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Memorandum (ISRP 2006-1) **January 13, 2006[1]**

To: Doug Marker, Fish and Wildlife Division Director, Northwest Power and Conservation Council

From: ISRP

Subject: Review of Salmon Subbasin Pilot Projects Monitoring and Evaluation Plan

Introduction

In this report, the Independent Scientific Review Panel (ISRP), at the request of BPA and the Council, reviews the plan for implementing the Salmon River Pilot Studies. These studies are part of a larger research monitoring and evaluation (RME) initiative that includes similar efforts, ongoing and proposed, in the Wenatchee, John Day and Grand Ronde River subbasins. The Salmon River Pilot Studies are a component of "*RME Pilot Project: Integrated Status and Effectiveness Monitoring Program*", a NPCC F&W Project (BPA #2003-017-000). The Council's and BPA's recommendations for funding this project included a provision that the M&E plans for different watersheds -- John Day, Wenatchee, and Upper Salmon -- be reviewed by the ISRP before implementation. The Wenatchee has been reviewed previously (see ISRP 2003-6[2] and ISAB&ISRP 2004-1[3]). The John Day and Upper Salmon draft plans are ready for review and potential implementation in FY06.

Background and Context for this Report

The project sponsor provides the following background information:

> *In the recent past the Columbia River basin has been host to a number of large-scale efforts to develop habitat and population status monitoring guidelines and management action effectiveness monitoring strategies. The RME Pilot Project was developed directly from the planning that underlies the status and trends*

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[1] Additional comments from the ISRP provided after the release of this memo on January 17, 2005 are included at the end of the memo, page 11.
[2] Review of Revised Mainstem Systemwide Proposals for Research, Monitoring, and Evaluation: www.nwcouncil.org/library/isrp/isrp2003-6.pdf
[3] ISAB and ISRP Review of the Draft Research, Monitoring & Evaluation Plan for the NOAA-Fisheries 2000 Federal Columbia River Power System Biological Opinion: www.nwcouncil.org/library/isab/isab2004-1.pdf

monitoring guidance or the Mainstem/Systemwide Provincial Review Process (Jordan et al. 2002), the parallel effort to define the status and effectiveness monitoring requirements for the 2000 FCRPS Biological Opinion (NOAA 2000; RPA 180, 181, and 183: Tier 1, Tier 2, and Tier 3, see Jordan et al., 2003), and the Columbia River Basinwide Salmon Recovery Strategy (Federal Caucus, 2000). However, while there has been a concerted effort to compile guidance and design considerations for RME efforts, there has not been a comparable effort to implement these programs – the RME Pilot Project serves a major role as the test-bed for the implementation of monitoring and evaluation methods and protocols that could form the basis for regional integrated status and effectiveness monitoring programs. The RME Pilot Project is coordinated with but distinctly different from two other regional monitoring and evaluation development programs, the Collaborative Systemwide Monitoring and Evaluation Project (CSMEP), and the Pacific Northwest Aquatic Monitoring Partnership (PNAMP). Both CSMEP and PNAMP are working at larger scales than the RME Pilot Project – PNAMP is a large-scale approach to developing policy buy-in for the implementation of integrated monitoring work across scales, questions and agencies, while CSMEP is a hands-on group of agency technical staff working to build design and evaluation templates for monitoring work across "All-Hs" for the interior Columbia River basin. The apparent overlaps between these three projects are important and each fills a necessary niche, yet each is a stand-alone effort serving critical regional technical, coordination, and policy roles.

The primary focus of the Salmon River Pilot Studies is the development and testing of analytical approaches that will make good use of data collected during monitoring and evaluation efforts. While it is acknowledged that RME will not be conducted identically in all subbasins, the Salmon River Pilot Studies are designed to produce results that will help subbasin planners design and implement monitoring projects that assess (1) habitat restoration effectiveness and (2) fish population status and trends.

The habitat restoration effectiveness and population status and trend monitoring studies will each take place in separate tributaries of the Salmon River. The habitat restoration monitoring study will examine the reconnection of spawning and rearing tributaries with the Lemhi River, and the population status and trend monitoring study will examine summer Chinook and steelhead population trends in the South Fork of the Salmon River. Both studies will build on existing monitoring efforts; however, both will employ novel approaches to the design, implementation and analysis of monitoring data.

