Accord Project Sponsors ISRP Response Report

Date: 2nd December, 2009.

Project Number	2009-004-00
Proposer	Columbia River Inter-Tribal Fish Commission
Project Title & Brief Description	Monitoring Recovery Trends in Key Spring Chinook Habitat Variables and Validation of Population Viability Indicators.
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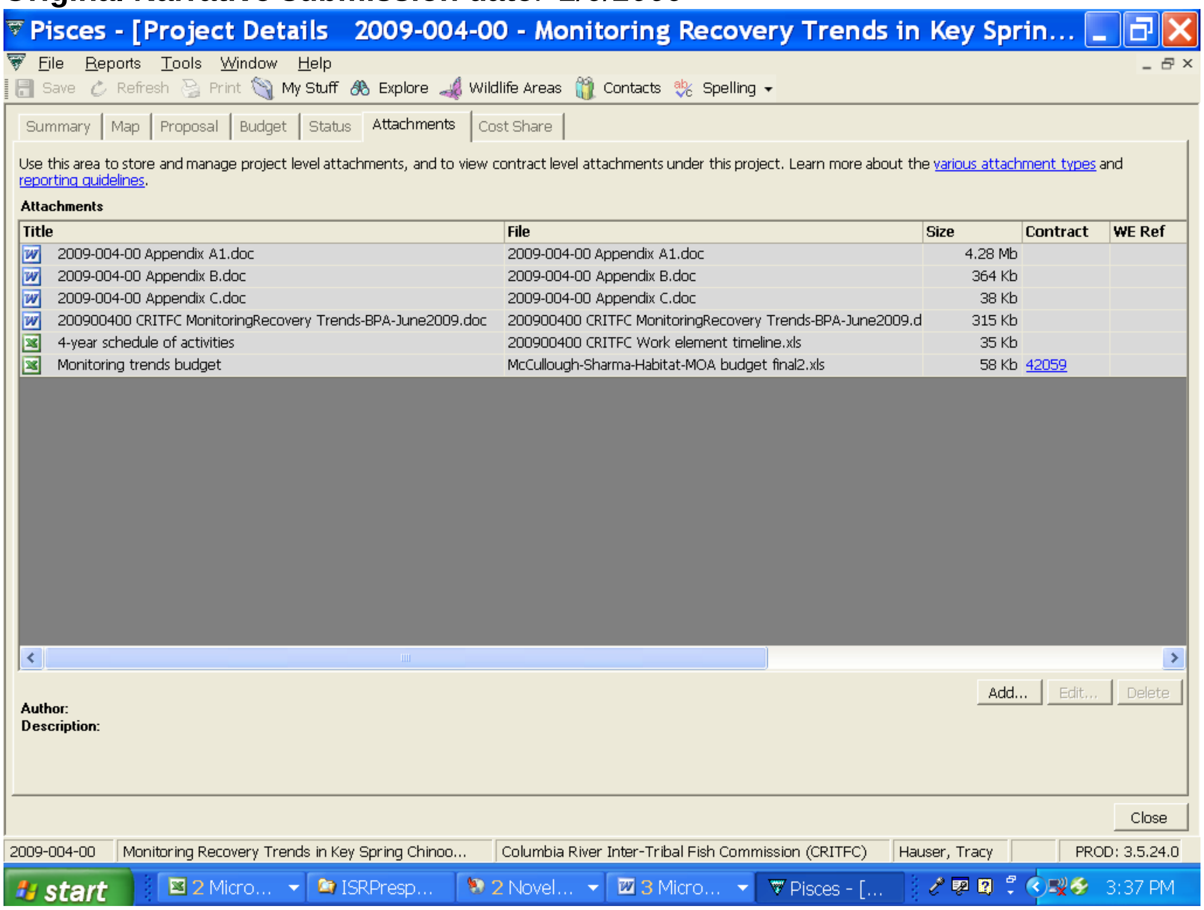
ISRP Review History:

Original Narrative submission date: *2/9/2009-*



Date ISRP Review comments were received: (ISRP 2009-33) July 27, 2009

ISRP Review results:

☐ Meets scientific criteria.

☐ Meets scientific criteria (qualified).

■ Response requested - meets scientific criteria (qualified).

□ Response requested – does not meet scientific criteria.

Response to ISRP Summary

□ The narrative will be revised and resubmitted by (insert target date).

■ A response to ISRP comments is provided in this document.

Response to ISRP Comments:

See the following attached documents:

1) 2009004 ISRP FAN1 Response.docx
2) 2009004 ISRP FAN1 ResponseAppendix1.pdf
3) 2009004 ISRP FAN1 ResponseAppendix2.pdf

CRITFC RESPONSE TO ISRP COMMENTS

This document summarizes all the statements made by the ISRP Review team and how the primary authors and staff involved in this project have responded. The column on the left specifies the ISRP comments and the column on the right displays the PI's intend to clarify their concerns. We also attach two appendices. The first appendix addresses the sample design and how the overall project connects both effectiveness and status and trends monitoring. The second appendix illustrates an example of how this would work, and conceptually displays our overall monitoring and evaluation objectives.

ISRP Comments:	CRITFC Habitat team Response
Additional scoping planning is necessary to guide the selection of particular variables to be measured, sampling design, field installations, equipment to be purchased, and where and when it will be installed. The ISRP does not see how it can be determined what equipment should be bought without this additional scoping and planning. Equipment should not be purchased under one objective when under the same objective funding is requested for "planning to plan" on how much equipment will be eventually needed. Based on this rationale, and given that most of the planning and critical literature review has not been done, only those aspects of the objectives involving actual scoping (i.e., "planning to plan"), planning, coordination, and literature review seem appropriate at this time. Following this scoping/planning phase when the project design has been more thoroughly formulated, the appropriate needs for equipment and facilities could then be identified and requested. Tasks 1.1 through 1.4 are thus appropriate and meet scientific criteria. Tasks 1.5 and the other Objectives (2-5) do not (yet) meet scientific criteria. A clearly articulated basis should be described for the necessary work elements under those objectives.	We identified a task for year 1 of reviewing all major habitat monitoring protocols used in the region. The perceived purpose of this was to compare methods that we believe, based on our extensive prior experience, to be the most reliable available against those methods that have achieved consistent recognition. We have had reason to believe that some methods that are popularly used are not highly accurate or precise. An example of this is the use of the Wolman pebble count method. We are looking for methods that are highly related to salmon survival and might allow measurements of high enough precision to show significant trends in specific stream reaches. Certain other methods are well established in the literature. For example, water temperature monitoring done with Hobo temperature loggers can detect temperatures with high accuracy when calibrated against a NIST thermometer. We have followed the protocols established by Oregon DEQ because our study sites are all located in Oregon and following ODEQ protocols is essential if data are to be provided to the state for use in any temperature TMDL or water quality analysis. Streamflow measurements have followed USGS protocols, which are recognized as reliable. Even though we feel fully competent to set out a plan for collecting data on many other habitat variables we think that because we will not be incorporating some of these into our protocols for some time, so it will be worth spending more time evaluating existing methodologies to find the best and most effective. Among those that justify greater scrutiny are streambank stability. CRITFC

	staff has already devoted considerable time evaluating methods for streambank stability analysis. Many regional monitoring programs continue to use simplistic qualitative methods that can likely be improved upon greatly. We believe that methods exist now in soil science to improve on these methods and need to be considered before launching such a monitoring effort. Other habitat variables such as carrying capacity involve complex theories of habitat structure and organization that will require a great deal of literature review and evaluation. These deliberations should not be rushed. It will most likely take us up to two years of work, given our staffing and extent of field work that we have undertaken, to come to a resolution on concepts such as carrying capacity. Equipment that we purchased in year 1 was all totally rational for conducting the first year's data collection on water temperature, streamflow, and sediment analysis. We know from subbasin plans and EDT analyses that these factors have always been listed as the most limiting factors in our study basins. Subsurface sediment monitoring can be done by a variety of methods. The freeze core method may be the one that results in minimal loss of fines, but it is expensive, is more time consuming, and not very suitable for remote locations. The McNeil core device, which we drew plans for based on several described devices in the literature, provided high quality samples down to typical egg pocket depths. We knew that we would have to be able to locate sample sites in the field with high accuracy. Basically there are three GIS-based options. One is to use a recreational GIS device (e.g., Garmin) with accuracies of ± 10 m. Another is to use an intermediate-grade GIS (e.g., Trimble, Topcon), which give accuracies of ± 0.3 m. The third is a high-end GIS (e.g., Trimble, Topcon) with accuracies of ± 0.02 m or better. The intermediate option appeared to us to provide a good balance of accuracy and cost. We researched the strengths and weakness of the Trimble vs. Topcon and decided that the Trimble unit was our best option. Given our intense focus on a limited set of key habitat variables and our extensive experience in monitoring these variables in the past, there

