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June 14, 2016

VIA ELECTRONIC FILING
Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: TransCanada Hydro Northeast Inc.'s June 1, 2016 Updated Study Results Meeting Summary
Project Nos. 1892-026, 1855-045, and 1904-073

Dear Secretary Bose:

TransCanada Hydro Northeast Inc. ("TransCanada") is the owner and licensee of the Wilder Hydroelectric Project (FERC No. 1892), the Bellows Falls Hydroelectric Project (FERC No. 1855), and the Vernon Hydroelectric Project (FERC No. 1904). The current licenses for these projects each expire on April 30, 2019. On October 31, 2012, TransCanada initiated the Integrated Licensing Process by filing with the Federal Energy Regulatory Commission ("FERC" or "Commission") its Notice of Intent to seek new licenses for each project, along with a separate Pre-Application Document for each project.

With this filing, TransCanada submits its June 1, 2016 Updated Study Results Meeting Summary for the three projects, as required by 18 C.F.R. §5.15(c)(3) and the Commission's current Process Plan and Schedule (dated May 5, 2016). The Meeting for the Updated Study Report filed May 16, 2016 was held at TransCanada's Operations Control Center in Wilder Vermont, with WebEx and call-in capability for participants who could not attend in person.

The attached meeting summary includes meeting notes, points of discussion, the list of meeting attendees, and a copy of the presentation slides used during the meeting.

If there are any questions regarding the information provided in this filing or the process, please contact John Ragonese at 603-498-2851 or by emailing john_ragonese@transcanada.com.

Sincerely,

John L. Ragonese
FERC License Manager

Attachment: June 1, 2016 Updated Study Results Meeting Summary

cc: Interested Parties List (distribution through email notification of availability and download from TransCanada's relicensing web site www.transcanada-relicensing.com).

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

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)

June 1, 2016 Updated Study Results Meeting Summary

June 14, 2016

The June 1, 2016 Updated Study Results meeting was held at TransCanada's Renewable Operations Center in Wilder, Vermont. Presentation slides (corrected) follow these notes.

Meeting attendees in person or identified on the telephone:

Name	Affiliation	Name	Affiliation
Bill Connelly	FERC	Mark Wamser	Gomez & Sullivan
Steve Kartalia	FERC	Chris Tomichek	Kleinschmidt
Frank Winchell	FERC	John Ragonese	TransCanada
Owen David	NHDES	Jen Griffin	TransCanada
Jeff Crocker	VANR	Matthew Cole	TransCanada
Eric Davis	VDEC	Pat Mock	TransCanada
Lael Will	VFWD	Erin O'Dea	TransCanada
Gabe Gries	NHFGD	Mike Chelminski	Stantec
Matt Carpenter	NHFGD	Robin MacEwan	Stantec
Julianne Rosset	FWS	Steve Eggers	Normandeau
Ken Sprankle	FWS	Adam Slowik	Normandeau
John Warner	FWS	Rick Simmons	Normandeau
Melissa Grader	FWS	Steve Adams	Normandeau
Alex Hoar	FWS	Mark Allen	Normandeau
Katie Kennedy	TNC	Doug Royer	Normandeau
David Deen	CRWC	Chris Gurshin	Normandeau
Andrea Donelon	CRWC	Steve Leach	Normandeau
Chris Yurek	CRWC	Maryalice Fischer	Normandeau
Tim Sara		Ethan Nedeau	Biodrawversity
Scott Dillon	VSHPO	Don Shannon	Willamette CRA
John Mudge	Landowner	Steve Olausen	PAL
Harold Peterson	US BIA	Suzanne Cherau	PAL
Rich Holschuh	CVNAA, Elnu Tribe		
John Moody	Winter Center for Indigenous Traditions, Abenaki Nation of NH		
Ron Shems	Diamond and Robinson, P.C.		

Study 8: Channel Morphology and Benthic Habitat Study

Mike Chelminski summarized the study and results.

Question (Q): How would the substrate below the dams differ from a natural riverine reach with the same gradient?

Answer (A): Stability analyses indicate that much of the coarse-grained substrate identified as part of this study is stable for the evaluated range of flows and therefore is not expected to be mobilized and transported downstream by project operational flows. Tributaries appear to be the primary source of coarse-grained substrate, for example the delta bars at the mouths of the Saxtons and Cold rivers.

Study 17: Upstream Passage of Riverine Fish Species Assessment

Steve Leach summarized the study and results.

Q: Were trout species differentiated?

A: No, we couldn't identify to species on the video necessarily, similar with bass and sunfish.

Q: At Bellows Falls unlike the other dams with eel, there are some negative counts early in the season – any thoughts on that?

A: I don't have specific thoughts without looking at the video frame-by-frame which we don't intend to do. There are many potential reasons for those negative (downstream) counts.

Q: With Vernon's higher runs, were Wilder and Bellows open later?

A: No they were open earlier.

Note: VANR has data for 2016 and the ladder was open earlier at Vernon in 2016.

Q: I haven't looked closely at the report yet, but it would be helpful to have the temperature profiles and discharge at the projects since we see pulses and then gaps in passage.

A: Those data are all presented in the report.

Q: I think it would be helpful to look at some general trends, if you could pull the data together and have 3 different sets of cumulative graphs/summaries for: 1) all species; 2) diadromous species only; and 3) resident species only to get a snapshot of when these different groups are moving. If you could also put vertical bars in the graphs with cumulative % that would be helpful too.

A: I would caution in using that approach, to be sure that we are not overweighting smaller numbers of fish of one species that would skew the data.

Q: Are you cautioning against double counting fish?

A: No, just cautioning against comparing 50 fish of one species to 10,000 fish of another species.

Q: Vernon ladder is a differently designed ladder. Wilder and Bellows Falls were designed to only pass salmon and as operated, may not be easy to pass resident species. Does the report address that? At Amoskeag, they changed the operating protocol which improved herring passage. At some projects, configurations/flows for salmon are more turbulent than other species prefer and can use.

A: No, the study objectives did not include engineering feasibility or optimization. This study was about species and seasonality.

Q: Fish seem to want to move upstream as opposed to being “resident” in the ladder itself. Why aren’t those fish moving through?

A: We aren’t saying they don’t move through, we are saying they generally do move through, but they take time in the resting pools (including the window) and get counted multiple times while they are doing that because it is a motion capture system. Anecdotally, at Holyoke while that is a fish lift, and therefore fish are presumably intent on moving upstream, they are captive in the viewing section of the system. Nonetheless, many species tend to move back and forth multiple times before exiting.

Q: To our knowledge white crappie aren’t present in the Connecticut River, and white perch were missing from the list. I would be curious to see if there were any white perch.

A: We weren’t opposed to adding fish to the list, white perch just didn’t come up in discussions.

Q: What about channel catfish?

A: They were listed as “other” the only way to distinguish them from other species would be to re-look at the video. The technicians indicated “other” was mostly channel catfish.

Q: You don’t want to make an assumption that species passing in larger numbers are more important than species passing in low numbers. Just because numbers are low doesn’t mean passage lacks importance to a particular species.

A: We were talking more to another point which was actual counts in the ladder, and ladder flows.

Q: Wilder Unit 3 provides attraction flow, so that flow was not included with generation flows?

A: Correct.

Q: For Vernon, why is attraction flow shutdown at night?

A: We think that is a carryover from when we were manually counting. Historically we’d close the attraction flow gates to enable an accurate count. Flow through the ladder was never shut down. Currently, attraction water is being provided 24/7.

Q: You mentioned confined space permits to enter fish ladders – how long does that take?

A: Generally within a day, there is no external regulatory permit required. It is a matter for having the proper qualified staff available and scheduling their work to be able to enter the ladder safely with required protocols and equipment in place.

Q: So the ladders were operated the same way all season?

A: Yes, based on the existing protocols used to normally pass salmon, and shad at Vernon. What we didn’t know was how operating for an extended period would affect trash buildup, etc. We saw this at Wilder and found a few orifices plugged with debris. So if the ladders were operated over longer periods, there would be additional maintenance required, including the need for confined space entry permits.

Q: Were the settings recorded so that you know what flows they were operating at or could specify the flow?

A: Wilder is automated and driven by head pond elevation. To change the amount of flow is an engineering calculation and then a need to program the whole ladder operation for that. Vernon isn't as automated and water is added/subtracted based on what we measure for elevation in a stilling well. To provide different flows, wouldn't be easy but we could (e.g., at Vernon) change attraction flows. Bellows Falls has the same features as Wilder, but is set manually within a narrower band due to head pond elevation and not as automated as Wilder.

Q: Do you know how long the potential obstructions at Wilder occurred?

A: There had been a major precipitation event that is likely to have led to the build-up of debris. When Brett came out we saw some difference in elevation height at several weirs and at that time station staff mentioned that a day or two prior to that, there had been debris in the area and they had sluiced it through the trash/ice sluice. This is explained in the report.

Note: A previous question was about why did we see more fish at Vernon? It is partly the habitat in the different tailraces. Bellows Falls and Wilder both have substantial bedrock formation and while Wilder has some littoral habitat it's limited by a relatively steep bank. Vernon's tailwater is affected by the Turners Falls dam and exhibits more reservoir conditions below the dam (high tailwater elevation and shorter riverine reach) providing more littoral habitat supporting sunfishes.

Study 19: American Eel Downstream Passage Assessment

Adam Slowik summarized the Study 19 route selection study and results.

Q: When you say some eels did not pass the project, what does that mean exactly?

A: They were either not detected at monitoring stations downstream of the project or not detected by receivers dedicated to monitoring the various conveyance routes at the project.

Q: With the Wilder fish, how many of the original 50 made it past Vernon?

A: 24 of the original 50.

Q: Of the remaining 26 Wilder fish, what do we know about the fate of those fish?

A: The report notes that some were detected at Wilder, some at Bellows Falls, some at Vernon. Five of the Wilder released fish didn't pass Wilder.

Q: Do we have information on the alternate units available when they passed?

A: Yes there are also % flow numbers and figures in the report. We have the data on what routes were available at the time of passage for each fish. We summarized the data overall in the report text and tables. What would be difficult to discern, say if the residency time was 5 hours and operational changes over that 5 hours. We could show what was going on at the exact time of passage but it doesn't show behavior in advance. We can provide more detail if necessary but wanted to get the report out and also make sure any additional analysis of the data, unit operation or behavior reflects what you want. We can share the approach with you before generating all the data.

Q: To clarify, when you say 112 of 118 eels arriving at Vernon successfully passed – you mean they passed by some route?

A: Yes, that is correct.

Steve Adams summarized the Study 19 turbine survival study and results.

Q: Conclusion on Wilder Unit 3, based on the combined graphs etc., even though Wilder unit 3 is Francis, it is smaller and higher RPM than the other tested units, so I would question how you could conclude that Wilder unit 3 could be similar to Vernon unit 4 with fewer RPMs.

A: That is somewhat based on the graphs of runner blades, size, speed e.g., characteristics. It could be potentially less at Wilder, and we can remove that statement from the report. It doesn't really matter because there are other things going on at Wilder Unit 3.

Q: It also couldn't be tested because eels and tags couldn't be recovered so there are differences at Wilder unit 3.

A: Yes, unit 3 is the attraction flow for the fish ladder. Water exiting the draft tube enters the fish ladder from below via a diffuser chamber in which the water passes through a grate with small spacing. We think eels were getting caught there.

Note: With regard to unit 3 at Wilder, we did assess it in Study 23 and it did come up as poor survival for eels.

Q: About the route selection portion and 112 eels that passed Vernon. Can you look at the difference between the group of eels that did pass vs. the ones that didn't? I don't care about their fate, but rather what were the typical conditions or is there a pattern when fish pass?

A: Most eels passed quickly but we can look at operations to see if there are any patterns.

Q: For all fish that survived and passed Vernon, I would like to see what the operation was, which unit did they use, and what were the conditions at that time?

A: We can accumulate all of that data. There is more information we can tease out and we will do that. But we can't say much about the fish that don't make it to the next project.

Study 22: Downstream Migration of Juvenile American Shad at Vernon

Adam Slowik summarized the Study 22 route selection study and results.

Q: Is residency the end point below the dam or at the dam?

A: At the dam, it is the first detection during downstream conveyance.

Q: There are some maps showing example passage routes with receivers well downstream of Vernon. Were those used in calculation of passage success.

A: For route selection, yes.

Q: For residency times of less than a minute, does that mean it wasn't detected before it passed?

A: No, short residency times were based on when we first picked them up on receivers on the upstream side of the dam and then detected them passing through the project on a conveyance route specific antenna. The report indicates that we assigned a residency time of < 1 minute if there was only 1 detection at passage (i.e. the conveyance route antenna).

Q: One of the tables showed where and when you released fish upstream. First you had three groups of seven fish released across the river, then one group of 20 was released in one spot rather than across the river. What made you change that?

A: We started that because we wanted to get some better information on fish that were coming down from the NH side and crossing the dam toward the non-spillway passage routes. *Additional clarification: At the time the approach changed we had begun to release more surrogates (non-tagged fish) along with the tagged fish and had concerns of predation. We hoped larger release groups (in one location) would fare better due to schooling behavior. However, there were not apparent differences in the data. Regardless of the release location across the release transect, fish still entered the study area in the same general locations.*

Q: The analysis we discussed earlier for eels about the proportion of flow when they passed, would be handy for this study too.

A: Agreed, we will provide this information.

<u>Paul Heisey summarized the Study 22 turbine survival study and results.</u>

Q: Is 48-hour survival presented in the report?

A: No, we did not present that because we feel that data would be statistically unreliable.

[Additional clarification: Three reports/publications (Heisey et al., 1992; Mathur et al., 1994; Ruggles et al., 1990;) discuss the effects of high control mortality on the reliability of estimated turbine passage mortality. Based on studies of juvenile clupieds it was recommended that in order to obtain reliable estimates of turbine passage mortality, control mortality in a turbine passage experiment be minimized (preferably <20%) and recapture rates maximized (preferably (>90%). We followed these criteria to produce reliable estimates. In the present case, the 1h estimate appeared more reliable and in agreement with results from similar studies on juvenile clupieds. The negative exponential relationship between the estimated turbine passage mortality and control mortality is illustrated in the figure below (reproduced from Mathur et al., 1994). It shows that as control mortality increases, estimates of turbine passage mortality increases thus producing uncertainty. As a result, it becomes increasingly difficult to separate the effects of turbine passage from those due to handling, tagging, and recapture.]

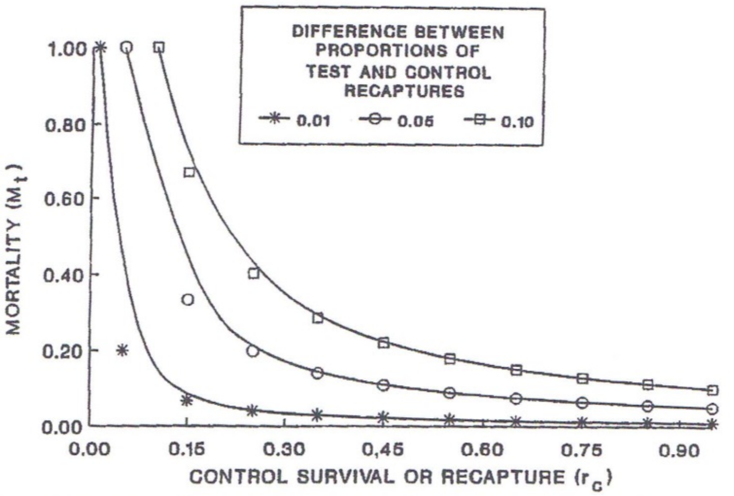

FIGURE 1.—Effects of control fish recapture rates on estimated turbine-related mortality (based on text equations 1 and 2) when the proportion of control fish recoveries exceeds the proportion of test fish recoveries by 0.01, 0.05, or 0.10.

References:

Heisey, P. G., D. Mathur, and T. Rineer. 1992. A reliable tag-recapture technique for estimating turbine passage survival application to young-of-the-year American shad (*Alosa sapidissima*). Canadian Journal of Fisheries and Aquatic Sciences 49:1826-1834.

Mathur, D., P. G. Heisey, and D. A. Robinson. 1994. Turbine-passage mortality of juvenile American shad in passage through a low-head hydroelectric dam. Trans. Am. Fish. Soc. 123:108-111.

Ruggles, C. P, T. H. Palmeter, and K. D. Stokesbury. 1990. A critical examination of turbine passage fish mortality estimates. Report to Canadian Electrical Association Research and Development, Montreal.

Q: How would it bias it if you present all the data and we also see the control mortality presented?

A: It could be calculated but it would still be unreliable.

[Additional clarification: Estimated 48h survival estimates were calculated after the meeting and were higher than the 1 h estimates primarily because the controls died at a little higher rate than the treatment fish during the 48h holding period. However the 48 h estimates are still considered unreliable because of the greater than 30% control mortality. Additionally, survival would not increase with time; therefore, the

48h estimates should not be higher than the 1h estimates. For consistency in all of our reports when 48h estimates are higher than the 1h, the 1h estimate is assigned to the 48h estimate.]

Q: Did you observe mortality of wild fish passing through turbines or did you observe any mortality?

A: I don't recall anyone seeing dead shad when we were in the tailrace collecting tagged shad from the turbine survival study.

Q: Why do you think the juvenile shad did better through Kaplan units while eels did better through Francis units?

A: We need to do more research on eels through Francis units to understand why eels did better through those. While shad are very sensitive and eels have tougher skins, it may have more to do with their approach or the approach hydraulics into the units, we just don't know.

<u>Chris Gurshin summarized the Study 22 run timing study (hydroacoustics) and results.</u>

Q: Questions on rose plot slide which indicated general directional movement toward the southwest cardinal direction.

A: The starting point of the plot has nothing to do with where the fish first entered the beam. It is the overall compass direction which shows a general southwesterly movement of where fish went once they entered the beam. The central tendency is a little north of the fish pipe and a little more toward units 5-8.

Q: If a fish were outside of the beam detection radius, is it also likely to be moving in the same direction?

A: Yes.

Q: Telemetry suggests a short residence time, while [daily vertical migration described by the hydroacoustic data] seems to indicate there is some residency prior to passage.