In this review, the ISRP comments on elements of the study designs and makes suggestions for how the monitoring studies could be improved. Overall, we strongly agree that studies of this type are needed. The Salmon River Pilot Studies represent an important component in a project that will yield valuable data for use throughout the basin.

Lemhi River – Effectiveness Monitoring

The study design includes the following elements:

1. *A watershed model that evaluates productivity and carrying capacity by life-cycle stage as a function of habitat availability and quality, and then simulates expected life-stage specific benefits from increased habitat availability or quality.*
2. *Reach-specific empirical measures of juvenile productivity, survival, and condition to determine whether tributary reconnection has provided high quality habitat that benefits fish vital rates (survival, growth etc.).*
3. *Measures of the movement and distribution of anadromous and resident fish to address the following questions:*
    a) *Are anadromous fish utilizing newly available habitat?*
    b) *Have the reconnections changed the distribution and connectivity of resident fish?*

There are 31 tributaries to the Lemhi River, and except for Hayden Creek and Big Springs Creek, all are claimed to be dewatered in their lower reaches during the irrigation season and remain isolated from the Lemhi River. A primary focus of the Lemhi Conservation Plan (LCP) is to re-establish tributary connectivity so fish can access spawning and rearing streams in these watersheds. The LCP proposes to reconnect at least 10 tributaries: four in the first five years of the plan (Phase I) – and six more over the next 30 years (Phase II) – if the original four reconnections are shown to be beneficial.

Watershed Model

The watershed model used for the Lemhi River restoration effectiveness study is based on a life cycle stage-based recruitment model developed by Ray Hilborn and his students (Sharma et al. 2005). Sequential survival estimates for each stage in the freshwater life cycle (egg, fry, parr, pre-smolt, and smolt) are mediated by stream characteristics that result from different land uses. The model produces relationships between habitat quantity (capacity), habitat quality (productivity), and life cycle stage-based abundance. The components of the model are given in Figure 2-1.

In section 2.1.1.2, *Developing a relationship between habitat quality/quantity and recruitment*, the study plan acknowledges that a number of assumptions regarding habitat quantity and quality in the Lemhi River watershed will be made. Most of these assumptions seem to be reasonable starting points until empirical data become available. However, the method of determining land use was not entirely clear. Is the land use type considered ridgetop to ridgetop, or only proximate to the channel? In either case, using the percentage of a land use type in a watershed may be less reliable than how land use types are distributed relative to each other and the streams themselves. A typical watershed in the Lemhi River basin is forested at the headwaters, then rangeland of probably two types at lower elevations: first shrubland, then a narrow wet meadow in the riparian zone. In addition, forest may not be the most productive type, especially compared to gravity irrigated pasture, which is generally fertilized and much higher in soil organic matter (hence nutrient retention) than other types. A mature forest has the majority of nutrients sequestered in organic matter that decays slowly. A young forest following fire or timber harvest will have higher primary productivity and more rapid turnover of nutrients; thus, its ability to contribute to stream productivity is different. The forest management history of the Lemhi region is one of early timber harvest followed by reforestation and fire suppression, with rare large wildfires of severe intensity that tend to bleed nutrients. All of these variations in condition have affected sediment production as well as temperature and nutrients. For these reasons, assigning a blanket productivity scalar to forest land cover is associated with a high degree of uncertainty.

Rangelands in this region are arid, and succession occurs very slowly. Heavy grazing by cattle, horses and sheep in the late 1800s, followed by fire suppression and introduction of invasive species such as cheatgrass has altered rangelands to the degree that short-term management interventions may not yield results for many years. Other land uses, including homesteading and mining have further impacted riparian areas and stream channels. When the channels have incised beyond their ability to access the floodplain, wet meadows have been replaced by long-lived upland shrub communities. Because the floodplain cannot store water, spring flows are higher and summer flows lower than in earlier times. Riparian areas are inherently unstable, and riparian recovery can be an unpredictable process. Years of streambank building can be lost in a single ice flow, while a drought period can result in accelerated revegetation. All these factors may confound land use-productivity assumptions.

Land use influences extend downstream. For example, upstream habitat loss can result in downstream flooding, sedimentation, and nutrient enrichment that has little to do with the land use adjacent to where the effects are ultimately observed. The history and condition of a particular site, as well as upstream influences, may be controlling the condition of stream habitat even more than the present land use, and the time lag following restoration can be substantial. None of these relationships can be assumed to be linear, nor can two sites that appear similar be assumed to function in a similar fashion following restoration project. Classification by land use might best be done using current condition within a land use type hierarchically nested within previous elevation, aspect, gradient, and riparian condition strata.

