Great River Hydro

John L. Ragonese
FERC License Manager
Great River Hydro, LLC
One Harbour Place, Suite 330
Portsmouth, NH 03801
tel 603.559.5513
em jragonese@greatriverhydro.com

November 13, 2018

VIA ELECTRONIC FILING
Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Re: Great River Hydro, LLC, ILP; Progress Report
Project Nos. P-1892-026, 1855-045, and 1904-073

Dear Secretary Bose:

Great River Hydro, LLC ("Great River Hydro") 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). On October 31, 2012, TransCanada (the previous licensee) initiated the Integrated Licensing Process ("ILP") 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. The current licenses for these projects each expire on April 30, 2019.

In accordance with the Commission's Revised Process Plan and Schedule for the Wilder, Bellows Falls, and Vernon Hydroelectric Projects dated February 15, 2018, Great River Hydro respectfully provides this progress report on the status of activities related to Studies 9 (Instream Flow), 24 (Dwarf Wedgemussel and Co-Occurring Mussels), and 33 (Cultural and Historic Resources) since the last progress report, filed August 13, 2018.

Consultation meetings with stakeholder members of the Aquatics Working Group continue. Meetings were held on September 11, 2018 and October 16, 2018 and a meeting is scheduled for November 20, 2018. At the September 11 meeting, Great River Hydro provided the working group and interested stakeholders with detail around wholesale energy markets, the economic landscape and the important role the projects play through a power point presentation (attached) describing:

- Overview of Energy Markets affected by Operations and Instream Flow,
- Operational Constraints and Impacts, and
- Project Economic Concerns.

Great River Hydro emphasized the importance of operational flexibility to grid reliability and stability and that the fast-start, responsive attributes of the Great River Hydro projects are critical to insuring that importance. Impacts on present-day fast-start capability, energy, capacity and reserve values must be considered when evaluating operational alternatives. Great River Hydro also expressed concern about significant energy and capacity losses that would be incurred if significant flow was spilled at the dam into the Bellows Falls bypass. The meeting ended identifying next steps to include 1.) Great River Hydro looking closer at habitat specific needs based upon feedback received in the VFWD presentation at the August 7, 2018 working group consultation meeting and what it would mean for operations, and 2.) stakeholders review the information presented and contact Great River Hydro with proposed next steps/agenda for next meeting.

The agenda for the October 16, 2018 meeting focused on Great River Hydro's understanding of, and thoughts around VFWD's presentation of August 7, 2018 prior to developing operational alternatives for further analysis. Terms used to describe, and calculations around dual-flow and two-flow were discussed, as well as the usefulness of the metrics for different species and life stages. The differing aspects and effects of up-ramping and down-ramping and maximum flow range were discussed. The other major topic of discussion was whether stakeholders would agree to GRH attempting to reduce the numbers of species and life stage habitat index curves, and flow analyses by combining similar shapes and seasonal needs where possible. Process steps to performing the species/life stages reduction, developing possible alternative operating scenarios, quantified through time series analysis using the Operations model (Study 5) and presenting results was discussed. All agreed that the next step would be for Great River Hydro to 1.) combine/reduce the number of species and life stages as deemed appropriate relative to shape and amplitude of AWS curves, seasonality, etc., 2.) develop flow scenarios for model runs of sensitivity, 3.) analyze output from the operations model in terms of feasibility and undesirable impacts (forced spill, unit capacity exceedance), and 4.) run output through time-series analysis for comparison to base case. It is unlikely all four steps will be completed before the November meeting, but a discussion of results from steps 1 and 2 with stakeholders is planned.

The continued direction of these consultation sessions is to seek a possible operating alternative that has improvement in habitat (identified through Study 9) compared to existing operations while providing critical operational and fast-start flexibility when necessary. At this time, Great River Hydro does not have an estimated filing date for the Study 9 and 24 report addenda. Meeting summaries and presentations from the August 7, September 11 and October 16, 2018 aquatic working group Study 9/24 consultation meetings are included in this progress report.

By November 30, 2018 Great River Hydro will submit its draft Programmatic Agreement to the State SHPO's and subsequently to tribal leaders for their review and comment. We are continuing efforts to complete any final changes to our TCP.

If there are further questions regarding this matter, please contact me at 603-498-2851 or jragonese@greatriverhydro.com. Thank you for your consideration.

Sincerely,

John L. Ragonese
FERC License Manager

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

Attachment: Meeting Summaries and presentations from:

August 7, 2018 Study 9/24 consultation meeting
September 11, 2018 Study 9/24 consultation meeting
October 16, 2018 Study 9/24 consultation meeting

Great River Hydro
ILP Study 9 Instream Flow Consultation Meeting
GRH Wilder VT conference room
Tuesday, August 7, 2018, 9:30 am - 3:00 pm

Meeting Notes

A consultation meeting was held August 8, 2018 at Great River Hydro's Renewable Operations Control Center in Wilder, VT to discuss agencies findings regarding instream flow effects.

Meeting attendees in person or identified on the telephone:

Name	Affiliation
Jeff Crocker	VT ANR (via phone)
Melissa Grader	FWS (via phone)
Ken Sprankle	FWS (via phone)
Mark Wamser	Gomez & Sullivan (via phone)
Jim McClammer	CRJC (via phone)
Andrea Donlon	CRC (via phone)
Semiu Lawal	Hatch (via phone)
Eric Davis	VT ANR
Norman Sims	American Whitewater
Lael Will	VTFWD
Katie Kennedy	TNC
Nicole Palmer	TNC
Gregg Comstock	NHDES
Matt Carpenter	NHFGD
Edwin Nason	GRH
John Hart	Gomez & Sullivan
Bob Nasdor	American Rivers
Steve Leach	Normandeau Associates
John Ragonese	GRH
Jen Griffin	GRH
Sean Keniston	GRH
Pete McHugh	VTFWD
Kathy Urffer	CRC

Introduction

John Ragonese opened the meeting and called for introductions by those participating via call in and around the table. He reviewed the last (June 8, 2018) meeting noting that agency/stakeholder wants regarding flows were discussed. He noted that GRH had no specific agenda for this meeting other than to provide an opportunity for VANR and stakeholders to discuss their initial review of Study 9 and other habitat study results and it was handed off to Pete McHugh to lead their review presentation.

Great River Hydro
ILP Study 9 Instream Flow Consultation Meeting
GRH Wilder VT conference room
Tuesday, August 7, 2018, 9:30 am - 3:00 pm

VANR Presentation

Pete McHugh presented a report of agency progress (attached) in review of Study 9, noting that the overall presentation had not yet been reviewed by the full Aquatics Working Group (AWG), but much of the material had been shared and discussed. Generally, everyone should view this as a work product, subject to change. He noted that the AWG task is to make recommendations regarding conservation flows, peaking operations, and impoundment WSE fluctuation considerations with reasonable assurance of meeting state water quality standards, federal protected species (ESA), and other laws. He noted that fish passage related flows were not being discussed in this meeting.

Ken Sprankle commented that CRASC has no plans to expand shad restoration beyond their historic range the falls between Bellows Falls and North Walpole; CRASC will not be looking for shad passage at Bellows Falls.

Pete noted that studies are largely complete and that reports and datasets have been shared by GRH. The AWG stakeholders convened to review flow and passage study results and discuss potential for flows to meet objectives.

Pete presented their assessment of the data (presentation attached). The stated goals of the presentation were to: (1) summarize key modeling results and other hydrological and biological factors that VANR is considering it its evaluation of the current license proposal included in GRH's license application, and (2) facilitate discussion on key findings and possible next steps towards identifying operating conditions that are protective of riverine resources and aquatic habitat, and maintain water quality levels that support designated and existing uses.

Notably, Peter indicated that a proposed operating regime is assumed to provide adequate protection if it (1) results in minimum habitat impact (defined by Study 9, instream flow) or (2) if executed in a way consistent with the river's natural flow regime (i.e., frequency, magnitude, and rate of change); but that the two could provide contradictory results. Have more information for instream flow, not so much for natural flow.

The assessment was mostly based on Study 9. The steady state model (flow vs. habitat) can be used for the Bellows Falls bypassed reach and minimum flows. For peaking operations, more useful to look at dual flow (immobile species) & two-flow (mobile species). 26 flows were modeled for 27 species/life stages on 44 transects. The assessment considered different flow pairs to compare relative impact on quantity and quality (based on suitability curves) of habitat available to a species or species group (slides 16-20). Discussion around how the assessment compared with collection studies, for example, the assessment showed little increase in % habitat remaining with increased flows for tessellated darter, yet the species was collected in all reaches and in high numbers in many reaches. This generated a conversation of suitability curves, whether a population is distressed due to operations as compared to whether indexed habitat is reduced and the need to consider all available data when moving from an assessment like this, to flow recommendations.

Bob Nasdor commented that the assessment assumes more habitat is better or required, how does it consider that some species have plenty of habitat under current operations? Peter responded that it's not an assessment of a species population, but of habitat availability.

Norm Sims remarked that FirstLight is focusing on specific species to determine flows. Ken responded that there are endangered species in that area that are being focused on, but up here looking at groups of species.

Slides 22-25 considered hydrology, using TNC's CRUISE model natural hydrology dataset to identify bounds for operations, noting challenges of: defining baseline, implementing without increasing variability, requires useable storage, does not address impoundment effects.

Slides 26-34 assessed species, habitat and flow in the Bellows Falls bypassed reach. Because of the prominence of a double channel and deep pool in this reach, available habitat decreased and then only increased slightly as flow increased. Bob and Norm noted that the assessment was done with the fish dam in place and wondered how it would change if the dam was removed.

Next steps (slide 40): consider hydraulic habitat conditions (study 9), hydrologic considerations (seasonality, generation frequency, and magnitude, rate of change, duration, and incoming flows), compatibility with desire for operational flexibility, other study considerations, and potential priority areas.

Continued Discussion

Bob asked about a filing date of an amended FLA, and whether flow requirements will be incorporated by general agreement.

John Ragonese noted that an amended final application filing would be on a schedule with FirstLight's amended FLA filing and confirmed that GRH would like to reach agreement regarding operational regimes for including in the amended FLA, which would ideally also be incorporated in the state 401 WQC's.

John Hart noted that FirstLight intended to file by June 30, 2019.

John Ragonese asked, what are the next steps from Stakeholder's perspective?

Mellissa Grader responded that without process of Settlement, we have to propose a mutually agreeable operations regime. It is not clear where we are toward that goal as no one has put flow numbers on the table. Not sure what the process is for taking that next step.

Bob noted that the process could help develop guidance - principles and priorities that would eventually guide proposals.

Andrea Donlon noted that Settlement has some formality, but our discussion has no structure.

John Ragonese disagreed that there is no structure, responding that FERC has given the AWG an opportunity to investigate study results and continue the Study 9 comment period. This allows us to assess potential alternative flows and operations in a formal FERC ILP consultation setting. GRH intends to file an amended FLA. Stakeholders will have an opportunity to comment on that. Settlement isn't part of the ILP process and therefore, there is no specific FERC time-period or process. Moving forward as we are does not preclude Settlement but in GRH's opinion, lacking better understanding of Study 9 and how alternative operating scenarios might impact habitat and project values, it is premature to suddenly enter into Settlement discussions.

Matt Carpenter suggested that GRH should propose operational regimes, generally understanding what the agencies want, but incorporating GRH's desired flexibility / constraints [to the extent possible].

Kathy Urffer suggested, and Eric Davis agreed that GRH consider as a first step, to develop a 'straw-man' [conceptual diagram] proposal – a schematic that describes triggers and limitations (incorporates ramping rates, minimum flows, habitat, market, etc.). John Ragonese agreed that might be a good way to better define and describe the various aspects incorporated in GRH's need for some flexibility.

Action Items

- 90-day update due for filing August 13, if made available, Peter McHugh's Presentation given in this meeting will be included in update.
- GRH will draft meeting notes with action steps [herein].
- GRH examine how to develop a 'straw-man' template that presents a hypothetical alternative operating plan and identifies the necessary flexibility that would be needed to accommodate the important values and markets critical for the hydro projects. Present the template at the next meeting before running it through the model.
- Meet monthly to discuss proposed model runs / results.
- Next meeting scheduled for Tuesday, September 11, 2018.
- Placeholder meeting dates have also been identified for October 16, and November 20.

Vermont Department of Environmental Conservation *Agency of Natural Resources*
Watershed Management Division
1 National Life Drive [phone] 802-490-6180
Montpelier, Vermont 05620-3522 [fax] 802-828-1544
watershedmanagement.vt.gov

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August 8, 2018

John Ragonese
FERC License Manager
Great River Hydro, LLC
One Harbour Place, Suite 330
Portsmouth, NH 03801

RE: Wilder, Bellows Falls, and Vernon Hydroelectric Projects (FERC Nos. 1892, 1855, & 1904)
Aquatics Working Group Presentation Materials

Dear John,

Please find enclosed the materials prepared by the Vermont Agency of Natural Resources and presented to Great River Hydro and the Aquatics Working Group on August 7, 2018. The presentation summarizes the Agency's ongoing review of Study 9 (Instream Flow) and related studies conducted in support of the relicensing of the Vernon, Bellows Falls, and Wilder hydroelectric projects. The goals of the presentation were to: (1) summarize key modeling results and other hydrological and biological factors that VANR is considering it its evaluation of the operations proposal including in the GRH's draft license application, and (2) facilitate discussion on key findings and possible next steps towards identifying operating conditions that are protective of riverine resources, aquatic habitat, and maintains a level of water quality that supports designated and existing uses.

Very truly yours,

Eric Davis
River Ecologist

Enc: Appendix A: Vermont ANR Study 9 Progress Report

c: Jennifer Griffin, Great River Hydro
Pete McHugh, Vermont FWD
Jeff Crocker, Vermont DEC

APPENDIX A

VERMONT ANR STUDY 9 PROGRESS REPORT

Progress report from Vermont ANR on the review of Study 9 results

August 7, 2018

Great River Hydro Operations Center

Wilder, Vermont

Overview of presentation

- Recap of tasks, work done to date, data sharing, etc.
- Context:
  - Hydrology and biology
  - Proposed operations
- Review of Study 9 (instream flow study) & key findings:
  - Evaluation of proposed operations (all projects, but Wilder as example)
    - Steady state (conservation flows)
    - Dual flow analysis (habitat in light of hydropeaking cycle)
  - Evaluation of Bellows Falls bypass reach (steady state)
- Concerns emerging from review of other studies
- Where to from here?

Study 9 Review Tasks

To evaluate whether the relicensing proposal has a reasonable assurance of satisfying state and federal laws, including State WQ standards, State & Federal ESAs, other relevant laws, in terms of:

a) Conservation flows
b) Hydropeaking operations
c) Impoundment considerations
d) [fish passage]

Work completed to date

- Studies largely complete, reports and relevant datasets have been shared by GRH
- The working group has convened several times in the last 14 months to:
  - Review flow and passage study results
  - Review supplemental studies
  - Discuss the ability of the relicensing proposal to provide necessary protections

Overview of presentation

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  - Hydrology and biology
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- Review of Study 9 (instream flow study) & key findings:
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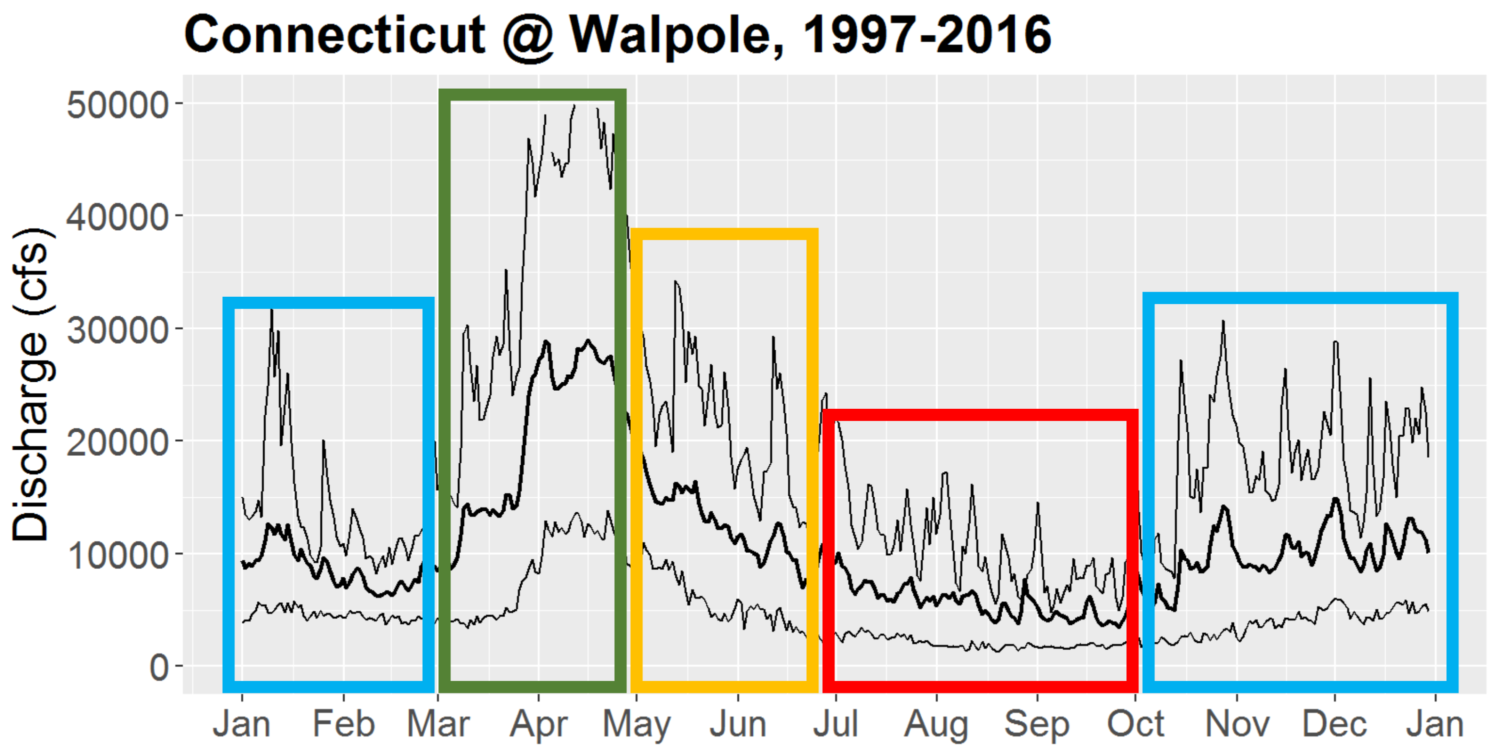
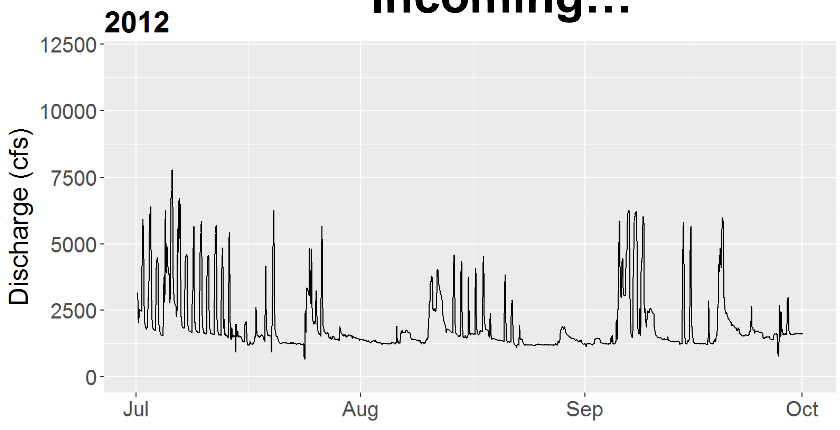


Hydrology context

- ~4 hydro-biological periods
  - Winter (Oct-Feb)
  - Early spring (Mar-Apr)
  - Late Spr./Early Sum. (May-Jun)
  - Summer (Jul-Sep)
- Altered incoming hydrology
  - Storage reservoirs
  - Peak generation (~1,000 / 6,000 cfs cycle from McIndoes)

Incoming…



Within VBW reach…

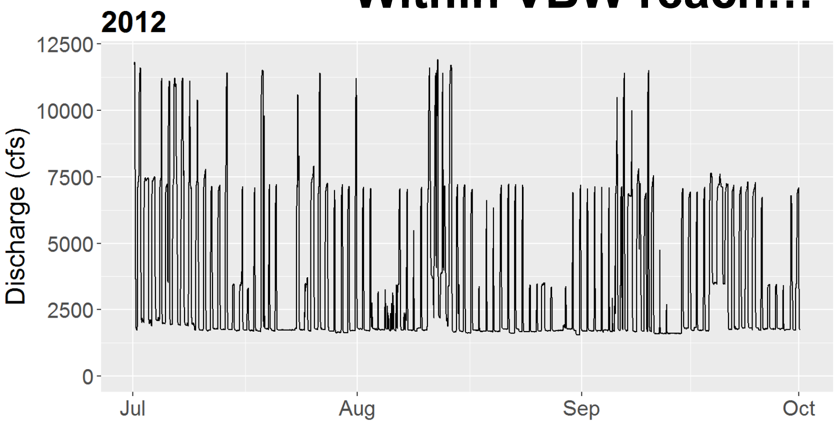


Table 2.1. Timing of key life history events, in full months; see Table 1.1 for sub-monthly life history details. The 1997-2016 daily median discharge at Walpole, rounded to the nearest 100 cfs, is provided below each month for considering linkages between life history and hydrology.

Species	Life stage	Jan 7,700	Feb 6,200	Mar 10,800	Apr 22,700	May 12,500	Jun 7,900	Jul 5,000	Aug 3,700	Sep 3,100	Oct 5,200	Nov 7,700	Dec 8,800
American Shad	Juvenile												
	Adult												
	Spawning												
Walleye	Fry												
	Juvenile												
	Adult												
	Spawning												
Fallfish	Fry												
	Juvenile												
	Adult												
	Spawning												
White Sucker	Fry												
	Juv/Ad												
	Spawning												
Longnose Dace	Juvenile												
	Adult												
	YOY												
Tessellated Darter	Adult												
Sea Lamprey	Spawning												
Smallmouth Bass	YOY												
	Juvenile												
	Adult												
	Spawning												
Macroinvertebrates	all aquatic												
Rainbow Trout	Adult												
Dwarf Wedgemussel[1]	Adult												
Co-occurring Mussels	Adult												

[1]Reproduction occurs summer/fall; glochidia release occurs in the following spring (March-June)

Biological context

- Native riverine & diadromous species
- Important sportfish
- Species of conservation concern:
  - DWM
  - Sea Lamprey
- Macroinvertebrates
- Seasonal presence/ significance

Current/proposed operations

Wilder Project: 675 cfs / 10,700 cfs

(conservation flow / max generation flow)

Bellows Falls Project: 1,083 cfs / 11,400 cfs

Bellows Falls bypass flow: leakage (100-300 cfs)

Vernon Project: 1,250 cfs / 17,100 cfs

(Note: other constraints also apply, e.g., drawdown rates, flood profile, etc.)