	seemed to be no reason to delay gathering data on these in the field. We used our first field season gathering an abundance of these types of data and in the process gained knowledge that will improve our procedures for the following years.
Because this project is both complex and ambitious, care should be taken not to over-promise what can be realistically delivered. There are limitations in how effectively some proposed variables can be measured, and how detailed measurements, such as sieving sediment, will be a step forward over simpler methods. Will the additional time and expense translate into useable information beyond what can be learned with simpler studies?	This comment is an important one. We do not want to promise more than can be delivered, but we are also committed to providing an accurate and consistent estimate of habitat condition on a very large portion of the subbasin. In terms of sediment analysis, we have proposed attempting to establish a relationship between surface fine sediment and subsurface fines. We have developed a new surface fine sediment method that we maintain is far superior to the Wolman pebble count method. Our purpose in devising this method was to find a relatively rapid method that could obviate the need for doing laborious McNeil subsurface sediment sampling. We are not certain yet that this relationship will be a totally reliable one, and relate effectively with subsurface fines, and thereby potential egg survival. On the other hand, to adopt a simple method alone, such as the Wolman pebble count method, presents the disadvantage of having a biased method that doesn't represent surface fines effectively and also one that may not have a solid relationship with subsurface fines, and thereby potential egg survival. We think that there is no substitute for measuring both surface and subsurface particle distributions and using the most accurate methods available should be of value in revealing a statistically significant trend within a 10-year period.
The proposal appears to have components of three types of studies: fundamental ecological processes, modeling, and landscape ecology, all at the same time. This leads to some confusion in the data needs described in Appendix B (modeling) and the ambitious habitat sampling program described in appendices A1 and A2. For example, the modeling appendix described using pool frequency to characterize improvements in life-stage survival, yet pool frequency was not one of the assumed primary limiting factors in Appendix A1 or in the general project description. Using one of the major putative limiting factors of	This is a valid criticism of our proposal. Appendix B highlighted the use of pool frequency as an example or proof-of-concept, but the key limiting factors identified in the body of the proposal were temperature, fine sediment, and flow. Appendix B was intended primarily as an example framework or proof-of-concept for analysis. Substituting a variable such as water temperature in place of pool frequency would have reduced the confusion. Regarding the large scope of our intended modeling approaches, we envision a process where different strategies (i.e., life-cycle modeling

temperature, fine sediment, or flow would have made the Appendix A2 example more appropriate and relevant to the project's objectives. It was therefore difficult at times to understand what the overall goals of this project were. Is habitat/fish life cycle model development the primary goal, or is it to develop a better specific understanding of the effects of a suite of restoration actions on spring Chinook in the upper Grande Ronde?	vs. empirical models of cumulative restoration efforts and land use using statistical design based methods) would complement each other regarding the type of data collected and analyses conducted. See new figure attached to the bottom of this document for a conceptual diagram of our planned work flow.
p. 3. It was therefore difficult at times to understand what the overall goals of this project were. Is habitat/fish life cycle model development the primary goal, or is it to develop a better specific understanding of the effects of a suite of restoration actions on spring Chinook in the upper Grande Ronde? p. 3. The proposal appears to have components of three types of studies: fundamental ecological processes, modeling, and landscape ecology, all at the same time. p. 3 Another focus of the proposal is a program of work for an intensively monitored watershed (IMW) analysis of the cumulative effects of multiple types of restoration on habitat condition and spring Chinook salmon in two medium sized watersheds in a single subbasin. p. 2 The goal of developing a robust model to project population sizes or population size changes based on water temperature, fine sediment, stream flow, and riparian condition, or their changes, is worthy. If successful it will provide an important planning tool in developing future habitat restoration projects. There is a clear need for effective quantification of habitat and a better understanding of how habitat can be improved to increase salmon production. The proposal describes an attempt to understand, quantify, model, and predict effects of habitat conditions and changes in habitat on the fish stock(s) from both top down and bottom up perspectives at the same time. This is an ambitious goal, especially the prediction aspect of the proposed study.	The ISRP critique does identify our major goals. From the BiOp we understand a primary assumption to be that it is feasible to improve the abundance and productivity of the Grande Ronde and Catherine Creek populations via cumulative habitat restoration actions. There is a linkage assumed between habitat condition and biotic response. The biotic response may have a lag time. Also, there is a probable lag between implementation of habitat restoration actions and the habitat condition response. The current habitat condition will be a result of its recent past condition, cumulative past restoration actions, each of which may be of different types and with different lag times for reaching full effect, ongoing degrading actions, newly implemented restoration actions, and natural patterns of disturbance. Detecting a habitat change can be done at an individual stream reach level, a major tributary level (e.g., the TRT MSA), or at the scale of the entire stream network (i.e., the entire spawning complex for the TRT population). It is the latter scale that is of most relevance in terms of assessing whether the assumptions in the BiOp are being realized and whether an appropriate level of restoration effort is being expended. It would be easier to monitor change at smaller spatial scales (e.g., a stream reach) with a locally effective action (e.g., riparian restoration). However, even a stream reach is likely to have all the kinds of human-caused and natural impacts itemized above going on in the watershed and also at the reach scale. Our first goal can be achieved by building a conceptual model integrating the effects of water temperature, fine sediment, and streamflow on abundance and productivity. The next step would be applying this model on a spatially extensive

The goal of developing a robust model to project population sizes or population size changes based on water temperature, fine sediment, stream flow, and riparian condition, or their changes, is worthy. If successful it will provide an important planning tool in developing future habitat restoration projects. One focus of the proposal is on the development of a habitat-fish population modeling protocol that could be extrapolated to other watersheds and subbasins in the mid and upper Columbia. The project proponents state on page 12 of the proposal: "The overall objective of this proposal is to develop a spatially-based system for modeling abundance, productivity, and growth rate for spring Chinook. The initial model will be a simple one based on water temperature, fine sediment (surface and depth), streamflow, and riparian condition in an attempt to create a robust alternative to EDT."	scale to estimate how the current condition of habitat, as distributed throughout the range of the population, would affect abundance and productivity. This effort is expected to provide much more realistic estimates than those based on heuristic evaluation, integrating conditions at a broad scale. These model estimates would be based on representative samples of conditions in various reach types that can then be weighted by the frequency of the reach type. A third goal would be to use the model to estimate, at a watershed scale (relative to the population distribution) the impact of various levels of habitat restoration (see new figure below). This restoration could be full restoration at the watershed scale, including the entire riparian system, or it could be in selected stream reaches distributed across the watershed. In the process of collecting the key habitat data at the watershed scale (i.e., points or reaches distributed throughout the historic spawning/rearing area for spring Chinook) it will hopefully be feasible to use the annual estimates to identify statistically significant trends in reaches where repeat measurements are made as well as overall trends in habitat condition by weighting the conditions of individual reach types. It is expected that it will require the full 10 years to be able to recognize a change of the magnitude expected for our two study watersheds. This will require gathering a baseline for habitat condition near the beginning of the study period and again toward the end. In reality, given the size of this basin, we may need to continue to monitor most of our key habitat variables annually.
Specific comments:	
Another inconsistency between the description of the population monitoring in Appendix B and the habitat assessment presented in Appendices A and C was the stratification of stream reaches. The description of the population modeling indicated that stream reaches would be stratified by land use. Habitat conditions for unsampled reaches would be assumed to be the same as those at the measured stream reaches in the same land use class. In contrast, Appendix C indicates that the reach-level stratification that will be used to	We will address these appendices to match the proposal. Stratification needs to occur before the study begins to account for natural variation. Both reach scale attributes and land-use will be used to stratify these areas. Appendix B will match Appendix C in terms of the approaches used (i.e. land use as well as Intrinsic watershed factors). One of the objectives of this study is to compare different classification systems.