Therefore, the ISRP believes that high priority should be given to locally calibrating the relationship between land cover, available habitat (pre- and post-reconnection), and the productivity scalar (**E**). In Table 2-1, forested land cover is assigned the highest productivity rating (1.0), with irrigated land, rangeland, urban, and “other” land assigned diminishing scalar values. These values should be verified or corrected for local conditions as soon as possible because the productivity scalar (**E**) strongly affects the values produced by equations (15) and (16), which in turn strongly influence the assessment of habitat restoration effectiveness in different land use types. Furthermore, footnote C to Table 2-1, states “These scalars will be developed based on empirical data collected over the course of the project” but it is not clear how this will be done. It is difficult to estimate the productivity scalar (**E**), especially if the habitat in question is underseeded.

The study plan partially addresses this problem in the discussion of estimating life-stage capacity $[\mathbf{c}_{k,i}]_t$ on pages 18 and 19. The plan states "if the spawner numbers are below seeded habitat levels, then the **c(k,j)** will be an underestimate. The best solution to this problem would be to do a sensitivity analysis by serially increasing the observed number of juveniles per unit area of the habitat available." This would be an ideal approach, but it would probably be quite difficult to implement in real world situations without placing barriers to migration into and out of test streams. Additionally, this approach would require that experimental units (stream reaches?) have similar food resources and other biological factors (predators and competitors) that could influence capacity. Those other factors would also be difficult to control. The ISRP sees no easy way around this dilemma; however, the most useful interim approach might be to utilize carrying capacity information estimated from years with relatively high escapement to the Salmon River subbasin. In that respect, Bjornn's data from the early 1970s in Big Springs Creek (Bjornn 1978) might be helpful.

The study plan uses carrying capacity data for coho salmon as surrogates for Chinook salmon carrying capacity. The coho data were from Oregon coastal streams (Nickelson et al. 1992a, 1992b), where habitat differs in many ways from the habitat of Lemhi River tributaries. The plan used these data for demonstration purposes only, and the ISRP hopes more applicable data (Chinook salmon in interior Columbia basin streams) are used for the real model runs.

In Table 2-3, the capacity of "Spawner to Egg" life history stage is given as 833 for "Spawning Grave" (should be Spawning Gravel). Does the number 833 refer to the number of surviving eggs per square meter of an actual redd, or the average number of survivors per square meter in a reach used for spawning?

Table 2-4 is a very important table, as it gives the overall survival from one life history stage to the next:

Table 0-1. Stage-based survival estimates ($\mathbf{s}_{ri}$).

Life Stage	Estimated Survival
Egg to Smolt	0.67
Fry to Smolt	0.6
Parr to Smolt	0.56
Presmolt to Smolt	0.9
Spawner to Egg	1,750

It is not clear from this table if the numbers are absolute constants or percentages, e.g., 0.67 vs. 0.67%. Additionally, values in the table were supposed to be derived from Bjornn (1978). However, the ISRP was unable to determine where in the Bjornn report these values occurred; in fact, the numbers appear rather high. On page 48 of Bjornn (1978) the statement is made that "The proportion of the estimated number of eggs deposited by spawners in the upper Lemhi River that survived to migrate from the river ranged from 0.15 to 0.52 (Table 36), and the proportion of eggs that survived to migrate as smolt-sized juveniles ranged from 0.04 to 0.16" [as compared to the value of 0.67 given in the Table 2-4 above]. Bjornn (also p. 48) asserts that the upper Lemhi River was seriously underseeded by Chinook, even in the 1970s: "After the first few years of study, it became obvious that the upper Lemhi River was not producing the maximum possible number of juvenile salmon because spawning escapements were inadequate." Therefore, both the capacity and productivity of the Lemhi River for Chinook remain largely unknown. More accurate predictions, however, will emerge once the model is calibrated with more accurate data, and the ISRP is aware that the values in the study plan were used primarily for illustration.

In fact, the text on page 20 can be interpreted to indicate that the values in Table 2-4 are not actually the survival from egg to smolt and fry to smolt, etc., but rather the proportional difference between "average" and "best possible" survival; "*Sr_i = average maximum survival rate from one stage to the next in the fresh-water life history of the species given age (Table 2-4) compared to a baseline in the best possible habitat suited for their survival.*" This plan could be improved by clarifying the text.