A: Route selection showed that most shad moved in the evening. A lot of published studies show that in the daytime juvenile shad school more closely and at night the school tends to break down as they move downstream. We did not use hydroacoustics to evaluate residency time, route selection did that.

Q: So none of these studies get to delay of wild fish. Maybe if you had released them during the day for route selection you might get some delay.

A: Travel time and residency time are reported by release group in the route selection study portion of the report (Table 4.1.2-1).

Q: Was hydroacoustic sampling done 24 hours/day?

A: Yes, it is in the report. The highest abundance in the beam was seen generally during the afternoon. What we can say is that there was no evidence of multi-day residence for untagged wild fish in this study. If shad were delayed in the forebay detection abundance in the beam would increase as shad arrived but did not pass.

Study 23: Fish Impingement, Entrainment, and Survival Study

Rick Simmons summarized the study and results.

Q: Do you see anything related to entrainment when head pond elevation is lowered?

A: The EPRI study found that large seasonal head pond elevation changes at high head dams (e.g., 25-30 feet or more) which tend to occur in winter drawdowns can cause high entrainment.

Q: Even at these [TransCanada] projects where they drop the ponds a couple of feet?

A: No, the EPRI database doesn’t flag small elevation changes as a factor in high entrainment.

Q: Are approach velocities so high that larger fish are drawn in?

A: No, velocities are generally low, and these species (adults) have high burst speeds. They stage in front of intakes and/or are chasing prey in forebays. We consider anything less than about 80% survival based on tagging data, to be low survival.

Q: Is that true also in winter?

A: Yes, EPRI found there can be higher entrainment in winter due to lower pond elevation typical of winter elevations, and this is worse at projects down south but with species we don’t have here and where impoundments are drawn down a lot more. EPRI also found this at projects with higher head than the TC projects. From the EPRI database for this study, we selected those projects that are similar to the TC projects e.

Q: At projects with power canals, would it be an issue when generation is increased or is the rack spacing large enough?

A: No, the rack spacing at Bellows Falls for instance is large and that shouldn't really be an issue. We don't really have emigrating shad above Bellows Falls.

Study 24: Dwarf Wedgemussel (DWM) and Co-occurring Mussel Study – Delphi Panel Report

Mark Allen summarized the Study 24 Delphi Panel process and resulting HSC.

Q: Where is benthic velocity measured? I assume there was a definition included in the questionnaire so that everyone understood the same definition of benthic velocity otherwise the HSC for this can't be used.

A: Generally, everyone considered benthic velocity to be right above the river bed, although panelists may have considered this in a slightly different manner. *Additional clarification: A post-meeting inquiry of panelists confirmed that all panelists and the moderator considered the range to be 1-2 cm above the river bed.*

Q: I didn't see the report on TC website.

A: It should be there but also it is on the FERC elibrary. *Additional clarification post-meeting: The Delphi panel report is on the TC website under Documents\Study Reports\Study Reports 1-33\Study 24.*

Ethan Nedeau summarized Study 24 next steps to completion of the study.

No questions.

Steve Eggers: As a note, benthic velocity and both shear stress variables are not done within the instream flow model so will require an extra step to calculate rather than being done automatically in the model. In other words, these are post-processed.

Study 9: Instream Flow Study – Consultation

Steve Eggers presented information and HSC from the memorandum provided to stakeholders in advance of the meeting. He noted an error in memo on pages 31 and 39: Shad Area Weighted Suitability (AWS) should be juvenile, adult and spawning not fry, juvenile, spawning as the graphs denote.

Q: So what is labeled in the memo as fry should be juvenile and juvenile should be labeled as adult?

A: Yes. *[A revised set of HSC was provided to the aquatics working group on June 2, 2016]*.

Steve: Time series can be run as soon as we know the species and life stages. Dual flow analysis needs flows bracketed and decided on.

John R: We'd like to get a schedule of process for stakeholder input, feedback, and the modeling. We are looking for initial feedback starting to limit species/life stages and consultation by mid-June with objective of possibly finishing study 9 by August 1. So that we can look at the operations model and design scenarios to look at this data.

Q: How iterative can it be? Is there pressure to make all the decisions at once?

A: We think it is better to be iterative. One of the comments previously was that doing a critical reach analysis would double the analysis if reach-based analyses stay the same so that needs discussion as well.

Study 33: Cultural and Historic Resources Study

<u>Don Shannon summarized the Study 33 Traditional Cultural Properties Study and results.</u>

Q: Which tribes did you consult with? We (USBIA) would also suggest the Connecticut tribes (Mashantucket Pequot Indian Tribe, Mohegan Indian Tribe of Connecticut).

A: Initially we reached out to about five bands representing Abenaki interests in New England and FERC initially reached out to federally recognized tribes. Several attempts were made to contact tribal representatives and get their involvement. FERC also reached out to other tribes.

Frank W [FERC]: Yes, FERC reached out to all the federally recognized tribes.

Q: John Moody (landowner and Abenaki representative), reported that he got a call from PAL about 5 years ago, but didn't hear back. There has been a lot of discussion within the Abenaki community over particularly the last year or year and one-half.

A: We indicated that we were doing the studies, and no one came forward expressing interest in participating, until just recently (the 05/13/16 FERC submittal by Elnu Abenaki Tribe).

Q: This is the beginning of our response and we'd like to structure a meeting to discuss the TCP [Mr. Moody provided a contact list for consultation with the Abenaki Nation].

A: Yes, we agree and will set up a means to make that happen. We originally reached out to several individuals on this new contact list.

Q: To clarify, the Elnu wasn't on the original list and now are the designated representatives of the Abenaki in the area of the projects.

A: Understood, we reached out to those we had information about at that time from the states.

Q: The book "Where the Great River Rises" (Rebecca Brown, ed. Dartmouth College Press, 2009, 284 pp.) has correct place names (see for example the map on page 134), and the place names in the TCP report are all incorrect. This is a good example of why we need a meeting, and to receive copies of the archaeology reports.

Q: The report drew only from a part of the literature and we welcome the opportunity to work on edits to the report. We do not view these things as resources or properties, these are relations. Many of the Abenaki are in communication with the Narragansett tribe.

A: We are not surprised that the Price book used for the report has errors in it. And we agree that this report is an outline. While not intended to be exhaustive, the report was intended to be thorough. Let's try to figure out a time for a meeting/consultation to move the report to a second phase based on tribal input.

<u>Steve Olausen summarized the status of Study 33 archaeological investigations.</u>

Q: Where are these sites roughly?

A: In general, TransCanada owns very little land so most of the APE land is privately owned and the APE is defined as within 33 feet from the shore and up into tributaries at the same extent. We sought and continue to seek permission from landowners to conduct research in those areas. In the case of NH, one site out of 6 or 8 gave permission (Lyme NH). VT sites are in Fairlee, Thetford, Bradford, and Putney. To clarify, in the Phase 1Bs we only looked at areas of identified, active erosion. TC has submitted these reports that are completed to states and to FERC. And it is state/federal law to limit access.

Frank W: From the perspective of FERC, if we have state recognized tribes, they would certainly be able to access those confidential reports. The Elnu has requested this via their recent letter (05/13/16 letter to FERC). Others should submit letters to FERC and put it on the record.

John R: It might be more convenient for others to not have to submit letters to FERC.

Scott D: VT will file formal comments on the Phase 1B soon. VSHPO does have some concerns about the low level of permission granted to look especially at erosion sites.

John R: Yes, TC has made honest attempts to gain permission, and maybe this is an ongoing long-term thing going into new licenses. There may be an opportunity to provide information and education on the process so that landowners better understand the reasons it is important to look at those sites.

Steve O: There are 2 more parts to the process in consultation with the parties - the HPMP and the Programmatic Agreement. These are in place at TC's Deerfield River, Fifteen Mile Falls, and at Vernon projects and they seem to work well.

John Mudge: The report will be released in the next few weeks?

John R: Yes generally, as soon as we can complete the review and get it submitted to FERC.

John Mudge: I have photos of severe erosion at the Fairlee site.

John Moody: TC's predecessor did a lot of work with the states and Abenaki to stabilize Skitchewaug site.

Don S: To follow up on the comment that Price is not the most reliable source for information on place names, related to that there really is no body of ethnographic work that has been done in the Connecticut River valley.

John Moody: Fred Wiseman's 3 books are the only somewhat ethnographic works out there, but there is a huge archive of information, much through elders. Locally and regionally there is a lot of information available if done confidentially to protect the sites from vandalism etc.

John R: So the next step is to organize some kind of meeting, check on schedules, and hopefully identify a process to interview, visit, look at additional archive materials, etc.

Frank W: The comments and responses just filed on May 31 did not include responses to Brattleboro Historical Society that was included in the list of commenters.

A: Thank you for pointing that out. TC's comment/response table for Study 33 was inadvertently not included in that filing and we apologize for this oversight. *[The document was filed with FERC on June 2, 2016].*

Wilder, Bellows Falls, and Vernon Project Relicensing

Updated Study Results Meeting: June 1, 2016

TransCanada

Agenda

Study No.	Study Title	Study Lead/Presenter
8	Channel Morphology and Benthic Habitat Study (Revised report filed 05/16/2016)	Mike Chelminski
17	Upstream Passage of Riverine Fish Species Assessment	Steve Leach
19	American Eel Downstream Passage Assessment	Adam Slowik, Paul Heisey
22	Downstream Migration of Juvenile American Shad – Vernon	Adam Slowik, Paul Heisey, Chris Gurshin
Break ~ 11:00 – 11:15		
23	Fish Impingement, Entrainment and Survival Study	Drew Trested
24	Dwarf Wedgemussel and Co-occurring Mussel Study – Delphi Panel Report	Mark Allen, Ethan Nedeau
Lunch ~ 12:45 – 1:15		
9	Instream Flow Study Consultation	Steve Eggers
Break ~ 2:30 – 2:45		
33	Cultural and Historic Resources – Traditional cultural Properties Report and Phase and Archaeological Investigations Progress Update	Don Shannon, Steve Olausen, Suzanne Cherau
Questions and Wrap up		

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Study 8
Channel Morphology and Benthic Habitat Study

The objectives of Study 8 included:

1. Assess the distribution and extent of existing substrate types, including gravel and cobble bars within the project-affected areas; and

2. Identify the current conditions of the channel and determine the stability of the present substrate/benthic habitat and potential project-related effects on these habitats.

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Study 8 – Channel Morphology and Benthic Habitat Study

Study Summary

Field Data Collection:
- Field studies completed in 2014

Analysis and Assessment:
- Review of field data and other Studies, including:
  - Riverbank Erosion Studies (Studies 1-3)
  - Hydraulic Modeling Study (Study 4)
  - Aquatic Habitat Mapping Study (Study 7)
  - Aquatic invertebrates studies (Studies 24, 25, 26)
  - Fish species studies (Studies 11, 12, 15, 16, 21)
- Distribution of coarse-grained sediment
- Potential sediment sources
- Substrate gradation and embeddedness at study sites
- Stability of coarse-grained substrates
- Availability & stability of coarse-grained benthic habitat
- Assessment of Project Effects

Study Report Status:
- Submitted Initial Study Report: March 2, 2015
- Submitted Final Study Report: May 16, 2016

Study Site 08-M07. Mid-channel bar upstream from Sumner Falls (riverine reach below Wilder).

Transect 1 at Study Site 08-M07. Representative substrate.

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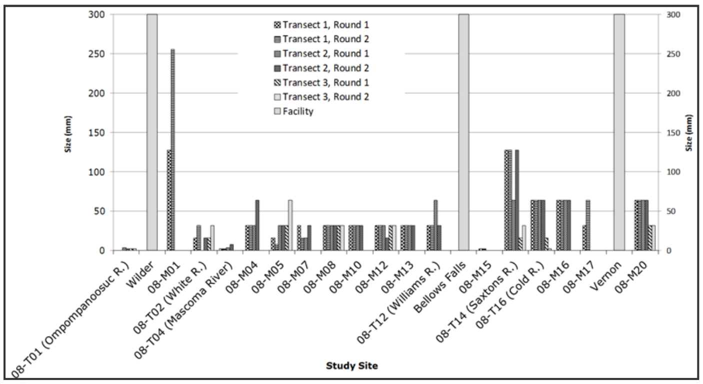
Study 8 – Channel Morphology and Benthic Habitat Study

Sediment Gradation

- Coarse gravel was dominant at study sites downstream from Wilder Dam
- Very coarse gravel was dominant at study sites downstream from Bellows Falls Dam
- Characteristics and influences of tributary sediment supply varied by tributary
- Temporal variability of particle size was limited within the study period



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Median-Diameter Particle Size: Mainstem and Tributary Study Sites

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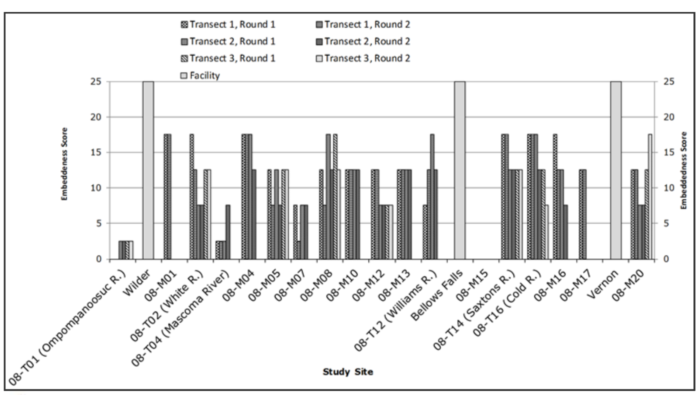
Study 8 – Channel Morphology and Benthic Habitat Study

Embeddedness

- Trends in inter-site variability (i.e., between transects) were not apparent at Mainstem Sites; Tributary Sites trended towards increased embeddedness at higher-elevation transects.
- Consistent trends in spatial variability were not apparent
- Temporal variability trended towards increased embeddedness in Round 2



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Embeddedness Scores: Mainstem and Tributary Study Sites

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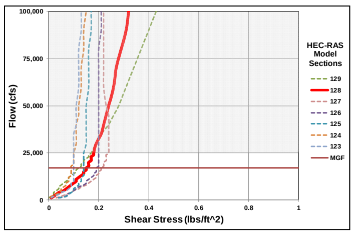
Study 8 – Channel Morphology and Benthic Habitat Study

Stability of Coarse-Grained Substrates

Study Site 08-M20. Mid-channel bar downstream from Vernon Dam



Study 4 Data: Study Site 08-M20

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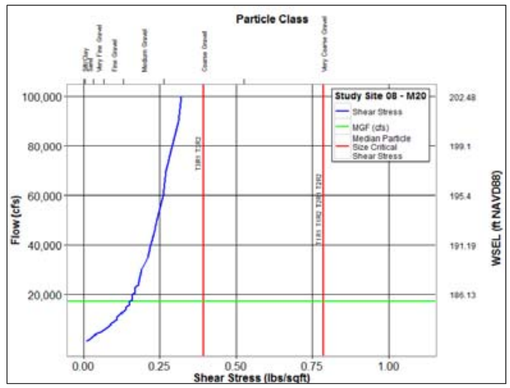
- Developed peak flow statistics
- Calculated critical shear stresses
- Correlated modeled flows with return intervals
- Assessed substrate stability at modeled flows



Stability Analysis: Study Site 08-M20.

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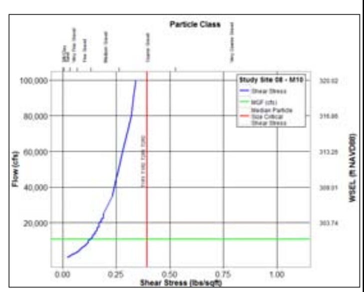
Study 8 – Channel Morphology and Benthic Habitat Study

Findings

- Dominate substrates at study sites were coarse gravel and very coarse gravel (Study 8 sites)
- Coarse-grained substrates are the dominant substrate in the riverine reaches downstream from the Project dams (Study 7)
- Persistent coarse-grained benthic habitat is present throughout the study area
- Coarse-grained habitat at study sites is generally stable at flows up to the maximum nominal generating flows (MGFs)
- Critical shear stresses for coarse-grained substrates at study sites generally occur at flows that significantly exceed MGFs
- Tributaries are a primary source of coarse-grained substrates
- Fine-grained material is the dominant material in mainstem riverbanks
- Trends were not apparent in spatial variability of embeddedness
- Flows greater than the MGFs are the dominant factors that contribute to the availability and stability of coarse-grained benthic habitat in the study area

Transect 2 at Study Site 08-M10.
Representative Substrate



Stability Analysis: Study Site 08-M10.

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Study 17
Upstream Passage of Riverine Fish Species Assessment

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Study 17 – Upstream Passage of Riverine Fish Species

Recap – Study Summary

- Fishways began operation and video equipment was installed on April 16 at Wilder, April 15 at Bellows Falls, and May 5 at Vernon.
- Video data was continually processed, reviewed and summarized on a weekly basis throughout the study season.
- Fishways were closed on January 7, 2016 at Wilder , and on January 6, 2016 at Bellows Falls and Vernon.
- Report filed May 16, 2016

NOTE: In variance to the RSP, temperature loggers were inadvertently not installed in fish ladders. Temperature data was obtained from nearby sites used in other studies (primarily Study 6).