extrapolate habitat condition to unsampled reaches will be based on physical characteristics of the channel and its valley, including channel size, gradient, and confinement. It is likely that both physical setting and land use will influence habitat. But assuming which stratification approach is best prior to collecting the data seems premature. The data collected in this study would enable a very thorough exploration of the relationships between landscape features and channel habitat conditions. These empirical relationships could then be used to predict habitat conditions at sites without data. It also was not clear how land will be associated with a stream segment. Will only the land use immediately adjacent to the channel segment be considered? What about land use upstream from the segment? This would seem to be especially important for attributes like sediment or temperature where the effects at one location can readily be transported downstream.	We will address issues upstream as well. One of our goals is to test the hypothesis whether restoration occurring within a limited buffer strip vs. total restoration within a watershed area presents a stronger signal in terms of fish response.
More importantly, while the proposal does a very thorough job of describing the approach that will be used to link various aspects of habitat condition to Chinook demographic response, it leaves many questions unanswered about how the relationship between habitat restoration and in-stream condition will be measured, and over what time frame. For example, will it be assumed in the modeling exercises that stream habitat will respond immediately to restoration? This may be the case for some actions such as water rights transfers, tributary reconnection, or pushup dam removal but other actions such as riparian re-vegetation will show a delayed response. It is unclear how this delay would be factored into the models. The extent of these time lags can be influenced by quite subtle elements of spatial structure of the watershed and the population. These time lags may make it very difficult to tie specific improvement projects to particular population changes. It may also mean that the desired population changes may not occur within the time constraints of this project.	The intent of this study is to estimate mechanistic relationships between habitat function and Chinook population dynamics. In phase I of this project we will collect field data on habitat condition and tie it to Chinook life-history based population estimates. Once this is established, we can establish large scale understanding between life-history variation in Chinook for the upper Grande Ronde and Catherine creek and tie it to habitat functionality (see attached figure). Habitat condition will be measured for the two basins temporally and compared to reference sites for habitat functionality (eg. Wenaha and/or Minam for reference sites). Based on the model we can hypothesize the effects of restoration and how this might occur on time lags or spatial scales greater than the duration of this project.
Other concerns:	We will probably only be able to assess cumulative effects over time. Through structural equation and

1. Is there any way within the study design to determine which restoration efforts are most effective in achieving their habitat goals? Additionally, the proposal skirts the issue of natural disturbances and how their effects would impact study design. As an example, how would the impact of a severe wildfire be partitioned from changes related to restoration actions?	multivariate modeling we may be able to parse out which actions are the largest contributors to achieving habitat goals. However we suspect that restoration activities have limited, diffuse effects as they propagate downstream a river network. We presume that detecting change due to restoration efforts will involve examining effects over larger spatial scales and longer time scales than previous studies.
2. It is not clear that the proposed time schedule is realistic to develop a robust model. Normal temporal variation in environmental conditions could well obscure the response of the populations to habitat changes.	This project is anticipated lasting 9 years from date of initiation. During this timeframe, we expect that the model should be able to meaningfully predict, based upon empirical data collected on the study streams and literature information on the impacts of key habitat variables, the response of Chinook during their freshwater life cycle. This model could be improved with time available to explore in-situ impacts of sediment on survival. Impacts of water temperature will be explored on the basis of fish densities by reach thermal type (e.g., longitudinal distribution) or growth rates by reach thermal type. Fuller understanding of the response will also come about by incorporation of certain other key habitat variables, such as pool frequency and pool volume. Models always become more robust with use, and ours would be no different. As far as natural disturbances affecting the design, we should be able to hypothesize effects within our modeling framework and the long-term effects on stream-type Chinook being modeled. Temporal variation in environmental conditions can obscure the response of populations to habitat change that should be attributed to restoration. For example, a high flow year might cause an accumulation of fine sediment to be transported out of a study reach in both restored and reference reaches. If restoration addressed the riparian road density, there might actually be a reduction in sediment delivery to the study reach. This effect might be small enough that the variation in natural rates of sediment transport out of the reach obscure the benefit of road obliteration. A long-term study might be needed to demonstrate that under all annual streamflow

	conditions, the in-channel fine sediment conditions are improving. If annual variations in fines are high in reference streams, the incremental improvements due to restoration might need to accumulate for many years to become measurable. The magnitude of improvement expected in the BiOp to address the survival gap was relatively high for these study basins, so it may be feasible to observe fine sediment conditions in a multitude of study reaches under a variety of annual antecedent flow conditions.
3. It is likely that the basic habitat characteristics of water temperature, fine sediment, stream flow, and riparian condition have a nonlinear impact on the spring Chinook population. For example, water temperature often has a nonlinear effect, as well as a threshold effect at the upper end of its range. This is also true for stream flow though this problem is substantially reduced by breaking the population model for the first year into several subclasses as the authors have proposed. How will nonlinear effects be incorporated?	Yes, that is true. We intend to use our model to identify the effects we might expect to see in the long-term (>10 years) or short term (given the natural variation in the system). Each of the habitat-biotic response relationships that we plan to incorporate into our model likely has non-linear behavior. For example, the relationships described in the literature for survival to emergence vs. percentage fine sediment have taken a variety of linear to non-linear forms. When all habitat-biotic response relationships are combined in a model, the overall response may also be non-linear. We have the capability and expertise to incorporate non-linear effects in our models.
4. There are implicit assumptions in the proposal that the proponents can select the most meaningful habitat attributes from a few key limiting factors, measure them accurately and precisely, and translate results via the model to an improved understanding of fish/habitat relationships locally and basinwide. Is there evidence in the literature to support these assumptions? The proponents need to review and evaluate the successes and failures in other studies and clearly identify what aspects of their particular study will allow them to succeed where others have not.	The modeling framework can be adapted to incorporate non-linear effects. We will explore alternative structures and how this might affect the overall outcome. There was an extensive review in the sub-basin plan and we chose these factors as our starting point (Grand Ronde Subbasin Plan 2005). If these limiting factors fail, we will look for other limiting factors. We will explore other habitat factors such as pool frequencies and stream bank stability at other times, but at this point we will focus our sampling intensity on these attributes.
5. The use of the fine-scale relationships to construct the models and their expansion	There is error involved in all studies of the effect of

to mid-level and basinwide estimates could lead to a potential for propagation of error. That is, fairly narrow confidence intervals at the fine scale can lead to fairly wide confidence intervals at the mid-scale and to very wide confidence intervals at the large scale. How this issue will be dealt with needs to be addressed more effectively. An appropriate place to consider the effects of propagation of error would be Figure 2, where there is measurement error associated with each of the boxes depicted.	fine sediment in spawning gravels on survival to emergence. However, all studies reveal a consistent directionality in survival vs. fine sediment concentration. The uncertainty is in how great the negative impact is. Consequently, this source of error could make our overall estimate of impact conservative or liberal. On this basis, if we were to confirm or deny the achievement of the BiOp goal for level of improvement in survival, we would have to consider the slope of the curve in this regression. For management purposes, it probably makes little difference that there was variability about the regression lines in a variety of laboratory studies of survival to emergence. The key to these studies is the slope of the regression. There is also going to be error involved in our empirical measurements of fine sediment in individual spawning reaches. All reaches that we sample throughout the basin will have various levels of variance in fine sediments in McNeil core samples. We expect to be able to interpret fine sediment concentrations in relation to channel gradient or stream power. This would allow reach-based estimates to be extrapolated to other unsampled reaches. If stream power supplies a useful tool for describing distribution of fines, our measures of streamflow and application of stream gauging statistics to ungauged stream cross sections would help in extrapolating fines to unsampled reaches. Depending upon the variance in this regression of fines on channel gradient or stream power, the extrapolation to the entire spawning stream network will be made with minimized error. In addition, one of our planned modeling approaches is the use of structural equation models, which accounts for measurement error via analysis of covariance tables and through the use of latent variables. Multiple measures of the same theoretical construct (e.g., measuring percent surface fines and using McNeil sampling to measure “sediment load”) in structural equation models is an effective method for assessing measurement error.
6. The proposal related the work to some existing restoration efforts elsewhere in	The model developed based on empirical measurements will be stochastic in nature. This