This is the operating regime included the draft license application; alternatives may be feasible, but this is what we have to work with currently.

Assessment of proposed operations

A proposed operating regime is assumed to offer adequate resource protection if it meets on of these conditions:

- If it has a minimal impact on the habitat of modeled species (assess using the **Study 9** steady state & dual flow/two flow results, other studies)

OR

- If it is executed in a way that's consistent with the river's natural flow regime, i.e., frequency, magnitude, rate of change, etc.

Overview of presentation

- Recap of tasks, work done to date, data sharing, etc.
- Context:
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- Review of Study 9 (instream flow study) & key findings:
  - Evaluation of proposed operations (all projects, but Wilder as example)
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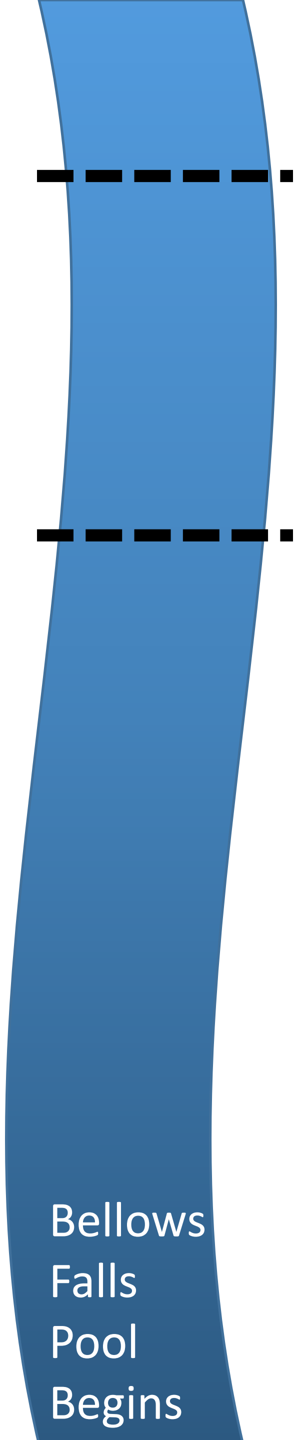
  - Evaluation of Bellows Falls bypass reach (steady state)
- Concerns emerging from review of other studies
- Where to from here?

Insights from instream habitat modeling

- Steady state model results (flow vs. habitat relationships)
- Dual flow (immobile species), two flow (mobile species)
  - Evaluate base/peak pairs and assess habitat impacts
  - Problems/challenges:
    - Denominator in '% habitat remaining'…lots of options, habitat at base, ave Q, or FMF incoming? (not a determining factor ultimately…)
    - Setting a specific bar for what constitutes a 'minimal impact'
    - Hydrologic & storage constraints will eliminate some base-peak pairs
- Impoundment fluctuation not assessed here



Wilder 1: Wilder Dam to White River:

- 1.5 mi (8%), 12 x 1D transects; pool & run habitat
- Negligible flow accumulation (= Accretion), $Q_{Trans} = Q_{WD}$

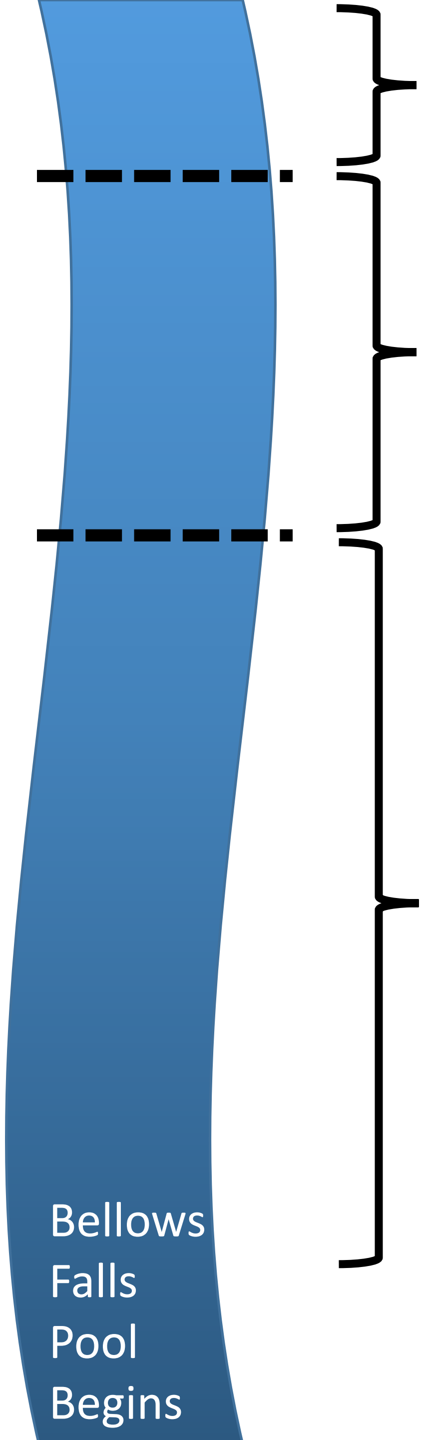
Wilder 2: White R to Ottauquechee R:

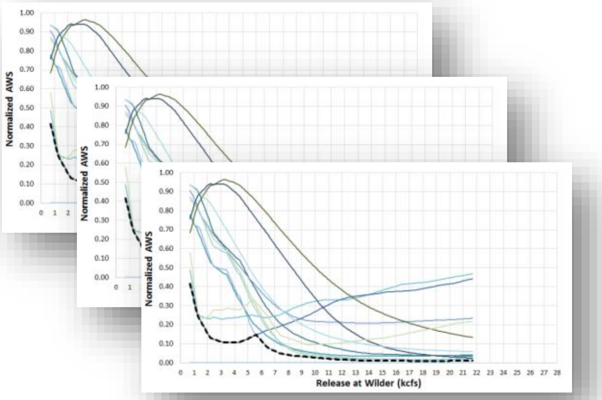
- 5.2 mi (29%), 16 x 1D transects; more habitat diversity & a 2D modeling site (Johnston Island)
- 600-2,500 cfs gained, depending on season, $Q_{Trans} = Q_{WD} + Q_{add1}$

Wilder 3: White to Ottauquechee segment:

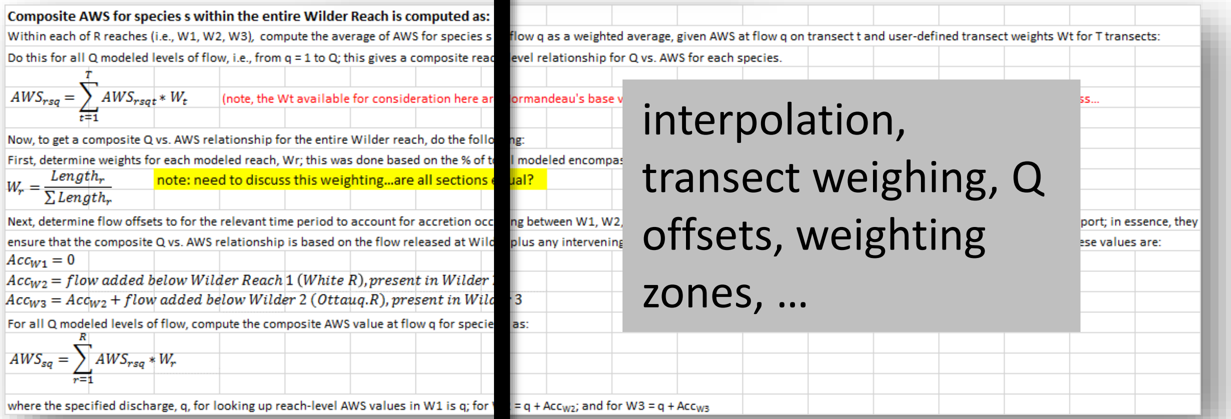
- 11 mi (63%), 16 x 1D transects; more habitat diversity & a 2D modeling site (Chase Island)
- Accretion: 800-3,300 cfs, depending on season , $Q_{Trans} = Q_{WD} + Q_{add1} + Q_{add2}$

26 flows (700-25,000 cfs) were modeled for 27 sp. on 44 transects, with 4 sets of weights…

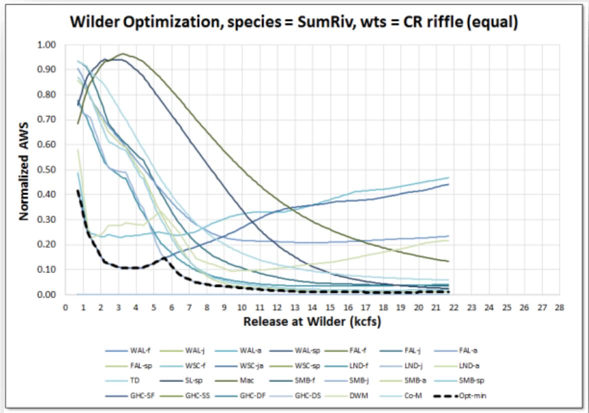




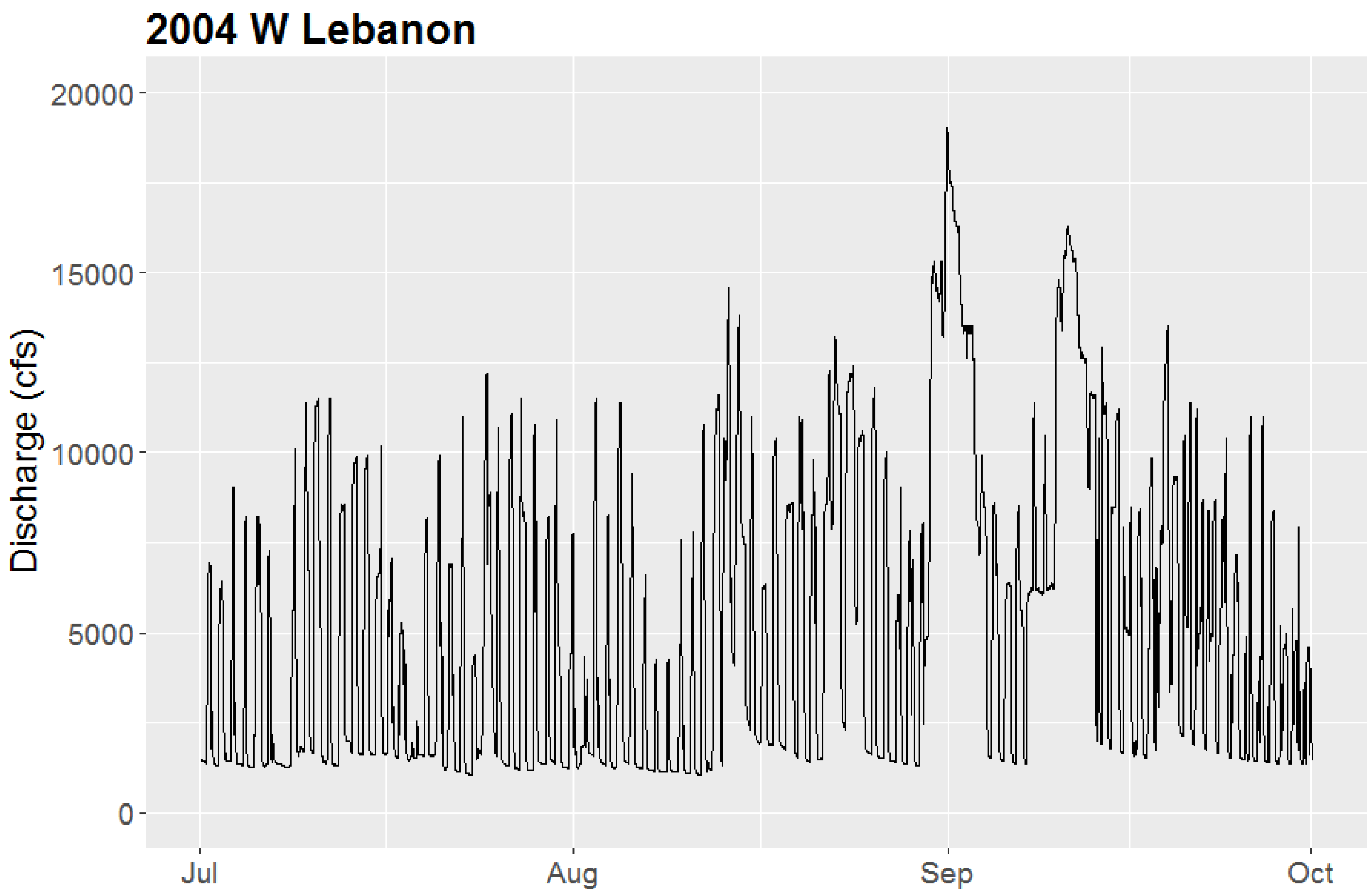
Transect & zone relationships



interpolation, transect weighing, Q offsets, weighting zones, …



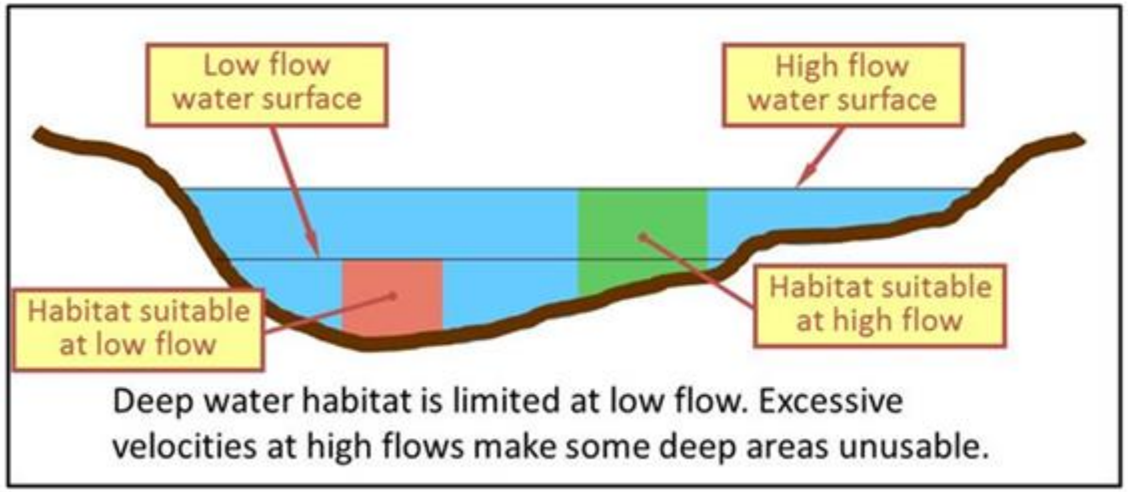
Composite Q vs. habitat relationship


2004 W Lebanon
Discharge (cfs)
20000
15000
10000
5000
0
Jul
Aug
Sep
Oct

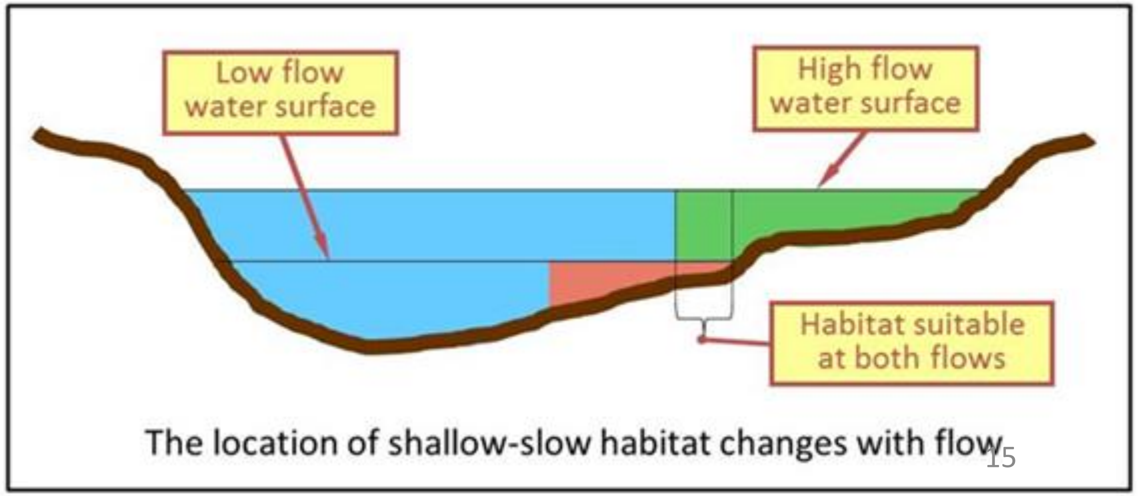
Dual flow & two flow assessments

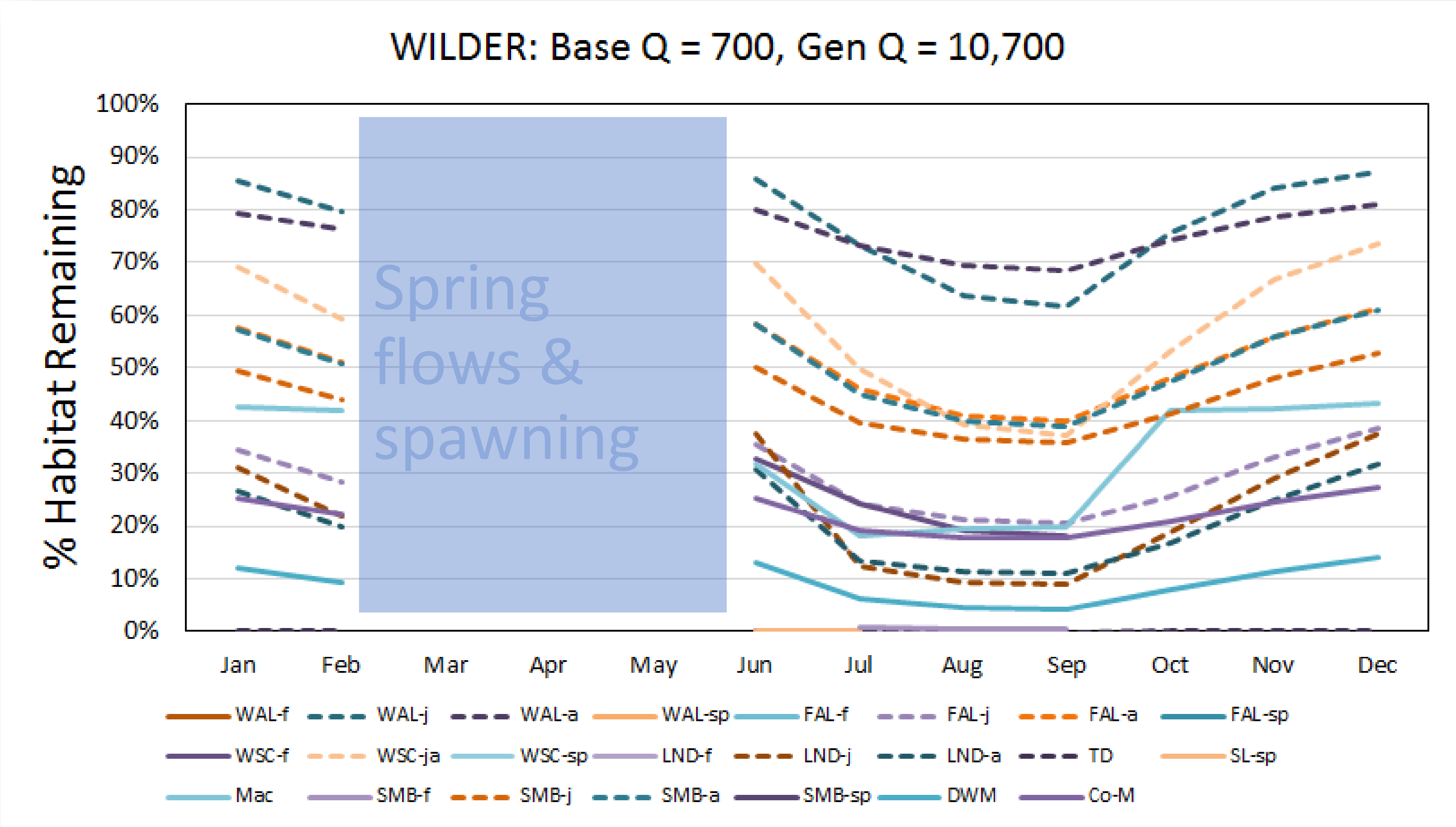
Base Flows	Base Flow AWS	Persistent AWS (ft2/ft) Peaking Flows									
		2500	3175	3850	4475	5400	6350	7025	7700	9525	11400
1300	118.0	np	np	np	59%	47%	36%	31%	27%	21%	16%
1500	115.7	np	np	np	63%	49%	38%	32%	28%	21%	17%
1750	113.3	np	np	np	68%	52%	40%	34%	30%	23%	18%
2000	110.5	np	np	np	72%	54%	41%	35%	31%	23%	19%
2250	106.0	np	np	np	75%	56%	43%	37%	32%	24%	20%
2500	100.8	np	np	np	78%	58%	44%	38%	33%	25%	20%
3000	90.8		np	np	82%	61%	47%	40%	35%	27%	21%
3500	82.9			np	85%	64%	49%	42%	37%	28%	23%
4000	75.6				88%	66%	50%	43%	38%	29%	24%
4500	67.3					67%	52%	44%	39%	30%	24%
5000	59.1					69%	53%	46%	40%	31%	25%
6000	45.6						55%	48%	42%	32%	26%