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Study 17 – Upstream Passage of Riverine Fish Species

Recap: Study Results – Wilder

Species	Upstream	Downstream	Net Total
Migratory Species			
Atlantic Salmon	1	0	1
American Shad	0	0	0
Sea Lamprey	4	-2	2
American Eel	203	-151	52
Resident Species			
Bass (Micropterus spp.)	454	-415	39
White Sucker	10	-9	1
Walleye	171	-150	21
Trout	1114	-1040	74
Sunfish (Lepomis spp.)	23	-28	-5
Bullhead	0	0	0
Crappie (Pomoxis spp.)	0	0	0
Pike (Esox spp.)	0	0	0
Yellow Perch	0	0	0
Carp	0	0	0
Other	0	0	0

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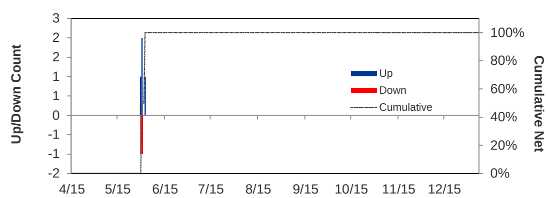
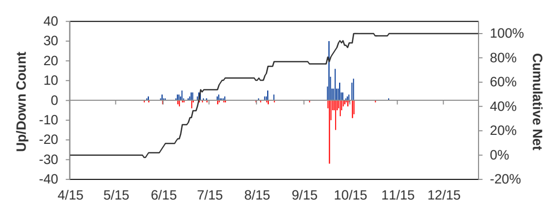
Study 17 – Upstream Passage of Riverine Fish Species

Daily Up / Down Count and Cumulative Net Passage, Wilder

Sea Lamprey
Up = 4
Down = -2
Net Up = 2



American Eel
Up = 203
Down = -151
Net Up = 52



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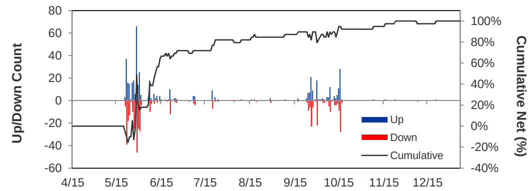
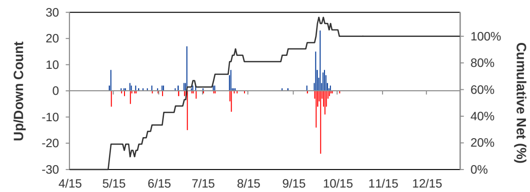
Study 17 – Upstream Passage of Riverine Fish Species

Daily Up / Down Count and Cumulative Net Passage, Wilder

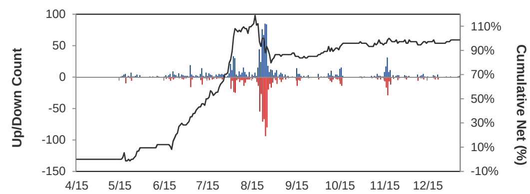
Bass
Up = 454
Down = -415
Net Up = 39



Walleye
Up = 171
Down = -150
Net Up = 21



Trout
Up = 1,114
Down = -1,040
Net Up = 74



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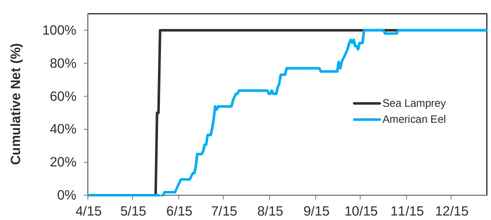
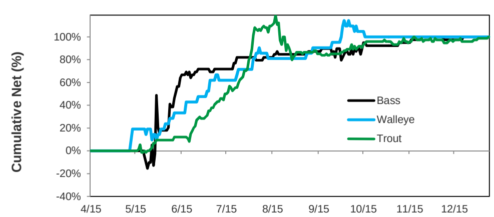
Study 17 – Upstream Passage of Riverine Fish Species

Cumulative Passage, Wilder

Sea Lamprey
Net UP = 2
American Eel
Net Up = 52



Bass
Net Up = 39
Walleye
Net Up = 21
Trout
Net Up = 74



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Study 17 – Upstream Passage of Riverine Fish Species

Recap: Study Results – Bellows Falls

Species	Upstream	Downstream	Net Total
Migratory Species			
Atlantic Salmon	1	-1	1[a]
American Shad	87	-43	44
Sea Lamprey	2341	-1371	970
American Eel	245	-185	60
Resident Species			
Bass (Micropterus spp.)	607	-654	-47
White Sucker	49	-42	7
Walleye	30	-28	-2
Trout	144	-136	8
Sunfish (Lepomis spp.)	30	-23	7
Bullhead	0	0	0
Crappie (Pomoxis spp.)	0	0	0
Pike (Esox spp.)	0	0	0
Yellow Perch	0	0	0
Carp	0	0	0
Other	0	0	0

[a] assumed net passage of +1 (because Wilder count=1)

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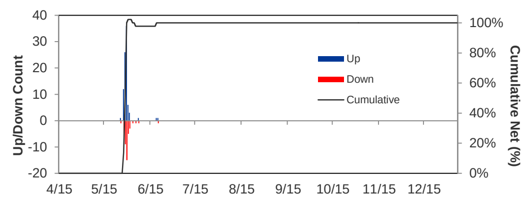
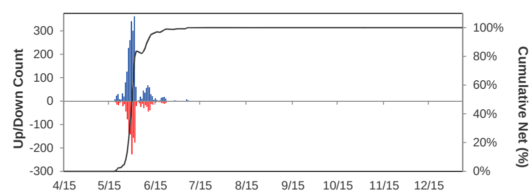
Study 17 – Upstream Passage of Riverine Fish Species

Daily Up / Down Count and Cumulative Net Passage, Bellows Falls

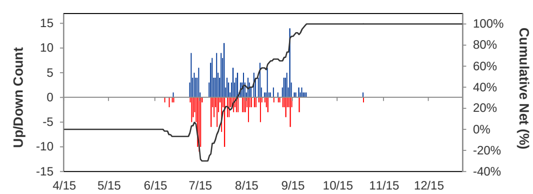
American Shad
Up = 90
Down = -46
Net Up = 44



Sea Lamprey
Up = 2,334
Down = -1,363
Net Up = 971



American Eel
Up = 245
Down = -185
Net Up = 60



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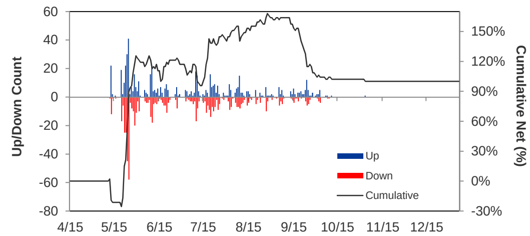
Study 17 – Upstream Passage of Riverine Fish Species

Daily Up / Down Count and Cumulative Net Passage, Bellows Falls

Bass
Up = 606
Down = -656
Net Up = -50



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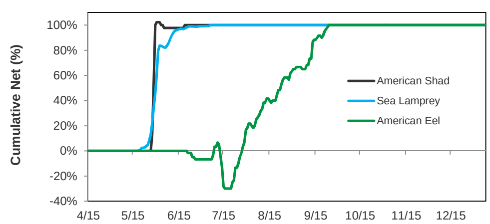
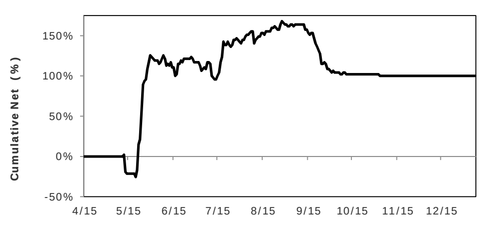
Study 17 – Upstream Passage of Riverine Fish Species

Cumulative Net Passage, Bellows Falls

American Shad
Net Up = 44
Sea Lamprey
Net UP = 971
American Eel
Net Up = 60



Bass
Net Up = -50



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Study 17 – Upstream Passage of Riverine Fish Species

Recap: Study Results – Vernon

Species	Upstream	Downstream	Net Total
Migratory Species			
Atlantic Salmon	6	-0	6
American Shad	55387	-16191	39196
Sea Lamprey	7700	-5260	2440
American Eel	4197	-3372	1545
Resident Species			
Bass (Micropterus spp.)	5320	-4559	761
White Sucker	2354	-2032	322
Walleye	131	-73	58
Trout	90	-60	30
Sunfish (Lepomis spp.)	4613	-3425	1188
Bullhead	8	-6	2
Crappie (Pomoxis spp.)	14	0	14
Pike (Esox spp.)	1	-3	-1
Yellow Perch	0	0	0
Carp	88	-80	8
Other	136	-124	12

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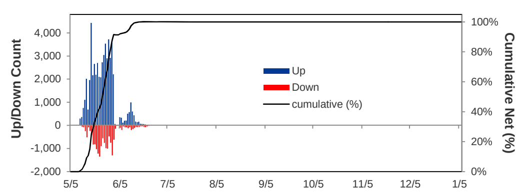
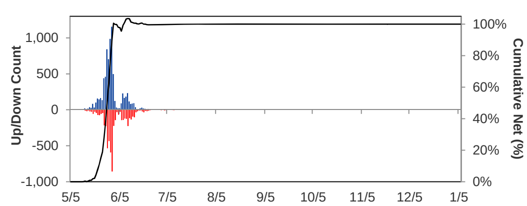
Study 17 – Upstream Passage of Riverine Fish Species

Daily Up / Down Count and Cumulative Net Passage, Vernon

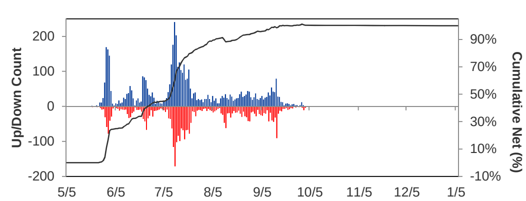
American Shad
Up = 54,890
Down = -16,092
Net Up = 38,798



Sea Lamprey
Up = 7,662
Down = -5,193
Net Up = 2,469



American Eel
Up = 4,914
Down = -3,369
Net Up = 1,545



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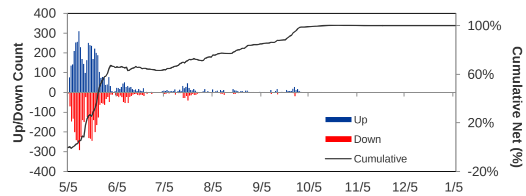
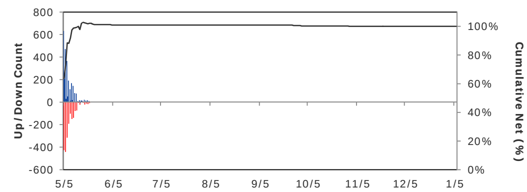
Study 17 – Upstream Passage of Riverine Fish Species

Daily Up / Down Count and Cumulative Net Passage, Vernon

Bass
Up = 5,304
Down = -4,538
Net Up = 766



White Sucker
Up = 2,353
Down = -2,010
Net Up = 343



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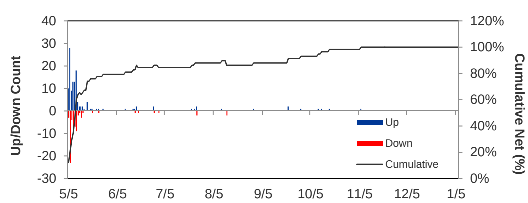
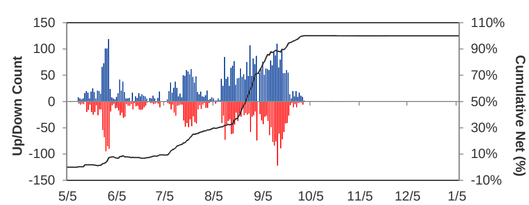
Study 17 – Upstream Passage of Riverine Fish Species

Cumulative Net Passage, Wilder

Walleye
Up = 132
Down = -73
Net Up = 59



Sunfish
Up = 4,612
Down = -3,422
Net Up = 1,190



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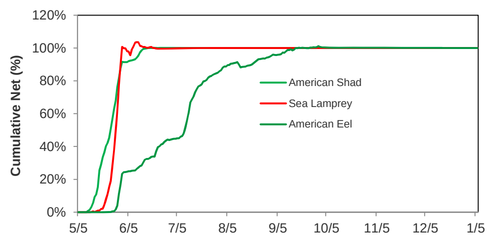
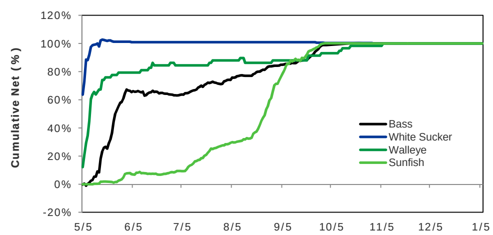
Study 17 – Upstream Passage of Riverine Fish Species

Cumulative Net Passage, Vernon

American Shad
Net Up = 38,798
Sea Lamprey
Net Up = 2,469
American Eel
Net Up = 1,545



Bass
Net Up = 766
White Sucker
Net Up = 343
Walleye
Net Up = 59
Sunfish
Net Up = 1,190



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Study 17 – Upstream Passage of Riverine Fish Species

Conclusions

- Low net passage by resident species at Wilder and Bellows
  - Based on current operational protocols, there is little compelling evidence to suggest operations for residents outside of the diadromous species passage season is necessary
- Vernon passed relatively high numbers of three resident species primarily during the spring and early summer period, though some species continued to pass in summer and fall (e.g., bass and sunfish)
  - Passage seasonality for most resident species suggests that operation beyond the existing anadromous passage window is not warranted
    - American Eel is an exception
  - Vernon fish ladder should be opened as early as possible in the spring for White Sucker and Walleye

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Study 19
American Eel
Downstream Passage Assessment

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Study 19 – American Eel Downstream Passage

Recapо - Study Summary

- **Eel Sourcing**
  - Eels were procured from a source in Newfoundland (with stakeholder concurrence)
  - Eels passed all pathology tests and were approved for import
- **Route Selection**
  - 170 individuals received radio tags and released upstream of Wilder, Bellows Falls, and Vernon on 5 occasions during a ten day period between October 27 and November 5, 2015
  - Fish were tagged and released in groups of 10 and released in four general areas approximately three miles upstream of each project
- **Turbine Survival**
  - 313 eels received HI-Z tags and were released (39 control fish) proportionally through different turbine types at all 3 projects.

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Study 19 – Route Selection

Wilder Route Selection Results

- Travel time from release to study area ranged from 1 hour, 39 minutes to 8 days, 2 hours, 31 minutes (median = 1d, 1h, 6m).
- Residency time within the project's study area ranged from 2 minutes to 1 day, 15 hours, 36 minutes (median = 13m).
- Most eels that passed used the turbine intakes: 93% (N=42) of all passed fish. The trash/ice sluice passed 6.7% (N=3)
- Five of the 50 released fish (10%) did not pass the project.

Passage Route	No.	% of all passed	% of all released
Turbine Units 1-2	32	71.1%	64.0%
Turbine Unit 3	10	22.2%	20.0%
Trash/ice sluice	3	6.7%	6.0%
Total Passed	45	100.0%	90.0%
Did not pass	5		10.0%
Total Released	50		100.0%

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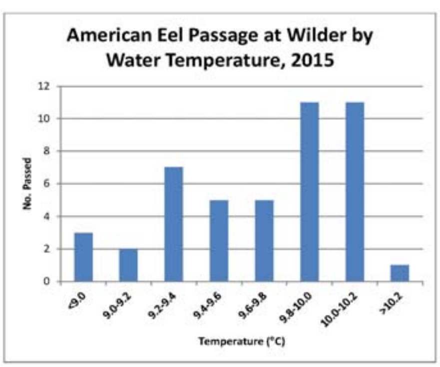
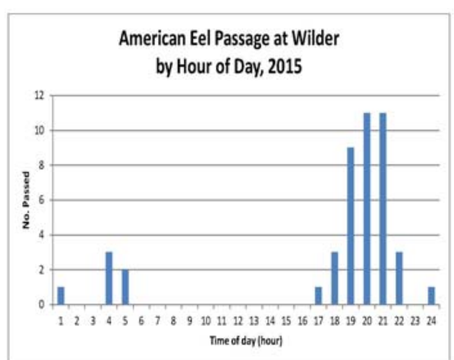
Study 19 – Route Selection Results - Wilder

- 48.9% (N=22) passed at water temperatures from 9.8°C -10.2°C
- 68.9% (N=31) passed between 19:00 and 21:00 hr





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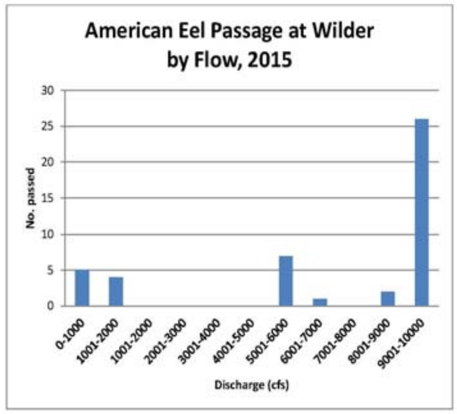
Study 19 – Route Selection Results - Wilder

- Eels passed from ~ minimum flow (746 cfs) to 9,834 cfs.
- 57.7% (N=26) eels passed at 9,000 - 10,000 cfs
- Flow through Units 1 and 2 at passage ranged from 0 - 9,018 cfs (99.8% of total project discharge).
- Flow through Unit 3 at passage ranged from 696 to 747 cfs (10.2% of total discharge).
- Flow through the trash/ice sluice at passage ranged from 410 to 694 cfs (7.2% of total discharge)



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Study 19 – Route Selection

Bellows Falls Route Selection Results

- Travel time from release site to study area for eels released into the Bellows Falls impoundment ranged from 41 minutes to 46 days, 15 hours, 44 minutes (median = 1d, 2h, 50m).
- Residency time ranged from 4 minutes to 3 days, 21 hours, 37 minutes (median = 38m).
- Eels released at the power canal had short travel times ranging from 4 minutes to 1 day, 23 hours, 43 minutes (median = 1h, 10m).
- Residency time ranged from less than 1 minute to 10 days, 5 hours, 34 minutes (median = <1m).
- Travel time from passage at Wilder to first detection at Bellows Falls for the 28 Wilder-released eels that arrived ranged from 2 days, 50 minutes to 20 days, 15 hours, 34 minutes (median = 3d, 7h).
- Their residency ranged from 7 minutes to 1 day, 14 hours, 59 minutes (median = 36 m).

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Study 19 – Route Selection Results – Bellows Falls

- Most eels used the turbine intakes: 81.7% (N=76) of all passed fish including Wilder releases.
- The trash/ice sluice passed 12.9% (N=12) and the spillway passed 5.4% (N=5). 4 passed during leakage flows and 1 passed late in the season during spill (December 21).
- 5 of 98 fish arriving at Bellows Falls (5.1%) did not pass the project.