the Grande Ronde and John Day Rivers. The proponents also connected this work to the Landscape Genetics project and the Climate Change project, both associated CRITFC Accord projects. However, there was not an adequate evaluation of how the results of those studies, some of which are in the Grande Ronde Basin, can and should be used in this proposed study. In addition, Van Dyke's (2009) field study in the Grande Ronde basin (conducted by ODFW), which involved very similar issues as this proposed study, albeit for one aspect of Chinook salmon's life history, was not included.	will give us estimates of uncertainty in the predictions. The model design for the functional link portion of study is analogous to the Shiraz model (Scheuerell et. al. 2007). In addition, the classification of reaches will account for a large degree of uncertainty when we collapse finer strata (habitat units and reaches) to larger units (basins). Climate scenarios obtained from the other Accord projects will be incorporated either as temperature or flow constraints to the modeling framework that will enable us to determine long term effects (either through air/ water temperature relationships or through an increased frequency of low flow events or air temperature increases that cause the temperature model to predict greater water temperatures under a defined riparian canopy shading condition). From the Accord Landscape Genetics work, we can use landscape variables to hypothesize small scale changes in genetic variation in these areas based on tissue samples collected from adults or juveniles in various tributaries or locations in the mainstem Grande Ronde or Catherine Creek that are classified by key habitat variables. Juvenile data can express local affinity of a genetic variant to environmental conditions. Tissue samples collected from adults passing upstream through weirs can reveal overall population genetic variation which can be compared with carcass genetic material from specific locales within the spawning distribution. Reference list now includes Van Dyke. We will include Van Dyke's findings in our work.
It was not clear in the proposal why a five-year evaluation period was selected for habitat analysis, Chinook population analysis, and model development in the upper Grande Ronde River and Catherine Creek. The ISRP needs information concerning why five years are believed to be sufficient: (1) to detect the life cycle-specific impacts of changes in temperature, fine sediment, and streamflow on overall demographic response; (2) to demonstrate the relationship between restoration projects and habitat improvement or	A 5-year period represents the completion of one complete Chinook life cycle. This will capture some of the inter-annual variation in brood year returns that we might expect to see on spring Chinook abundance and productivity. In addition, we hope we will have sufficient contrast in spawning densities given this time period. We originally conceived of our Accord habitat project as two 5-year projects where we could study first, two highly damaged watersheds

continued degradation; and (3) to test the hypothesis that temperature, fine sediment, and limited streamflow are the principal limiting factors for spring Chinook in this subbasin.	supporting spring Chinook populations of high value to viability of an MPG, followed by two watersheds having lesser impacts. The idea was that it might be feasible to conduct LiDAR, FLIR, and temperature modeling work on all four of these systems in a 10-year period and the work done in each 5-year period would be similar in the two pairs of watersheds. However, it is true that all of the responses being monitored will likely take many years to become fully realized, or even be able to demonstrate the expected magnitude of change within the full 10-year period. These habitat changes really need to be studied for at least the next 2 or 3 decades. For this 10-year project, we realize now that there will be great value in studying the restoration in the Grande Ronde and Catherine Creek for the full 10 years. However, we expect to be able to employ a type of rotating panel design where some sites are monitored each year and others are monitored every 3 years, for example. This could give us at least 3 points on a trendline for all sites in the first 10 years. We also intend to monitor selected reference reaches in other similar watersheds within the Grande Ronde subbasin, such as the Wenaha and Minam. These can be good references for sediment and temperature conditions within the key spawning areas to contrast with those in the GR and CC. These reference sites can also be used for contrasting to the GR and CC in studies of Chinook growth rates in stream reach types or in contrasting macroinvertebrate drift rates and species composition (aquatic and terrestrial).
The timeframe is especially short if a BACI design at multiple spatial scales is to be employed for the study. A BACI design requires the collection of pre-treatment data that ideally consists of three or more years for the fish data. Were this to occur, followed by treatment application in year four, post-treatment data collection would be limited to a single year.	We agree with the statement about the timeframe needed to accomplish a BACI design. In this case, 5 years is not sufficient to define before and after conditions. It is unlikely that there are experimental systems set up in the GR or CC that are amenable to a BACI design at the scale of the entire watershed. There would be no capability to find another watershed similar to the GR having the same distribution of impacts, but without any restoration occurring, or

	with the same pattern and level of past restoration, but with no new restoration. Also, it is not reasonable to think that any watershed will restrain all restoration activities for the duration of the "before" period. If there are only 2 study watersheds and 2 control (reference) watersheds, this may not be sufficient to control the level of natural disturbance. A landslide even in one control watershed could be a chance event that would make any restoration appear to be effective in a treatment watershed by comparison. At the scale of tributaries, there may be more potential to demonstrate the effectiveness of specific restoration actions. The same difficulty occurs with establishing a "before" comparison. But, there are more opportunities to find other reference conditions. In the process of monitoring the trends in fine sediment at the entire watershed scale, for example, we will need to monitor reaches in a multitude of tributaries. These data should provide the ability to compare sites in terms of treatment and reference, or rather a continuum of treatment to reference conditions. The restoration being conducted on McCoy Creek by the CTUIR represents probably the most extensive restoration work being done on a tributary within the GR. Following trends in fine sediment in this stream might allow comparison with other similar streams in the watershed and would likely be able to demonstrate an effect within 10 years because the magnitude of the restoration action is so great.
The relatively short timeframe of the study also will make it difficult to address interannual variations in climate. Large storms or droughts can impact the relationship between habitat condition and survival. The BACI design, preferred in this study, does help to address this problem assuming that a reference watershed is established (see comment below). But these factors can cause large variations in survival making it difficult to accurately determine the relationship between habitat conditions and population performance. Ideally, this problem could be resolved by an understanding of how habitat conditions affect salmon under various climate regimes but	We intend to have some index sites established that we will monitor every year to assess change in habitat, but we will rely on the fish-habitat model to assess changes in fish densities over time.

developing this information would be a long-term effort.	
Reference/treatment pairs are required to interpret fish response at all spatial scales that will be investigated in this study. However, the proposal indicates that there will be no reference or control at the watershed scale. Appendix A lists restoration actions will be occurring during the study period in both the Upper Grande Ronde and Catherine Creek. As a result, it will be very difficult, or impossible, to evaluate the impact that multiple restoration actions within the watershed will have on egg-smolt survival and watershed-scale carrying capacity. To have a reference site at the watershed scale demands that restoration activities be suspended in one watershed for the duration of the study.	We will assess treatment/reference effects. We will sample an array of differentially impacted sites (upper Grande Ronde, Catherine creek with reference to some site). We will do this in 2 ways: 1) We will have measurable attributes in a fixed number of sites in each of these watersheds and compare them to reference sites over time. Implicit in this analysis is that the habitat treatments have cumulative effects on the basin as represented by these sites, and we can compare and contrast these results using an ANOVA design. 2) The second option will look at a measured response (e.g., fish density) as a function of sediment, temperature and flow at each of these sites, and account for differences occurring in our response as a function of habitat restoration work. It is not realistic to think that we would find watersheds where restoration activities would be suspended for the duration of a study. Also, it may not be possible to perfectly match the level of background anthropogenic impact in two streams (a treatment and a control). We hope to be able to develop indices of magnitude of impact and its effective strength at a stream reach. For example, the effectiveness of an impact on a reach is likely a function of the size of the impact and its instream distance from the source. If sediment impacts can be indexed by the predicted level of sediment production or delivery to a study reach, there would be a quantitative or semi-quantitative index to fine sediment in the study reach.
There are a number of aspects of data collection that need clarification. The ISRP notes that some of the work elements such as 1-m resolution LiDAR including vegetation interpretation and Forward-Looking Infrared (FLiR) analysis of streams in the study sites are likely to be quite costly. Have qualified subcontractors been selected to do the work? Likewise, the fish tracking research involving PIT-tagged individuals will involve fairly	We have selected a qualified subcontractor for the LiDAR work (i.e., Watershed Sciences, Inc.). This was via a competitive bid process. We also received several independent recommendations for using the services of Watershed Sciences from knowledgeable staff at regional agencies. The LiDAR data have already been collected for our study streams in summer of 2009.

large numbers of marked fish including small fish that are carrying dye markers and both the tagging and mark census efforts will be time consuming and expensive. Application of restoration treatments also will present a challenge. In order to alter habitat condition sufficiently to cause a detectable fish population response, multiple treatments will be required, applied over a very short period of time as noted in the discussion of the project timeline above. Application of these treatments will be very expensive and require a huge amount of planning and coordination. This problem was not addressed in the proposal. Sample size determination, based on the targeted CV and signal to noise ratio, provided on page 27, is not adequately justified.	We agree that the best opportunity to detect a response signal from habitat restoration work is to monitor a reach having multiple treatments or at least some very intense treatment. We agree that this work is expensive, but we are not funded to do restoration work or planning. This is the responsibility of federal and state agencies or the tribes. We are merely monitoring the results of the level of restoration activity that has been done or is planned, and taking the combined exisiting restoration efforts as "natural experiments." It is quite possible that the cumulative restoration efforts do not make up for the cumulative negative land use impacts (e.g., grazing), and one of our findings might be that not enough restoration is being conducted, with recommendations for how much restoration needs to be done to see improvement in Chinook populations. The assumption made in the BiOp was that the level of restoration being planned would be sufficient to result in the magnitude of improvement in Chinook productivity noted (see Accord agreement for a table of anticipated benefits). The estimated improvements expected for the UGR and CC were substantial for a 10-year period and may or may not be achievable. We hope to produce a method that would make these kinds of predictions more reliable. We also hope to produce a monitoring design that would make it feasible to monitor a trend in these kinds of limiting factors so that it can be determined whether the expected improvement in survival actually occurred. To some extent, we may be able to estimate whether the implemented restoration actions would result in the expected survival improvements if enough time were allowed for the project to mature (i.e., for the lag times to be overcome). For example, the temperature model we intend to build is expected to permit scenario building to explore levels of riparian shade restoration by stream reach, an effect with a very large time lag granted it takes decades for trees to grow up.
The study will focus on a few limiting factors that are assumed to constrain Chinook salmon production at the study sites. The reduction in assessed habitat factors to those few considered to be critical is an improvement over the approach	We agree that there are likely limiting factors other than those highlighted in subbasin plans or EDT, even though these limiting factors were itemized by knowledgeable basin experts. For example, our initial scoping year of work in the