The ISRP agrees that section 2.1.2.1 outlines a useful way of stratifying habitat types and land use classifications in order to estimate the amount of habitat in a given watershed in a given time. If obtaining electrofishing data for rearing densities in all habitat types over all possible land use categories proves too daunting, it might be possible to substitute Montgomery and Buffington reach types (Montgomery and Buffington 1998) for individual habitat units. The Montgomery and Buffington reach types are based on channel forming processes that can be influenced by land use, and therefore they may provide the type of information needed for the Lemhi watershed model. Additionally, it is a lot simpler to sample a reach than individual habitat types. Average rearing densities for reach types can be treated in the capacity model (equations 21-23) the same as habitat units.

The abundance sections of the study plan (2.1.2.3 and 2.1.2.4) were generally well written. It is not clear however, in the section on estimating adult abundance, how the upstream second collection of individuals to estimate $\mathbf{m_{e,t}}$, the number of adults in the second sample that are recaptured with the mark, will be conducted. Will this be accomplished by carcass sampling or some other method? The sampling procedures are labor intensive but the data should prove very useful.

In section 2.1.3.5 "*Evaluating changes in fish or habitat condition in a pre versus post framework*", it is suggested that various measures of fish condition be related to changes in habitat quality after treatment application. Length at age, weight at age, and condition factor of fish are the three metrics that could be indicators of productivity change. The ISRP notes that these metrics are likely to be density dependent as well as strongly influenced by seasonal and annual variation in climate and trophic conditions. Interpreting length, weight, and condition factor should include a consideration of these potential influences.

In section 2.1.4.2, "*Juvenile abundance estimates*", the study plan states that non-randomly selected fixed location sites will be snorkeled to determine fish use of reconnected streams. The authors are undoubtedly aware of some of the pitfalls of index sites and therefore have added a concluding paragraph on page 39:

> *In order to generate more representative juvenile density estimates for both anadromous and resident salmonids, and to generate juvenile habitat associations*

by life-stage, a randomized snorkeling component will be added to existing fixed snorkeling sites.

The ISRP believes more detail is needed about the randomized snorkeling component; specifically, how will random sites be selected and approximately how many new sites will be needed to improve accuracy? This addition could be very labor intensive, depending on how many randomly selected sites are required to generate more representative abundance estimates.

<u>Other editorial suggestions for this section of the plan:</u>

The numbering of subsections is inconsistent with the text. All the subsections are numbered in a 2.1.x.x series, whereas the text refers to subsections 2.x.x.x. For example, on page 24, first paragraph, first sentence: *Sections 2.4.4.1 and 2.4.4.2 developed information needs and estimators for partitioning land-use classifications into….* There is no section 2.4.4.x. Section 2.1.1.2 concerns developing a relationship between habitat quality/quantity and recruitment.

Some of the capacity notation for section 2.1.1.1.1 Ocean immature adult life-cycle stages (page 15) seem out of order; "c_5 *is the ocean capacity for age 2+ fish*." $\mathbf{c_5}$ was defined in the preceding section as "*the maximum production of smolts dependent on over-wintering rearing area.*"

Three citations are missing from the references: Bisson et al. 1981, Casella and Berger 1992, and Trapani et al. 2004.

Page 11, last sentence. *In short, we will ~~k~~now be able to estimate how effective habitat actions were at increasing the abundance and overall quality of habitat, the expected value of the habitat changes as a function of fish vital rates, the empirical response in fish vital rates, and the probability that the changes in vital rates would be detectable given the precision that accompanies various estimators*.

Page 12 and throughout this chapter. Use "effect" to indicate the end result and "affect" to indicate act on. Reviewers believe "effect" should be used in all cases except for the following sentence on page 12. "Equations 17 and 18 (Section 2.4.1.3) provide a means to determine whether changes in such attributes affect productivity."

Page 13. Remove period from et in *Sharma et. al. (2005)*. Include a discussion of how the results may be affected (sensitivity) by the condition that parameters are assumed known as stated in the following sentence. "*For modelling, we assume known proportions of the population maturing in year t+2, t+3, t+4 and t+5). These parameters will of course be influenced by ocean conditions and we also assume known estimates of survival from one age class to the next in the ocean.*"

Page 17. Footnote c in table 2-1 states, "*Forest habitat is assumed to represent pristine conditions, and thus sets the upper limit for productivity.*" Is this statement universally accepted as true? Is the assumption limited to old-growth forest or forests of any age and management history?