Passage Route	No.	% of all passed	% of all released
Bellows Falls Impoundment and Canal Released Fish			
Turbine Units 1-3	56	86.2%	80.0%
Trash/ice sluice	3	4.6%	4.3%
Dam spillway	6	9.2%	8.6%
Total Passed	65	100.0%	100.0%
Did not pass	5		7.1%
Total Released	70		100.0%
Combined Wilder and Bellows Falls Released Fish			
Turbine Units 1-3	76	81.7%	77.6%
Trash/ice sluice	12	12.9%	12.2%
Dam spillway	5	5.4%	5.1%
Total Passed	93	100.0%	94.9%
Did not pass	5		5.1%
Total Released	98		100.0%

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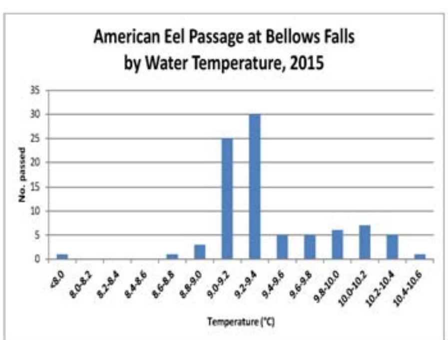
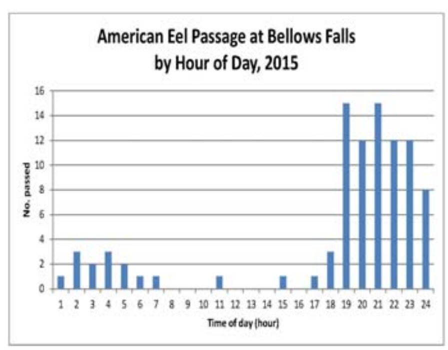
Study 19 – Route Selection Results – Bellows Falls

- Water temperature data was available for 89 eels and of those 59.1% (N=55) passed at 9.0 - 9.4°C
- 71% (N=66) passed between 19:00 and 23:00 h





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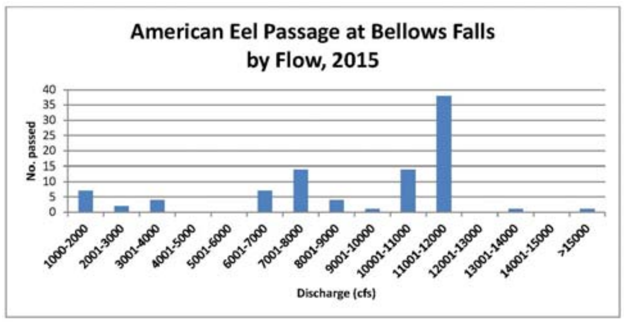
Study 19 – Route Selection Results – Bellows Falls

- 55.9% (N=52) eels passed at flows between 10,001 and 12,000 cfs
- Flow through Units 1-3 at passage ranged from ~ minimum flow (1,380 cfs) to 11,185 cfs (97.5% of total project discharge).
- Flows through the trash/ice sluice at passage ranged from 0 - 166 cfs (1.4% of total project discharge).
- Flow through the spillway at passage ranged from ~125 cfs (leakage flow) to 2,594 cfs. Only one eel passed via the spillway during active spill at the dam.



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Study 19 – Route Selection

Vernon Route Selection Results

- **Vernon Releases:**
  - Travel times from the Vernon release point to initial detection ranged from 26 minutes to 9 days, 9 hours, 57 minutes (median = 1d, 6h, 32m).
  - Residency time ranged from 6 minutes to 19 days, 3 hours, 37 minutes (median = 47m).
- **Bellows Falls Releases:**
  - Travel times from initial release above Bellows Falls to detection at Vernon study area ranged from 17 hours, 9 minutes to 50 days, 23 hours, 50 minutes (median = 6d, 8h, 49m).
  - Residency for impoundment releases ranged from 15 minutes to 34 days, 19 hours, 44 minutes (median = 1h, 5m)
  - Travel time for canal releases ranged from 1 day, 3 hours, 57 minutes to 20 days, 39 minutes (median = 3d, 6h, 58m).
  - Residency time for canal releases ranged from 43 minutes to 1 day, 21 hours, 28 minutes (median = 1 h, 2 m).
- **Wilder Releases:**
  - Travel times from initial release above Wilder to detection in the Vernon study area ranged from 3 days, 3 hours, 50 minutes to 7 days, 15 hours, 56 minutes (median = 5d, 8h, 40m).
  - Residency time ranged from 33 minutes to 1 day, 20 hours, 34 minutes (median = 2h, 2m).

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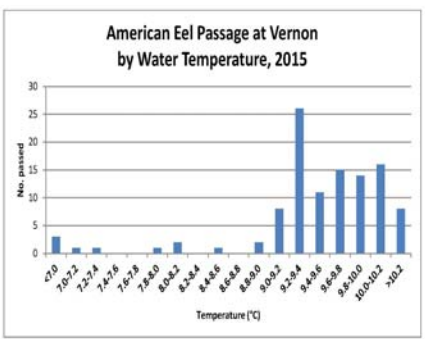
Study 19 – Route Selection Results - Vernon

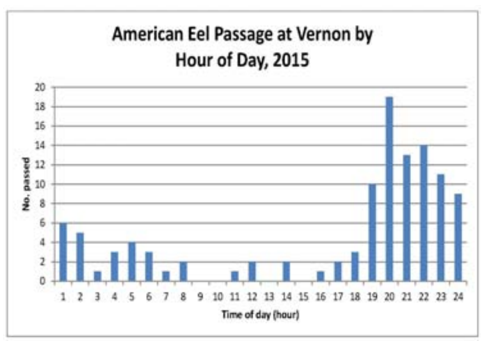
Passage Route	No.	% of all passed	% of all released
Vernon Released Fish			
Turbine intake 5-8	23	52.3%	46.0%
Turbine intake 9-10	11	25.0%	22.0%
Fish pipe	4	9.1%	8.0%
Turbine intake 1-4	3	6.8%	6.0%
Trash/Ice sluice	1	2.3%	2.0%
Fish tube	1	2.3%	2.0%
Fishway	1	2.3%	2.0%
Attraction flow pipe	0	0.0%	0.0%
Total Passed	44	100.0%	88.0%
Did not pass	6		12.0%
Total Released	50		100.0%

Passage Route	No.	% of all passed	% of all released
Combined Wilder, Bellows Falls, and Vernon Released Fish			
Turbine intake 5-8	48	42.9%	40.7%
Turbine intake 9-10	31	27.7%	26.3%
Fish pipe	21	18.8%	17.8%
Turbine intake 1-4	7	6.3%	5.9%
Trash/Ice sluice	3	2.7%	2.5%
Fish tube	1	0.9%	0.8%
Fishway	1	0.9%	0.8%
Attraction flow pipe	0	0.0%	0.0%
Total Passed	112	100.0%	94.9%
Did not pass	6		5.1%
Total Released	118		100.0%

Study 19 – Route Selection Results - Vernon

- Water temperature data was available for 109 eels and most (N=98, 82.6%) passed at 9.0°C or higher
- Seventy-six (67.9%) passed between 19:00 and 24:00 h





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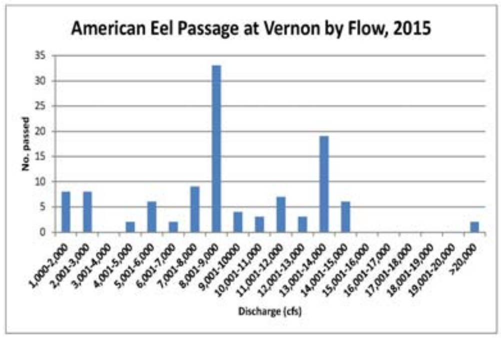
Study 19 – Route Selection Results - Vernon

- 29.5% (N=33) passed at flows 8,000 - 9,000 cfs
- 32.1% (N=36) passed at flows 9,000 - 14,000 cfs
- Most eels used Units 5 - 8 (42.8%). Flow through those units at passage was 0 - 7,042 cfs (58.6% of total project discharge.
- 27.7% used Units 9 - 10. Flow through those units at passage was ~ 1,280 to 3,326 cfs (36.5% of total discharge).

- The fish pipe passed 18.8% of all eels at flow ~350 cfs (5.9% of total discharge).
- Units 1 – 4 passed 6.2% of all eels at 0 - 4,252 cfs (19.3% of total discharge).
- The trash/ice sluice passed 2.7% of all eels at leakage flows



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Study 19 – Route Selection

Route Selection Conclusions

- 154 of 170 eels released at all three projects (90.5%) emigrated past their intended project on average within 24 hours of their release above, or after first detection at the project.
- 112 of 118 eels arriving at Vernon from all three projects (94.9%) successfully passed.
- The vast majority of eels in this study exhibited minimal wandering behavior although a few did: 13.3% at Wilder, 5.3% at Bellows Falls, and 5.9% at Vernon (examples follow and in report appendix).
- Therefore, silver eel ability to locate downstream routes of passage through the projects does not hinder the timing of emigration.

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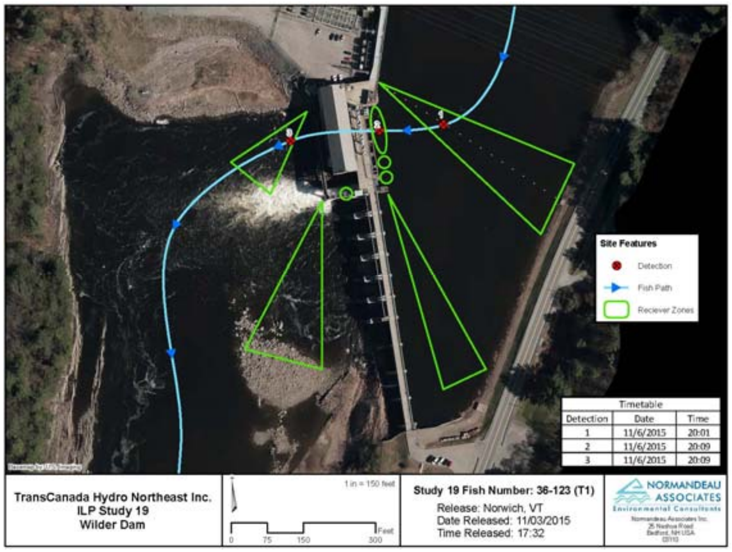
Example of No Wandering Behavior – Wilder



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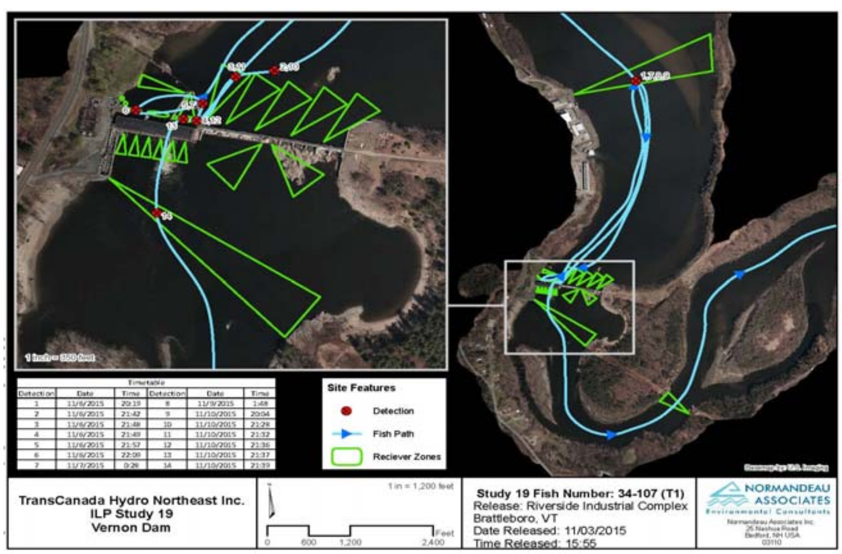
Example of Wandering Behavior - Vernon



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Study 19 –Turbine Passage Survival

Turbine Survival - Releases

- Eels were passed through Vernon Units 4, 8, and 9; Bellows Falls Unit 2; and Wilder Unit 2

Date	Water Temp (°C)	Vernon				Bellows Falls	Wilder		Combined Controls	Actual Treatment Release
		Unit 4 Francis @1000 cfs	Unit 8 Kaplan @ 1000 cfs	Unit 8 Kaplan @ 1700 cfs	Unit 9 Francis @1300 cfs	Unit 2 Francis @ 3200 cfs	Unit 2 Kaplan @ 1700 cfs	Unit 3 Francis		
10/26	8.4		48							50
10/27	8.0				48				10	50
10/28	8.3	48							9	50
10/30	7.7					50			10	53
10/30	7.7							10		10
11/01	7.5						50		10	50
11/03	9.1			50						50
Total		**48**	**48**	**50**	**48**	**50**	**50**	**10**	**39**	**313**

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Study 19 –Turbine Passage Survival

Study Variance:

- Turbine testing at Wilder Unit 3 was curtailed after 10 fish were tested when it was determined that most of the discharge was directed into the fishway and the features within the fishway prevented the recapture of seven of the ten eels.
  - It was determined that the egress pattern at Unit 3 would not permit the determination of reliable survival/injury estimates.
  - The aquatics working group was notified of this study plan variance on November 13, 2015.

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Study 19 –Turbine Survival Results

Study Results

- Larger Francis Units at Vernon and Bellows Falls had highest survival (98%) and lowest injury (<10%)
- Kaplan Units at Vernon and Wilder had lower survival (62-87%) and more injuries (27-40%)
- Survival based only on recaptured fish is 0 to 10% higher

Station	No. Released	48 h Survival All fish	recaptured only	Malady-free Rate*
Vernon Unit 4 (Francis)	48	93.5%	95.6%	68.1%
Vernon Unit 8-1 kcfs (Kaplan)	48	87.5%	91.3%	73.4%
Vernon Unit 8-1.7 kcfs (Kaplan)	50	74.0%	84.1%	74.4%
Vernon Unit 9 (Francis)	48	97.9%	100%	96.4%
Bellows Falls Unit 2 (Francis)	50	98.0%	98.0%	90.8%
Wilder Unit 2 (Kaplan)	50	62.0%	66.0%	60.6%
Control	39			

* Includes injury and loss of equilibrium, adjusted for injured control eels

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Study 19 –Turbine Passage Survival

Summary - Wilder Turbine Survival

- Direct survival estimate for Kaplan Unit 2 was lower at this unit than any of the other units tested at Bellows Falls and Vernon.
- Injury-free rate for the recaptured eels was also the lowest observed and most injuries were classified major - primarily bruised or severed bodies.
- Similar survival and injury results would be expected for the untested Kaplan Unit 1 at Wilder.

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Study 19 –Turbine Passage Survival

Summary – Bellows Falls Turbine Survival

- 48h direct survival for Francis Unit 2 at Bellows Falls was the highest obtained at any of the turbines tested.
- The injury-free rate was the second highest observed but less than half of injuries were classified major - primarily bruises to the body.
- Because all the Bellows Falls units are similar, eels should incur little mortality and injury passing the Bellows Falls turbines.

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Study 19 –Turbine Passage Survival

Summary – Vernon Turbine Survival

- Larger Francis turbine Unit 9:
  - Highest injury-free rate of any of the turbines tested.
  - None of the injuries (bruises on head and body, fin damage) were classified as major.
- The smaller Francis Unit 4 had relatively high survival
  - Lowest injury-free rate of the Vernon units tested, and somewhat higher than Wilder Unit 2. Slightly over half were classified major injuries - primarily bruises to head and body.
- Kaplan Unit 8 survival was higher at the lower discharge tested (1,000 cfs), than at the higher discharge (1,700 cfs) .
  - injury-free rates were similar for the two discharges tested.
  - The lower discharge inflicted fewer major injuries than the higher discharge.
  - More fish injuries were classified as major at the higher discharge (76.9% vs 28.6%) and more fish were severed at the higher discharge.

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Study 19 –Turbine Passage Survival

Summary – Vernon Turbine Survival Continued

- Emigrating eels should incur high survival and few injuries passing the two larger Francis Units 9 and 10.
- Turbine passage should also be relatively high for eels passing the smaller Francis Units 1-4.
- Kaplan Units 5-8 effects on eel passage survival and severity of injuries appears to be partially dependent upon discharge rates with better passage conditions at lower discharges.

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Study 19 –Turbine Passage Survival

Overall Summary of Turbine Survival

- Direct survival and injury estimates for the present study at Wilder, Bellows Falls, and Vernon indicate that the eels fared better passing through the larger and slower speed Francis turbines than through the Kaplan (propeller type) turbines.
- Higher survival through these Kaplan turbines is consistent with other direct survival/injury studies.
- Survival relative to other Francis turbines has not been conducted (other than the similar FirstLight study conducted in 2015, not yet filed) so comparisons of this turbine type are not available at this time.