Mobile spp/stages, habitat = $\min(\Sigma H_{bi}, \Sigma H_{pi})$

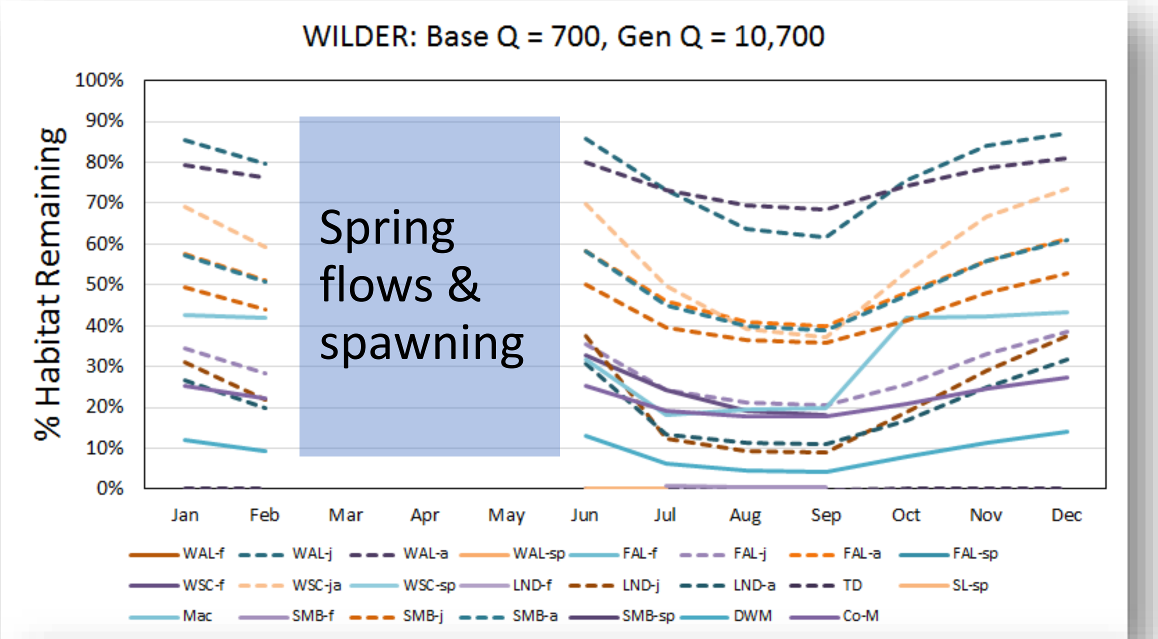


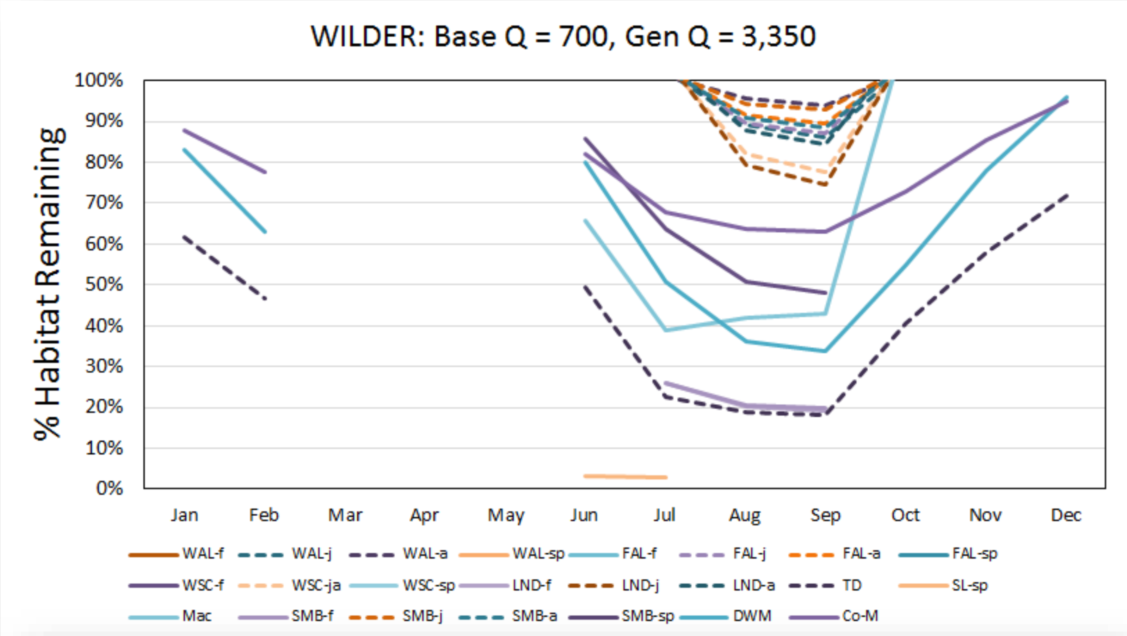
Immobile spp/stages, habitat = $\Sigma(\min(H_{bi},H_{pi}))$

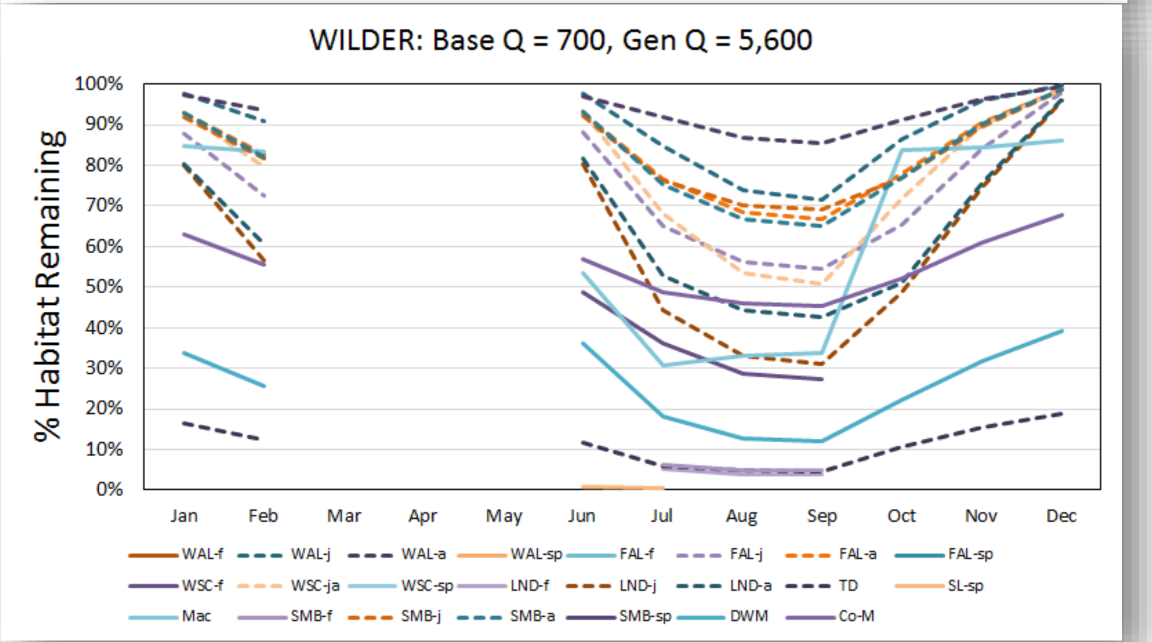


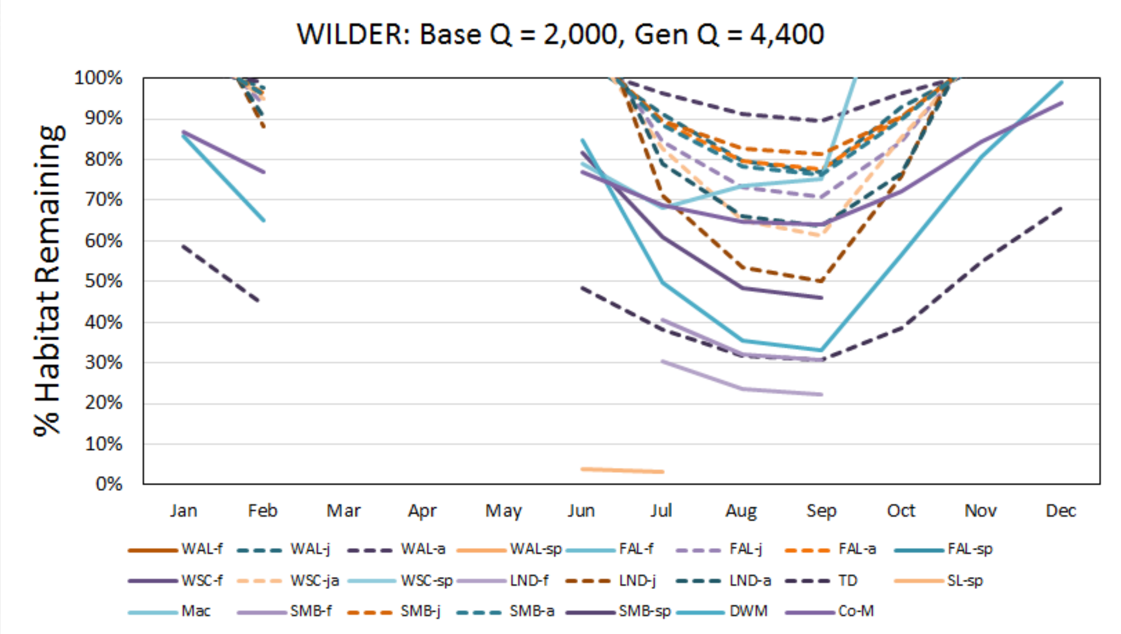

WILDER: Base Q = 700, Gen Q = 10,700
% Habitat Remaining
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Spring flows & spawning
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
WAL-f WAL-j WAL-a WAL-sp FAL-f FAL-j FAL-a FAL-sp
WSC-f WSC-ja WSC-sp LND-f LND-j LND-a TD SL-sp
Mac SMB-f SMB-j SMB-a SMB-sp DWM Co-M

Current/proposed regime



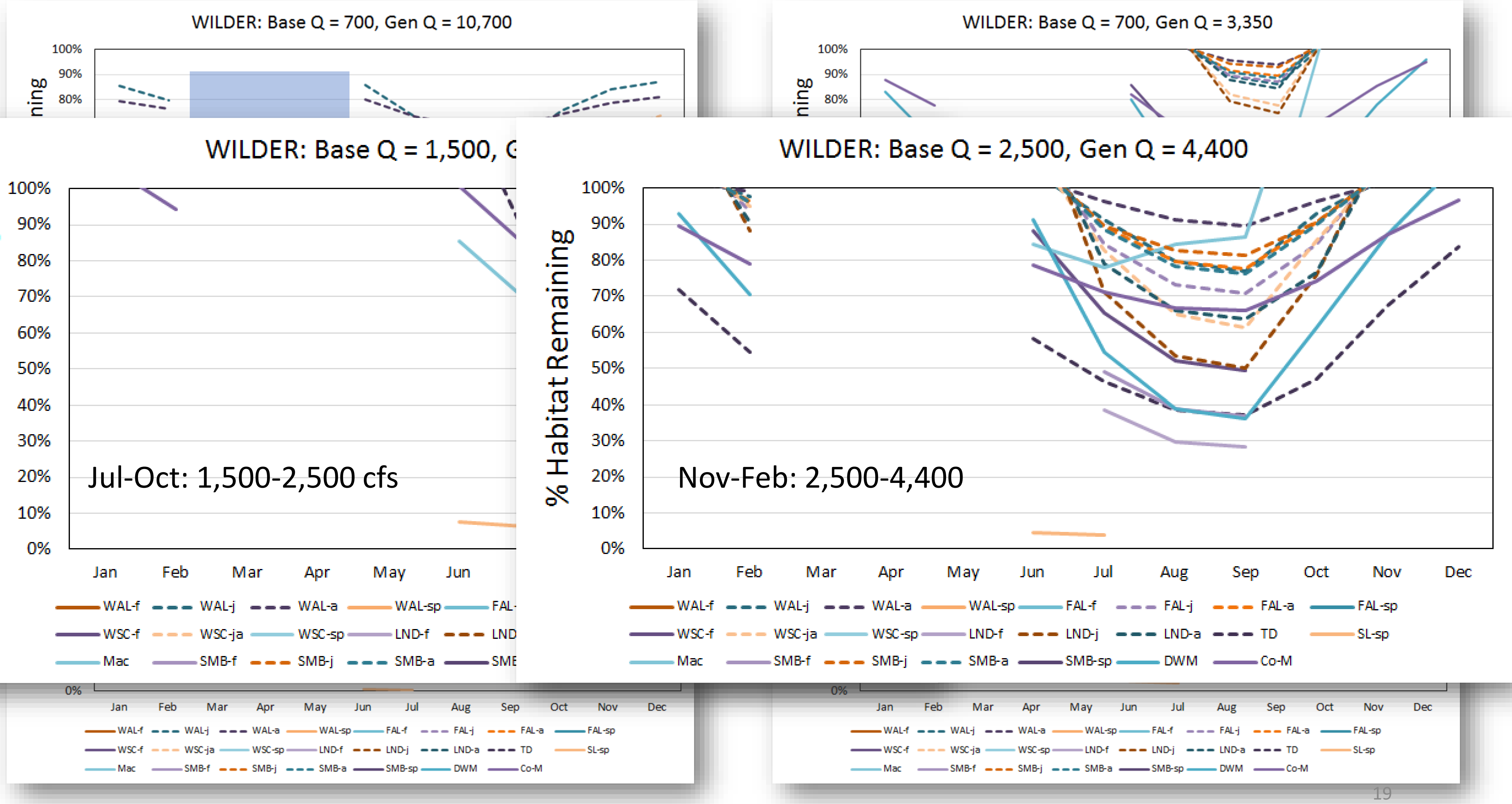


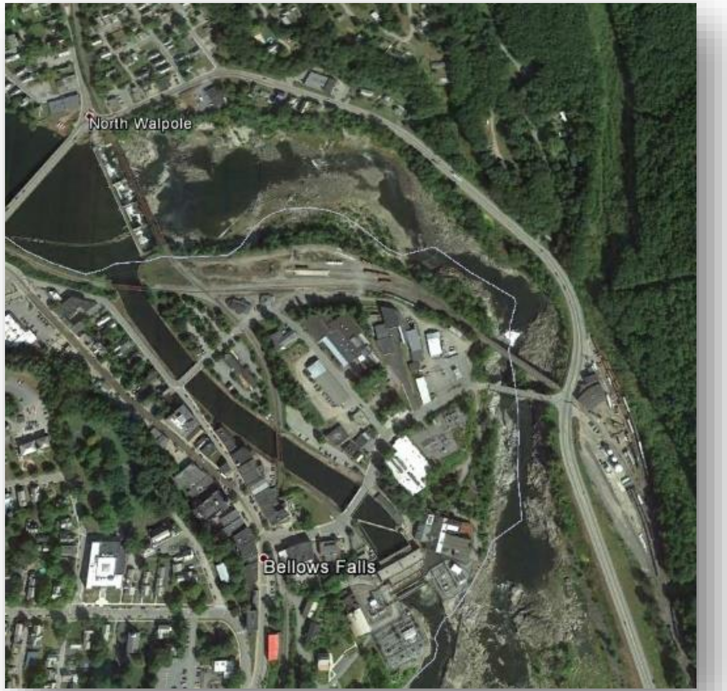




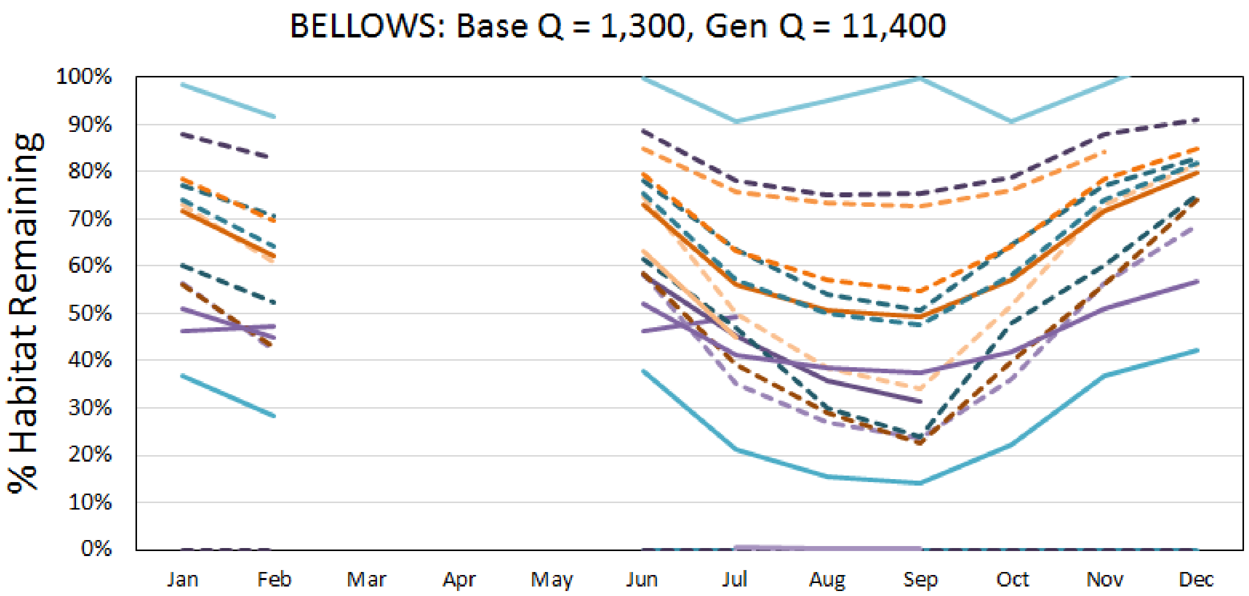
Current/proposed regime

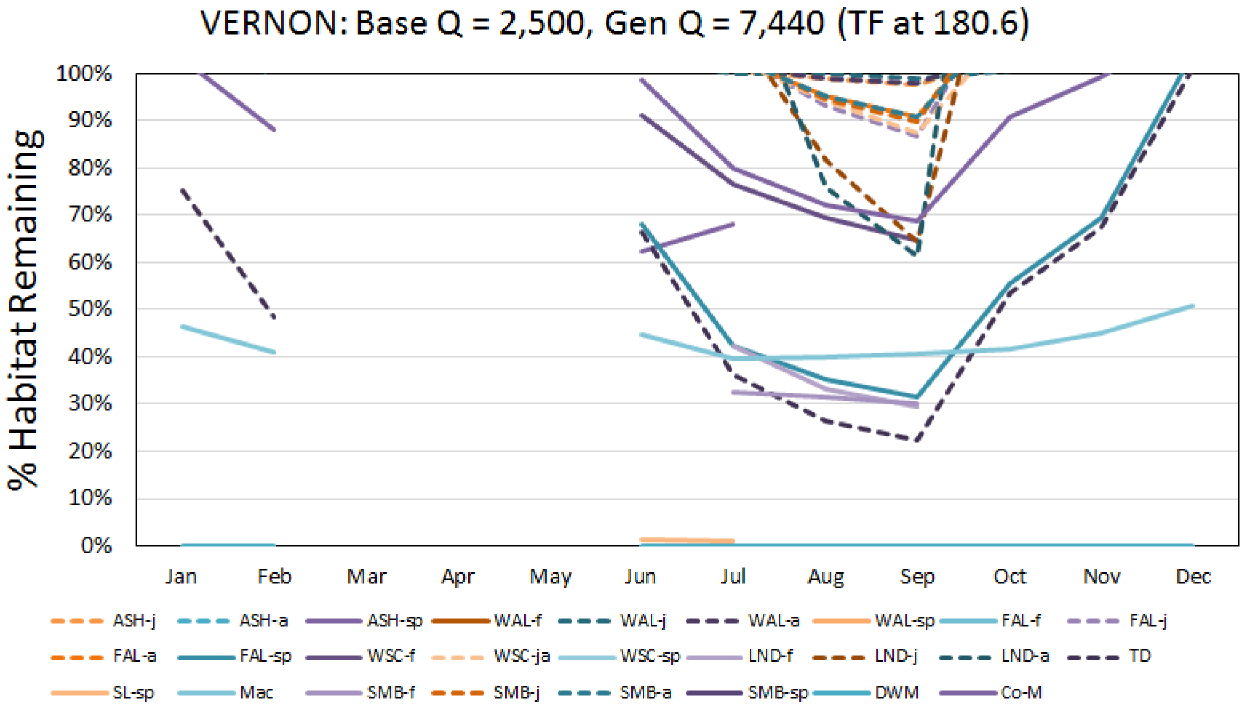
Current/proposed regime




North Walpole
Bellows Falls


Google Ea
© 2018 Google


BELLOWS: Base Q = 1,300, Gen Q = 11,400
% Habitat Remaining
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


VERNON: Base Q = 2,500, Gen Q = 7,440 (TF at 180.6)
% Habitat Remaining
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
ASH-j
ASH-a
ASH-sp
WAL-f
WAL-j
WAL-a
WAL-sp
FAL-f
FAL-j
FAL-a
FAL-sp
WSC-f
WSC-ja
WSC-sp
LND-f
LND-j
LND-a
TD
SL-sp
Mac
SMB-f
SMB-j
SMB-a
SMB-sp
DWM
Co-M

Assessment of proposed operations

A proposed operating regime is assumed to offer adequate resource protection if it meets on of these conditions:

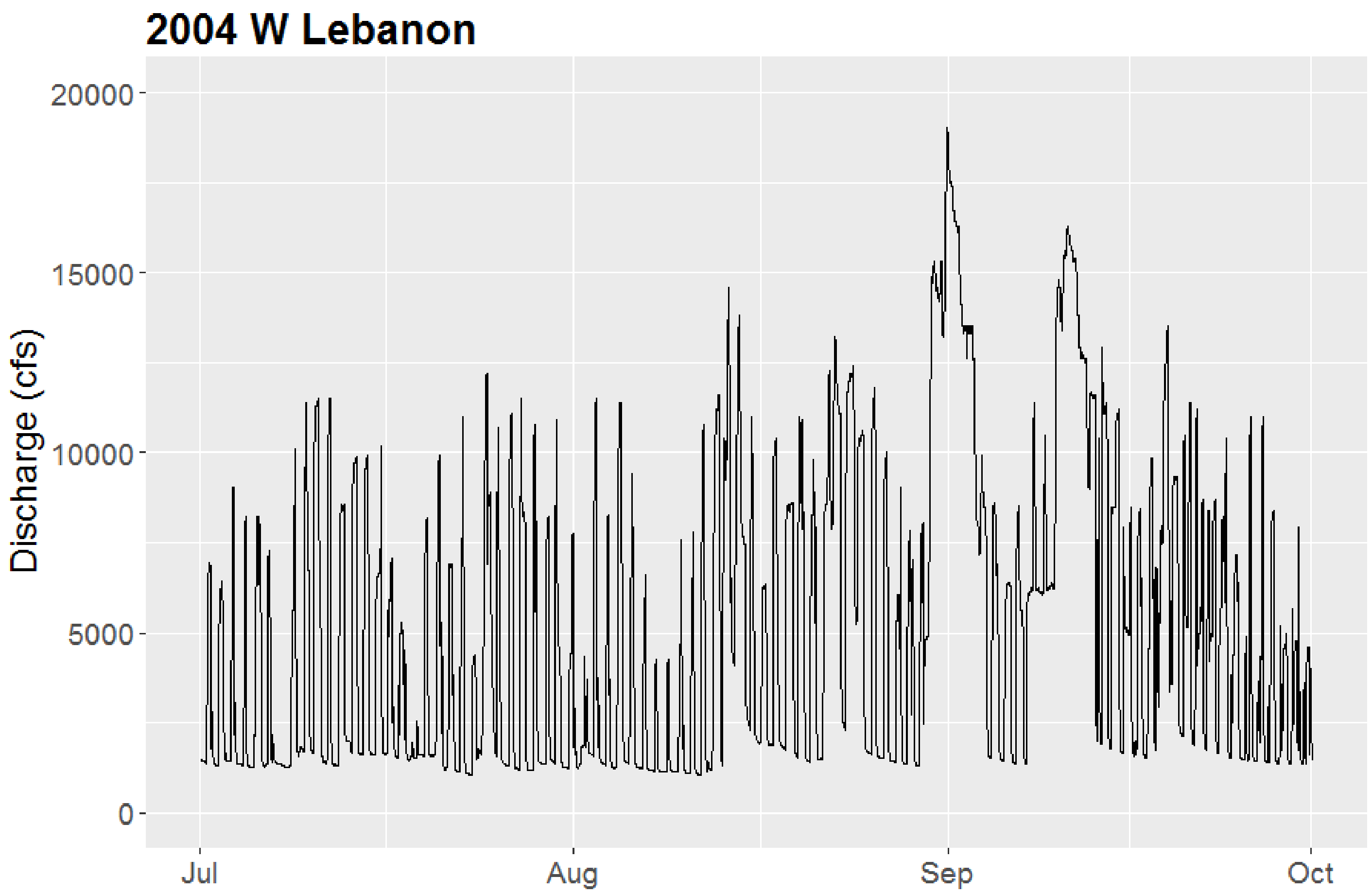
- If it has a minimal impact on the habitat of modeled species (assess using the **Study 9** steady state & dual flow/two flow results, other studies)

OR

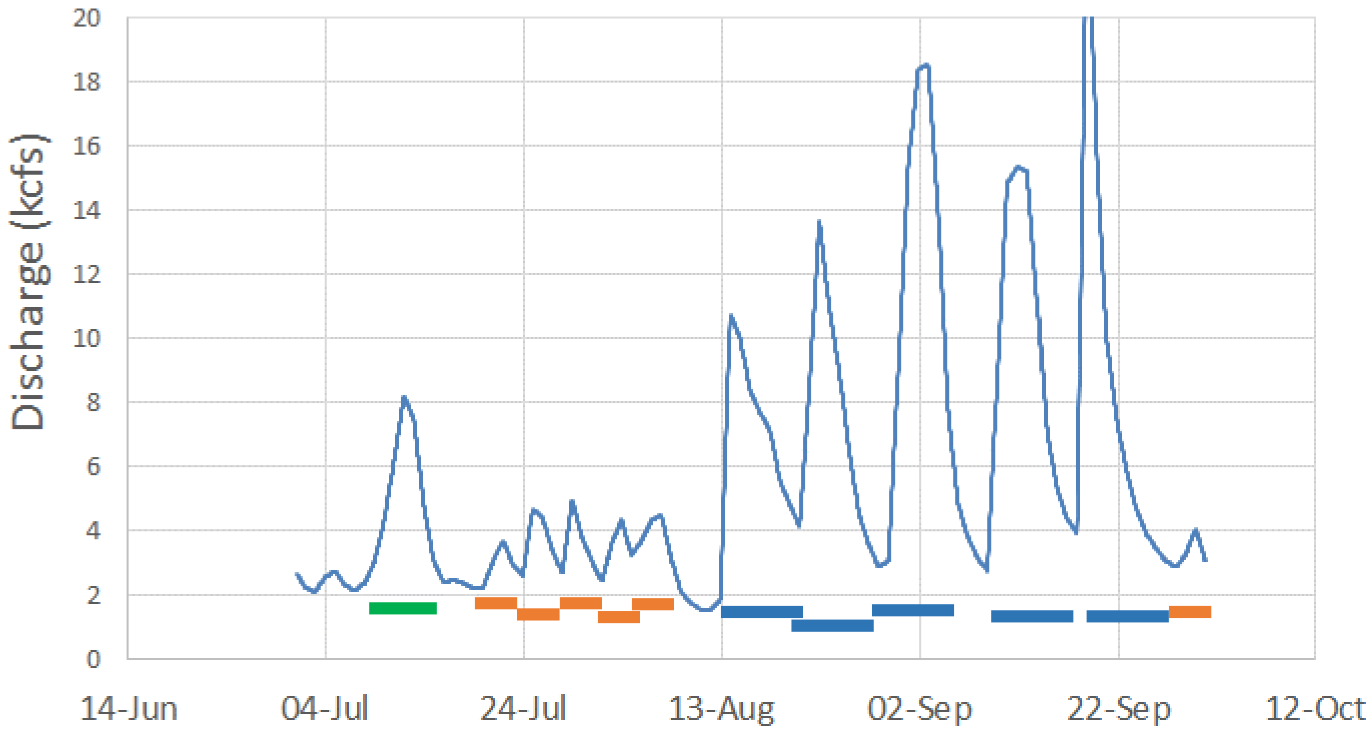
- If it is executed in a way that's consistent with the river's natural flow regime, i.e., frequency, magnitude, rate of change, etc.

Insights from a natural flow perspective

- Quantify relevant statistics of background hydrology (freq, mag, etc.)
- Use these to identify potential bounds for operation
- Problems/challenges:
  - What is the right hydrologic baseline for evaluation?
  - How to implement without increasing flow variability overall?
  - Practical constraints to implementation?
  - Requires usable storage and does not address impoundment fluctuation


2004 W Lebanon
Discharge (cfs)
20000
15000
10000
5000
0
Jul
Aug
Sep
Oct

Frequency & Magnitude



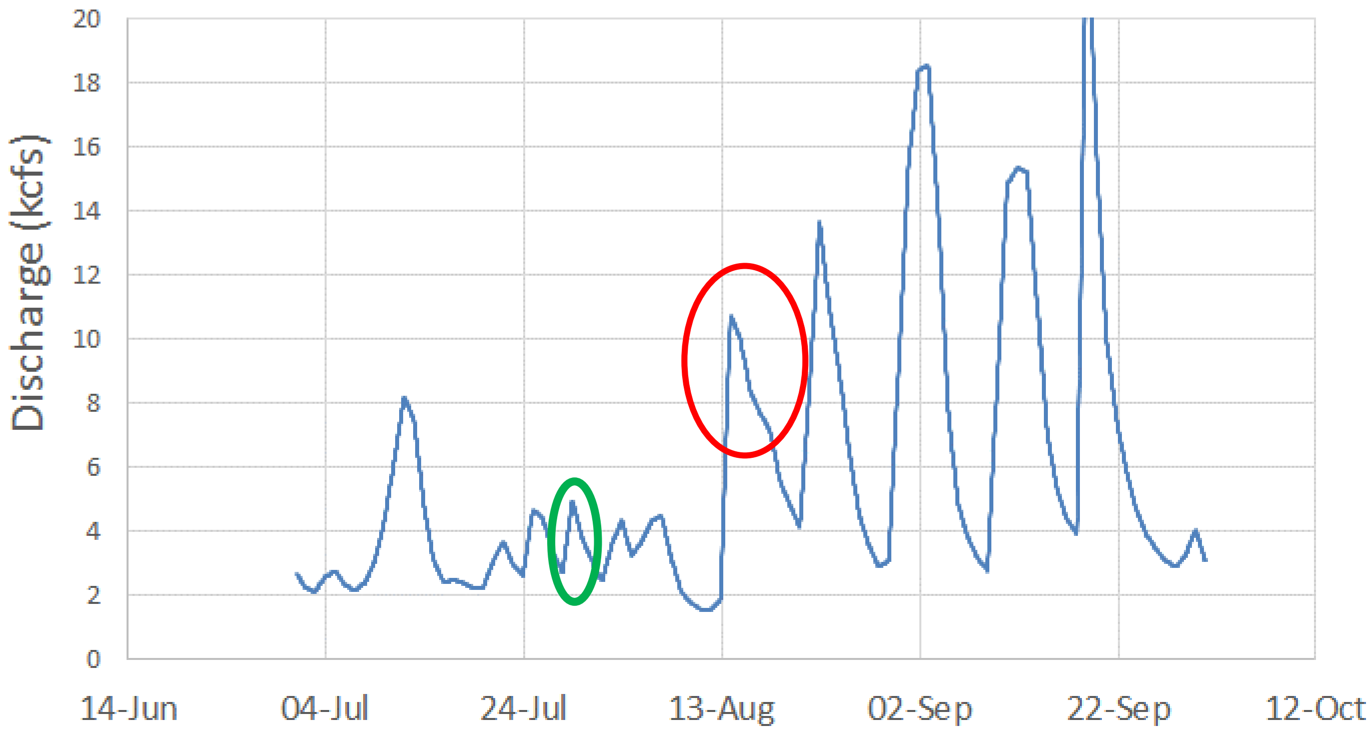
Approx. 2-3 kcfs to 4-5 kcfs, n = 6

Approx. 2-3 kcfs to 8 kcfs, n = 1

Approx. 2-3 kcfs to 10+ kcfs, n = 5

(i.e., 12 events vs. 80-90 ~1 kcfs to 8-10 kcfs per summer currently)

dQ/dt & Duration



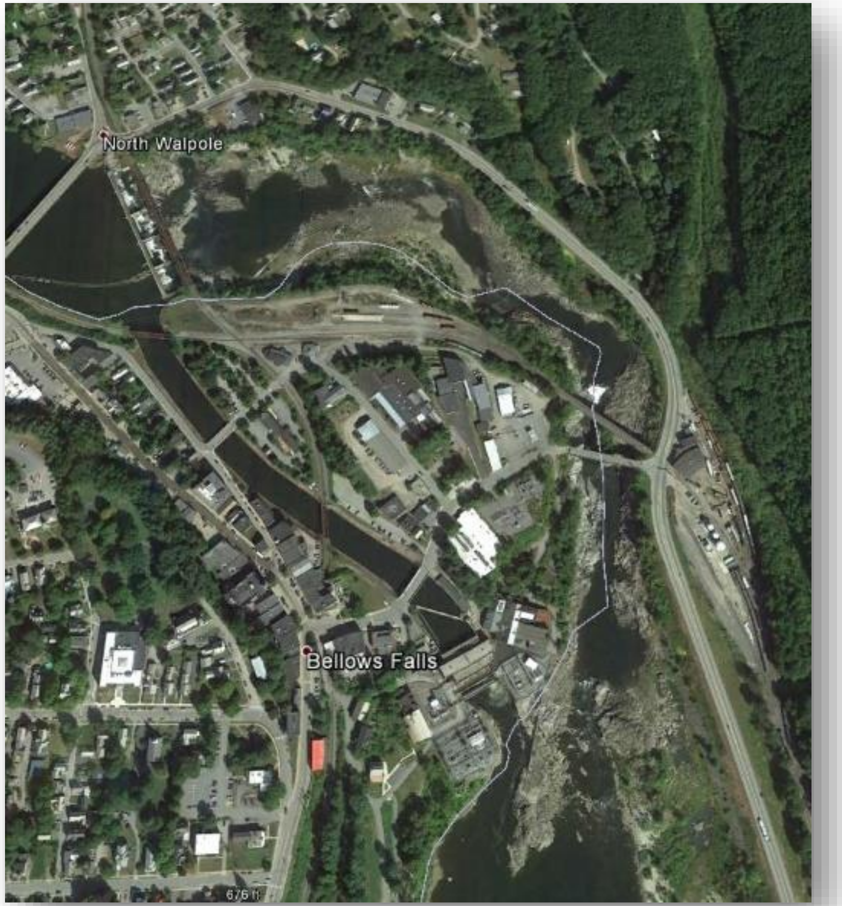
Event 1, 27-31 July:
2.7 to 4.9 kcfs
Duration: 4 d (96 h)
dQ/dt: +87 & -34 cfs/h

Event 2, 11-20 Aug:
1.5 to 10.7 kcfs
Duration: 9.2 d (221 h)
dQ/dt: +173 & -39 cfs/h

Current Operations:
~1 to 11 kcfs
Duration: 1 d (24 h)
dQ/dt: 600-700 cfs/h

The Bellows Falls bypass reach

- ~0.7 mi long, pool-dom'd (73%)
- Fish dam at bottom
- Several species present, likely spawning hab. ltd.
- Current flow 100-300 cfs; 7Q10 is ~1500 cfs
- Habitat survey incl. 7 transects (2 pool, 5 run/riff/gld)



The Bellows Falls bypass reach

- What species & life stages to include?

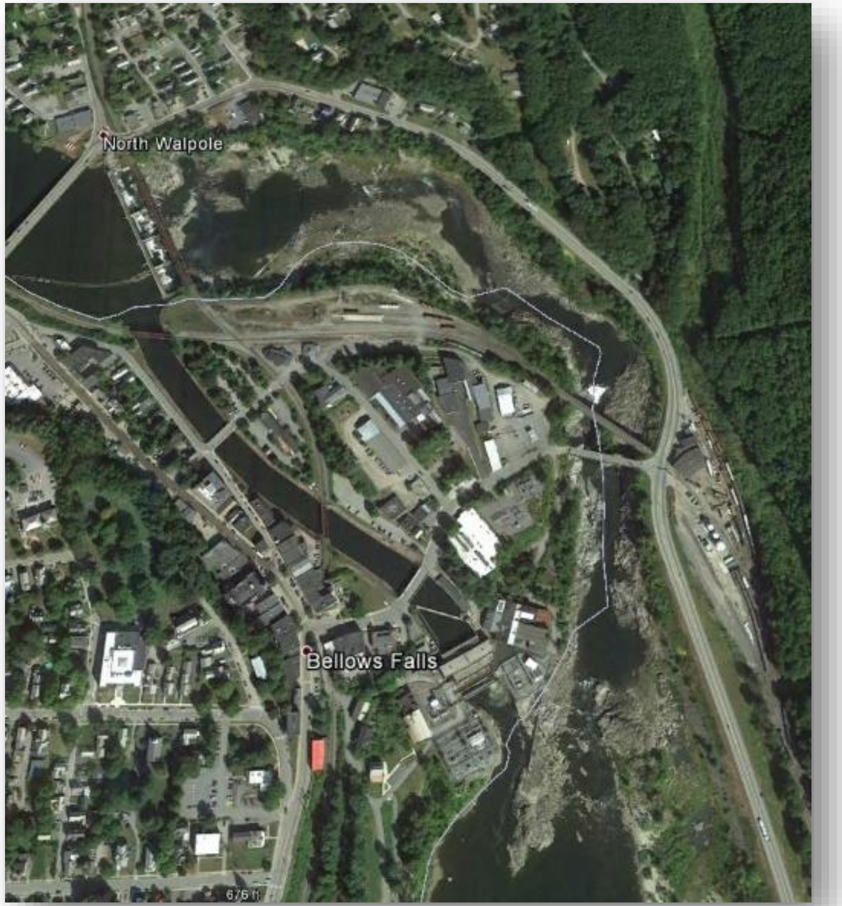


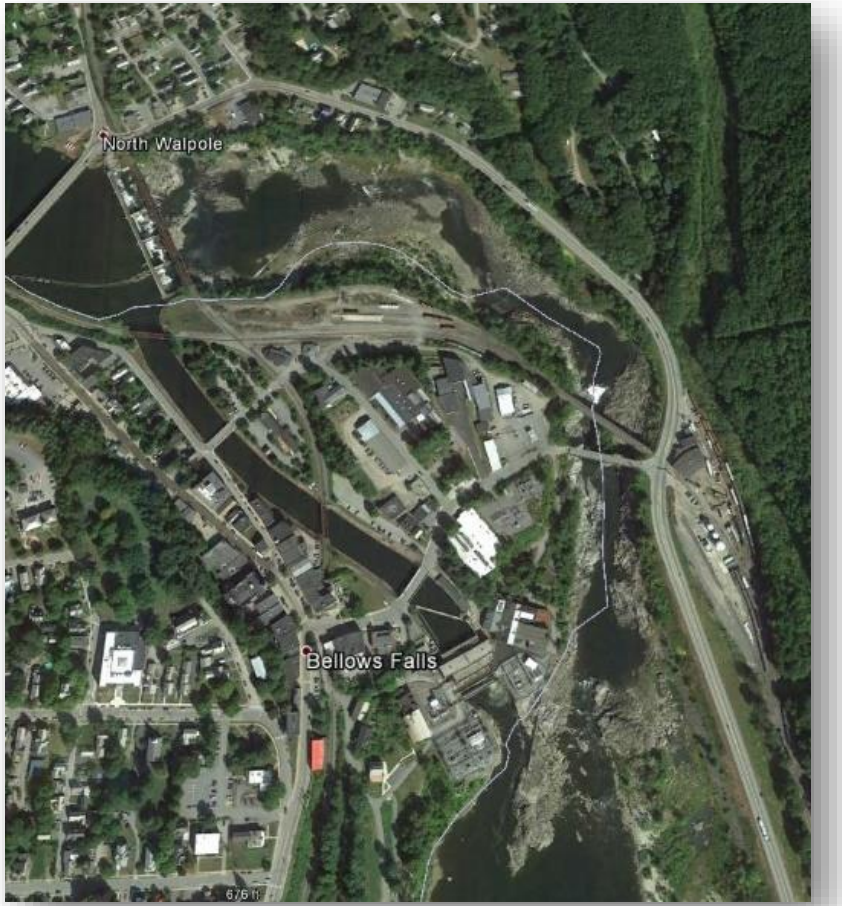
Table 2.1. Timing of key life history events, in full months; see Table 1.1 for sub-monthly life history details. The 1997-2016 daily median discharge at Walpole, rounded to the nearest 100 cfs, is provided below each month for considering linkages between life history and hydrology.

Species	**Life stage**	**Jan** 7,700	**Feb** 6,200	**Mar** 10,800	**Apr** 22,700	**May** 12,500	**Jun** 7,900	**Jul** 5,000	**Aug** 3,700	**Sep** 3,100	**Oct** 5,200	**Nov** 7,700	**Dec** 8,800
American Shad	Juvenile												
	Adult												
	Spawning												
Walleye	Fry												
	Juvenile												
	Adult												
	Spawning												
Fallfish	Fry												
	Juvenile												
	Adult												
	Spawning												
White Sucker	Fry												
	Juv/Ad												
	Spawning												
Longnose Dace	Juvenile												
	Adult												
	YOY												
Tessellated Darter	Adult												
Sea Lamprey	Spawning												
Smallmouth Bass	YOY												
	Juvenile												
	Adult												
	Spawning												
Macroinvertebrates	all aquatic												
Rainbow Trout	Adult												
Dwarf Wedgemussel[1]	Adult												
Co-occurring Mussels	Adult												

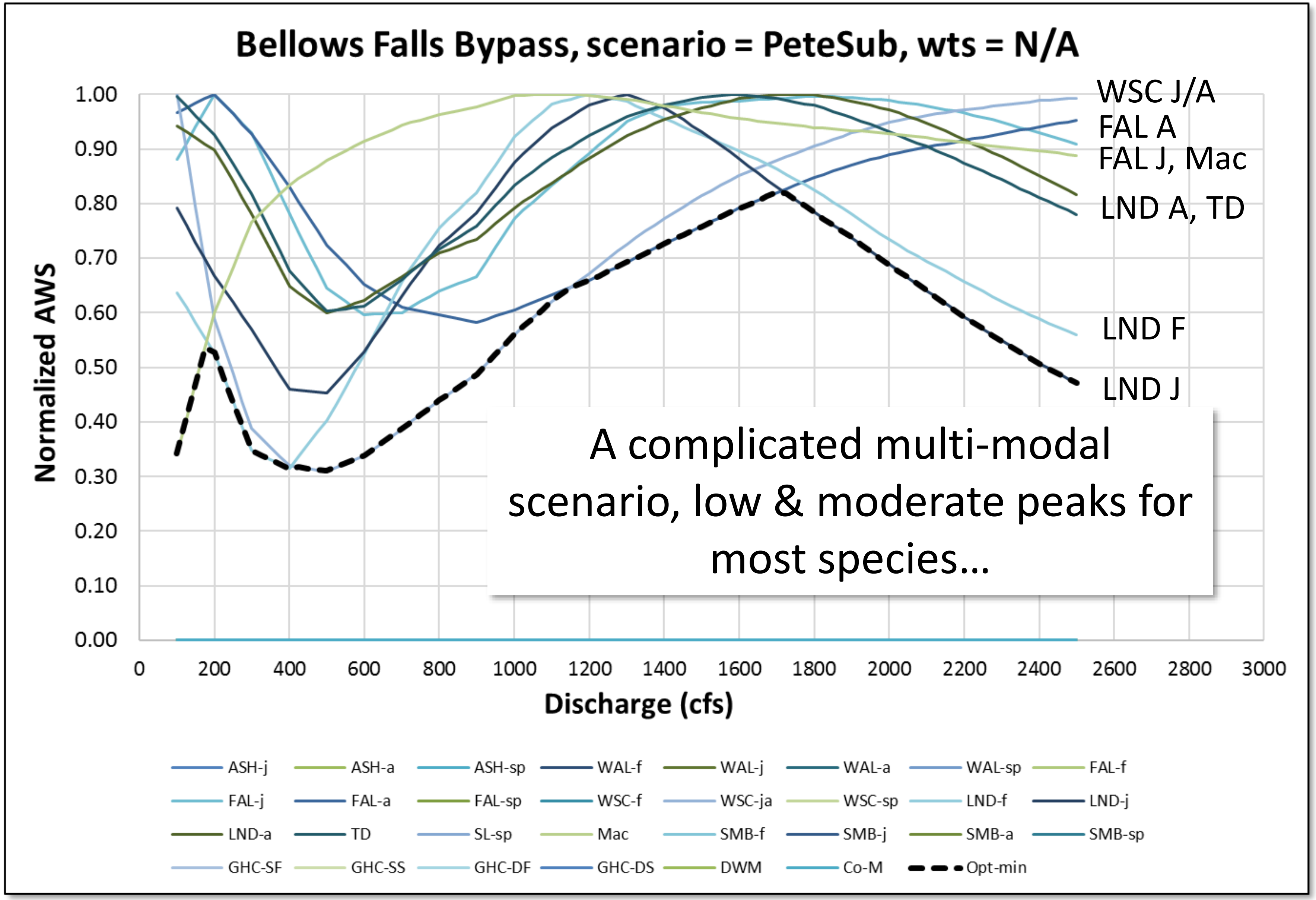
[1]Reproduction occurs summer/fall; glochidia release occurs in the following spring (March-June)