Page 21, equation 17. It is not clear that a simple linear regression is an adequate model because the independent variables will not act separately on abundance and productivity.

Page 22. The sentence beginning, "*Assuming that we can logistically implement a balanced cross-sectional design with n stream segments in each land-use classification*…" begs the question: What if the assumptions are not satisfied?

Page 23, equation 23. This equation for the variance of a product of random variables does not appear to be correct. Please provide a citation.

Page 23. The placement and meaning of the word "above" in the following sentence is confusing, "*Simulations will be used to estimate expected adult returns by incorporating the variances and distributions estimated from equations 19-22 and 26 (above)*."

Pages 27 and 29. Are both Figures 2-2 and 2-4 necessary?

Pages 31 and 32. **Y(i)** in equations 29, 30 and 31 should be defined for completeness.

Page 32. The following sentence is confusing because equation 24 does not indicate estimation of a variance. "*Variance of the estimates will come directly out of the analysis, but are essentially equivalent to variances calculated from equations 23 and 24 directly*.**"**

Page 32. The covariate WS presented in equation 31 should be identified here and its use justified.

Page 33. Justify the assumption of normality and discuss implications and alternatives if normality may not be assumed in the sentence that begins, "*Assuming normality and using the error structure described in equation 18* …"

Pages 32, 33, 34 contain duplicate equations numbered 31 and 32.

Page 35. The sentence before equation 36 is confusing due to the placement of "**(F)**". The sentence begins, "*If we have no pre-treatment data for fish condition, the effects of differing levels of stream connectivity (F) on fish condition can be evaluated* …" Move "(F)" to after "fish condition."

Page 35. Define and justify the independent variable **tr(i)** used in equation 36 here.

Page 36. More explanation of how equations 32 to 36 will provide information on dispersal and distribution would be helpful here.

Page 37. Figure 2-5 is repeated.

Page 38. Is Figure 2-6 necessary?

South Fork Salmon River Status and Trend Monitoring

The objectives of this component of the study are given as follows:

> *The primary purpose of the South Fork Salmon River (SFSR) Pilot Project is to determine whether innovative methods can be employed to increase the accuracy and precision of juvenile and adult abundance estimates for summer Chinook salmon at the subpopulation, population, and major population group (MPG) scales and for steelhead at the subpopulation and population scales.*

The study plan proposes to take advantage of existing monitoring studies (Figure 3-1 and Table 3-1) and would add more sites and other census methods to obtain better status and trend information for steelhead and summer Chinook salmon. Three alternative designs (including maintaining the current status quo) are suggested.

1. status quo;
2. status quo plus additional sampling effort capable of yielding juvenile and adult abundance estimates, including stage-specific SARs (from the tributary to LGD, LGD to LGD, and LGD to tributary), for natural origin summer Chinook salmon and steelhead populations and the summer Chinook salmon MPG; and
3. extensive re-allocation of existing effort to provide juvenile and adult abundance estimates, including SARs (from the tributary to LGD, LGD to LGD, and LGD to tributary), for natural origin summer Chinook salmon and steelhead populations and the summer Chinook salmon MPG.

The second alternative is further subdivided into two monitoring options, depending on the feasibility of operating an adult trap in the lower mainstem of the South Fork of the Salmon River. The study plan does a good job of describing alternatives 2 and 3, but it is not clear from the plan which alternative will finally be selected.

In section 3.4, "*Statistical Framework for the SFSR Pilot Project*", there is a description of the mathematical approach to estimating juvenile abundances based on PIT tag tracking. The study plan notes that the highest precision will be obtained when PIT tagging effort is distributed equally among the major tributaries. This is an excellent idea in theory but it will be very hard to implement equal tagging and recovery effort in practice. The plan proposes to equalize sampling by employing a "*randomized electrofishing effort stratified among each major tributary, with some proportion (e.g., 25%) of captured fish receiving a PIT tag*". There will surely be significant barriers to implementing a truly randomized electrofishing effort in the SFSR, not the least of which will be gaining access to randomly selected sites. A similar concern applies to adult abundance estimates, in which PIT tags will be applied to adults captured in the lower mainstem SFSR and recovered at or near the spawning grounds. The variance and efficiency equations assume equal sampling effort in order to extrapolate results to the entire subbasin. Because equal sampling effort cannot be completely achieved, the study plan should include some way of assessing how much deviation from equal sampling can be tolerated without compromising the overall objectives.