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Study 22
Downstream Migration of
Juvenile American Shad - Vernon

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Study 22 – Downstream Migration of Juvenile American Shad

Recap: Study Summary

- Wild juvenile shad were collected for route selection and turbine survival studies
  - Route selection included 310 shad radio tagged and released upstream of Vernon dam in 15 events between September 25 and October 30, 2015
  - Turbine survival tagging and releases of 150 shad each at Unit 4 and Unit 8, along with 150 controls, from October 6-11
- Hydroacoustics:
  - Schools first seen on hydroacoustics on August 23
  - Presence of juveniles was confirmed visually on August 26
  - Density of schools peaked on October 5-6, 24, and 30
  - Last fish schools were seen on hydroacoustics on October 30

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Study 22 – Route Selection Results

Route Selection Results

- Overall successful passage of 91.6% of radio-tagged shad

Status	No. of Shad	%
Emigrated Shad	284	91.6
Confirmed Passed Shad	233	82.0
Non-emigrated Shad	43	15.1
Unknown Passage Route	8	2.6
Total Tagged	310	100

- Travel and Residency:

	Travel Time (dd:hh:mm)		Residency (dd:hh:mm)	
All Release Groups	Min	00:00:01	Min	00:00:00
	Max	03:21:25	Max	08:13:09
	Average	00:08:28	Average	00:18:32
	Median	00:01:40	Median	00:01:00

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Study 22 – Route Selection Results

- 75% passed through turbines, 9% used downstream fish bypasses:

Passage Route	No. of Shad	%
Turbine intake 5-8	102	42.3
Turbine intake 9-10	48	19.9
Turbine intake 1-4	31	12.9
Trash/Ice sluice	22	9.1
Fish pipe	21	8.7
Attraction flow pipe	3	1.2
Fish tube	5	2.1
Fishway	1	0.4
Unknown	8	3.3
Total	241	100

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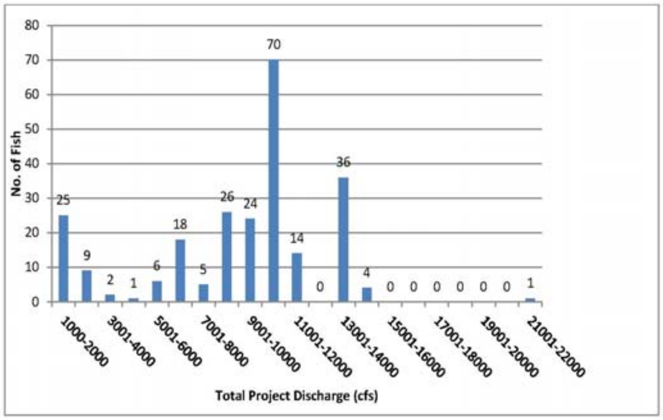
Study 22 – Route Selection Results

- 1 shad passed during spill, but passed through the turbines
- 10.4% (N=25) passed at minimum flow
- Approximately half of shad (N=120) passed at flows 8,000 -11,000 cfs



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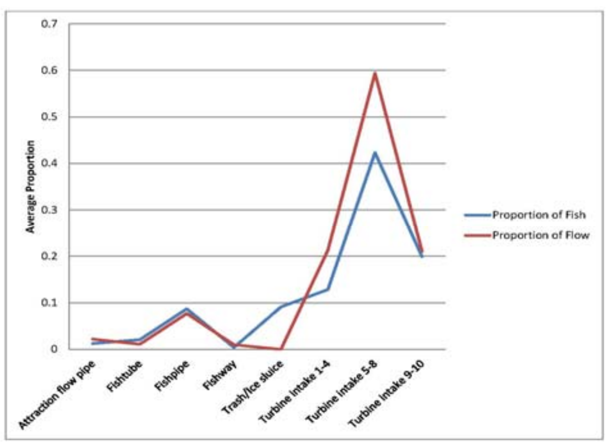
Study 22 – Route Selection Results

- In general, the proportion of fish utilizing a given downstream passage route coincided with the average proportion of flow passing through that route.



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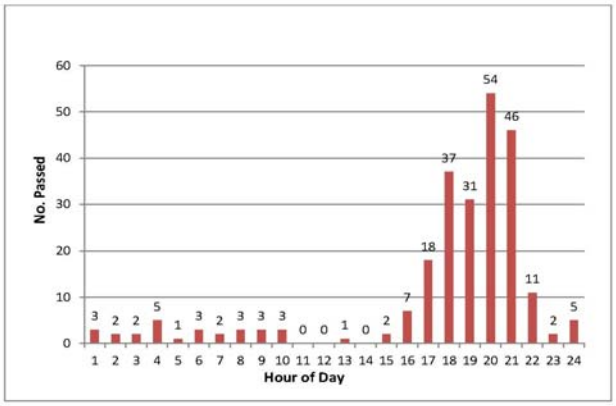
Study 22 – Route Selection Results

- Passage of shad occurred mostly during the evening and early overnight hours, consistent with previous studies.
- 199 shad (82.6%) passed between 18:00 and 05:00.



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Study 22 – Route Selection

Route Selection Conclusions:

- Dominate routes taken (Units 5-8, Units 9-10, Units 1-4, respectively) were also the routes with the most flow at the time of passage.
- With short residency times, the ability of juvenile American Shad to locate downstream routes of passage through the Vernon project does not appear to hinder the timing of the emigration.

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Study 22 – Turbine Passage Survival

Turbine Passage Survival Results

- 1 h survival adjusted for control fish: All released fish - 91.7% for Unit 4 and 95.2% for Unit 8; for recaptured only fish, respective values 100.0% and 99.3%.
- 48 h survival not presented due to high control mortality (30%) during delayed assessment period
- Injury-free rate adjusted for control fish: 97.9% for Unit 4 and 99.1% for Unit 8

Station	No. Released	1 h Survival All fish	1 h Survival recaptured only	Injury-free Rate*
Vernon Unit 4 (Francis)	151	91.7%	100.0%	97.9%
Vernon Unit 8 (Kaplan)	150	95.2%	99.3%	99.1%
Control	150			
*Based only on recaptured fish				

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Study 22 –Turbine Passage Survival

Comparison to Other Studies

- Twenty other HI-Z tag studies were conducted with juvenile clupeids (herring and shad) passing through turbines
- Survival estimates (1 h) ranged from 68-100%
- Survival estimates for Vernon Unit 4 (91.7%) and Unit 8 (95.2%) were close to the median of 93.0% for the other studies

Turbine Survival Conclusions

- Based on turbine characteristics, estimated direct juvenile shad survival for the three turbine types tested, and a previous direct survival study on juvenile Atlantic Salmon at Vernon, juvenile shad should fare best passing through:
  1. Kaplan Units 5 through 8
  2. Francis Units 9 and 10.
  3. The smaller Francis Units 1 through 4 would likely be least fish friendly.

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Study 22 – Run Timing Analysis with Hydroacoustics

Recap: Run Timing

Objectives:

- To determine timing of the outmigration of juvenile American Shad in the forebay of Vernon powerhouse
  - Date of onset & departure
  - Number, timing, duration, & relative magnitude of peak abundance
- To describe diel and depth patterns in abundance
- To relate with environmental and operational factors

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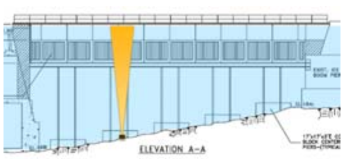
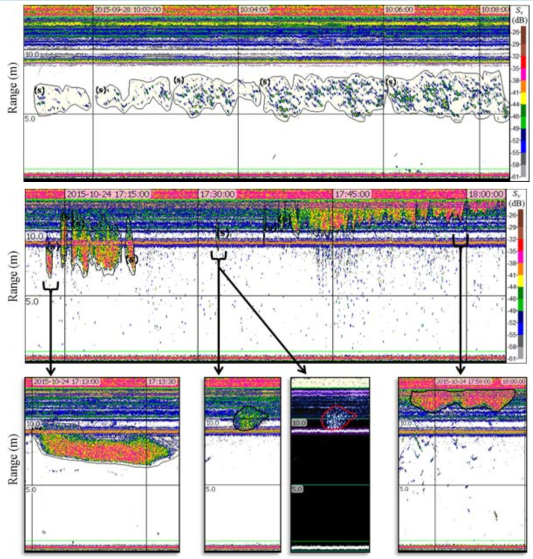
Study 22 –Manual Classification of "School" Echoes

- 420 kHz HTI Split-beam echosounder
- 8-10 pings per second
- Aug 15 -Nov 15, 2015
- Acoustic fish density from classified school echoes





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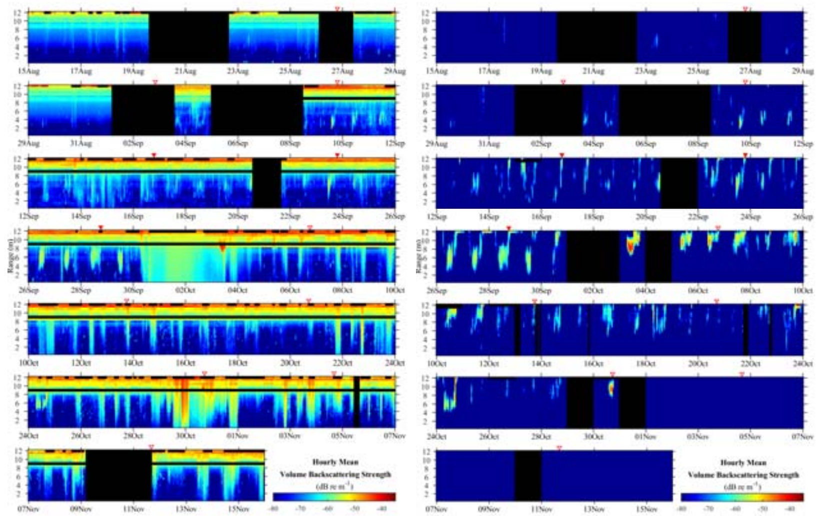
Study 22 – Sv Versus Classified School Echoes Time Series



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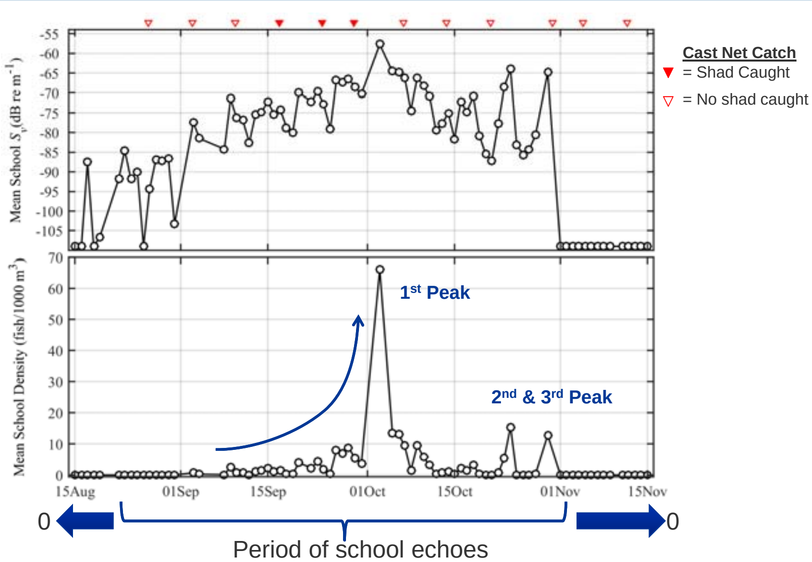
Study 22 – Daily Time Series of School Echoes



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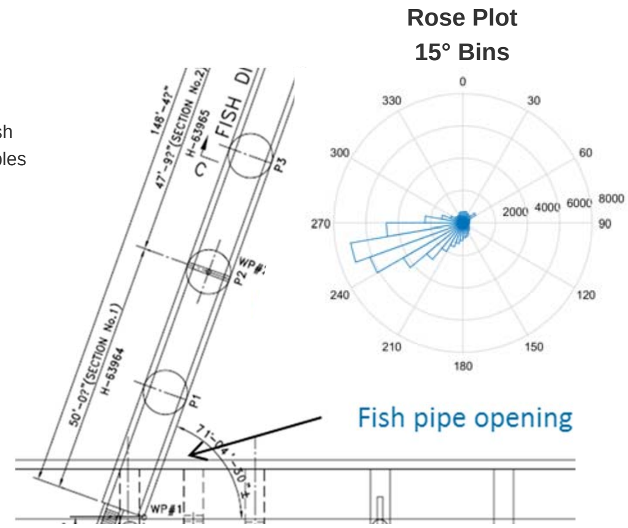
Study 22: Horizontal Direction (Azimuth) of Shad-Sized Fish

<u>Filtered tracks</u>

- TS = -55 to -45 dB
- Min 7 SEDs per tracked fish
- Excluded tracks from bubbles
- September-October only



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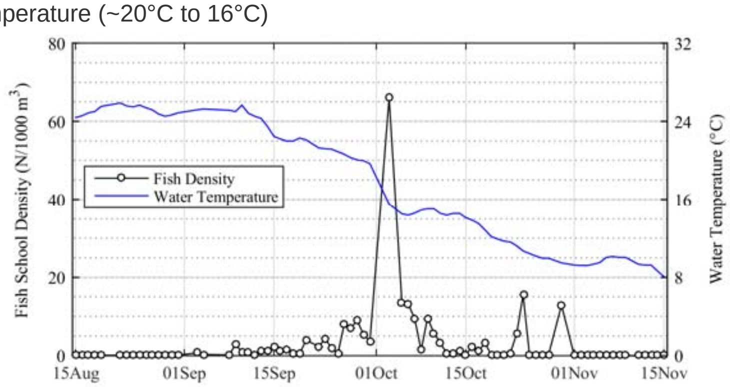
Study 22: Environmental Factors on Acoustic Index of Shad

- Significant but weak positive relations between classified school echoes and unit flow
- A daily rate of change in water temperature was significantly correlated with an increase in fish density of classified school echoes
- Fish school echoes were most abundant following a sharp decrease in water temperature (~20°C to 16°C)



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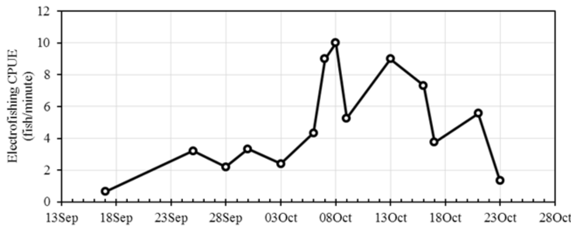
Study 22 – Verification Sampling of Shad

Visual Observations, Cast Nets, Electrofishing, & Imaging Sonar



- Cast nets caught juvenile American Shad in forebay on September 16, 23, & 28 (n=5, 97-117 mm, mean =104 mm)
- Visual observations of juveniles near surface in forebay from 26 August through October 13
- Electrofishing confirmed presence of juvenile American Shad
- Not observed by cast net crew at dusk October 20 to November 11

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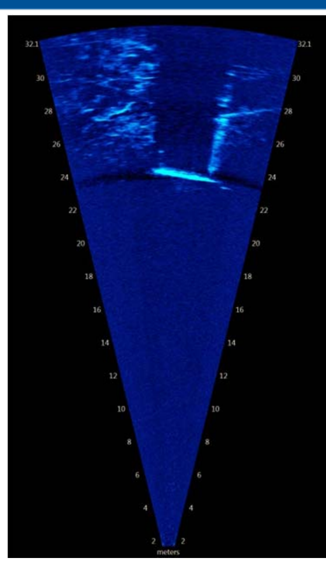
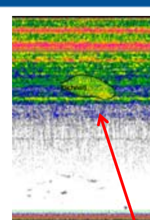
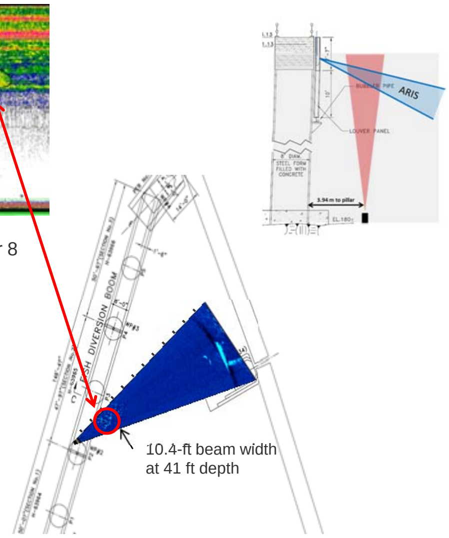
Study 22 – ARIS Imaging Sonar Verifies School Echoes





October 8



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Study 22 – Summary of Juvenile Shad Outmigration

- Schooling fish present for 74 days (Aug 17-Oct 30)
- Incremental increases beginning September 3
- 1st & highest peak on October 3 (Sep 25-Oct 8 = 13 days)
- 2nd Peak on October 23-24 (2 days)
- 3rd Peak on October 30 (1 day)
- Densities of schooling fish highest during the 13:00-18:00 (late day/dusk)
- Schools were mostly within 4 meters below fish pipe sill during day, moved up to fish pipe depth layer at dusk – especially in October
- Fish school echoes were most abundant following a sharp decrease in water temperature (~20°C to 16°C)
- Absent once water temperatures remained below 10°C.
- Visual observations, electrofishing, cast netting, and imaging sonar support these echo patterns reflect the timing of out-migrating juvenile American Shad arriving and departing the forebay of Vernon powerhouse.

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Study 23
Fish Impingement, Entrainment, and Survival Study

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Study 23 – Fish Impingement, Entrainment, and Survival

Methods

- Reviewed fish assemblage information (Study 10) and identified representative fish community for each impoundment
  - Includes all diadromous species
  - Includes resident species comprising greater than 1% of impoundment catch
  - Included additional species as needed to ensure all major families are represented
- Evaluated existing literature for:
  - Generalized life history characteristics for each represented family
  - Swim-speed information for each included fish species
  - Entrainment studies conducted at other hydroelectric projects
- Provided description of Project intakes and calculated approach velocities based on intake dimensions and flows

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Study 23 – Fish Impingement, Entrainment, and Survival

Methods – continued

- Evaluated impingement likelihood based on existing trash rack spacing and estimated fish body width information
- Ranked entrainment potential (using a multi-step rank from High to Medium to Low) for each representative fish species based on:
  1. Habitat and life history relative to project characteristics
  2. Swim speed relative to approach velocities
  3. Entrainment data from comparable sites (as available)
- Developed an overall entrainment potential for each target species and life stage based on consideration of comparisons 1, 2, and 3 (above).

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Study 23 – Fish Impingement, Entrainment, and Survival

Methods – continued

- Developed estimates of turbine survival:
    - Calculated blade strike probabilities (i.e., Franke formula) based on intake and turbine specifications for project units
    - Literature review of available turbine survival studies (i.e., EPRI 1997)
- Developed an overall qualitative rating for project entrainment survival based on calculated and literature obtained estimates for each species
- Reviewed and incorporated passage route studies for American Shad (Studies 21, 22) and American Eel (Study 19) to aid in the estimates of total project survival for diadromous fish species

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Study 23 – Fish Impingement, Entrainment, and Survival

Results - Impingement

- Fish impingement is a function of body width, clear spacing on trash racks, and fish ability to escape the flow field associated with the intake structures.
- For target species and representative lengths, calculated body widths suggested:
    - Wilder Units 1 and 2 (5.0 in): least likely to impinge fish
    - Wilder Unit 3 (1.625 in): most of the target species which can reach 15 inches or more in total length have a calculated body width exceeding the rack spacing
    - Bellows Falls (4.0 in): only Northern Pike and Walleye with a body length greater than 30 inches reached calculated body widths wider than the trash rack clear spacing at Units 1-3
    - Vernon Units 9 and 10 (3.625-in): similar to Bellows Falls.
    - Vernon Units 1-8 (1.75 in): most of the target species which can reach 15 inches or more in total length have a calculated body width which make them vulnerable to impingement.