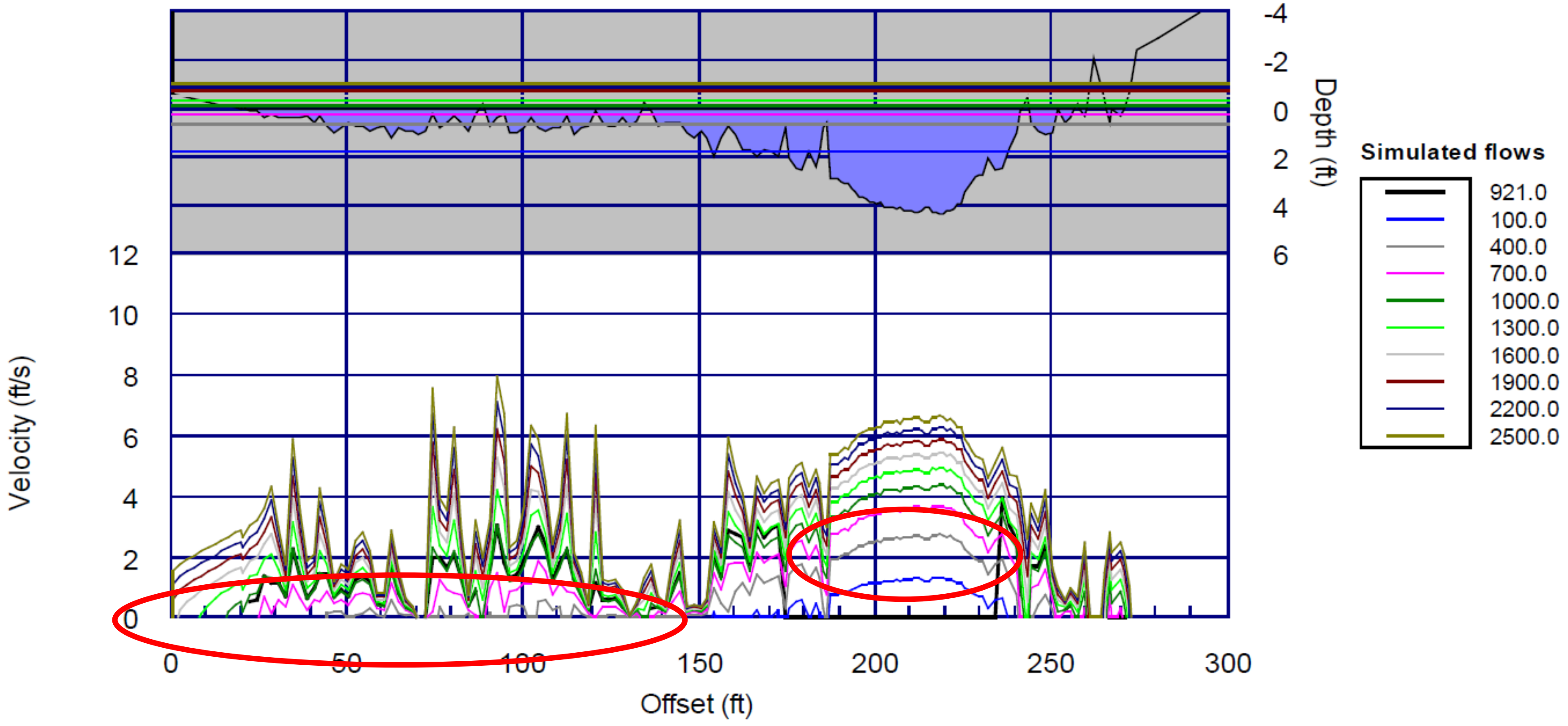
The Bellows Falls bypass reach

- What species & life stages to include?
- Focus on fast-water, riverine species, non-spawning stages; non-pool habs
- Draft list:
  - Fallfish J/A
  - Longnose Dace F/J/A
  - Tessellated Darter
  - White Sucker J/A
  - Macroinverts

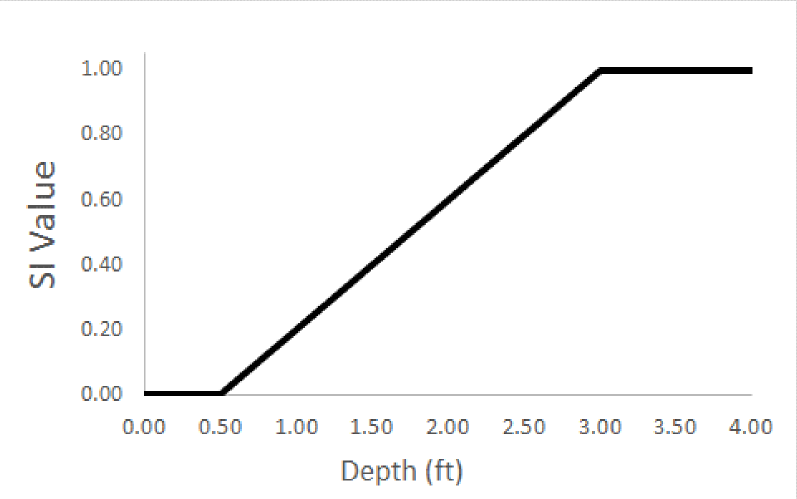


Habitat modeling results

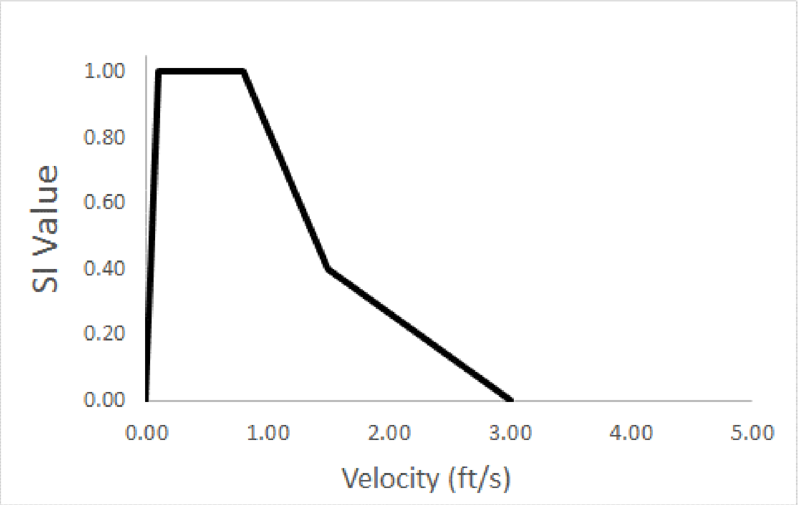




Velocity (ft/s)
Depth (ft)
Offset (ft)
Simulated flows
921.0
100.0
400.0
700.0
1000.0
1300.0
1600.0
1900.0
2200.0
2500.0

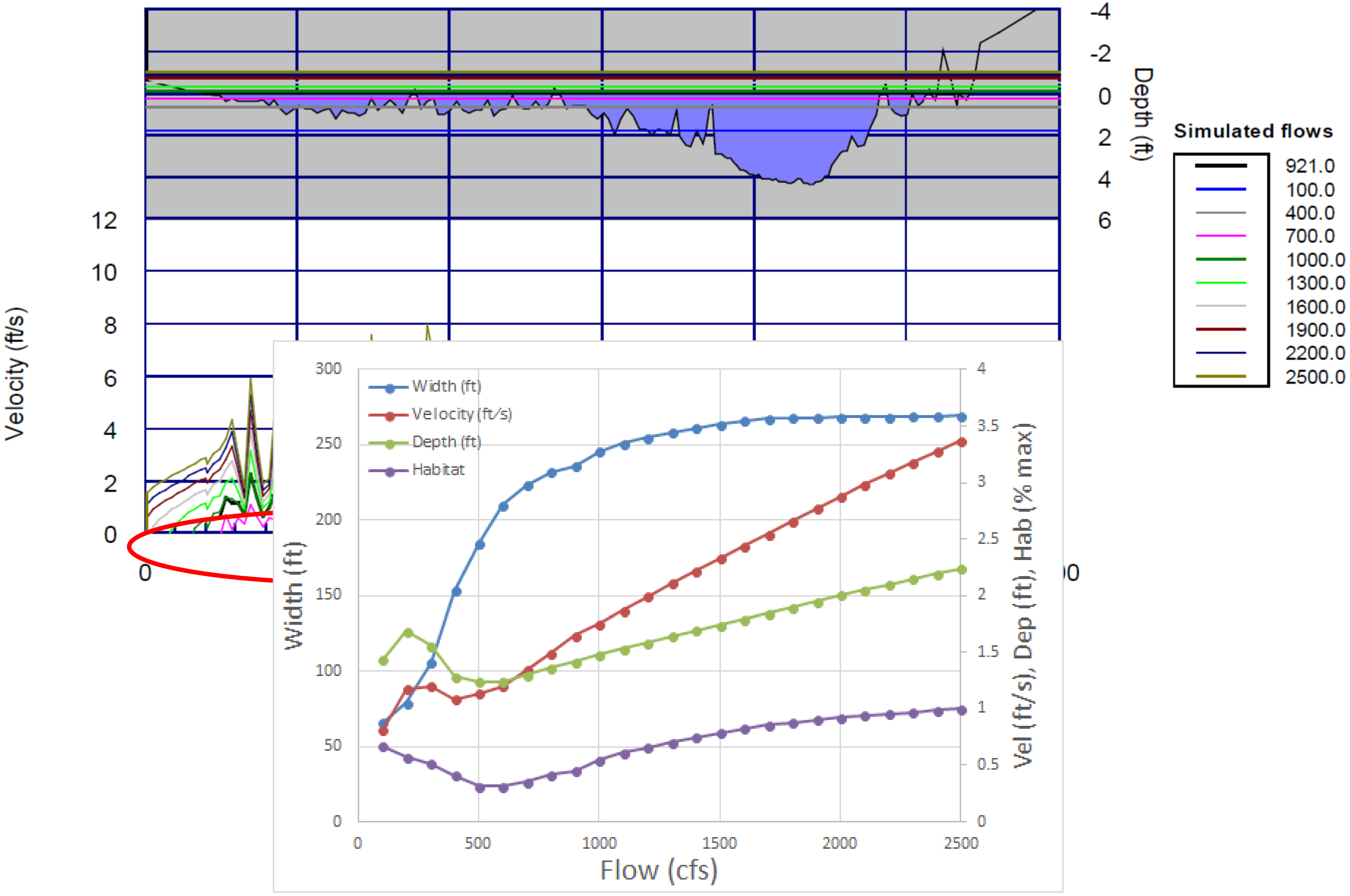


SI Value
Depth (ft)

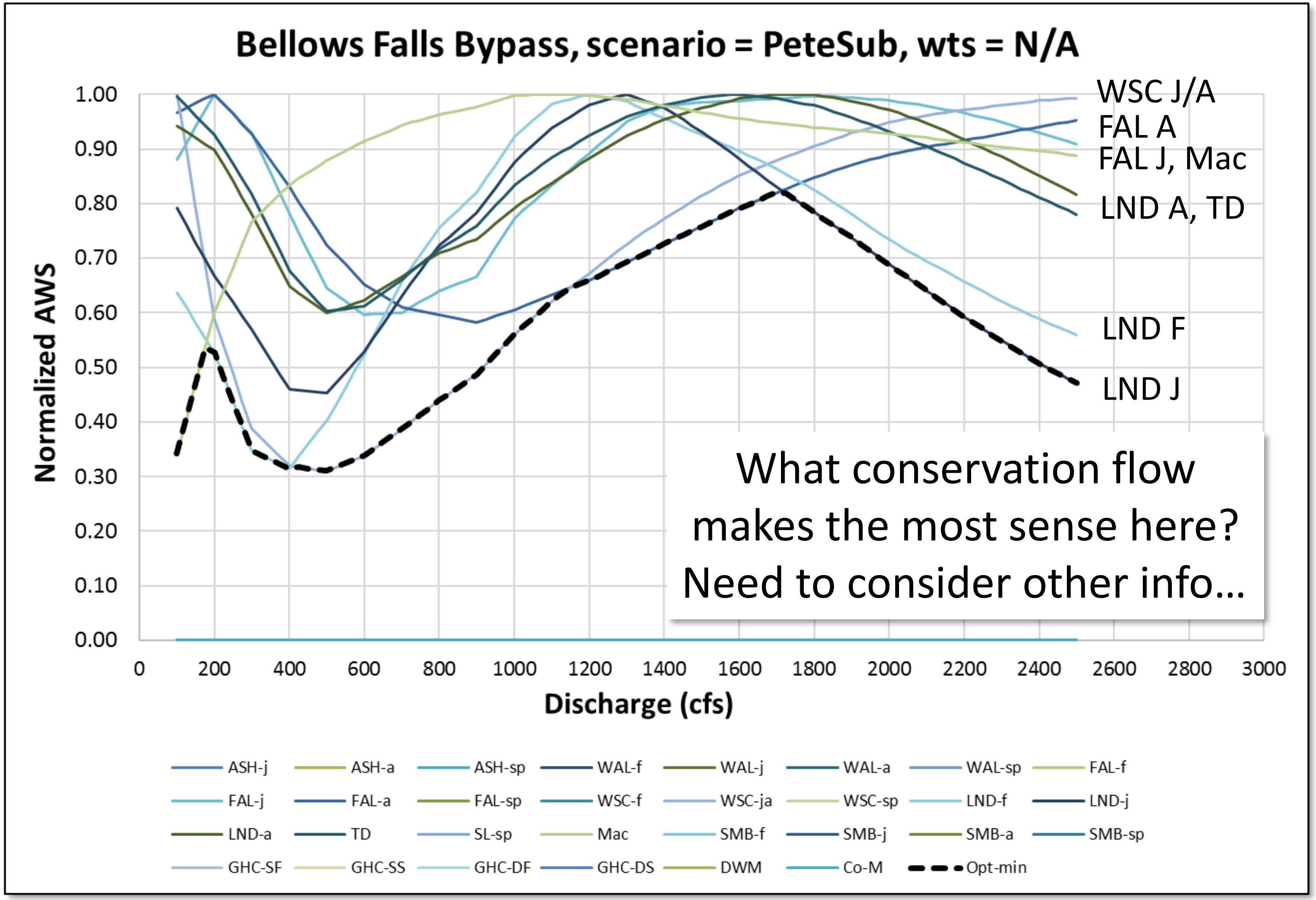


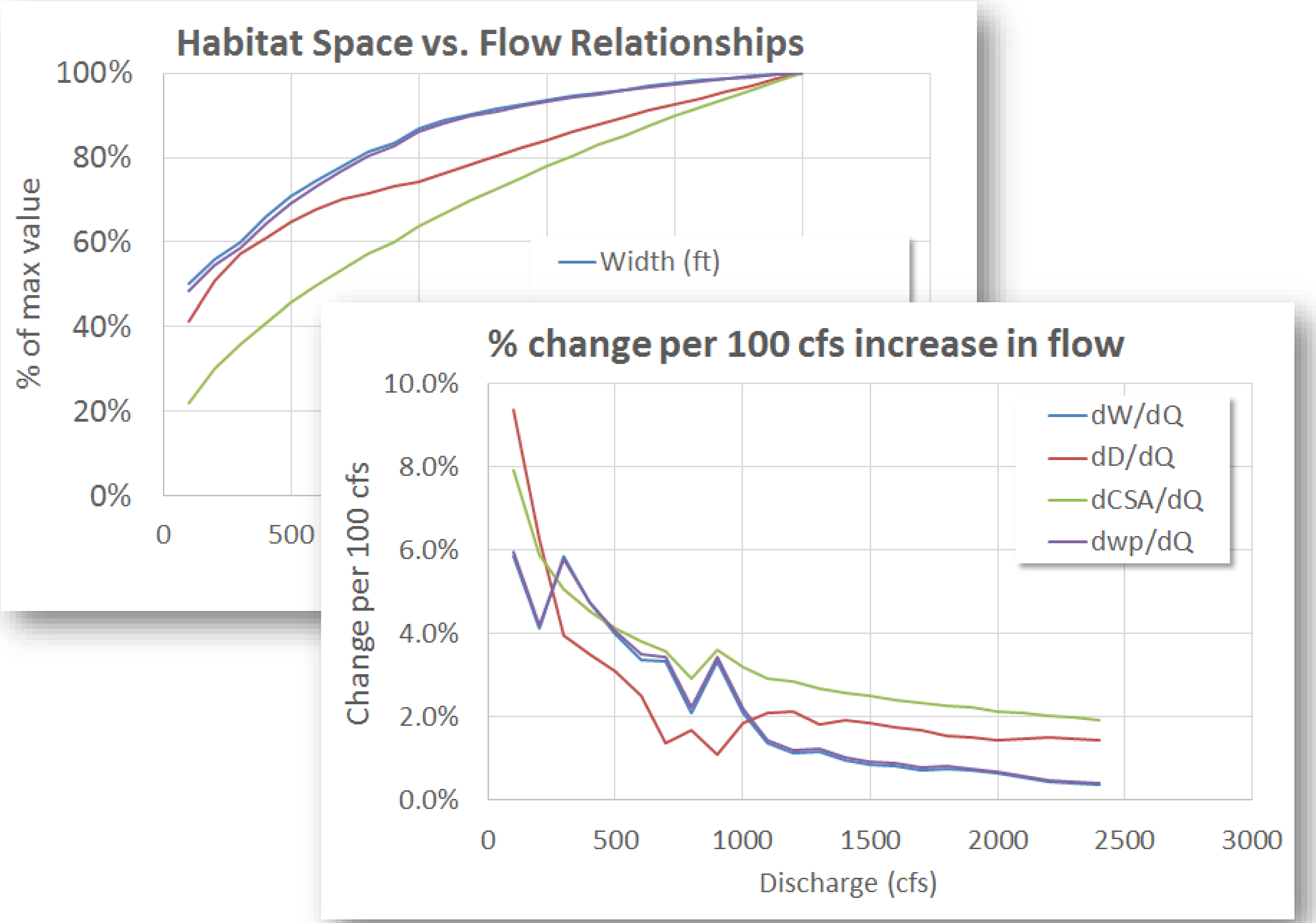
SI Value
Velocity (ft/s)

BFB4: Mid Velocities



Habitat modeling results




Habitat Space vs. Flow Relationships
100%
80%
60%
40%
20%
0%
% of max value
0
500
Width (ft)
% change per 100 cfs increase in flow
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Change per 100 cfs
0
500
1000
1500
2000
2500
3000
Discharge (cfs)
dW/dQ
dD/dQ
dCSA/dQ
dwp/dQ

Overview of presentation

- Recap of tasks, work done to date, data sharing, etc.
- Context:
  - Hydrology and biology
  - Proposed operations
- Review of Study 9 (instream flow study) & key findings:
  - Evaluation of proposed operations (all projects, but Wilder as example)
    - Steady state (conservation flows)
    - Dual flow analysis (habitat in light of hydropeaking cycle)
  - Evaluation of Bellows Falls bypass reach (steady state)
- Concerns emerging from review of other studies
- Where to from here?

RT&E Species Studies

1. Study 28: Fowler's Toad rearing habitats vulnerable to washout (tadpoles, eggs) from project-related flow increases
2. Study 26: routine inundation of adult habitat and larval burrows, sometimes completely so; only Cobblestone found, no Puritans
3. Study 25: Impacts of rapid water level fluctuation to SGCN taxa (Riverine Clubtail) during eclosion window
4. Study 24: Dwarf wedgemussel and Co-occurring mussels…?

Effects of operations on spawning (Studies 14-16)

1. Early spawning fish species:
   - Yellow Perch egg masses highly susceptible
2. Late spawning fish species:
   - Dewatering & sedimentation at ~1/3 Smallmouth Bass nests (riverine sites)
   - Dewatering of ~1/3 Fallfish nests (riverine)
   - Shallow or dewatered LMB and sunfish nests
   - 26% of Sea Lamprey redds dewatered at least once; sedimentation evident (project effect?)
3. Info on esoscids, Walleye, suckers, other cyprinids insufficient to determine impacts

Non-biological Studies

1. Studies 2-3: Erosion study, many comments submitted and results are in dispute (?)
2. Study 30: Recreation study, 43% of interviewed users identified a desire for lower flow fluctuation
3. Study 31: Desirable flows for whitewater paddling at Sumner Falls (4.7 and 13 kcfs) and Bellows Falls Bypass (2.0-4.4 kcfs) identified
4. Study 32: Bellows Falls aesthetics study suggests flows 1,600-2,400 cfs most desirable

Overview of presentation

- Recap of tasks, work done to date, data sharing, etc.
- Context:
  - Hydrology and biology
  - Proposed operations
- Review of Study 9 (instream flow study) & key findings:
  - Evaluation of proposed operations (all projects, but Wilder as example)
    - Steady state (conservation flows)
    - Dual flow analysis (habitat in light of hydropeaking cycle)
  - Evaluation of Bellows Falls bypass reach (steady state)
- Concerns emerging from review of other studies
- Where to from here?

Where to from here?