Nevertheless, the ISRP agrees that the status and trends pilot study will provide important data and hopes that the project members are able to implement this work without unnecessary complications.

In the final paragraph on page 55 the plan, authors state that "*existing information needs may or may not be met by either of the proposed alternatives*". Specifically Lake Creek is currently an Idaho Supplementation Studies reference stream and neither proposed alternative would provide adult or juvenile abundance estimates for this stream. In the final implementation of this, and any other standardization of monitoring in the Salmon River or other Columbia River subbasins, it is critical that ongoing artificial production and habitat improvement monitoring be coordinated. This involves more than just the loss or addition of reference locations. In the South Fork Salmon River watershed there is an important supplementation program ongoing in Johnson Creek, and the Sesech River is under consideration as a potential reference stream for both Johnson Creek and for supplementation in the Grande Ronde/Imnaha subbasins. For Johnson Creek and other locations in the South Fork Salmon River watershed, there is a need to control the fraction of hatchery and wild adults that have access to spawning sites. This will require retaining or constructing weirs, not just to collect broodstock for hatchery production, but weirs for enumerating and culling (if necessary) adults. This challenge is only partially addressed in this monitoring plan.

Other editorial suggestions for this section of the plan:

Page 49. Figure 3-6 should be identified as 3-5.

Page 59. Tables 3-3 and 3-4 should be identified as tables 1 and 2 in the Appendix.

References

Bjornn, T. C. 1978. Survival, production, and yield of trout and chinook salmon in the Lemhi River, Idaho. University of Idaho, Bulletin 27, Moscow.

Montgomery, D. R., and J. M. Buffington. 1998. Channel processes, classification, and response. Pages 13-42 *In* R. J. Naiman and R. E. Bilby, editors. River ecology and management: lessons from the Pacific coastal ecoregion. Springer-Verlag, New York, N.Y., USA.

Nickelson, T., J. Rodgers, M. F. Solazzi, and S. Johnson. 1992a. Seasonal changes in habitat use by juvenile coho salmon (*Oncorhynchus kisutch)* in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 49:783–789.

Nickelson, T., M. F. Solazzi, S. Johnson, and J. Rodgers. 1992b. Effectiveness of selected stream improvement techniques to create suitable summer and winter rearing habitat for juvenile coho salmon in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 49:790-794.

Sharma, R., A. B. Cooper, and R. Hilborn. 2005. A quantitative framework for the analysis of habitat and hatchery practices on Pacific salmon. Ecological Modeling 183:231-250.

Additional Comments on Salmon River RME Model

These comments were considered by the ISRP just after release of the memo and are provided to assist the project sponsors in improving and implementing the pilot project.

Acceptance of a comprehensive and promising model (or set of models) to an assessment of habitat restoration in the Columbia River Basin could be precedent setting and the method might be very appealing for those working elsewhere, e.g., mainstem and estuary. It is encouraging to see the proponents setting up a detailed calibration and assessment scheme, since if the model approach is accepted they will be establishing a high standard for work elsewhere.

A study component for movements (or residency) of Chinook in winter should be added. In winter the Chinook are difficult to census except possibly night snorkeling or electrofishing under ice. Sometimes they move downstream during a temporary warming and possibly could move from the tributaries to the Lemhi River and maybe even further downstream (factors studied experimentally by Bjornn 1971 TAFS 100:423-438). Would these kinds of movements affect estimates of, for example, pre-smolt to smolt in various reaches?

In spring-summer, availability of some of the habitats would change with flow, e.g., riparian habitat might be flooded during a freshet but not under lower flow. The ISRP assumes the model can accommodate these situations that require consideration of cross-channel differences in habitat.

The model seems to solely concern itself with the "physical" habitat that is appropriate for under utilized or newly utilized systems. However, it is possible the newly reconnected/restored habitats quickly might be used heavily and biological factors such as inter- or intra-specific competition or predation might start to become important factors. Will the fish community in the restored/reconnected habitat be the same as "control" or "pre-restoration" sites? It might be worthwhile to ask if the models can be augmented to accommodate such questions.

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