used in EDT. But it also is important to include measures in the study to determine if key limiting factors have been omitted. Perhaps some exploratory sampling or small-scale experiments could be incorporated into the study to ensure that potential issues, like chemical contamination, are not preventing responses to the improvement in other habitat factors.	UGR and CC indicated that primary pool habitats for adult holding are minimal. The availability of cold water in holding pools would also constrain population abundance and survival. We noted that habitat factors such as this would need to be monitored in future years to estimate carrying capacity, which is both a survival and abundance effect.
a. Water temperature Locations of stream temperature monitoring sites are shown in Figure 3 of Appendix A1; however, it was not clear how these locations related to the locations of habitat restoration projects. Will the recording thermographs be able to detect the signature of habitat improvement efforts?	Sites for placing stream water temperature loggers were selected based on the physical requirements of providing input data to the water temperature model. The model can be best calibrated by having loggers recording data upstream of nodes in the stream network where tributaries enter mainstems. There is no direct connection between these sites and the location of restoration projects. When combined with FLIR data, the model will be able to predict water temperature on a spatially continuous basis which will incorporate upstream and downstream ends of all individual restoration projects. A future repeat of the FLIR data collection would be effective in demonstrating improvements in the water temperature spatial distribution but the network of temperature loggers will also provide data on the maximum annual temperatures by site, which can be tracked in time. We anticipate placing approximately 70 loggers throughout the two study basins. This intense coverage should provide a means to track trends in water temperatures that are a result of cumulative changes on a watershed basis above each monitoring site. However, if we do identify specific streamside restoration projects, temperature loggers upstream and immediately downstream of these projects could be most effective and economical as a means of demonstrating the thermal benefits of specific projects.
b. Habitat restoration treatments Tables 1-4 in Appendix A1 give lists of restoration priorities and specific habitat improvement actions for the *entire* Grande Ronde subbasin, but they do not highlight the projects that will take place within the proposed study areas of Catherine	To a great extent, the geographic specificity of restoration projects undertaken in the past and proposed in the future is poor. We have recently obtained from the Grande Ronde Model Watershed group a database listing all projects conducted in the basin and proposed. The locations are often vague and will require doing substantial investigation to piece together exactly

Creek and the upper Grande Ronde River. Where are the existing restoration projects located within the study areas? Will they affect enough length of the streams to have a reasonable chance of being measured in terms of fish response?	which reaches were involved and how much restoration actually took place. It is virtually a research project in itself to define the extent of restoration completed and planned. It remains unclear, then, whether enough restoration is planned in the UGR or Catherine Creek to be able to detect a change in key habitat limiting factors. It is not the scope of our project to plan or propose any restoration. We are merely attempting to monitor habitat and fish population response in a way that can confirm whether the improvements in habitat quality and Chinook productivity in the BiOp are occurring or were reasonable.
c. Fine sediment It would helpful to give some indication of how ambitious the fine sediment sampling regime would be. Sieving many samples and weighing the fractions takes considerable time. Do the proponents have the facilities and staff to carry out the sediment sampling program? Approximately how many samples will be taken during the initial scoping year? If a comprehensive sampling program cannot be implemented, how will subsequent sampling be stratified to reduce costs but still achieve project objectives?	In the initial scoping year over a 5-day period we took McNeil depth fines samples on the Grande Ronde mainstem (5), Fly Creek (5), Limber Jim (5), Sheep Creek (5), and Meadow Creek (5). This is a total of 25 samples. We preliminarily consider 5 samples for a reach class to be the minimum needed but the results of this preliminary sample may indicate enough variation that we will need to increase our sample size. We want to take samples throughout the currently used spawning habitat, which will require collecting samples soon after emergence is complete. We mapped all redd locations for the 2009 brood year with the Trimble GPS unit and photographed each redd. Relocating these points will allow us to assess fine sediment concentrations after emergence is complete. In addition, we want to sample areas not currently spawning areas but known to be used historically, in order to determine how much improvement would be needed to restore these sites to a level where they could again be productive. All reaches would be identified by reach class. Classes would be identified at a minimum by gradient. Recent analysis that we completed on several years of percentage fines data from the Entiat River indicated a strong correlation with stream gradient. Such a relationship established in the UGR and CC would allow us to reduce our sampling intensity and extrapolate fine sediment results on the basis of gradient. It is likely that level of watershed or streamside disturbance (e.g., level of grazing) would also set the background conditions for fines to be expressed in relation to gradient.

d. Streamflow It was unclear how many stream gauging sites will be installed in this study or if the project will simply make use of existing gauging stations and attempt to draw discharge inferences from correlations between study sites and locations with gauged flow. In addition, the methods used to relate flow improvements in reaches receiving restoration treatments were not described in adequate detail.	The proposal specified installing two flow gauges. We were not able to accomplish this in our initial year because it took considerable time getting the location data of all flow gauges already installed in these basins. We have made good progress in assembling these data, and when complete, we will be able to assess where additional gauges would be needed. Our intent is to use data from all existing gauges to allow prediction of flows at any ungauged site. Diversions or irrigation from groundwater sources connected hydraulically to surface water appear not to be significant for the upper 80% (approx.) of each study basin but are significant in the lower parts of each basin. Hydrological analyses available from the Oregon Water Resources Department provide summer low flow statistics for many of the tributaries in the UGR and CC. A comparison of these flow statistics with those calculated from data collected at all available UGR and CC flow sites should allow estimation of the flow deficits created from watershed development. Future climate change scenarios may indicate changes in date of completion of snow melt or total annual precipitation, which could be related to percentage reductions in summer flows. Stage-discharge relationships could then be used to estimate percentage changes in available spawning area during the September period. Methods for computing these flow statistics are detailed in Orsborn (1990).
e. Channel parameters There did not appear to be any surveys of habitat unit (riffle and pool) frequency. How will cross-sectional data be translated unto habitat parameters that can be related in a quantitative way to spring Chinook abundance or survival?	It is true that we did not identify conducting riffle-pool habitat surveys for year 1. Stream cross-section data will be needed at streamflow location sites for calculating streamflows. These sites can also serve as long-term sites for evaluating changes in channel bed elevations, cross-section channel form, or channel width and mean depth. Site-specific analysis of changes in channel aggradation-degradation might better be detected by conducting an extensive survey of selected response reaches with multiple, closely spaced cross-sections to represent the 3-dimensional volume of channel alluvium over time. Cross-section data will also be used to develop relationships between drainage area and channel

	bankfull and water surface wetted width. The ICTRT made predictions of the extent of the stream network that would potentially support spawning on the basis of wetted width for spring Chinook. Our cross-sectional analysis for the UGR and CC will allow improvement on these ICTRT estimates. It is true that spring Chinook abundance estimates will depend upon obtaining data on riffle-pool frequencies. We anticipate being able to use the high quality LiDAR data to derive accurate water surface gradient profiles that may be able to identify key breaks between riffles and pools. LiDAR data will be supported with color video or aerial photography on the full drainage network flown for LiDAR. We expect that pool locations can be mapped from the combination of LiDAR and aerial photos. This can be ground-truthed using a sub-sample procedure.
f. Vegetation (including in-stream large wood) How will riparian vegetation surveys be related quantitatively or qualitatively to fish habitat quality and productivity? Appendix A2, beginning on page 6, describes the process, but what will be done to verify the assumptions given in Appendix A2, Table 4 and Table 5, about habitat composition and Chinook abundance? The Bjornn data are a good starting point, but additional field verification is needed.	Riparian vegetation will initially be mapped using LiDAR. LiDAR will provide information on the height distribution and volume of riparian vegetation. It will also define riparian buffer width, channel orientation and buffer gap width. With these data, solar radiation penetration to the stream can be calculated mathematically for any day and time. This information will then be applied with the water temperature model to calculate current daily maximum water temperature. Summer rearing survivals and population distribution will be estimated using literature information on physiological thermal tolerance, behavior under thermal regimes, and distribution information relative to competing species. Vegetation surveys on the ground in future years will be used to confirm gross vegetation mapping afforded by LiDAR and aerial photos, such as tree/shrub/grass cover, canopy height, width, and shading. More detailed riparian vegetation analysis could be applied in specific reaches where juvenile summer rearing growth rates or migration behavior is studied. Growth rates would be a good indication of temperature suitability of specific reaches and survival effects.