Considerations for identifying a protective operating regime:

- Hydraulic habitat conditions (Study 9)
- Hydrologic considerations:
  - Seasonality of operations
  - Frequency of generation cycles
  - Magnitude (min/max)
  - Rate of change on front/back of a generation cycle
  - Duration
  - Incoming flows
- Other studies and considerations
- Compatibility with desire for operational flexibility?
- Potential priority areas?

Great River Hydro
ILP Study 9 Instream Flow Consultation Meeting
Web based meeting
Tuesday, September 11, 2018, 9:30 am - 12:30 pm

Meeting Summary

Consultation on Great River Hydro's instream flow study (Study 9) continued with a web-based meeting held on September 11, 2018.

Meeting attendees identified on the telephone:

Name	Affiliation
Jeff Crocker	VT ANR
Eric Davis	VT ANR
Pete McHugh	VTFWD
Lael Will	VTFWD
Melissa Grader	FWS
Ken Sprankle	FWS
Gregg Comstock	NHDES
Mark Wamser	Gomez & Sullivan
John Hart	Gomez & Sullivan
Andrea Donlon	CRC
Kathy Urffer	CRC
Jim McClammer	CRJC
Katie Kennedy	TNC
Dan Sullivan	Lyme Properties 2 LLC
Semiu Lawal	Hatch
Steve Leach	Normandeau Associates
Edwin Nason	GRH
Shawn Keniston	GRH
Clint Birch	GRH
Rebecca Acosta	GRH
John Ragonese	GRH
Jen Griffin	GRH

Introduction

John Ragonese opened the meeting and following introductions, stepped through a power point presentation of GRH operations that focused on:

- Overview of energy markets affected by operations and instream flow,
- Operational Constraints and Impacts, and
- Project Economic concerns

The presentation was distributed during the meeting as requested by Katie Kennedy and is included with these meeting notes. Some of the presentation slides were revised for clarity after the meeting and based on discussion during the meeting. Primary discussion points are provided in this meeting summary.

Clint Birch noted that there are three energy reserve markets GRH bids into:

- 10-minute spinning reserve - the unit breaker is closed and the unit can generate to a set max within 10 minutes [post meeting note: currently, the Wilder, Bellows Falls, and Vernon projects are not bid into this market]
- 10-minute non-spinning reserve – the unit breaker is open but the unit is able to produce specified MW's within 10 minutes (post meeting note: the Wilder, Bellows Falls and Vernon projects are always bid into this market]
- 30-minute operating reserve – the amount of MW's the unit can achieve within 30 minutes.

Dan Sullivan asked if operation related to Capacity Markets was transferred into Capacity Factor. John explained it is not. Capacity factor is the ratio between actual MWh produced and potential production (MWh) of the unit or project over a one-year period.

Pay for Performance (PFP) – $2,000/MWh assessed in 5-min increments, is the current penalty for not meeting declared reserve capacity when called on by ISO-New England during a capacity scarcity condition. The penalty is increasing annually to a maximum rate of $5,450/MWh. If you underperform you lose, overperform you gain. However, the penalty is often greater than the income. We generally bid into the forward capacity market at station capacity, which is at or very near the electrical interconnection limit of the station.

Kathy Urffer asked if any of the three projects ever failed to perform when called on for capacity reserves. Edwin answered rarely, once in 2014 debris on the racks impacted operations at Wilder. John elaborated that because we have storage we can reasonably expect to meet our capacity requirement. Storage and dispatch capability allow flexibility to meet requirements.

Melissa Grader asked the difference between audits and weekly quizzes.

There two types of audits. Claimed capability audits are conducted in summer and winter on our larger units (including Wilder) and are the basis for our claimed capacity on those units insuring we have the capacity we bid into the Forward Capacity Market. For Bellows Falls and Vernon, the ISO calculates the claimed capacity based on a number of factors including amount of upstream storage, head and flows. When the ISO dispatches a unit (as opposed to normal scheduled operation) they can also "audit" and assess if we are able or not able to provide the required dispatch or if called upon provided the claimed capacity.

John explained that if the reservoir operating range is reduced, available storage is reduced, or head is reduced, GRH would not be able to produce the maximum capability we do now and thus we would lose capacity dollars.

Dan – is seasonality the limiting factor for the capacity you have to perform to?

Clint – claimed capability is based on 5-year median for each of the two seasonal periods (summer and winter). Always try to generate to the max the unit can operate. Don't audit during spill.

Melissa – how would a change in operation effect operating in these markets?

John – Limiting the reservoir range or operation, or storage capacity would affect capacity as just mentioned. Likewise, the ability to come on when called on affects our ability to participate in the reserve market. We must have the ability to respond to be in the reserve market whether or not we are dispatched. Similarly, if we are called on and cannot respond as requested, our ability to participate in this market is essentially eliminated.

There were a couple of questions about the layout of slide 12 – the order of bullets in the third column are not necessarily related to the order of bullets in the second column, and the bullets are not necessarily listed in any particular order.

Andrea Donlon asked if run-of-river projects participate in the markets.

John – CORRECTION: Some run-of-river Stations have capacity supply obligations but they are typically significantly discounted from their nameplate capability by the ISO which significantly reduces their capacity payment income.

Kathy – in another meeting I thought you said you bid zero in day-ahead market, in other words a price taker.

John – no, we don't bid zero, but we bid our minimum flow at a low price for self-schedule that takes us out of the market when running min flow (price taker). Minimum flow requirements on these projects would have to be "or inflow", couldn't be guaranteed min flow.

John – Slide 14 – ramping is huge for us, can't participate in market if unable to respond in 10 and 30 minutes.

Eric Davis – see in your table that there are impacts from up-ramping, are there any impacts from down-ramping?

Clint/Shawn Keniston – no typically not at this time, but it's something ISO is very interested in and concerned about as additional variable energy resources become part of the energy mix. The ISO is examining whether or not there should be price signals to ensure units can come off the grid as quickly as they go on.

Andrea observed that the projects don't have a lot of storage, and speculated about a 2-hr window of capacity; so, you maintain 2-hrs of full flow regardless of what the units are doing? So, ROR or reducing reservoir operation would not affect capacity.

John – the drawdown max is 0.3 ft of reservoir elevation per hour, so there are reserves. If operating flexibility is reduced, it tightens our ability to participate in the market and meet market obligations as well as potentially reduce the claimed capability.

Ken Sprankle – Slide 15 – REC value at Vernon is for units 5-8, correct?

John – yes; it is based on a calculation of the energy gain to the station from those units and a portion of the total energy produced. Although it is a significant amount presently, the price for REC's is dropping all the time; we don't anticipate REC's continuing to be available through the next 40 years.

John showed a graph of project operations and economics during a period in late September 2017 when the ISO grid was stressed. Because GRH participates in the Reserve Market, ISO did not call on us to run more than our day-ahead schedule but rather held the remaining capacity in reserve should additional fast-start resources be required during the event. ISO never called on us, but we were paid for the reserve capacity. This type of emergency event is currently more infrequent than frequent, but whether that continues is questionable given climatic conditions, fuel availability, etc. These types of events are unanticipated so difficult to predict when or how often they'll occur. It is somewhat predictable, however, that we would be held in reserve and not dispatched during these conditions.

Summary from GRH perspective:

- ISO saying it needs more flexibility – to this end we can't get rid of fast start, it's critical.
- We can't give up some of our operating constraints without flexibility.
- Struggling with the significant losses we would incur with a significant flow in the Bellows Falls bypass.

John – Considering VT's presentation at the last meeting, GRH anticipates similar information will be provided for Bellows Falls and Vernon; next steps would include looking closer at habitat specific needs from VT's presentation and what it would mean for operations.

Action Items

- GRH presentation will be finalized and distributed to the AWG.
- GRH distribute meeting notes.
- Stakeholders will review this information and call GRH with proposed next steps / agenda for next meeting.
- Next meeting scheduled for Tuesday, October 16, 2018.
- Placeholder meeting date has also been identified for November 20.

Study 9 Instream Flow, Study 24 Dwarf Wedge Mussel
Aquatic Working Group
Study Report Consultation meeting

September 11, 2018

Meeting Agenda

- Overview of Energy Markets affected by Operations and Instream Flow
- Operational Constraints and Impacts
- Project Economics concerns
    - Future of Energy Markets, Needs, Drivers and Technologies are **unknown**
    - **Value of hydro is** reflected in energy pricing – **variable, unpredictable**
    - While current markets can be described, **broader view of future** cannot rely on Renewable Portfolio Standards and Renewable Energy Credits over a **40- year license window**
    - Refer to Exhibit D

Overview of Energy Markets

- ## Types of Electric Generating Resources
  - **Baseload generating resource:** A **generating unit used to satisfy all or part of the minimum load of the system** and, as a consequence, produce electric energy continuously and at a constant rate. These units are usually economic to operate on a day-to-day basis.
  - **Intermediate-load generating resource:** A generating unit that is used during the **transition between baseload and peak-load** requirements.
  - **Peak-load generating resource:** A generating unit that is used to meet system requirements **during peak-load periods** when the demand on the system is the greatest. These **units typically operate at a relatively high cost and run when the price of electric energy is high.**
  - **Fast-start resource:** A generation unit that can start up and be at full load in less than 30 minutes, which helps with recovery from contingencies and assists in serving peak demand. These units are often held in reserve when the price of electric energy is high and capacity margin is tight.
  - **Marginal resource: The price-setting generator; the last unit committed** to meet load in economic dispatch.

Overview of Energy Markets - Generation energy markets

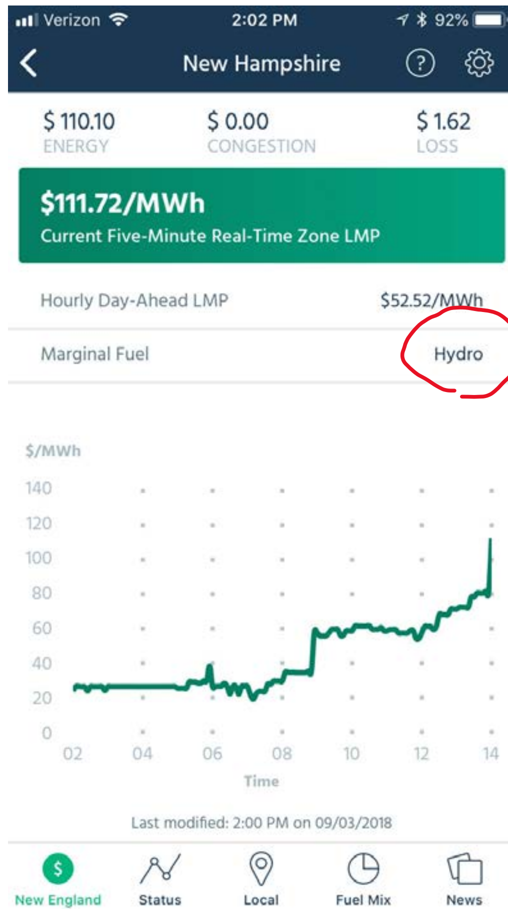
- **Day Ahead market (DA)** - a market that produces financially binding schedules for the production and consumption of electricity one day before the operating day

- **Real-time (RT) energy market** - a market that balances differences between the day-ahead scheduled amounts of electricity needed and the actual real-time load requirements

- **Locational Marginal Price (LMP):** The calculated price of electric energy at a node, load zone, reliability region, and the hub.
  - **Day Ahead prices:** Locational marginal prices reflecting the current incremental generation block bid or offer in the day ahead market.
  - **Real-time prices:** Locational marginal prices resulting from the dispatch of power within the operating day.
- **Marginal resource (fuel):** The price-setting generator; the last unit committed to meet load in economic dispatch**.**
- **Price-taker:** A market participant whose buying and selling actions do not affect the market price; a generator that has offered into the market at zero or has self-scheduled, is willing to operate at any price, and is not eligible to set clearing prices.

Overview of Energy Markets - Generation energy markets

Examples of recent high and low-load periods



Overview of Energy Markets - Ancillary Services Markets

- **Forward Capacity Market (FCM):** The locational capacity market whereby the ISO will project the needs of the power system **three years in advance** and then hold an **annual auction** to purchase power resources to satisfy the region's future needs. The aim of the FCM is to send **appropriate price signals to attract new investment and maintain existing resources** where and when they are needed, thus **ensuring the reliability of the New England electricity grid.**

  - **Capacity**: The **rated and continuous load-carrying ability**, expressed in megawatts or megavolt-amperes, of generation, transmission, or other electrical equipment.
  - **Capacity Commitment period**: The one-year period from June 1 through May 31 of the following year for which Forward Capacity Market obligations are assumed and payments are made.
  - **Capability Period**: Is one of two specific time periods within a power year. The **summer** period is June 1 through September 30; the **winter** period is October 1 through May 31.
  - **Claimed Capability:** A **generator's maximum output level as demonstrated to ISO** (twice a year for each Capability Period).

Overview of Energy Markets - Ancillary Services Markets

- **Operating Reserves -** *the "insurance policy" that allows the ISO to be able to keep electricity flowing in the event of any unexpected outages*

  The megawatt capability of a power system greater than system demand, which is required for **providing frequency regulation, correcting load forecasting errors, and handling forced outages or reserves that may be used to recover from a contingency (sudden loss of generator or transmission)** drawn from spinning and non-spinning sources of power.

  - **Forward Reserve Market (FRM):** A market used for acquiring the generating resources needed to satisfy the requirements for 10-minute non-spinning reserves and 30-minute operating reserves. It is an auction we participate in twice a year (summer and the winter) that we bid into to secure an obligation for the following capacity period to provide reserves.
  - **Real-time Reserve Market:** An ISO market where resources capable of providing 10-minute and 30-minute reserves are designated in real time, for which they are paid the reserve market clearing price.

Overview of Energy Markets - Ancillary Services Markets

Three types of Reserves in the Real Time Reserve market:

- **Ten-Minute Spinning Reserve (TMSR):** The **reserve capability** that an online, synchronized generator can fully convert into electric energy **within 10 minutes** after receiving a request (DDP or Desired Dispatch Point) from ISO New England to do so.

- **Ten-Minute Non spinning Reserve (TMNSR): Off-line generation that can, within 10 minutes, be electrically synchronized** to the system and increase output to respond to a contingency and serve demand after receiving a DDP from ISO New England to do so. . Wilder Example – Wilder is producing 18 mw's and its max is 41, ISO would have 23 mw's into the TMNSR market.

- **Thirty-Minute Operating Reserve TMOR):** This is the amount of MW's that we can achieve on an asset in 30 minutes which is always the same or higher than what we can do in 10.

Overview of Energy Markets - Ancillary Services Markets

- **Pay-for-performance (PFP)**

  A design feature of the Forward Capacity Market which provides incentives for resource owners to make investments to ensure their resource's perform during capacity scarcity conditions (CSCs).

  A CSC is when there is a deficiency in one or more of the three reserve requirements:

  - The ISO must maintain a sufficient amount of reserves to be able to **recover from the loss of the largest single system contingency within 10 minutes**.
  - Additional reserves must be available **within 30 minutes to meet one-half of the second-largest system contingency**.
  - The ISO also identifies **local resources** to meet the second-contingency requirements **in import-constrained areas**.

  A CSC can occur in one or more five-minute pricing intervals.

Overview of Energy Markets - Ancillary Services Markets

- **Pay-for-performance (PFP)**

  Penalizes or rewards resources based on their performance below or above their [obligated] share of the system's requirements. Eliminated the many exceptions allowed for underperformance under the previous FCM rules.

  Failure-to-Activate Flag: A flag placed on a forward-reserve resource when the **resource fails to respond** when asked to **activate its claimed 10-minute non-spinning reserve or 30-minute operating reserve**. A Failure-to-Activate flag results in **a <u>financial penalty</u>**.

  Failure-to-Reserve Flag: A flag placed on a market participant's delivered forward-reserve megawatts associated with a reserve zone when these megawatts are less than the participant's associated forward-reserve obligation. **A Failure-to-Reserve flag results in a forfeiture of payment for any forward-reserve megawatts not delivered <u>plus a financial penalty</u>.**

Overview of Energy Markets – Emergency and Scarcity Events

- **Emergency:**
  - Abnormal condition of an electric system requiring manual or automatic action to maintain system frequency or to prevent the involuntary loss of load, equipment damage, or tripping of system elements that could adversely affect the reliability of the system or the safety of people or property.
  - Could also be a fuel shortage requiring departure from normal operating procedures to minimize the use of such scarce fuel or any condition that requires the implementation of emergency procedures by ISO.

- **Shortage event:** A designated period (hours) of system stress during which capacity resources are most needed on the basis of system conditions.
- **Reserve-Shortage Pricing Event:**
  - When the control area is **experiencing a deficiency in total 10-minute operating reserves** or the ISO is taking actions to maintain 10-minute operating reserves.
  - The ISO will also declare this condition when the control area is experiencing **a deficiency in total operating reserves that has lasted for at least four hours** and the ISO has begun taking actions to maintain or restore operating reserves.

Overview of Energy Markets – Power System Status Descriptions

- **Normal -** Conditions are considered normal when electricity supply is sufficient to meet expected demand plus required operating reserves**.**
- **Master/Local Control Center Procedure No. 2 (M/LCC 2) alert** is issued either for the entire region or for a local area when abnormal conditions on the region's power system exist or are anticipated.
- **OP 4 (ISO Operating Procedure No. 4) Action during a Capacity Deficiency** - when available resources are insufficient to meet anticipated electricity demand plus required operating reserves. **The procedure includes 11 actions that the operators can take to either increase the available supply of electricity for the region or reduce the actual real-time demand for electricity.** These actions can be implemented in any order depending on the circumstances of the capacity deficiency. In addition, some of the actions can be implemented in advance of an anticipated capacity deficiency situation.
- **Minimum Generation Emergency (CROP.25005)**
- **Cold Weather Watch, Cold Weather Warning, or Cold Weather Event**
- **Energy Emergency** in the Seven-Day Capacity Forecast. The Energy Emergency is declared when the ISO forecasts a shortage of fuel for generators resulting in a potential loss of operable generating capacity needed to meet requirements for system demand for electricity and ten-minute operating reserves..

Operational Constraint Scenario – Impacts

CONSTRAINT	IMPACT	FLEXIBILITY to Address Impacts
Reservoir Stabilization		
Reduction in Impoundment Operating Range Reduce Drawdown Rate	• Loss of Capacity and capacity payments; Increased risk to not meeting capacity supply obligation • Reduction or loss of Forward and Real-time Reserves • Pay-for-Performance penalty risk • Loss of generation due to lack of storage • Shift from peak to off-peak generation • Reduction in energy income	• Need to exercise reservoir when called upon by ISO. • Need to exercise reservoir to conduct winter and summer audits
Stabilized Reservoir; inflow equal outflow	• Loss of all rated Capacity and capacity payments; • Loss of Forward and Real-time reserves • Pay-for-Performance penalty • Loss of generation due to lack of storage • Shift from peak to off-peak generation • Reduction in energy income	• Need to exercise reservoir when called upon by ISO. • Need to exercise reservoir to conduct winter and summer audits
Reduction in Reservoir Profile Operation range	• Potentially greater energy generation in some instances when flows are just above the threshold but not likely to cause spill • Potentially loss of energy generation due to higher likelihood of spill	• Need to operate for flood control and abatement

Operational Constraint Scenario – Impacts

CONSTRAINT	IMPACT	FLEXIBILITY to Address Impacts
Minimum Flow		
Below the Station	• Shift from peak to off-peak generation • Reduction in energy income – price-taker	• Must be or inflow – upstream gage plus calculated inflow below gage & above dam
Minimum flow Into Bellows Falls bypass	• Significant Generation loss • Significant reduction in energy income • Potential loss of capacity due to lack of water and/or head losses • Loss of reserve capability and revenue due to lack of water/or head losses • Greater exercise of storage (reservoir range) to meet capacity obligation • Pay-for-Performance penalty risk	• Must be proportionally reduced if total inflow is less than minimum flow requirement.

Operational Constraint Scenario – Impacts

CONSTRAINT	IMPACT	FLEXIBILITY to Address Impacts
Discharge Constraints		
Ramping Rates Increasing and Decreasing Generation	• Loss of Capacity and capacity payments; Enhanced risk to not meeting capacity supply obligation • Loss of reserve capability and revenue • Pay-for-Performance penalty • Reduction in energy income	• Need to ignore ramping requirement when called to dispatch by ISO – 10-minute spinning and 30-min non-spinning reserves. • Need to ignore ramping requirement when called to dispatch by ISO in order to meet forward capacity obligation.
Maximum station discharge reduced	• Loss of Capacity and capacity payments; Enhanced risk to not meeting capacity supply obligation • Loss of reserve capability and revenue • Pay-for-Performance penalty • Reduction in energy income	• Need to ignore maximum discharge requirement when called to dispatch by ISO – 10-minute spinning and 30-min non-spinning reserves. • Need to ignore maximum discharge requirement when called to dispatch by ISO in order to meet forward capacity obligation. • Need to maximize station discharge if headed toward spill
Scheduled generation	• Loss of Capacity and capacity payments; Enhanced risk to not meeting capacity supply obligation • Loss of reserve capability and revenue • Pay-for-Performance penalty • Potential loss of energy generation due to lack of reservoir optimization • Reduction in energy income – price taker	• Need to ignore generation schedule requirement when called to dispatch by ISO – 10-minute spinning and 30-min non-spinning reserves. • Need to ignore generation schedule requirement when called to dispatch by ISO in order to meet forward capacity obligation.

Economics

Exhibit D License Applications - Annual Value of Project Power (2016 $'s and 10-yr Ave generation)

REVENUE SOURCE VALUE	WILDER		BELLOWS FALLS		VERNON	
On-peak Energy	$ 2,827,376	36%	$ 3,847,877	36%	$ 2,680,181	29%
Off-peak Energy	$ 2,176,829	27%	$ 3,696,990	34%	$ 2,264,803	25%
Capacity	$ 2,512,818	32%	$ 2,963,367	27%	$ 1,953,600	21%
Real-time reserves	$ 371,372	5%	$ 259,358	2%	$ 259,478	3%
Volt-ampere-reactive support	$ 32,003	0%	$ 23,455	0%	$ 15,029	0%
RECs	$ -	0%	$ -	0%	$ 2,020,000	22%
Total value	**$ 7,920,398**	**100%**	**$ 10,791,047**	**100%**	**$ 9,193,091**	**100%**
Annual costs (30 yr yr analysis) Incl. cost of capital, taxes, depreciation/amortization, O&M)	$ 6,219,165		$ 10,444,894		$ 7,327,917	

Economics

- Current Value mix in % of revenue for LC Projects (YT 7/18) :
  - Energy 64-66%
  - Forward Capacity 27% - 32%
  - Other Ancillary (includes reserves) 1-2%
  - RECs (Vernon 5-8) 7%

- Forward Capacity Supply obligation
  - 100% station capacity through May 31, 2022
  - As of 2/19, through May 31, 2023

Economics

- Having the flexibility in our operations to participate in Capacity and Reserves Markets is ESSENTIAL

- Exercising that flexibility is distinct from having the flexibility.

