapidly flowing rivers (Dunkle, 2000; Nikula et al., 2007; Paulson, 2011), the species is generally uncommon and poorly studied, and a review of known sites suggests that this species may show some preference for semi-lotic habitat. Hunt et al. (2010) identified the species only upstream of Vernon dam. In Study 25, only one individual of this species was found at one site in the upper half of the Wilder impoundment (Site 25-02). The species has also been documented immediately upstream of the Amoskeag dam on the Merrimack River during the New Hampshire Dragonfly Survey (Pam Hunt, personal communication, dated June 13, 2017). Additionally, the nymph stage of this species was initially described from a semi-lotic habitat in Ontario (Walker, 1932). Although the species may be more likely to occur in lotic habitat, these observations shed doubt on that assertion.

Comment 57

The assumptions used as part of the usable habitat elevations and the approach to the analysis evaluating water level rise potentially results in an underestimate of projects effects. While the report identifies two potential effects of project operations, the first being inundation of usable habitat, define[d] as steep bank, the report also indicates that no consistent trend was found in substrate or habitat preference based on observed odonates or abundance. Acknowledging that there may be differences in species habitat / substrate preference for emergence it would be more informative to provide information on the proportion of habitat types available below the low habitat elevation being used identified in the report, especially for the riverine habitat where there is between 1.5 – 4 feet of substrate that was documented being used by odonates.

- At most sites, available habitat in this area was fine sediment
- Two sites, each in the lower impoundment of their respective project (Wilder [Site 25-03] and Bellows Falls [Site 25-07]) contained significant amounts of coarse woody debris.
- Remaining two sites in the Bellows Falls Project (Site 25-06 in the impoundment and Site 25-08 in the riverine reach) each contained two transects with significant cobble

- At low water levels, odonates more likely at transects with fine substrates at Sites 25-06 and 25-08 (82% of observations) than those with cobble substrates at the same sites (18% of observations).
- *Stylurus amnicola* not found at any transects with cobble habitat, despite more than half of the observations of this species occurring at Site 25-06. This is consistent with the note in VANR Comment #56 that the species showed a preference for finer substrates.
- Habitat below toe of the bank slope averages approximately 50% shallower compared to the lower river bank (30% grade below the bank versus 62% grade on the bank).
- Although odonates may travel a greater horizontal distance at low water levels, Study 25 found horizontal distance to be a poor predictor of vertical distance (see section 6.3 of the Final Study Report).

Comment 58 and 60

The analysis of water level rise of 8-inches over a 30 minute period as a result of project operations is an underestimation of the project effects. During the surveys the full eclosion process was observed a limited amount of time and for those observed it ranged from 20 – 45 minutes with a mean of 31 minutes. This time step does not include the time for the teneral to harden and take flight. The Agency believes that this analysis should at least evaluate water level rise from project operations over a 45-minute period. However, the Agency recommends that a conservative approach be taken for this analysis and evaluate the water level rise over the course of one-hour.

- WSE data reviewed to determine the frequency at which water levels rise by 8 inches over a 1-hour period during the critical eclosion period (04:00 to 21:00).
- Although 1-hour analysis results in an increase in frequency of potential mortality events, the threat to eclosing odonate larvae is still very low, and mortality is unlikely to have a significant effect on odonate populations.
- Sites with greatest water level fluctuations (riverine Sites 25-04 and 25-08) experienced water level rises of 8 inches within one hour ~ 7% of the time versus <2% in the 30-minute analysis.
- Assuming all larvae eclose at the lowest observed height, this would result in 7% mortality at these sites due to rising water levels.
- >50% of sites had no water level rises of 8 inches within one hour, and the remaining three sites ranged from 0.27% to 4.57% frequency.

FWS Comment 14

Given that only 8 *Stylurus spiniceps* were tracked, the data set that project effects analysis was based on appears limited. Our concern is that water level logger data collected during those eclosure periods may not be representative of typical conditions. We would appreciate GRH providing any information that verifies that the data set is representative.

- **Analysis of the water level logger data during the critical period of eclosion was not limited to the observed eclosion periods of *Stylurus spiniceps*, but included all daylight hours during the study period and is therefore, necessarily representative of the 2015 study period (see Figure 5.1 in the Final Study Report). This is consistent with other studies and with the literature (i.e., Corbet, 1999). Water level loggers recorded data over fifteen minute intervals. For each fifteen minute reading, the maximum positive change in water level was calculated for the prior critical time period (30 minutes in the report, 1 hour in the subsequent analysis herein). Inundation frequencies were calculated by dividing the total number of changes that exceeded the critical elevation determined during the study (8 inches) by the total number of time periods.**

Comment 59

The analysis of vertical distance from the water surface at which an exuvia was found was assumed to be the vertical distance from the water surface at which the individual eclosed, likely results in an overestimate of the distance traveled by an individual. The Agency suggests a method to potentially limit the overestimation of the distance travel is for each sampling period at each site the mean, maximum, and minimum water level be presented for a one week period prior to the survey.

- **Although weekly statistics are calculable based on collected data, they do not provide a reliable correction of the effects of water level fluctuations on observed exuviae heights. Use of these statistics requires the assumption that odonates eclose uniformly and that water levels vary uniformly during the week prior to the survey. Since water levels are affected by project operations as well as by inflows and precipitation, neither of these assumptions is reasonable, and violation of these assumptions could result in a greater overestimation of eclosion heights.**
- ***Stylurus spiniceps* was used as an analog for other species. Although other species eclose at different heights field observations and literature suggest that this approach is conservative, as members of the genus *Stylurus* typically eclose at lower heights than other species.**

Comment 61

It seems that to assess project effects, the study should look at the height of WSE change over the critical time period (30 minutes in this study, but CRC would prefer 1-2 hours, as FirstLight did) and compare with the typical distance above water that eclosure takes place. Despite the habitat elevations and hourly WSE's in figures in the report, we could not find information that would help us understand the amount of change in a 30-min, 1-hour, or 2-hour period. For example, on page 20 it states that, "The mean vertical distance from the water surface at which eclosing *Stylurus spiniceps* were observed was 12 inches (range of 8-16 inches)." What is the likelihood in the study areas that the water level would rise by 12 inches in the span of 30 minutes, 1 hour, or 2 hours?

- **Additional analysis was conducted with a critical time period of one hour. During the study, eclosing odonates left their eclosion site prior to their first flight, generally travelling upward along the bank. Additionally, individuals may not fly at the first possible moment, thus the transition from flightless teneral to flying adult is not determinable (Corbet, 1999). Although the FirstLight study considered a time period of two hours, the 95th percentile during the study for start-flight was only one hour and sixteen minutes. As such, the two-hour time period is not representative even under the broader critical time period suggested.**