	Riparian composition types will be used in the growth studies as an index to the food availability. Invertebrate food supplies in the drift come either from benthic sources or from terrestrial sources (i.e., primarily from streamside vegetation). Riparian vegetation type defines the diversity of organic matter inputs to the reach and its sustainability throughout the year as a food base. Riparian shading also indicates the balance between detrital inputs and autochthonous production. The types (species, sizes, seasonal timing, lipid content) of invertebrate input into drift probably relate to riparian characteristics. Growth rates are expected to be a function of water temperature, food availability, and inter-and intra-specific competition intensities. Intensity of competition is expected to be a function of the number and density of fish species populations involved at a stream reach type.
g. Anthropogenic impacts Spatially referenced maps of grazing pressure, as outlined in Appendix A1, should be very helpful. A simple correlation approach between road density and sediment and temperature levels may be fine for routine watershed assessments, but for this project a better understanding of the mechanisms driving habitat changes is needed. This may be accomplished by an inventory of road crossings, direct-entry culverts, length of stream channel directly impacted by road-related riparian shade removal, and other more causative metrics.	We agree with this perspective. Anthropogenic impacts related to sediment delivery may include factors such as grazing intensity, road density, logging intensity, mining, etc. Grazing, roading, logging, and mining would need to be described in terms of occurrence in streamside zones vs. upslope area. The landforms where the impacts occur can be classified according to landscape sensitivity (e.g., erosivity) and sediment transport capacity to streams. Relative to the effectiveness of the impact on a stream reach of interest (i.e., response reach, or the site where the cumulative effect of upstream impacts is monitored), the intensity of the impact, area involved, and instream distance to the response reach must all be considered. Impact can be an inverse function of distance from the source of impact (e.g., instream distance to the centroid of the source) and a direct function of size of the area affected. For estimation of sediment impacts in either a correlation sense or a quantitative predictor, roads would need to be classified by length, width, surface type, width of the cut and fill slopes, presence of roadside ditches of various types, and location of output from roadside culverts. Road location would need to be assessed according to erosion potential, which might be a function of slope gradient, soil depth, lithology, vegetative

	cover, precipitation zone, etc. To the extent that we are able to use GIS, LiDAR, aerial photography, available maps to identify sources and conditions of anthropogenic impacts, we may be able to develop semi-quantitative indices of impact strength. However, it is probably beyond the scope of our generally broad-scale study of these large study basins to get into fine-scale mechanistic explanations of sediment dynamics. Temperature dynamics will be relatively well described quantitatively by application of LiDAR data and the temperature model. This is based upon well established physical processes.
h. Biota Estimating food availability to drift-feeding fishes is one of the most difficult measurements in aquatic ecology. Considerable resources can be expended with few conclusive results to show for the effort. An invertebrate sampling program, if implemented, should be carefully reviewed by an aquatic entomologist. Care should be taken to estimate the contribution of terrestrial invertebrates as well as aquatic invertebrates to Chinook diets. There appear to be some inconsistencies between the proposal and Appendix A in the approach that will be used to evaluate food availability for Chinook salmon. The proposal document indicates that the macroinvertebrate community will be evaluated with one of the widely used indices of community integrity. Available indices are mostly focused on water quality and these may not provide a reliable indication of invertebrates that are of greatest significance to juvenile Chinook. The methods described in Appendix A are more compatible with the objectives of the study in that they will provide an indication of macroinvertebrate density in the drift, a parameter more indicative of the food resource for the fish. It might also be worthwhile to compare the composition of the drift with Chinook dietary preferences derived from literature information, possibly augmented with evaluation of gut contents at the study sites.	We agree that measurement of invertebrate drift food organisms must differentiate aquatic and terrestrial sources. Species composition for drift should provide an indication of the seasonality of the food supply. Riparian structure and diversity has often been associated with the diversity, abundance, and seasonality of terrestrial invertebrate input to the drift. The same riparian characteristics partially define the aquatic community composition. Functional feeding group assemblages are found in proportion to the sources of organic matter in the stream reach. These aquatic organisms have varying propensities for entering the drift at various stages of their life cycle (also with season). Size distribution, biomass flux, and species composition, along with published accounts of caloric equivilents, can be used to estimate the nutrient or caloric content of the drift. Food electivity could be assumed to be a function of size of particle in relation to the size of the fish. Alternatively, with empirical information on food preference as suggested based on gut content analysis, we might weight the particles available by caloric content. Monthly food availability (i.e., sustainability of the food resource during the growing season and in relation to temperature regime) would be critical in predicting the growth potential and validating this by measured growth rates.
i. Fish populations	Referring to our new figure (see attached), one

Some of the details regarding life cycle-specific survival determinations seem to be missing. For example, how will intragravel egg-to-fry survival be measured? Will redd capping, as recommended by Chapman and McLeod be used? Because of the ESA status of spring Chinook in this subbasin, will it be possible to get a permit to handle enough fish for PIT-tagging, electrofishing, stomach pumping, blood withdrawals, and other activities to achieve sufficient sample sizes for the study? The PIT-tag antenna array is a good idea and should provide useful information, by tracking movements of individuals, on whether spring Chinook in the upper Grande Ronde all conform to a single life cycle strategy.	component of this study involves first measuring key limiting factors in the field, then using functional relationships established in the best evidence from scientific literature to model the predicted Chinook biological parameters. Intragravel egg-to-fry survival will be estimated from fine sediment concentrations measured in GPS-located Chinook redds from various reach types (e.g., gradient classes). Another component of our study involves direct measurement of Chinook biological parameters such as estimates of spawning density (already conducted summer of 2009), young-of-the-year estimates via streamside visual surveys, early and late-summer rearing abundance via snorkeling and/or electrofishing. Conducting instream estimates of STE (survival to emergence), although desirable, would be beyond the feasibility of a project of our funding level and scope.
Appendix B indicates that carrying capacity of various stream reaches will be determined empirically. It would seem that an empirical estimate of capacity would require fully-seeded conditions, which seems unlikely to be achieved at very many of the study sites given the current abundance of spring Chinook salmon in the watershed. The authors indicate that they will use a sensitivity analysis to account for underseeding in estimating carrying capacity, but the proposal does not explain how this approach would enable carrying capacity of a stream segment to be estimated.	We agree that empirical estimation of the carrying capacity for the entire Grande Ronde or CC systems as a whole in its current condition would imply testing various stocking levels up to and beyond full seeding. However, to the extent that we can do either snorkeling or electroherding to estimate juvenile densities by reach type, we can generate an understanding of the relationship between reach quality (habitat unit composition, habitat quality) and fish density for the lower range of densities that might be expected. We may have an opportunity in coming years to combine our growth rate studies with studies of stocking density in comparable test reaches in the mainstem GR and CC. It may be feasible to block various reaches and measure growth rates and current seeding densities, and 25%, 50%, 100%, and 125% stocking density. These studies would also be accompanied by assessing survival (decline in population abundance by reach) over the summer period. Comparison of different thermal regimes would make this study more meaningful. The ability to estimate carrying capacity for restored conditions for the historically used habitats would have to be made based on information abstracted from other stream systems as well as empirical observations in the UGR and