- LC Hydro as a FAST-START resource is critical to the ISO and therefore more often NO RUN but held in reserve

- September 24-28-2017 is an example

Great River Hydro
ILP Study 9 Instream Flow Consultation Meeting
Web Based Meeting
Tuesday, October 16, 2018, 9:30 – 12:00

Meeting Notes

Consultation on Great River Hydro's instream flow study (Study 9) continued with a web-based meeting held on October 16, 2018.

Meeting attendees identified on the telephone:

Name	Affiliation
Pete McHugh	VTFWD
Jeff Crocker	VT ANR
Eric Davis	VT ANR
Gregg Comstock	NHDES
Melissa Grader	FWS
Ken Sprankle	FWS
Matt Carpenter	NHFGD
Katie Kennedy	TNC
Kathy Urffer	CRC
Andrea Donlon	CRC
Jim McClammer	CRJC
Mark Wamser	Gomez & Sullivan
John Ragonese	GRH
Jen Griffin	GRH
Edwin Nason	GRH
Steve Leach	Normandeau Associates
Sarah Allen	Normandeau Associates
Semiu Lawal	Hatch
Bob Nasdor	American Rivers
Dan Sullivan	Lyme Properties 2 LLC

Introduction

John Ragonese opened the meeting with introductions and a statement regarding the intent of the meeting: a brief meeting to discuss GRH's thoughts on and interpretations of the presentation given by Pete McHugh on August 21, 2018, and how GRH intends to move forward to propose operational alternatives for analysis.

John introduced a PowerPoint presentation to illustrate agenda, concepts, and talking points for the discussion (attached here).

John with Jen Griffin and with clarifications from Pete McHugh described Dual-Flow and Two-Flow analyses to clarify the differences. Dual-Flow compares the change in habitat on a cell by cell basis. The resulting metric represents the specific habitat that persists under both a base flow and another flow. Dual-Flow is used as a method for analyzing habitat effects of changing from one flow to another on immobile species such as mussels, nest spawning fish, and some fry. Two-Flow compares the total area (AWS) of habitat at base flow and the second flow. Suitable habitat does not need to be persistent or spatially connected. Two-Flow may be appropriate for analyzing effects of different flows on mobile species which will move behaviorally to suitable habitat as it shifts (juvenile and adult fish, broadcast spawning, some fry).

Pete noted that ensuring that GRH and stakeholders are on the same page is time well spent, and confirmed the interpretations of the two techniques. He noted that they (VTFWD) usually include fry as immobile species and so would use Dual-Flow.

John explained that GRH understands that fry may not be capable of transecting the river to locate suitable habitat when previously occupied habitat becomes unsuitable due to increasing depth and/or velocity, but when habitat shifts toward newly inundated and adjacent habitats (such as shallow side of channel / bar) would be available to most fry so GRH would include fry as mobile species.

Katie Kennedy noted that both techniques are useful tools; interpretation must be based on proximity of the habitat –whether it is accessible varies with species, life history, rate of change, etc.

John presented graphical data (slides 5 and 6; combined suitability indices (CSI) plotted on cross-section of river by flow) demonstrating the connectivity of suitable habitat and described that although the graphic suggests that a substantial amount of habitat (for Tessellated Darter) is lost when transitioning from a low flow to a higher flow (1200 cfs to 4,000 cfs in this case), it is important to bear in mind that just because depth and velocity indicate suitable habitat, the species may never have occupied much of the initial suitable habitat (higher flows are the controlling factor for population at that location). The percentage loss in either Dual-flow or Two-flow calculations would overstate the base habitat loss as the base habitat would unlikely be used consistently.

Eric Davis noted, keep in mind that the data do not interpret biology.

Mellissa Grader noted that some things are not captured in these analyses. For example, a riffle with cobble substrate may provide velocity refuge.

John showed on slide 7, graphical depiction of percent of habitat remaining (from minimum flow to generation flow) by month for the suite of species/life stages from Pete's slides.

Pete noted that the slides are tricky to interpret because the denominator in the calculation of % habitat remaining changes every month. It is not a time-series and the lines are just connecting a single point for each month, not intended to indicate seasonal trends. The denominator is based on median monthly naturalized flows. The numerator is the resulting metric of either Dual-Flow or Two-Flow, so it is the persistent or available habitat, depending on mobility.

John asked how we can tell the denominator by looking at the graph.

Pete stated that we would have to look at the output table. He noted that there is a sound rationale for the denominator – it is the habitat occurring at the base (minimum flow) of a daily operational cycle. The numerator is habitat occurring at the peak of the daily cycle. This incorporates seasonal variability. The take-away is that it is a tool to look at seasonal impacts. This was not meant to indicate any flow regime proposal, but to use a real hydrologic lens to analyze.

John showed a slide (#8) with graphic of AWS by flow for a section of Bellows Falls Bypassed Reach with bimodal peak. [The initial peak occurs at relatively low flows then habitat declines as velocity / depth increase with flow until main channel bank is overtopped.] GRH is obviously more interested in the lower flow peak because it provides suitable habitat without sacrificing flow. The concept of shifting a minimum flow from 200 cfs to 1700 cfs (to achieve the second mode) is a Project breaker, economically.

Bob Nasdor stated that is seems there is an assumption that we are comparing steady state alternatives (minimum flow is consistent). We should be mindful of natural variability with high and low flows.

John noted that minimum flows to bypassed reaches are typically fixed.

John showed slides 10 – 12 that suggest the number of species modeled can be reduced in order to focus the analyses. For example, for some species with AWS curves that have the same shape, it makes sense to use one species as surrogate for others, or to combine (e.g., normalized average curves) and asked for reactions.

Pete concurred and noted that part of why it has taken a long time to get to the point of analyzing alternatives is a need to reduce the signal to noise [ratio].

John noted that GRH is not attempting to eliminate or mask anything important, but to focus the analyses to potentially identify common needs.

Mellissa stated that conceptually she agreed, but noted that GRH is focused on minimum flows, not down-ramping. Are you open to running scenarios with reduced peaks at certain times of the year?

John answered, generally no, that is a massive capacity hit, however there could be some considerations, but we need to look at the time series. It is possible that concessions such as increased minimum flow would change the probability of higher flow peaks due to water usage.

Matt Carpenter stated that more naturalized seasonal variation is important. Pete's analysis maybe shows when the greatest seasonal impacts occur. For example, during low flow periods, frequent [large magnitude] fluctuations would have greater impacts.

John asked which was more detrimental, operational range or high spill events?

Matt replied, frequent high magnitude changes are more detrimental than high flow events that recede more slowly. Katie supported Matt point.

John noted that GRH would not be proposing flow regimes that mimic natural conditions in a peaking system, but maybe the frequency and duration can be affected indirectly through other operational changes.

Matt agreed, that would be closer to natural conditions, which is what they are interested in.

John retuned discussion to species/life stages reduction, noted that to assess impacts we need to analyze time series over various hydrologies.

Mellissa noted that operational flexibility has been discussed and asked John to clarify if GRH may be willing to reduce peaks at certain times of the year but allowing for higher flows when called upon by ISO-NE?

John replied that reducing peak operating range in the license is a capacity reduction. That doesn't necessarily mean we can't attempt to describe and provide provisions for a typical and emergency operations in the license. For example, typical operation might include a minimum flow increase and ramp rate change, which could reduce the frequency and extent of high magnitude peaks on a weekly basis, but such a provision wouldn't restricted capacity to peak at the higher magnitude should we be required to or need to for economic reasons.

Bob asked John to distinguish between flexibility and capacity. If there was a cap on generation you wouldn't be able to claim a certain capacity?

John explained that GRH must prove the capacity it claims. If generation is capped, the claimed capacity is lost. In the reserve market, need to be flexible to go to peak.

Melissa noted they're looking for ways to look outside the box to address what GRH needs and what stakeholders need.

Matt noted, some common ground, down ramping rate is more important, ecologically, than up-ramping rate.

John stated next steps – GRH intends to combine/reduce species as we feel appropriate in review of shape and amplitude of curves, seasonality, etc. Then attempt to develop operational alternative scenarios based upon that information. Output from the operations model runs of these alternatives will be analyzed initially in terms of feasibility and undesirable impacts (forced spill, unit capacity exceedance). If reasonably feasible, habitat impact will be examined through time-series analysis of the model output flows for each of the 5 reaches (3 below Wilder, 1 below Bellows and 1 below Vernon) for comparison to base case. Results to be reported at next meeting, assuming it can all be done in time.

Mellissa asked if GRH is not seeking potential scenarios from agencies; Katie indicated they were waiting on GRH to prepare the first proposals. John said he wasn't shutting the door on stakeholders providing scenario, but at this point, GRH will take the lead and report back.

Mellissa noted that this is responsive of GRH, but a subset of stakeholders plan to develop some scenarios as well.

John asked whether we are moving in the right direction. There was general agreement with the steps that he has outlined.

Matt asked if GRH understands what the agencies are looking for.

John replied that, philosophically, yes but noted that we may not be in agreement whether that can be accomplished.

Greg Comstock and Eric Davis acknowledged approval of next steps. Eric noted that minimizing curves makes sense, with caution not to eliminate important species; not so sure about normalizing.

The next meeting is scheduled for November 20, 2018.

Study 9 Instream Flow, Study 24 Dwarf Wedge Mussel
Aquatic Working Group
Study Report Consultation Meeting

GREAT RIVER HYDRO

October 16, 2018

Meeting Agenda

- Discussion on Stakeholder review of Study 9 report an analysis
- Developing operational alternative
- Analysis of Operational Alternative(s)
- Results from Analysis

Discussion on Stakeholder review of Study 9 report and analysis

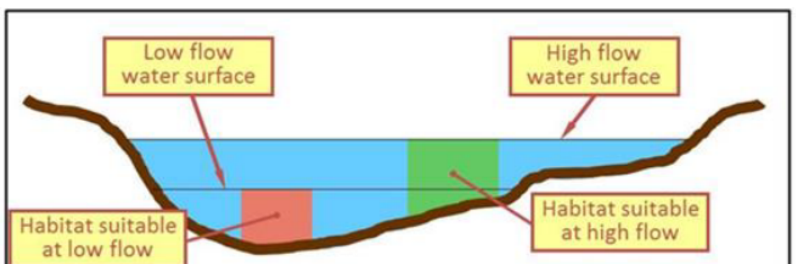
- **Dual Flow vs Two Flow**
  - **Understanding terminology, distinctions and application**
  - **What it means.**
  - **What it doesn’t mean.**

Discussion on Stakeholder review of Study 9 report and analysis

Dual flow & two flow assessments

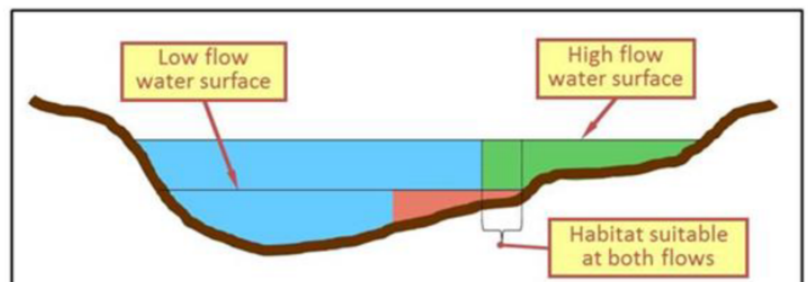
Base Flows	Base Flow AWS	Persistent AWS (ft2/ft)									
		Peaking Flows									
		2500	3175	3850	4475	5400	6350	7025	7700	9525	11400
1300	118.0	np	np	np	59%	47%	36%	31%	27%	21%	16%
1500	115.7	np	np	np	63%	49%	38%	32%	28%	21%	17%
1750	113.3	np	np	np	68%	52%	40%	34%	30%	23%	18%
2000	110.5	np	np	np	72%	54%	41%	35%	31%	23%	19%
2250	106.0	np	np	np	75%	56%	43%	37%	32%	24%	20%
2500	100.8	np	np	np	78%	58%	44%	38%	33%	25%	20%
3000	90.8		np	np	82%	61%	47%	40%	35%	27%	21%
3500	82.9			np	85%	64%	49%	42%	37%	28%	23%
4000	75.6				88%	66%	50%	43%	38%	29%	24%
4500	67.3					67%	52%	44%	39%	30%	24%
5000	59.1					69%	53%	46%	40%	31%	25%
6000	45.6						55%	48%	42%	32%	26%

Mobile spp/stages, habitat = $\min(\Sigma H_{bi}, \Sigma H_{pi})$



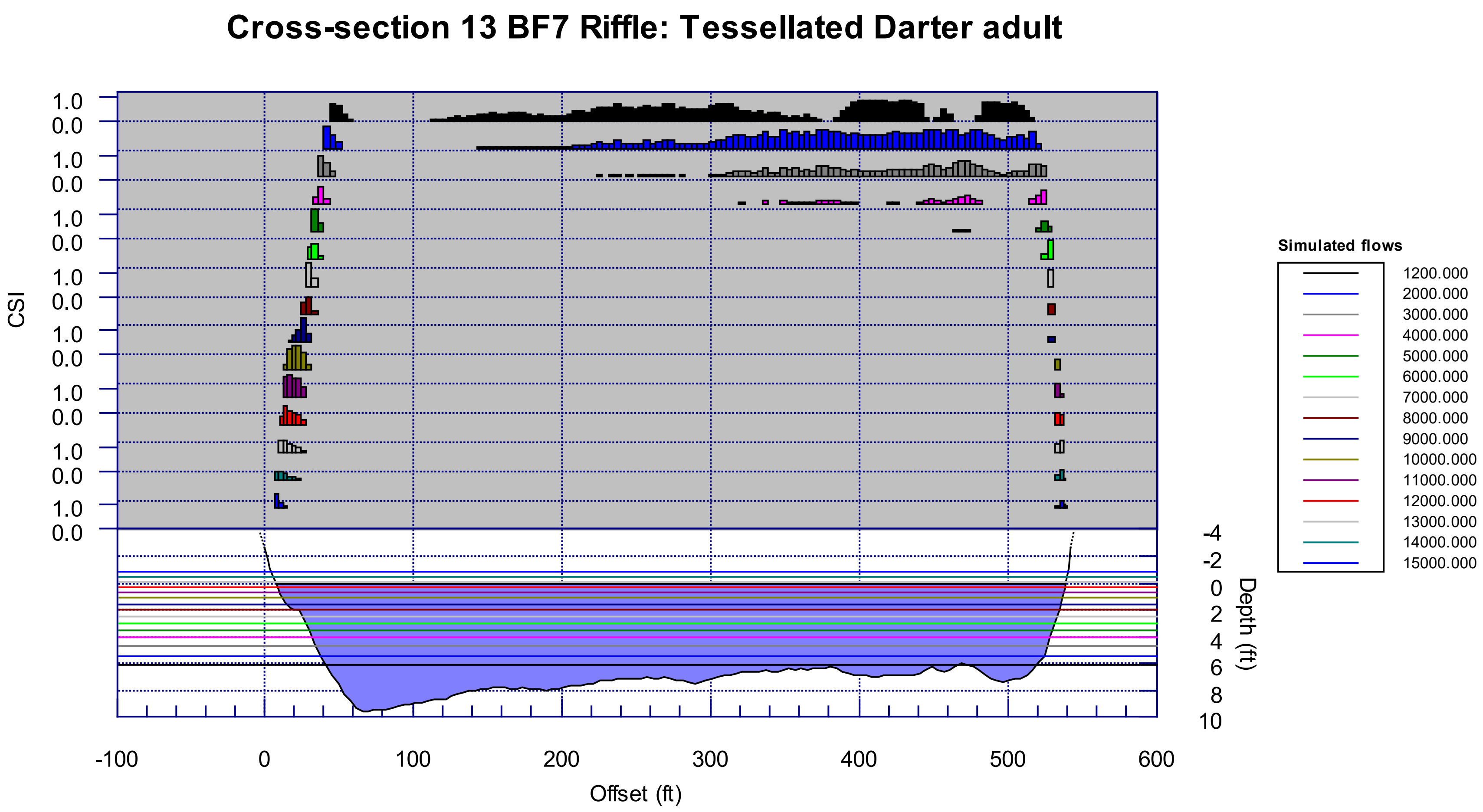
Deep water habitat is limited at low flow. Excessive velocities at high flows make some deep areas unusable.