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Study 23 – Fish Impingement, Entrainment, and Survival

Results – Qualitative Entrainment Potential

- Fish most susceptible to entrainment are those that require downriver movement as well as small (i.e., juvenile) fish particularly juvenile American Shad (at Vernon) as they move in large schools near the center of the river channel and towards the upper portion of the water column.
- Juvenile littoral fish species (i.e., Bluegill, Largemouth Bass and Smallmouth Bass) are likely more susceptible to entrainment than adults due to their lesser swimming abilities.
  - More prevalent in shallower, shoreline habitat and would likely have lower entrainment potential at units positioned near the center of the channel.
  - Similar preference for more nearshore habitat of forage species such as Golden and Spottail Shiner may help to offset their relatively weak swimming ability and lower their entrainment potential.
- Pelagic, predatory species (Walleye, Yellow Perch) entrainment potential may be increased while following prey species into the intake areas (e.g., during the fall emigration of juvenile American Shad at Vernon). However, adults of those species are strong swimmers and should be capable of avoiding intake velocities at the three projects.

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Study 23 – Fish Impingement, Entrainment, and Survival

Results – Entrainment Survival Potential

- Fish size was the ranking variable (more important than species) when assessing fish survival potential.
- Survival of juvenile fish at each of the three projects was generally rated between Moderate-High and Moderate due to their smaller body sizes.
- The overall rating of entrainment survival for adult fish ranged from Moderate-High to Low, with fish species attaining larger size as adults (e.g., Northern Pike, Walleye, etc.) having lower overall survival ratings.

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Study 23 – Wilder Predicted Survival Potential

Species and Life stage	Approx. Size Range (in)	EPRI Source Data		Calculated Survival Potential		Overall Rating of Survival Potential
		% Survival by fish size	Rating by fish size	% Survival by fish size	Rating by fish size	
American Eel						
Juvenile	1.0-24.0	95.4-73.2	H-L	86.5-49.5	M-L	MH-M
Adult	24.0-40.0	93.4-73.2	MH-L	49.5-0.0	L	M-LM
Bluegill						
Juvenile	1.0-4.0	95.4-93.9	MH	98.9-86.5	H-M	MH
Adult	4.0-8.0	94.8-91.6	MH	98.9-73.0	H-L	MH
Brown Bullhead						
Juvenile	1.0-8.0	95.4-91.6	H-MH	98.9-73.0	H-L	MH
Adult	8.0-14.0	93.4-73.2	MH-L	97.9-73.0	H-L	M
Fallfish						
Juvenile	1.0-6.0	95.4-91.6	H-MH	98.9-73.0	H-L	MH
Adult	6.0-18.0	94.8-73.2	MH-L	98.9-49.5	H-L	M
Golden Shiner						
Juvenile	1.0-4.0	95.4-93.9	H-MH	98.9-86.5	H-M	MH
Adult	4.0-8.0	94.8-91.6	MH	98.9-73.0	H-L	MH
Largemouth Bass						
Juvenile	1.0-6.0	95.4-91.6	MH	98.9-73.0	H-L	MH
Adult	6.0-18.0	94.8-73.2	MH-L	97.9-49.5	H-L	M
Northern Pike						
Juvenile	1.0-16.0	95.4-73.2	H-L	98.9-49.5	H-L	M
Adult	16.0-48.0	93.4-73.2	MH-L	49.5-0.0	L	M-LM

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Study 23 – Wilder Predicted Survival Potential - Continued

Species and Life stage	Approx. Size Range (in)	EPRI Source Data		Calculated Survival Potential		Overall Rating of Survival Potential
		% Survival by fish size	Rating by fish size	% Survival by fish size	Rating by fish size	
Sea Lamprey						
Juvenile	6.0-24.0	94.8-73.2	MH-L	98.9-49.5	H-L	MH-M
Adult	24.0-36.0	93.4-73.2	MH-L	49.5-0.0	L	M-LM
Smallmouth Bass						
Juvenile	1.0-8.0	95.4-91.6	H-MH	98.9-73.0	H-L	MH
Adult	8.0-20.0	91.6-73.2	MH-L	97.9-49.5	H-L	M
Spottail Shiner						
Juvenile	1.0-2.0	95.4-93.9	H-MH	98.9-86.5	H-M	MH
Adult	2.0-4.0	95.4-93.9	H-MH	98.9-86.5	H-M	MH
Tessellated Darter						
Juvenile	1.0-2.0	95.4-93.9	H-MH	98.9-86.5	H-M	MH
Adult	2.0-4.0	95.4-93.9	H-MH	98.9-86.5	H-M	MH
Walleye						
Juvenile	1.0-16.0	95.4-73.2	H-L	98.9-49.5	H-L	M
Adult	16.0-30.0	93.4-73.2	MH-L	96.1-0.0	H-L	LM
White Sucker						
Juvenile	1.0-12.0	95.4-86.9	MH-M	98.9-73.0	H-L	MH-M
Adult	12.0-24.0	93.4-73.2	MH-L	73.0-0.0	L	M-LM
Yellow Perch						
Juvenile	1.0-8.0	95.4-91.6	H-MH	98.9-73.0	H-L	MH
Adult	8.0-12.0	87.2-86.9	M	97.9-49.5	H-L	M

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Study 23 – Bellows Falls Predicted Survival Potential

Species and Life stage	Approx. Size Range (in)	EPRI Source Data		Calculated Survival Potential		Overall Rating of Survival Potential
		% Survival by fish size	Rating by fish size	% Survival by fish size	Rating by fish size	
American Eel						
Juvenile	1.0-24.0	93.9-73.2	MH-L	96.8-75.8	H-L	MH-M
Adult	24.0-40.0	73.2	L	75.8-51.8	L	L
Bluegill						
Juvenile	1.0-4.0	95.4-93.9	MH	96.8-93.6	H-MH	H-MH
Adult	4.0-8.0	94.8-91.6	MH	96.8-87.1	H-M	MH
Brown Bullhead						
Juvenile	1.0-8.0	93.9-91.6	MH	96.8-87.1	H-M	MH
Adult	8.0-14.0	91.6-73.2	MH-L	93.6-87.1	MH-M	M
Fallfish						
Juvenile	1.0-6.0	93.9-91.6	MH	96.8-87.1	H-M	MH
Adult	6.0-18.0	91.6-73.2	MH-L	93.6-75.8	MH-L	M-LM
Golden Shiner						
Juvenile	1.0-4.0	93.9	MH	96.8-93.6	H-MH	H-MH
Adult	4.0-8.0	91.6	MH	96.8-87.1	H-M	MH
Largemouth Bass						
Juvenile	1.0-6.0	95.4-91.6	MH	96.8-87.1	H-M	MH
Adult	6.0-18.0	94.8-73.2	MH-L	93.6-75.8	MH-L	MH-L
Northern Pike						
Juvenile	1.0-16.0	93.9-73.2	MH-L	96.8-75.8	H-L	MH-M
Adult	16.0-48.0	73.2	L	87.9-51.7	M-L	LM-L

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Study 23 – Bellows Falls Predicted Survival Potential - Continued

Species and Life stage	Approx. Size Range (in)	EPRI Source Data		Calculated Survival Potential		Overall Rating of Survival Potential
		% Survival by fish size	Rating by fish size	% Survival by fish size	Rating by fish size	
Sea Lamprey						
Juvenile	6.0-24.0	91.6-73.2	MH-L	93.6-75.8	MH-L	MH-L
Adult	24.0-36.0	73.2	L	75.8-51.7	L	L
Smallmouth Bass						
Juvenile	1.0-8.0	93.9-91.6	MH	96.8-87.1	H-M	MH
Adult	8.0-20.0	91.6-73.2	MH-L	93.6-75.8	MH-L	MH-L
Spottail Shiner						
Juvenile	1.0-2.0	93.9	MH	96.8-93.6	H-MH	H-MH
Adult	2.0-4.0	93.9	MH	96.8-93.6	H-MH	H-MH
Tessellated Darter						
Juvenile	1.0-2.0	93.9	MH	96.8-93.6	H-MH	H-MH
Adult	2.0-4.0	93.9	MH	96.8-93.6	H-MH	H-MH
Walleye						
Juvenile	1.0-16.0	93.9-73.2	MH-L	96.8-75.8	H-L	MH-M
Adult	16.0-30.0	73.2	L	87.9-51.7	M-L	LM-L
White Sucker						
Juvenile	1.0-12.0	93.9-73.2	MH-L	96.8-87.1	H-M	MH-M
Adult	12.0-24.0	73.2	L	93.6-75.8	MH-L	LM-L
Yellow Perch						
Juvenile	1.0-8.0	93.9-91.6	MH	96.8-87.1	H-M	MH
Adult	8.0-12.0	91.6-73.2	MH-L	93.6-87.1	MH-M	M

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Study 23 – Vernon Predicted Survival Potential

Species and Life stage	Approx. Size Range (in)	EPRI Source Data		Calculated Survival Potential		Overall Rating of Survival Potential
		% Survival by fish size	Rating by fish size	% Survival by fish size	Rating by fish size	
American Eel						
Juvenile	1.0-24.0	95.4-73.2	H-L	98.2-59.1	H-L	H-L
Adult	24.0-40.0	93.4-73.2	MH-L	93.2-18.2	MH-L	MH-L
American Shad						
Juvenile	1.0-3.0	95.4-93.9	H-MH	98.2-89.1	H-M	MH
Adult	20.0-30.0	93.4-73.2	MH-L	93.2-18.2	MH-L	M-LM
Bluegill						
Juvenile	1.0-4.0	95.4-93.9	MH	98.2-89.1	H-M	MH
Adult	4.0-8.0	94.8-91.6	MH	98.2-78.2	H-L	MH-M
Brown Bullhead						
Juvenile	1.0-8.0	95.4-91.6	H-MH	98.2-78.2	H-L	MH-M
Adult	8.0-14.0	93.4-73.2	MH-L	96.4-78.2	H-L	M
Fallfish						
Juvenile	1.0-6.0	95.4-91.6	H-MH	98.2-89.1	H-M	MH
Adult	6.0-18.0	94.8-73.2	MH-L	96.4-59.1	H-L	MH-M
Golden Shiner						
Juvenile	1.0-4.0	95.4-93.9	H-MH	98.2-89.1	H-M	MH
Adult	4.0-8.0	94.8-91.6	MH	98.2-78.2	H-L	MH-M
Largemouth Bass						
Juvenile	1.0-6.0	95.4-91.6	MH	98.2-78.2	H-L	MH-M
Adult	6.0-18.0	94.8-73.2	MH-L	96.4-59.1	H-L	MH-M
Northern Pike						
Juvenile	1.0-16.0	95.4-73.2	H-L	98.2-59.1	H-L	M
Adult	16.0-48.0	93.4-73.2	MH-L	93.2-18.2	MH-L	M-LM

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Study 23 – Vernon Predicted Survival Potential - Continued

Species and Life stage	Approx. Size Range (in)	EPRI Source Data		Calculated Survival Potential		Overall Rating of Survival Potential
		% Survival by fish size	Rating by fish size	% Survival by fish size	Rating by fish size	
Sea Lamprey						
Juvenile	6.0-24.0	94.8-73.2	MH-L	96.4-59.1	H-L	M
Adult	24.0-36.0	93.4-73.2	MH-L	93.2-18.2	MH-L	M-LM
Smallmouth Bass						
Juvenile	1.0-8.0	95.4-91.6	H-MH	98.2-78.2	H-L	MH-M
Adult	8.0-20.0	91.6-73.2	MH-L	96.4-59.1	H-L	MH-M
Spottail Shiner						
Juvenile	1.0-2.0	95.4-93.9	H-MH	98.2-89.1	H-M	MH
Adult	2.0-4.0	95.4-93.9	H-MH	98.2-89.1	H-M	MH
Tessellated Darter						
Juvenile	1.0-2.0	95.4-93.9	H-MH	98.2-89.1	H-M	MH
Adult	2.0-4.0	95.4-93.9	H-MH	98.2-89.1	H-M	MH
Walleye						
Juvenile	1.0-16.0	95.4-73.2	H-L	98.2-59.1	H-L	M
Adult	16.0-30.0	93.4-73.2	MH-L	93.2-18.2	MH-L	M-LM
White Sucker						
Juvenile	1.0-12.0	95.4-86.9	MH-M	98.2-78.2	H-L	MH-M
Adult	12.0-24.0	93.4-73.2	MH-L	96.4-59.1	H-L	M-LM
Yellow Perch						
Juvenile	1.0-8.0	95.4-91.6	H-MH	98.2-78.2	H-L	MH-M
Adult	8.0-12.0	87.2-86.9	M	96.4-78.2	H-L	M

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Study 23 – Fish Impingement, Entrainment, and Survival

Total Project Survival

Per RSP based on FERC study request, estimate total project survival considering all passage routes for American Eel, Atlantic Salmon, and Sea Lamprey at Wilder, Bellows Falls and Vernon and American Shad and river herring at Vernon.

- Sea Lamprey - no available data related to the downstream route selection or passage survival
- Atlantic Salmon - lack of the species presence so no total station survival estimates provided.
- No returns of Blueback Herring at Vernon recorded since 2000. It is suspected that the total project survival for juvenile river herring would be similar to juvenile American Shad.

- American Eel and juvenile and adult American Shad survival were assessed.

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Study 23 – Total Project Survival – American Eel

Route	No. of Fish	Proportion	Survival Rate	Survival Source
Wilder				
Unit 1 & 2	32	0.71	62.0%	Hi-Z Testing; Study 19
Unit 3	10	0.22	24.8%	Franke Probability; Study 23
Trash/ice sluice	3	0.07	66.7%	Telemetry Detection; Study 19
Bellows Falls				
Units 1-3	76	0.82	98.0%	Hi-Z Testing; Study 19
Trash/ice sluice	12	0.13	83.3%	Telemetry Detection; Study 19
Spillway	5	0.05	80.0%	Telemetry Detection; Study 19
Vernon				
Units 1-4	7	0.06	93.5%	Hi-Z Testing; Study 19
Units 5-8	48	0.43	80.8%	Hi-Z Testing; Study 19
Units 9-10	31	0.28	97.9%	Hi-Z Testing; Study 19
Fish pipe	21	0.19	100%	Telemetry Detection; Study 19
Fish tube	1	0.01	100%	Telemetry Detection; Study 19
Trash/ice sluice	3	0.03	100%	Telemetry Detection; Study 19
Upstream Fishway	1	0.01	100%	Telemetry Detection; Study 19

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Study 23 – Total Project Survival – American Shad

Route	No. of Fish	Proportion	Survival Rate	Survival Source
Adult Shad				
Fish pipe	11	0.25	100%	Telemetry Detection; Study 21
Units 5-8	9	0.20	100%	Telemetry Detection; Study 21
Spillway	9	0.20	100%	Telemetry Detection; Study 21
Units 1-4	7	0.16	100%	Telemetry Detection; Study 21
Unknown	5	0.11	80%	Telemetry Detection; Study 21
Units 9-10	3	0.07	100%	Telemetry Detection; Study 21
Juvenile Shad				
Units 5-8	102	0.42	95.2%	Hi-Z Testing; Study 22
Units 9-10	48	0.20	94.7%	Hi-Z Testing; Normandeau, 1996
Units 1-4	31	0.13	91.7%	Hi-Z Testing; Study 22
Trash/Ice sluice	22	0.09	100%	Telemetry Detection; Study 22
Fish pipe	21	0.09	100%	Telemetry Detection; Study 22
Attraction flow pipe	3	0.01	100%	Telemetry Detection; Study 22
Fish tube	5	0.02	100%	Telemetry Detection; Study 22
Fishway	1	0.00	100%	Telemetry Detection; Study 22
Unknown	8	0.03	100%	Telemetry Detection; Study 22

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Study 24 – Dwarf Wedgemussel and Co-occurring Mussels

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Study 24 – Dwarf Wedgemussel and Co-occurring Mussels

Recap - Study Progress

- **2013** Phase 1 field work, report filed in Volumes IV - V of the ISR
- **2014**
  - Phase 2 study plan, consultation and plan revision (Vol. VI of the ISR)
  - Field work in 2014 based on revised study plan
- **2015**
  - FERC determination issued January 22, 2015
  - Phase 2 study report filed March 2, 2015
  - Additional consultation March 5, 2015
- **2015 – 2016**
  - Delphi Panel process and development of HSC
  - Model habitat in project-affected reaches using 1D and 2D modeling (Study 9)
  - Final report

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Study 24 – Dwarf Wedgemussel and Co-occurring Mussels

2015-2016 "Phase 2A" – Delphi Panel Process

Develop Habitat Suitability Criteria (HSC)

- Draft HSC criteria framework for key parameters, with written rationale
- Identify regional experts willing to be part of the Delphi panel and provide background information
- Draft questionnaire to solicit opinion of the Delphi panel
- Fine-tune, eliminate, or add HSC variables based on responses from experts.
- Revise HSC based on comments and resubmit proposed HSC to panelists
- Repeat process 3 or 4 times until resolution and agreement is reached

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Study 24 – Dwarf Wedgemussel and Co-occurring Mussels

Phase 2A: Delphi Panel Process

- Proposed candidate list of variables:
  - Water depth
  - Mean column water velocity
  - Benthic water velocity
  - Substrate composition
- Added:
  - Bed shear stress
  - Relative (dimensionless) shear stress
  - Shear Velocity
- Developed proposed "strawman" HSC curves

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Study 24 – Dwarf Wedgemussel and Co-occurring Mussels

Phase 2A: Delphi Panel Process

- 1st round: initial transmittal document and the subsequent panelist responses.
- 2nd round: revised transmittal document (with modified HSC curves) and the subsequent panelist responses.
- This process was repeated until each panelist indicated that all HSC curve revisions were "acceptable" to them.
  - "Acceptable" not necessarily complete agreement, but panelist(s) felt the HSC curve was adequate for use in modeling DWM habitat in the study area.
- 3rd round proposed HSC curves were final HSC with acceptance and the Delphi process was terminated.