	CC, and from our modeling of the restored condition of the stream systems. Thus, based on the literature, and our observations, we can generate different population trajectories based on different assumptions and data, and simulate the effect on the Spring Chinook stock.
3. M&E (section G, and F) It is not clear why representative reaches were selected by channel gradient, watershed area class, and valley width class, as opposed to the more commonly-used stream segment classification system of Montgomery and Buffington, with reaches selected from a "rotating panel" EMAP-type design. However, if site access in the area is as difficult as the proposal suggests, perhaps selection of study reaches will be dictated more by land ownership than by valley and channel morphology. The ISRP agrees this is not an easy task.	Access to sites is a very difficult problem in these two study basins that are so critical to the viability of the Grande Ronde major population group (MPG). In the UGR, the historic key spawning area was found on the segments of the mainstem Grande Ronde and Sheep Creek location on the Vey Meadows area. Access has been denied to biologists in these extensive, low gradient areas for years. So, certain geomorphic conditions many not be well represented in our sampling. This also becomes a problem in accounting for annual variations in smolt production. Although we realize that an EMAP-type design is widely used in the region to track trends in habitat conditions, we believe that the purposes of developing a spatial integration of habitat condition that would allow calculation of a weighted survival and abundance for spring Chinook can only be done using a systematic, classification approach, not unlike but not identical to the approach of Montgomery and Buffington. We also suspect that the smaller spatial scale of our study (compared to most EMAP projects) warrants more frequent visitation of individual sites than the rotating panel design would permit. We propose classifying stream reaches for monitoring trends over the 10-year period of this Accord project and beyond, hopefully. We like the concept of monitoring some stream reaches annually, with others being monitored in a rotating panel design at longer intervals. Given the time needed to generate a basin-wide estimate of sediment conditions, a full basin evaluation, stratifying by reach types, might take up to three years to complete. Trends in condition (e.g., sediment) for annual or triennial samples from a set of 60 to 100 representative sample sites should provide strong evidence of local and cumulative upstream restoration (or indicate the net change

	in management effect, where active restoration is balanced against negative anthropogenic impacts). The integration of the fish life stage survivals predicted from all of these habitat quality factors and sites (by weighting sites according to their proportional occurrence) would be a good indicator of overall upstream watershed condition trend over time. We also expect that the trends of many of the local monitoring sites can be explained by a qualitative or quantitative analysis of the local (lateral) and cumulative upstream restoration history. ISRP review comments allowed us to evaluate exactly how we plan to use stream classification in our study. Stream classification has a long history of use in aquatic ecology (e.g., Frič 1872, Strahler 1952, Huet 1959, Warren 1979, Vannote *et al.* 1980, Frissell *et al.* 1986, Hawkins *et al.* 1993, Rosgen 1994, Montgomery & Buffington 1997). Classification systems are used, among other reasons, to (1) identify sample units of similar zoogeographic and physio-chemical nature for comparison of site characteristics across broad regions (Stoddard 2004) and (2) for guiding restoration efforts in geomorphically-similar river sections having the capacity to respond to treatments in a parallel manner (Ebersole & Liss 1997). In this project, a hierarchically-nested stream classification (*sensu* Frissell *et al.* 1986) will be used to guide selection of monitoring sites for key limiting factors of Chinook salmon at different life history stages (Fig. 1). For example, a simple classification system based on valley form and average channel gradient (Cupp 1989) could be used to stratify sampling effort throughout the upper Grande Ronde and Catherine Creek watersheds. This classification could then be extended to other, comparable tributaries in the basin with minimal habitat degradation so that sites with negligible human impact can be incorporated into analyses. EMAP's rotating panel design using GRTS (Stevens 1997) also recommends the use of a particular classification system—Montgomery and Buffington's (1997) delineation of gradient and bed-form types—in order to stratify ecologically-comparable sites. Later as this project evolves, various classification

systems can be overlaid on the initial, simple classification scheme to examine how model output changes under different classification scenarios. Because this project aims to describe the relative influence of anthropogenic factors (e.g., the cumulative effects of land use *vs.* restoration) on key limiting factors for Chinook salmon using a transparent stream classification process, findings could later be extrapolated to other basins with similar physio-chemical properties and scenarios of anthropogenic impacts.

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It appears, at least initially, that many of the modeled outcomes will be based on information from the scientific literature. For example as stated in Appendix C, page 1, “the potential impact of summer water temperature regimes on summer rearing survival will be assessed from available literature”. While such assumptions form the basis for testable hypotheses, the most critical assumptions will need to be field validated at some point. The proposal acknowledges this problem but does not explain how the study will separate temperature effects from the effects of other environmental factors. With regard to sediment monitoring, Appendix C does not explain how surface fines can be substituted for sub-surface fines in the context of inferring quantitative impacts on Chinook egg survival. Appendix C provides few details on the habitat monitoring and evaluation design.	Our proposal indicates the use of literature information to model the effect of water temperature and fine sediment on survivals during the summer rearing and the winter incubation periods, respectively. In the modeling realm, these factors are separated because they are multiplicative impacts that occur in sequence, from one life stage to the next. Each effect is based on experimental studies. For temperature, most useful studies would be laboratory studies that allow distinguishing thermal death from death by disease, competition, bioenergetic depletion, behavioral avoidance, etc. Field studies of thermal effects are generally not capable of distinguishing all the mechanisms for mortality or reduction in population density in a reach from one time period to the next. Consequently, field-based evidence is more correlative in nature. Growth rates of individuals in the field that are known to occupy a reach having measured thermal characteristics would constitute a useful validation exercise of the impact of water temperature regime on fish viability. Studies of movement patterns and fish densities by temperature zone that were mentioned would also be a validation of the behavioral aspects of temperature avoidance as fish track weekly changes in temperature distribution patterns.

	There have been reports in stream sediment literature indicating a relationship between surface and subsurface fine sediment. If a good correlation does exist, it could then be feasible to use surface trends to indicate what may be related trends in subsurface fines. Possibly surface fines may not be able to be a perfect substitute for subsurface fines that could then be used to predict incubation survival. However, they could be a more rapid method for tracking basin-wide trends in fine sediment availability that indicates potential for improvement or worsening of conditions at depth during the winter incubation period as fine sediment infiltration processes occur. Given sediment transport mechanics, it is expected that the cleaned gravels in redds persist only for a short time in streams with high sediment loads or high levels of fine sediment at the substrate surface because the fine sediment is easily transported and sediment conditions in the cleaned gravels rapidly respond to bedload sediment transport (Lisle, 1989; Diplas, 1991). Thus, the active cleaning of gravels within redds by spawning salmon probably has a limited effect on the ultimate survival-to-emergence of salmon because it probably cannot offset rapid subsequent sedimentation by fine sediment, especially in streams with fine sediment at the bed surface. If the course of fine sediment infiltration at egg pocket depth is a function of surface fine accumulations detected from surface fines monitoring, it seems natural to attempt to detect a correlation of surface fines with depth fines. Fine sediment levels can also remain deleteriously high at depth while surface conditions indicate improvement because the removal of intruded fine sediment at depth appears to require flows that are not only low in fine sediment concentration but also large enough to entrain all the sediment particles in the channel substrate at a depth (Diplas, 1991). Thus, improvements in surface fine sediment may not necessarily equate to improvement in substrate conditions at depth. Therefore, although surface fine sediment levels should be adequate for screening for the need to

	improve habitat conditions, other substrate parameters such as fines by depth should be monitored to assure that habitat conditions improve. We expect that future validation of the annual spring Chinook productivity in relation to habitat quality will be assessed using various options: (1) evaluating gross adults in and smolts out from the UGR and CC watersheds, (2) evaluating decline in juvenile numbers from week to week during a summer rearing period using snorkel counts, and (3) assessing the decline in juvenile numbers that have been PIT-tagged and tracked using PIT-tag detectors. Counting juvenile fish within blocked segments of spawning/rearing areas could take place prior to adult migration (e.g., June-mid July). Use of PIT-tag arrays could permit survival or growth rates to be determined in a stream segment, or among monitored segments, but it then becomes more difficult to assess the thermal history of fish. Diplas, P., 1991. Interaction of fines with a gravel bed. Proc. Fifth Fed. Interagency Sedimentation Conf., pp. 5-9 to 5-16, Federal Energy Regulatory Comm., Washington, D.C. Lisle, T., 1989. Sediment transport, and resulting deposition in spawning gravels channels, north coastal California. Water Resour. Res., 25: 1303-1319.
Appendix B provides many modeling details taken directly from Sharma (2005) without clearly demonstrating how that reference will be applied to this project. Some questionable statistical approaches are included such as using a dummy variable regression approach in place of paired and unpaired t-tests and claiming that the finite population correction can be ignored when sample size increases sufficiently. A reference to Scheuerell et al. (2006) that describes the Shiraz model is included, but this model is not explicitly discussed in the proposal. More details concerning the application of the Shiraz model should be presented.	The Shiraz model would be examined to ascertain how the sediment, temperature, and flow variables are related to survival and abundance. This would be evaluated against the literature that we believe is appropriate to use in modeling. Decisions were also made in the EDT context for how to interpret quantitative habitat conditions. These decisions will also be evaluated when deriving our own model relationships.

Issue: Throughout the ISRP review, The ISRP identified issues of whether we had identified enough study sites, and how we intend to examine effects on these basins with reference to some control sites. The following section clarifies the study design and how we intend to empirically demonstrate differences between these watersheds (status and trends monitoring), and use them in a projection modeling framework (effectiveness monitoring). We break them into three pieces for reviewers to understand our thought process.

Study design

Introduction

The study basins are the Upper Grande Ronde (UGR) and Catherine Creek (CC). Each basin will have 40 different sites identified.