Immobile spp/stages, habitat = $\Sigma(\min(H_{bi},H_{pi}))$

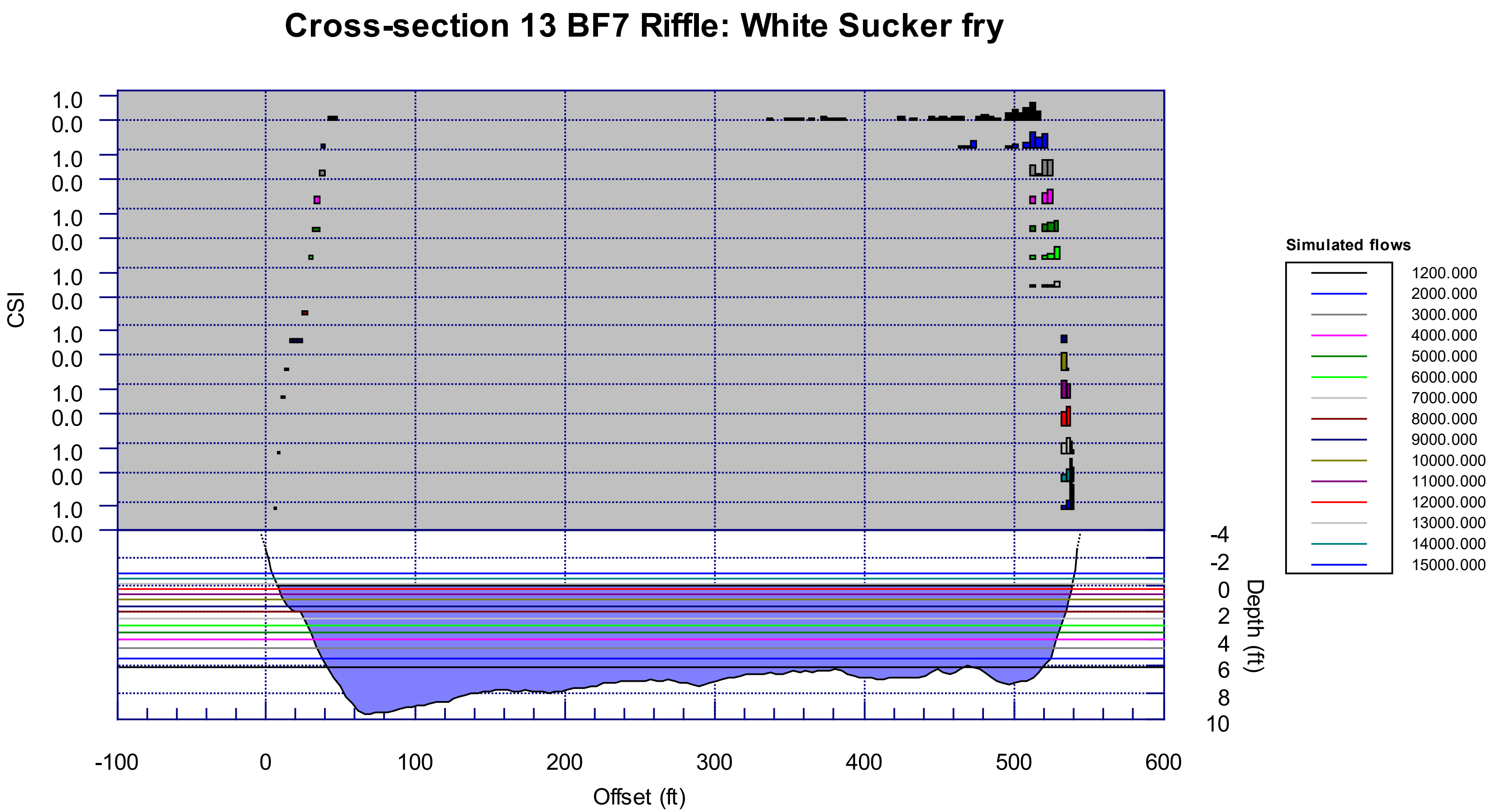


The location of shallow-slow habitat changes with flow

Discussion on Stakeholder review of Study 9 report and analysis



Discussion on Stakeholder review of Study 9 report and analysis



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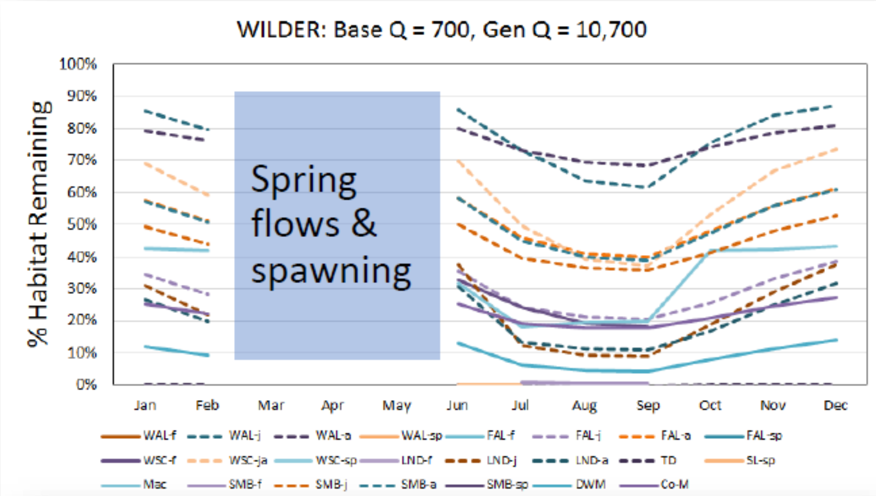
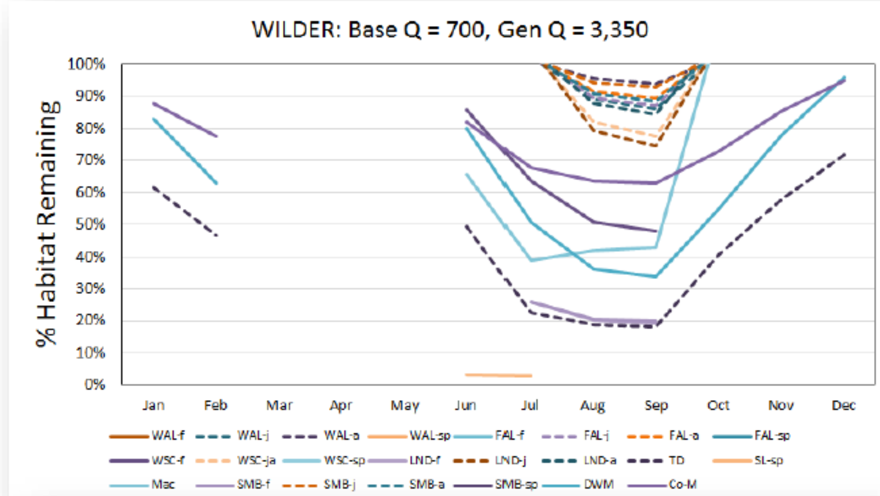
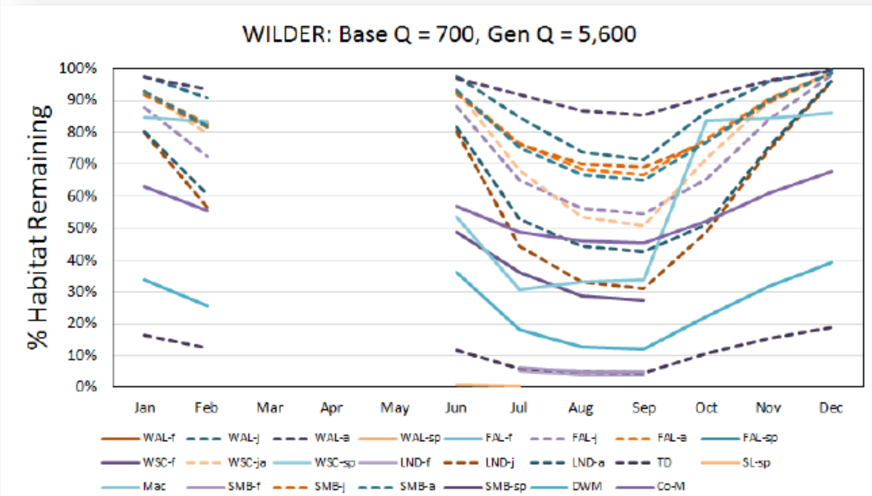
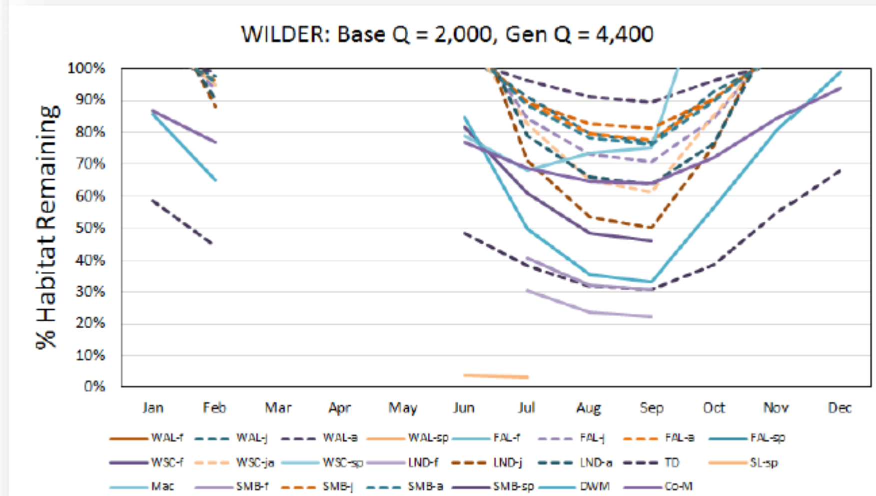


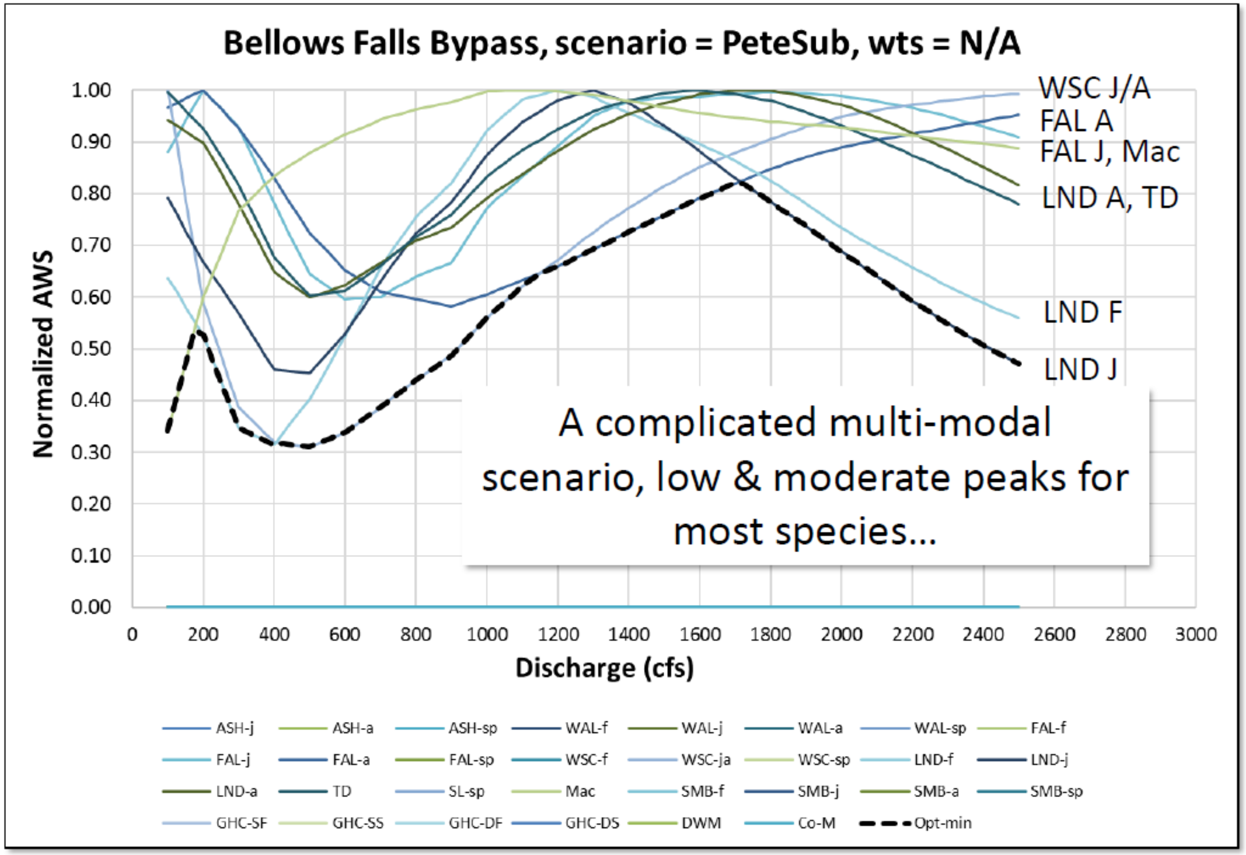




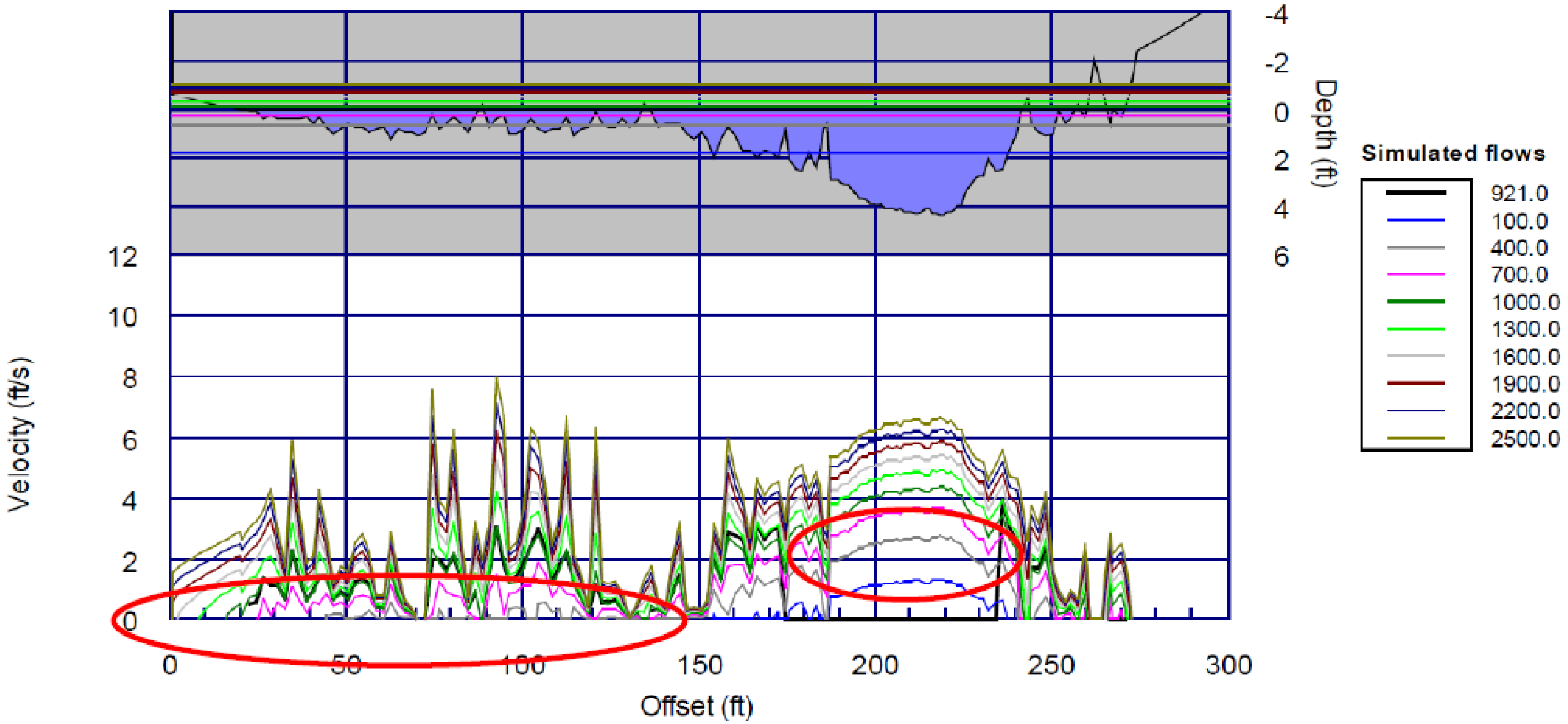


Bellows Falls Bypass

Habitat modeling results

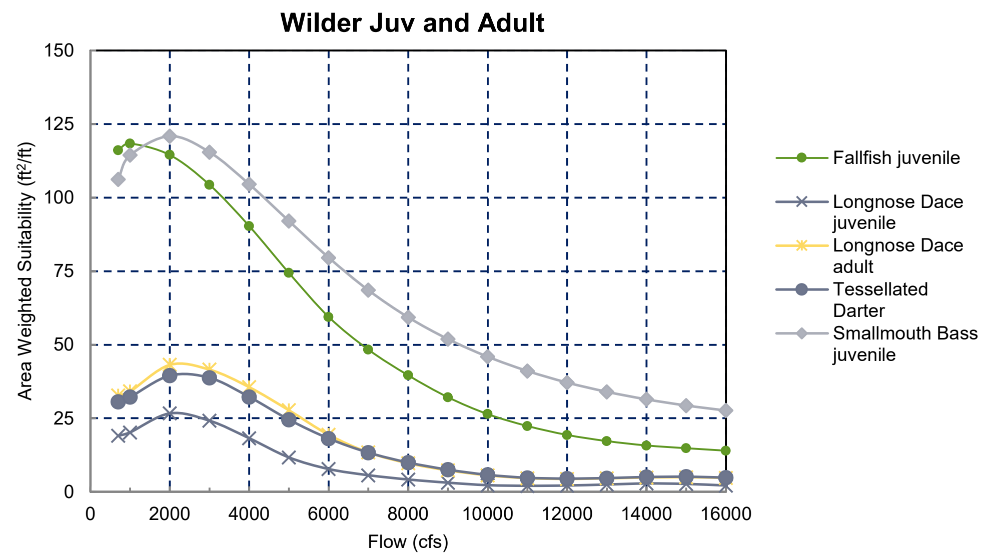


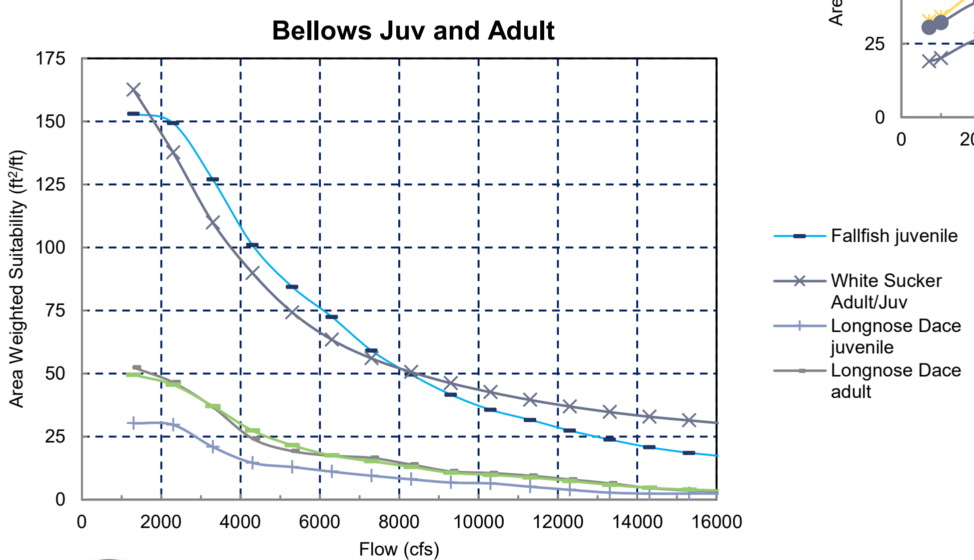
Bellows Falls Bypass



Developing operational alternative

Species and life stages can be combined based on similar AWS curves





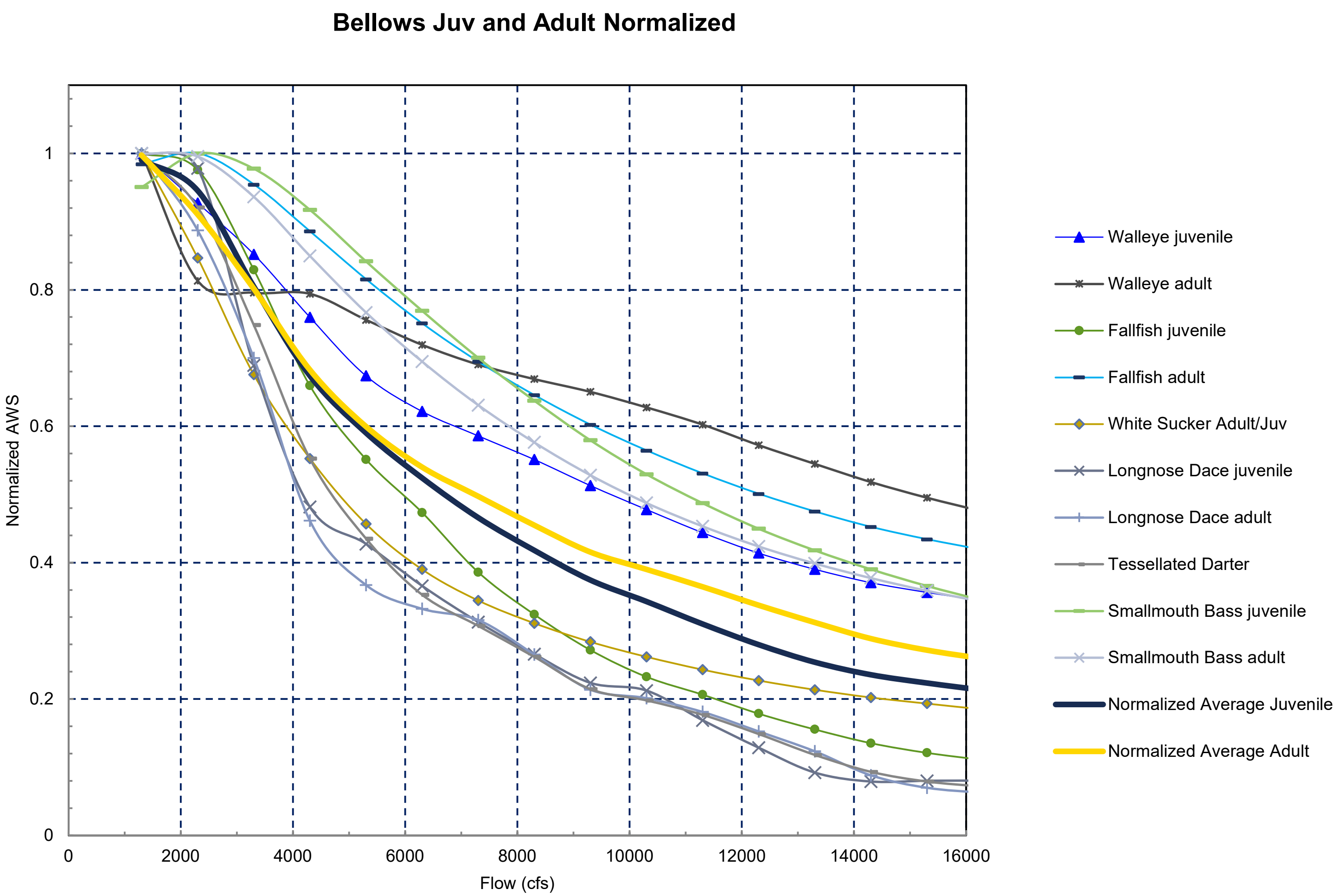
Developing operational alternative

One way is to normalize and average life stages – Example juvenile and adult

Normalized Juvenile and Adult (some overlap with White Sucker)

Flow (cfs)	Walleye juvenile	Walleye adult	Fallfish juvenile	Fallfish adult	White Sucker Adult/Juv	Longnose Dace juvenile	Longnose Dace adult	Tessellated Darter	Smallmouth Bass juvenile	Smallmouth Bass adult	Normalized Average Juvenile	Normalized Average Adult
1300	1	1	1	0.98	1	1	1	1	0.95	1	0.99	1.00
2300	0.93	0.81	0.98	1.00	0.85	0.98	0.89	0.92	1.00	1.00	0.95	0.91
3300	0.85	0.80	0.83	0.95	0.68	0.69	0.70	0.75	0.98	0.94	0.80	0.80
4300	0.76	0.79	0.66	0.89	0.55	0.48	0.46	0.55	0.92	0.85	0.67	0.68
5300	0.67	0.76	0.55	0.82	0.46	0.43	0.37	0.44	0.84	0.77	0.59	0.60
6300	0.62	0.72	0.47	0.75	0.39	0.37	0.33	0.35	0.77	0.69	0.52	0.54
7300	0.59	0.69	0.39	0.69	0.34	0.31	0.32	0.31	0.70	0.63	0.47	0.50
8300	0.55	0.67	0.32	0.65	0.31	0.27	0.27	0.26	0.64	0.58	0.42	0.45
9300	0.51	0.65	0.27	0.60	0.28	0.22	0.21	0.21	0.58	0.53	0.37	0.42
10300	0.48	0.63	0.23	0.56	0.26	0.21	0.20	0.20	0.53	0.49	0.34	0.39
11300	0.44	0.60	0.21	0.53	0.24	0.17	0.18	0.18	0.49	0.45	0.31	0.36
12300	0.41	0.57	0.18	0.50	0.23	0.13	0.15	0.15	0.45	0.42	0.28	0.34
13300	0.39	0.54	0.16	0.48	0.21	0.09	0.12	0.12	0.42	0.40	0.25	0.31
14300	0.37	0.52	0.14	0.45	0.20	0.08	0.09	0.09	0.39	0.38	0.24	0.29
15300	0.36	0.50	0.12	0.43	0.19	0.08	0.07	0.08	0.37	0.36	0.22	0.27
16300	0.34	0.48	0.11	0.42	0.18	0.08	0.06	0.07	0.34	0.34	0.21	0.26
17300	0.33	0.46	0.10	0.40	0.18	0.08	0.06	0.07	0.33	0.33	0.20	0.25
18300	0.32	0.44	0.09	0.39	0.17	0.06	0.06	0.06	0.31	0.32	0.19	0.24
19300	0.30	0.43	0.09	0.38	0.16	0.05	0.05	0.06	0.30	0.30	0.18	0.23
20300	0.29	0.42	0.08	0.37	0.16	0.05	0.05	0.05	0.28	0.29	0.17	0.22
21300	0.28	0.41	0.08	0.36	0.15	0.05	0.04	0.05	0.27	0.29	0.17	0.22
22300	0.27	0.40	0.07	0.36	0.15	0.05	0.04	0.05	0.26	0.28	0.16	0.21
23300	0.26	0.39	0.07	0.35	0.14	0.04	0.03	0.04	0.25	0.27	0.15	0.20
24300	0.25	0.38	0.06	0.34	0.13	0.04	0.03	0.04	0.25	0.26	0.15	0.20
25300	0.24	0.37	0.06	0.34	0.13	0.03	0.03	0.03	0.24	0.26	0.14	0.19

Developing operational alternative



Developing and Analyzing operational alternatives

- Combine as best we feel is appropriate
  - Shape
  - Amplitude
  - Seasonality
- Look for distinct flow needs
- Will unlikely limit max station flows
- Sensitivity versions
- Output analyzed in terms of feasibility and impacts
- Output run though Time series analysis
- Comparison to Base Case time series
- Report out at next meeting