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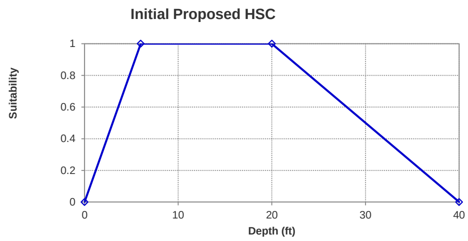
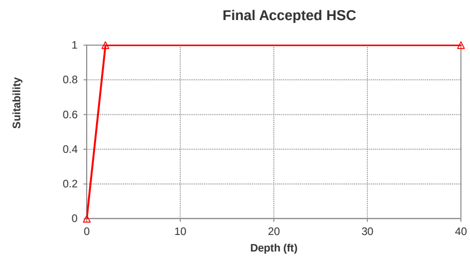
Study 24 – Delphi Panel Results

Depth (ft)





Variable	Value	Suitability
Depth (ft)	0	0.00
	2	1.00
	40	1.00

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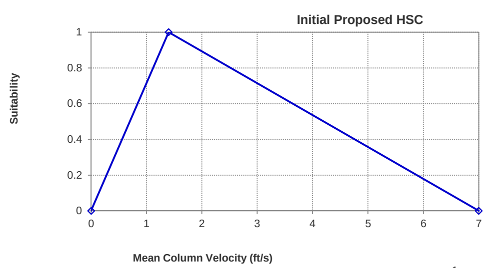
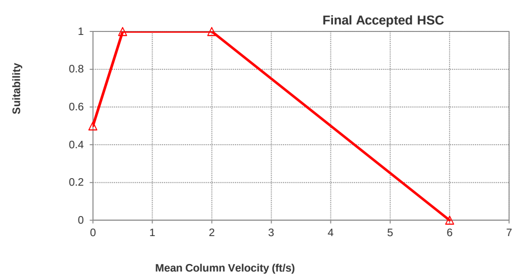
Study 24 – Delphi Panel Results

Mean Column Velocity (ft/s)





Variable	Value	Suitability
Mean Column Velocity (ft/s)	0	0.50
	0.5	1.00
	2	1.00
	6	0.00

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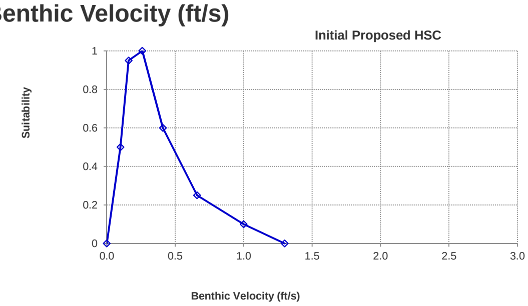
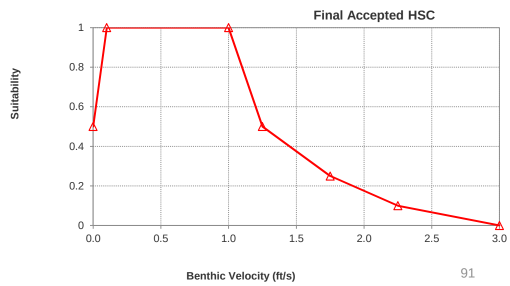
Study 24 – Delphi Panel Results

Benthic Velocity (ft/s)



Variable	Value	Suitability
Benthic Velocity (ft/s)	0	0.50
	0.1	1.00
	1	1.00
	1.25	0.50
	1.75	0.25
	2.25	0.10
	3	0.00



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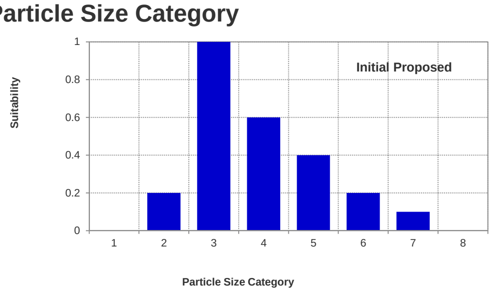
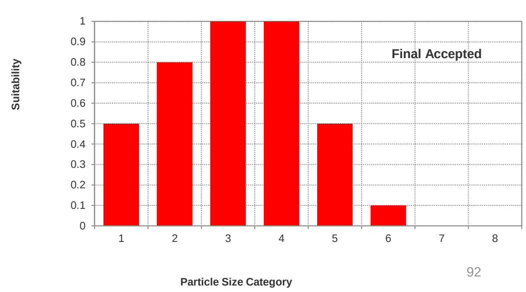
Study 24 – Delphi Panel Results

Particle Size Category



Code	Description
1	Submerged Aquatic Vegetation (25 mm)
2	Clay/Silt (0.01 mm)
3	Sand (1 mm)
4	Fine Gravel (5 mm)
5	Gravel (36 mm)
6	Cobble (160 mm)
7	Boulder (256 mm)
8	Bedrock (1000 mm)

Variable	Value	Suitability
Substrate Particle Size	1	0.50
	2	0.80
	3	1.00
	4	1.00
	5	0.50
	6	0.10
	7	0.00
	8	0.00



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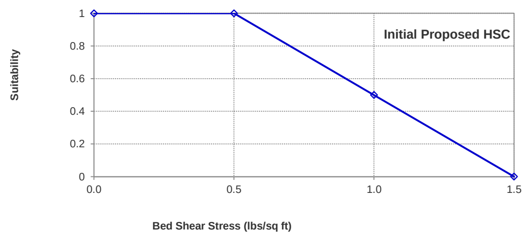
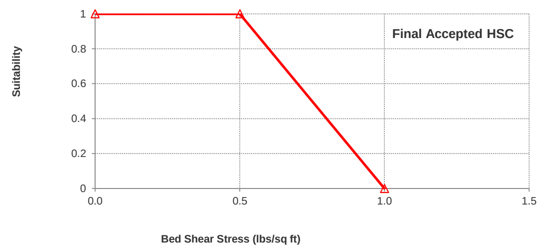
Study 24 – Delphi Panel Results

Bed Shear Stress (lb/ft^2)



Variable	Value	Suitability
Bed Shear Stress (lbs/ft^2)	0.0	1.00
	0.5	1.00
	1.0	0.00



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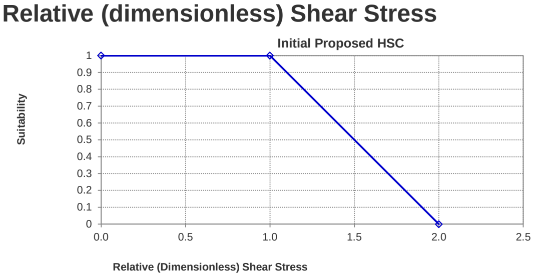
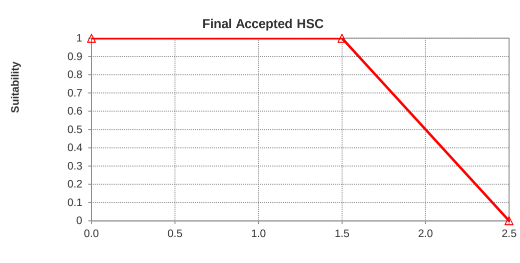
Study 24 – Delphi Panel Results

Relative (dimensionless) Shear Stress



Variable	Value	Suitability
Relative Shear Stress	0.0	1.00
	1.5	1.00
	2.5	0.00



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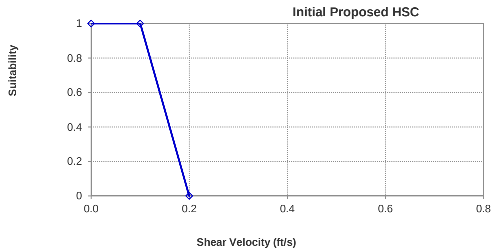
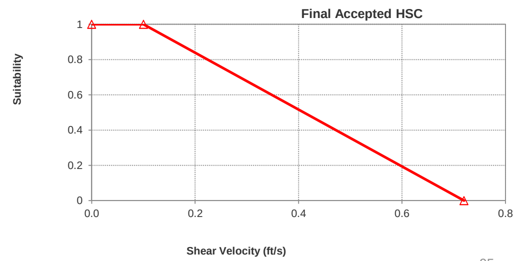
Study 24 – Delphi Panel Results

Shear Velocity (ft/s)



Variable	Value	Suitability
Shear Velocity (ft/s)	0.0	1.00
	0.1	1.00
	0.72	0.00



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Study 24 – Dwarf Wedgemussel and Co-occurring Mussels

Remaining Activities

- Receive and discuss via conference call, comments on Delphi Panel Report and these HSC. Would like comments back by June 14 if possible.
- Analyses of quantitative and qualitative mussel and habitat data (2011-2014), including that from TransCanada's supporting studies.
- Evaluate, test, and possibly modify HSC based on these data and preliminary modeling. Develop similar HSC for co-occurring mussels.
- Final HSC will be used in the 1D and 2D modeling (Study 9)
- Draft and final study report when modeling is complete.

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Study 9
Instream Flow Study

Consultation and Study Update - June 1, 2016

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Study 9 – Instream Flow Study

Remaining Activities Identified: March USR Meeting

- Habitat times series
  - Selection of species and life stages to analyze
  - 5 operational models
- Dual-Flow analysis
  - Selection of species and life stages to analyze
  - Determine flow combinations (e.g. base-peak)

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Study 9 – Instream Flow Study

Target Species and Life Stages:

	Species	Life stage	Periodicity	Study Reaches
1	American Shad	Juvenile	June 7 - Nov 30	V, B
2	American Shad	Adult	May 1 - June 30	V, B
3	American Shad	Spawning	May 1 - July 15	V, B
4	Walleye	Fry	May 1 - July 1	V, B, W
5	Walleye	Juvenile	Year round	V, B, W
6	Walleye	Adult	Year round	V, B, W
7	Walleye	Spawning	April 1 - May 31	V, B, W
8	Fallfish	Fry	June 1 - July 1	V, B, W
9	Fallfish	Juvenile	Year round	V, B, W
10	Fallfish	Adult	Year round	V, B, W
11	Fallfish	Spawning	May 1 - June 30	V, B, W
12	White Sucker	Fry	June 1 - Sep 30	V, B, W
13	White Sucker	Adult/Juv	Year round	V, B, W
14	White Sucker	Spawning	April 1 - June 30	V, B, W
15	Longnose Dace	Juvenile	Year round	TBD
16	Longnose Dace	Adult	Year round	TBD
17	Longnose Dace	YoY	July 1 - Sep 30	TBD
18	Tessellated Darter	Adult	Year round	V, B, W
19	Sea Lamprey	Spawning	May 1 - July 15	V, B, W
20	Smallmouth Bass	YoY	July 1 - Sep 30	V, B, W
21	Smallmouth Bass	Juvenile	Year round	V, B, W
22	Smallmouth Bass	Adult	Year round	V, B, W
23	Smallmouth Bass	Spawning	May 1 - June 30	V, B, W
24	Macroinvertebrates	na	Year round	V, B, W

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Study 9 – Instream Flow Study

Reduction of Number Species/Life Stages

- Similar habitat requirements
  1. Area Weight Suitability (AWS) habitat index results
  2. Habitat time series sensitivity analysis
  3. Dual-Flow (effective habitat) sensitivity analysis
- Prioritize species/life stages

  1) Rank Importance
  - spawning versus fry
  - recreational species

  2) Minimal project effects (spring spill)

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Study 9 – Instream Flow Study

Target Species and Life Stages:

Different periodicity or habitat requirements does not allow combining or grouping of some species/life stages

	Species	Life stage	Periodicity	Study Reaches
1	American Shad	Juvenile	June 7 - Nov 30	V, B
2	American Shad	Adult	May 1 - June 30	V, B
4	Walleye	Fry	May 1 - July 1	V, B, W
8	Fallfish	Fry	June 1 - July 1	V, B, W
12	White Sucker	Fry	June 1 - Sep 30	V, B, W
3	American Shad	Spawning	May 1 - July 15	V, B
7	Walleye	Spawning	April 1 - May 31	V, B, W
11	Fallfish	Spawning	May 1 - June 30	V, B, W
14	White Sucker	Spawning	April 1 - June 30	V, B, W
19	Sea Lamprey	Spawning	May 1 - July 15	V, B, W
23	Smallmouth Bass	Spawning	May 1 - June 30	V, B, W
24	Macroinvertebrates	na	Year round	V, B, W

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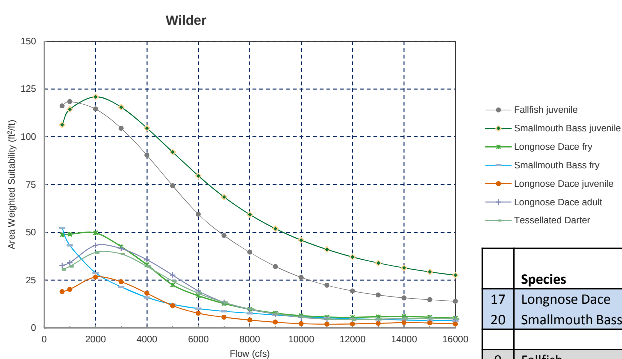
Study 9 – Instream Flow Study

Compare AWS Curves: Wilder



	Species	Life stage	Periodicity	Study Reaches
17	Longnose Dace	YoY	July 1 - Sep 30	TBD
20	Smallmouth Bass	YoY	July 1 - Sep 30	V, B, W
9	Fallfish	Juvenile	Year round	V, B, W
21	Smallmouth Bass	Juvenile	Year round	V, B, W
15	Longnose Dace	Juvenile	Year round	TBD
16	Longnose Dace	Adult	Year round	V, B, W
18	Tessellated Darter	Adult	Year round	V, B, W

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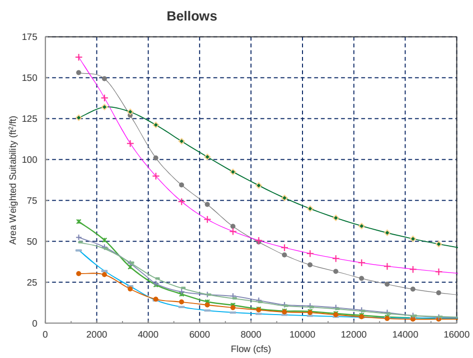
Study 9 – Instream Flow Study

Compare AWS Curves: Bellows



	Species	Life stage	Periodicity	Study Reaches
17	Longnose Dace	YoY	July 1 - Sep 30	TBD
20	Smallmouth Bass	YoY	July 1 - Sep 30	V, B, W
9	Fallfish	Juvenile	Year round	V, B, W
21	Smallmouth Bass	Juvenile	Year round	V, B, W
13	White Sucker	Adult/Juv	Year round	V, B, W
15	Longnose Dace	Juvenile	Year round	TBD
16	Longnose Dace	Adult	Year round	V, B, W
18	Tessellated Darter	Adult	Year round	V, B, W

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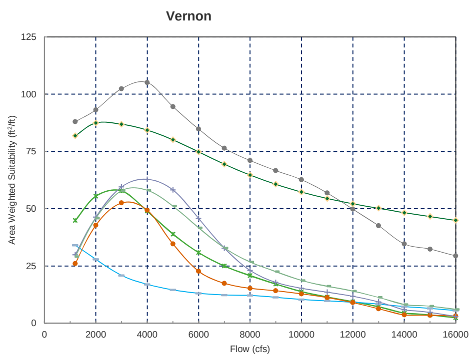
Study 9 – Instream Flow Study – Habitat Index

Compare AWS Curves: Vernon



	Species	Life stage	Periodicity	Study Reaches
17	Longnose Dace	YoY	July 1 - Sep 30	TBD
20	Smallmouth Bass	YoY	July 1 - Sep 30	V, B, W
9	Fallfish	Juvenile	Year round	V, B, W
21	Smallmouth Bass	Juvenile	Year round	V, B, W
15	Longnose Dace	Juvenile	Year round	TBD
16	Longnose Dace	Adult	Year round	V, B, W
18	Tessellated Darter	Adult	Year round	V, B, W

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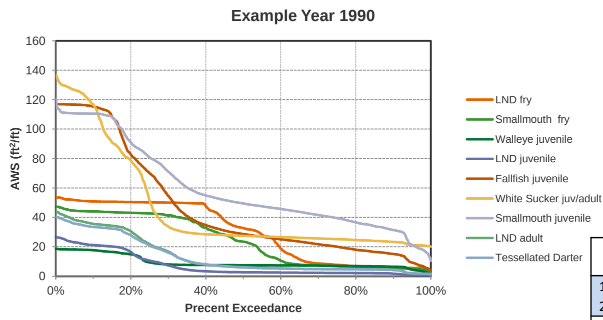
Study 9 – Instream Flow Study

Compare Habitat Duration: Wilder



	Species	Life stage	Periodicity
17	Longnose Dace	YoY	July 1 - Sep 30
20	Smallmouth Bass	YoY	July 1 - Sep 30
5	Walleye	Juvenile	Year round
15	Longnose Dace	Juvenile	Year round
9	Fallfish	Juvenile	Year round
13	White Sucker	Adult/Juv	Year round
21	Smallmouth Bass	Juvenile	Year round
16	Longnose Dace	Adult	Year round
18	Tessellated Darter	Adult	Year round

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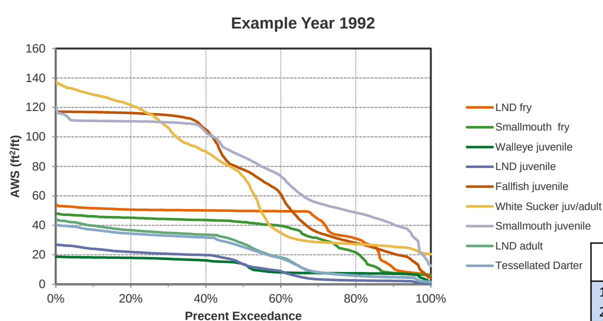
Study 9 – Instream Flow Study

Compare Habitat Duration: Wilder



	Species	Life stage	Periodicity
17	Longnose Dace	YoY	July 1 - Sep 30
20	Smallmouth Bass	YoY	July 1 - Sep 30
5	Walleye	Juvenile	Year round
15	Longnose Dace	Juvenile	Year round
9	Fallfish	Juvenile	Year round
13	White Sucker	Adult/Juv	Year round
21	Smallmouth Bass	Juvenile	Year round
16	Longnose Dace	Adult	Year round
18	Tessellated Darter	Adult	Year round

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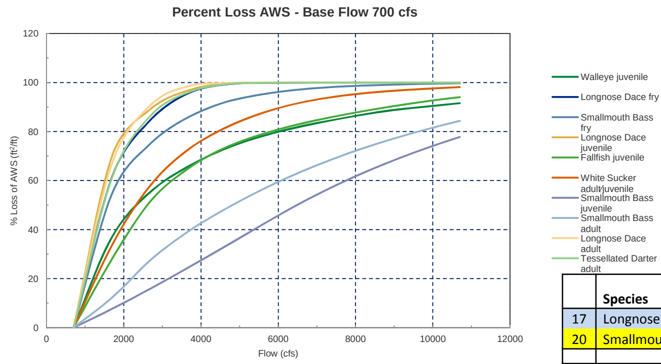
Study 9 – Instream Flow Study

Compare Effective Habitat: Wilder



	Species	Life stage	Periodicity
17	Longnose Dace	YoY	July 1 - Sep 30
20	Smallmouth Bass	YoY	July 1 - Sep 30
5	Walleye	Juvenile	Year round
9	Fallfish	Juvenile	Year round
13	White Sucker	Adult/Juv	Year round
15	Longnose Dace	Juvenile	Year round
16	Longnose Dace	Adult	Year round
18	Tessellated Darter	Adult	Year round
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21	Smallmouth Bass	Juvenile	Year round
22	Smallmouth Bass	Adult	Year round

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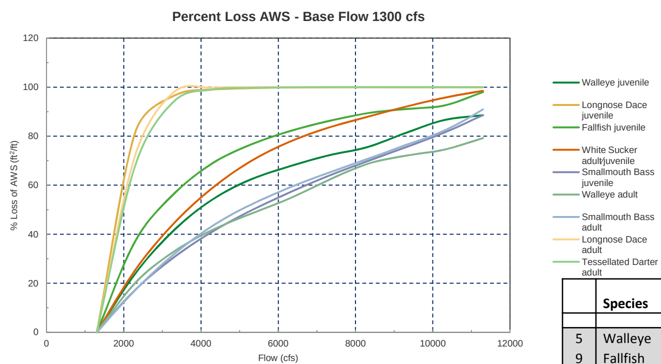
Study 9 – Instream Flow Study

Compare Effective Habitat: Bellows



	Species	Life stage	Periodicity
5	Walleye	Juvenile	Year round
9	Fallfish	Juvenile	Year round
13	White Sucker	Adult/Juv	Year round
15	Longnose Dace	Juvenile	Year round
16	Longnose Dace	Adult	Year round
18	Tessellated Darter	Adult	Year round
21	Smallmouth Bass	Juvenile	Year round
6	Walleye	Adult	Year round
22	Smallmouth Bass	Adult	Year round

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Study 9 – Instream Flow Study

Species and Life Stages with similar habitat response:

	Species	Life stage	Periodicity	Study Reaches
17	Longnose Dace	YoY	July 1 - Sep 30	TBD
20	Smallmouth Bass	YoY	July 1 - Sep 30	V, B, W
9	Fallfish	Juvenile	Year round	V, B, W
13	White Sucker	Adult/Juv	Year round	V, B, W
9	Fallfish	Juvenile	Year round	V, B, W
21	Smallmouth Bass	Juvenile	Year round	V, B, W
15	Longnose Dace	Juvenile	Year round	TBD
16	Longnose Dace	Adult	Year round	TBD
18	Tessellated Darter	Adult	Year round	V, B, W

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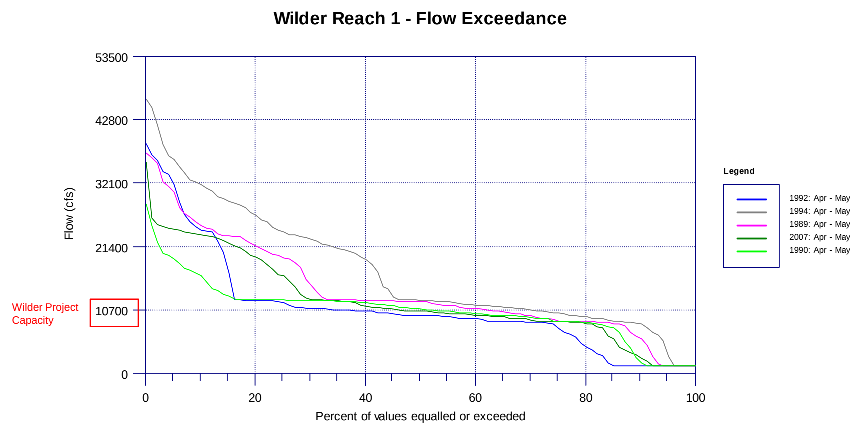
Study 9 – Instream Flow Study

Project Effects: Walleye Spawning (April-May)



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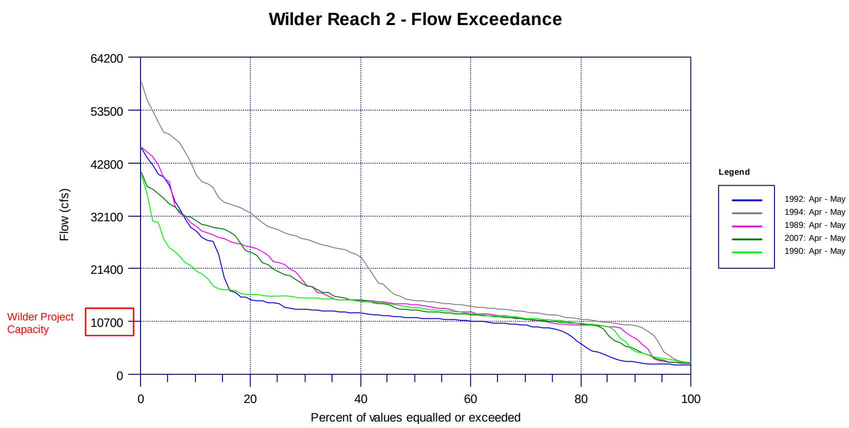
Study 9 – Instream Flow Study



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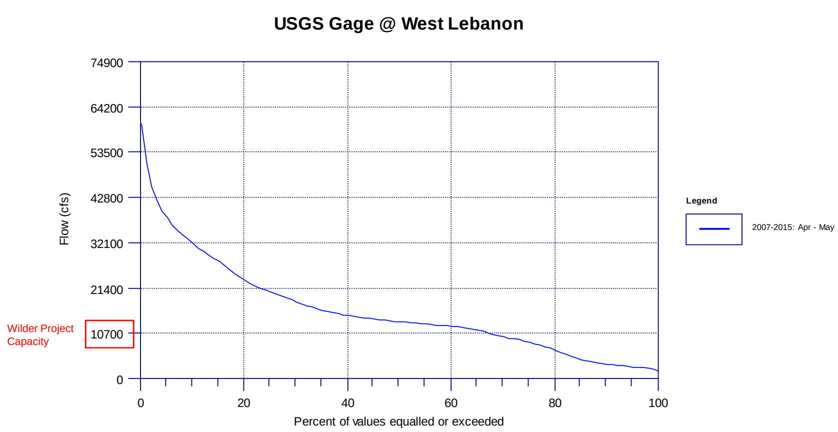
Study 9 – Instream Flow Study



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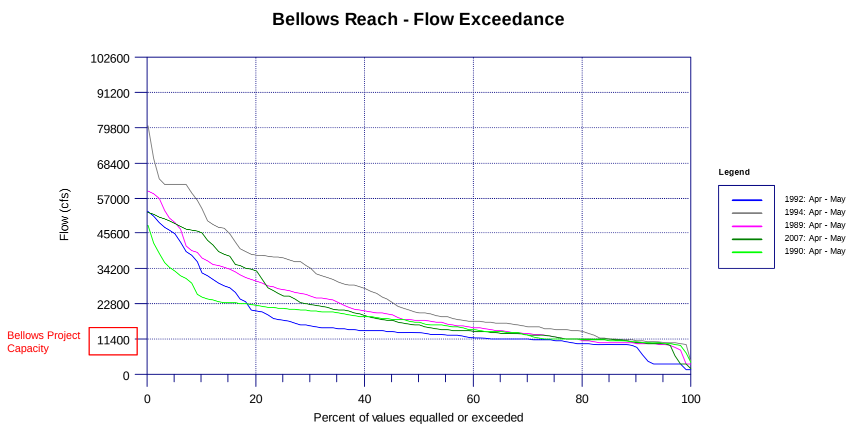
Study 9 – Instream Flow Study



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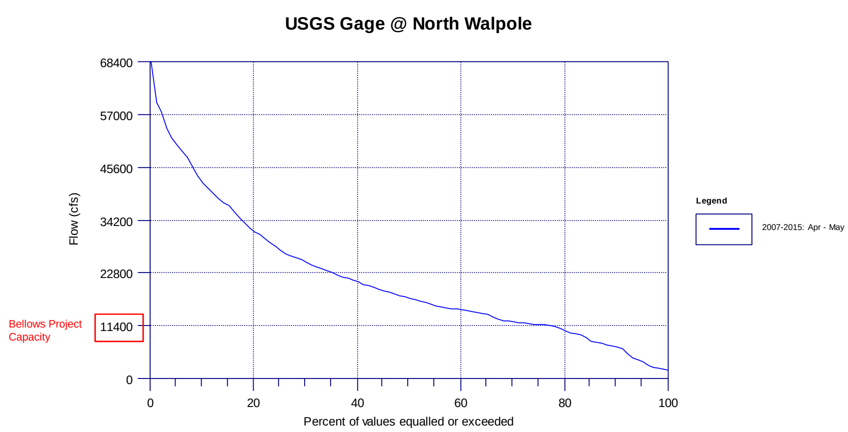
Study 9 – Instream Flow Study



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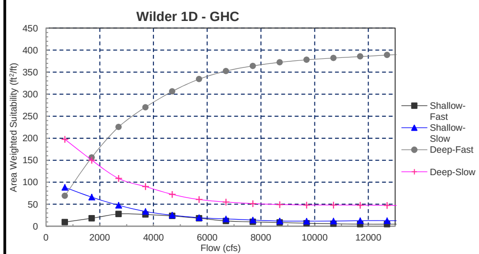
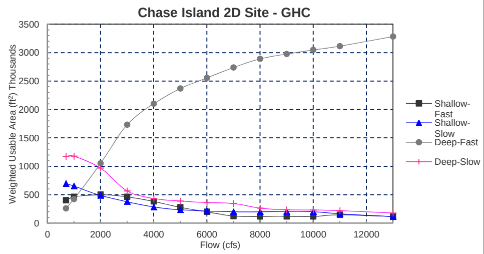
Study 9 – Instream Flow Study

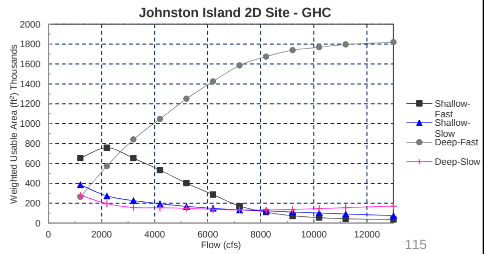
Wilder 1D vs 2D





Similar Habitat Indices – Wilder 1D transects and Chase Island 2D site

	Wilder 1D	Chase 2D	Johnston 2D
Pool	56%	56%	30%
Glide	23%	16%	9%
Run	15%	22%	34%
Riffle	5%	6%	27%



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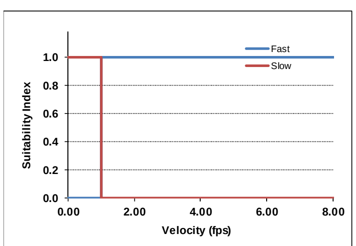
Study 9 – Instream Flow Study

Generalized Habitat Criteria (GHC)

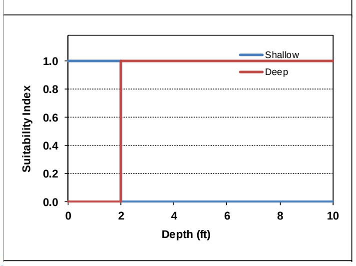


Fast

Velocity (ft/s)	SI
0.00	0.00
1.00	0.00
1.01	1.00
10.00	1.00

Slow

Velocity (ft/s)	SI
0.00	1.00
1.00	1.00
1.01	0.00
10.00	0.00



Shallow

Depth (ft)	SI
0.00	1.00
2.00	1.00
2.01	0.00
10.00	0.00

Deep

Depth (ft)	SI
0.00	0.00
2.00	0.00
2.01	1.00
100.00	1.00

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Study 9 – Instream Flow Study

Memorandum Errata:

American Shad graphs (p 31 and 39 of the memo) identify life stages as fry, juvenile, spawning; but they should be juvenile, adult, spawning, respectively

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Study 9 – Instream Flow Study

Dual-Flow Analysis – Selection of Paired Flows

Normally use a range of minimum flows compared to a range of peaking flows

- Selecting minimum flows
  - Current minimum generation flow
  - Alternate minimum(s) based on evaluation of habitat indices
- Selecting peaking flows
  - Current maximum station capacity (e.g. Wilder 10,700 cfs)
  - Based on turbine capacity, efficiency and number of turbines
    - Wilder 2 units, Bellows 3, Vernon 10

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Study 33
Cultural and Historic Resources Study

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Study 33 – Historic and Cultural Resources

Traditional Cultural Properties Study Report

Methods

- Methodology driven by:
  - National Historic Preservation Act, Section 106 -36 CFR 800
  - Consultation on historic properties of significance to Indian tribes…
  - Are there places eligibility to National Register in Project area?
  - National Register Bulletin #38 *Guidelines for Evaluating and Documenting Traditional Cultural Properties* (Parker and King, 1998).
- Report modeled on similar studies conducted to meet FERC relicensing requirements.
- Based on archival and literary research only due to lack of Tribal input at this time.

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Study 33 – Historic and Cultural Resources

Traditional Cultural Properties Study Report

Results

- Archaeological sites all along Connecticut River, these can be considered TCPs.
- Place names in Native Languages all along Connecticut River.
- Tribes cleared out of study area through wars and bounties
  - Documentation shows survivors were absorbed by regional tribes

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Study 33 – Historic and Cultural Resources

Traditional Cultural Properties Study Report

Place Name	Meaning (if available)	Notes
Kowasék (Cowasuck), Cowass	Place of the white pines	Village near Newbury, VT, marked on early French maps as an ancient village.
Ompompanoosuc	Not Available	VT tributary to the CT River. Indian burial ground found 350 m from mouth of river.
Mascoma River, also Mas Kam Ok	Place of the Great Trees	NH tributary to the CT River.
Ottauquechee, also Anglicized as 'Waterqueechy'	Not Available	VT tributary to the CT River.
Ascutney/Askutegnik (Sugar River)	a. From the Abenaki word Ascutegnik, which was the name of a settlement near where the Sugar River meets the Connecticut River. The Abenaki name for the mountain is Cas-Cad-Nac, which means "mountain of the rocky summit." b. "at the end of the river fork" is the translation of Ascutegnik	The Sugar River is a VT tributary to the CT River.
Skitchewaug	Not Available	Village site dating to A.D. 1100. Mountain near Bellows Falls, VT.
Wantastiquet	Abenaki for "river which leads to the west."	Mountain in West Chesterfield, NH
Coasset	Not Available	This area is also the vicinity of an archaeological site (Vermont site VT-WD-11) consisting of "a large village near the old railroad station at South Vernon… with 30 prehistoric "granaries."
Ashuelot River and Pisgah Mountains	"To the good fishing place" "to the place of the beautiful mountains"	NH tributary to the CT River just south of the Vernon project area.

Study 33 – Historic and Cultural Resources

Traditional Cultural Properties Study Report

Recommendations

- Consultation with Federally recognized Tribes to determine:
  - if areas identified in report are of cultural importance to the affected Tribes
  - if there are places not identified in this report that are of importance to the Tribes.
- Determine if additional information through oral histories or other research should be gathered to supplement the research in this study.
- If Tribal consultation provides information on ancestral, traditional, and current use of places within the APE that indicates cultural importance and there is a direct impact on such due to project operations then the following actions are recommended:
  - If places are within the APE but privately owned by others, the Licensee should attempt to foster communication between the Tribe and the landowner in order to develop a mutual understanding of the cultural significance of the place and examine opportunities to preserve its heritage.
  - If places are within the APE and on Project land held in fee by the Licensee, the Licensee should, through communication with and cooperation by the Tribe, develop an understanding of the cultural significance of the place, examine opportunities to protect its heritage and to the extent possible, implement measures to do so.

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Study 33 – Historic and Cultural Resources

Traditional Cultural Properties Study Report

Status

- Report filed May 16, 2016.
- Any comments received will be addressed.

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Study 33 – Historic and Cultural Resources

Archaeological Investigations - Study Progress

Phase IB and Phase II Archaeological Surveys – Wilder, Bellows Falls, and Vernon Projects in New Hampshire:

- Phase IB testing was completed in September 2015 on all TransCanada-owned lands and private properties where permissions have been granted.
- Phase IB report submitted to NH SHPO via hard copy mail submittal on October 29, 2016 (FERC filing on March 23, 2016).
- 1 pre-contact site recommended for Phase II investigations to evaluate its eligibility for listing in the National Register.
- NH SHPO provided written concurrence on Phase IB survey findings and Phase II site investigations field methodology on December 16, 2015.
- Phase II survey fieldwork at the 1 site in New Hampshire has been completed and the Phase II report is forthcoming.

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Study 33 – Historic and Cultural Resources

Archaeological Investigations - Study Progress

Phase IB and Phase II Archaeological Surveys – Wilder, Bellows Falls, and Vernon Projects in Vermont:

- Phase IB testing was completed in September 2015 on all TransCanada-owned lands and private properties where permissions have been granted.
- Phase IB report submitted to VT SHPO via CD mail submittal on March 14, 2016 (FERC filing on March 23, 2016).
- 6 pre-contact sites recommended for Phase II investigations to evaluate their eligibility for listing in the National Register.
- VT SHPO provided stamped concurrence on Phase II site investigations field methodology on April 20, 2016.
- Phase II survey fieldwork at the 6 sites in Vermont commenced on April 18, 2016 and is ongoing.

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