Establishing the habitat condition baseline

In the first year, do status (baseline) monitoring at the basin scale and also modeling for temperature and sediment and flows. Status is based on 40 different sites per basin.

Annual and rotating panel design

Each year 40 sites are sampled per basin. (See figure for sampling design). Of these, 30 are sentinel sites (sampled every year) and 10 are on a rotating panel, where sites are sampled every 2 years. This scheme produces a total of 30 sites that are sampled every year and 20 that are sampled bi-annually, or a total of 50 sites. This rotating panel and annual monitoring of sentinel sites provides the long-term data for trend monitoring.

Establishing the historical and currently planned restoration background for habitat condition baseline and trends

The Grande Ronde Model Watershed group has a comprehensive listing of past habitat restoration projects in the Grande Ronde basin. This consists primarily of a list of projects and general locations where projects have been done or are planned. This work must be followed by investigating the original documents describing all projects in the study area so that they can be mapped. The intensity and type of work needs to be reviewed to allow conversion of this information to a quantitative form that would permit estimation of benefits. In many cases the effectiveness of past restoration projects may not be well documented. For example, riparian planting often results in failure. If project effectiveness had never been monitored, it would produce erroneous results to count a riparian restoration project that failed as a reflection of effectiveness of these types of projects. To the extent that projects are not effective in reducing sediment inputs or increasing stream shading on a site specific basis, a coarse-scale monitoring of fine sediment distribution and surface water temperature patterns would reveal only that many more efforts to control sediment and water temperature are required to have a meaningful effect.

Use the information on restoration actions to define gradients of improvement in environmental conditions.

<u>Map ongoing land use actions</u>

A quantitative assessment of all ongoing land management activities will reveal the extent to which habitat degradation actions may be compromising the benefits of habitat restoration actions. Land use activities will be evaluated which relate most directly to the key limiting factors being assessed in fish habitat.

Physical/biological modeling building, i.e. Effectiveness Monitoring

Scientific literature will be reviewed in order to develop the best available models relating physical habitat conditions to Chinook survival at various life stages. In particular, we will develop models:

(1) relating Chinook embryo survival during the fall/winter incubation period to fine sediment concentrations in spawning gravel, measured in the vicinity of constructed redds. Locations for redd construction will be identified using a Trimble GPS unit.
(2) relating Chinook summer rearing survival to water temperature regimes
(3) predicting the variation in available spawning gravel to spawning period low flows.
(4) Relating channel bankfull width to drainage area
(5) To allow extrapolation of surface and subsurface sediment characteristics to channel slope and drainage area by stream reach
(6) That predict surface water temperature distribution throughout the historically used spawning areas using FLIR data and LiDAR-based riparian canopy cover density, canopy gap, and channel orientation
(7) That predict the spatial distribution of riparian vegetation. This will be based on our valley classification and make use of available riparian reference conditions in comparable systems as well as historical vegetation maps. We will also contrast our riparian vegetation mapping with past ODEQ efforts.

Trends for study basins, i.e. Status and Trends Monitoring

In order to evaluate whether a basin is experiencing restoration, this can be done in various ways:

(1) Each basin's habitat trends can be evaluated on an individual basis using:
   a. Physical habitat trends
      i. At the scale of the entire basin by showing the trends in each of the 40 sample sites for each habitat factor (e.g., water temperature, fine sediment, riparian condition). Explanation of the long-term trends in habitat condition in relation to the mapped, quantitative analysis of restoration actions and degradational landuse actions is a historical, narrative form of explanation
      ii. At the scale of the entire basin by showing trends in the conditions near the mouth of the basin
   b. Biotic response
      i. At the scale of the entire basin by extrapolating the site habitat conditions to similar reach and channel unit types, followed by using the habitat/fish survival models for water temperature and fine sediment to estimate trends in potential spring Chinook population survival. These biotic response measures would represent an integrated assessment of habitat condition translated to overall population survival.
      ii. At the scale of the individual monitoring site by using the habitat/fish survival models to estimate trends in potential spring Chinook survival at the site.

(2) Basins can be contrasted in the sense of a treatment/reference test. An example of this is:
   a. Comparing the physical habitat condition and water quality response of the basins undergoing restoration (UGR and CC) with the conditions of other basins that serve as reference conditions (e.g., Wenaha, Minam). This can be accomplished by:
      i. Comparing conditions among the mouths of the study basins (restoration and reference)
      ii. Comparing conditions from selected comparable locations with the study basins, representing various drainage areas and cumulative upstream restoration/degradation conditions. This would represent a subsample of

all monitoring sites within the key study basins. The comparable sites will be identified using a hierarchical classification system.

(3) Use the experience in developing models:
  a. the physical models such as:
    i. the water temperature model,
    ii. the watershed characteristic/streamflow statistics model,
    iii. the fine sediment/incubation survival model
  b. and the biological models such as:
    i. The fine sediment/incubation survival model
    ii. The water temperature/Chinook rearing survival model
  c. and the detailed information of status at the basin scale to plan studies of restoration effectiveness. After approximately 3 years of collecting baseline habitat data in the two study basins and up to two reference basins (e.g., Wenaha and Minam), we will have a better ability to effectively classify stream reaches as monitoring sites. At this time, specific intense, local restoration actions will likely become known that would provide the best ability to monitor local habitat trends as a measure of project effectiveness. Meanwhile, overall basin monitoring will also reflect the ability of individual projects, such as those intensively monitored, to restore conditions more broadly at the basin scale.

<u>Develop classification system</u>

Do a GIS analysis of basin characteristics. Basin characteristics are frequently used as predictive tools for basin hydrological response (Orsborn 1990). Also, regional (ecoregion), basin (watershed), valley, segment, reach, and channel unit characteristics are important elements useful in fish habitat classification. We hypothesize that the classification systems that we develop will be useful in comparing channel unit physical responses at the intra- and inter-basin levels.

<u>Predict future trends in habitat condition</u>

Combine the various physical models, status monitoring, and mapping of environmental restoration/ongoing actions to make predictions of future trend. For example, the water temperature model in conjunction with the potential natural riparian vegetation model can be used with current and predicted future climate models to estimate the potential for recovery in water temperature patterns. The water temperature model can also be used to map on a spatially extensive basis the maximum daily water temperatures that occur with daily variations in meteorological conditions.

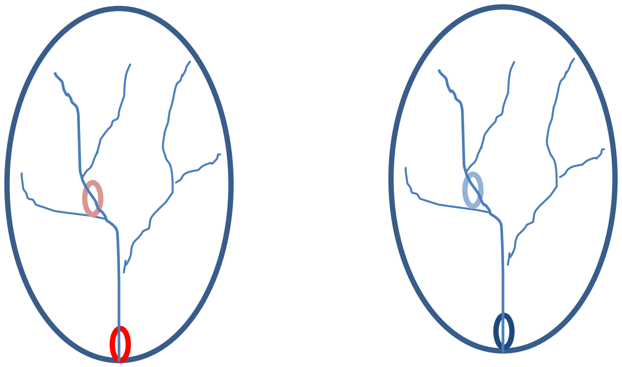
Monitor trends to validate the predictive model

In addition to estimating the quantitative habitat conditions that would result as the desired endpoint of all restoration actions, the intermediate steps can be described through trend monitoring and these data can be used as a means of model validation. For example, the water temperature model will be developed and calibrated using FLIR data on surface water temperatures throughout the spawning stream network, riparian vegetation cover data from LiDAR remote sensing, streamflow data, and meteorological data for the day the FLIR flight was made. This model can be validated in the near term from additional water temperature measurements at strategic sites, by using time-specific meteorological data and flow data. Over the course of the 10-year period as riparian conditions change, validation can also take the form of evaluating specific stream reaches for which riparian vegetation conditions are compared with LiDAR-based data to detect changes during recovery. The water temperature model run with the site-specific riparian canopy data can be used to validate the model at the local level.

Example of how this approach is intended to work

The following pages outline how this proposal intends to monitor changes in habitat quality and compare it to some reference sites (pgs 2-4). The example also displays what variables will be used in a classification analysis (pg 5-7), and how the rotating panel design is intended to work over the funding period (pg 8). Finally, through graphical schematics we display how this project ties different elements of effectiveness monitoring, status and trends monitoring (pgs. 9 and 10), as well as developing an empirical model for future projections based on data collected through this project (pgs 11 and 12).

Cumulative effects monitoring at the scale of the watershed where the response reach is above the watershed mouth.



Grande Ronde   Wenaha

- Reach A, 100% drainage area, gradient 0.005
- Reach B , 100% drainage area, gradient 0.005
- Reach C , 30% drainage area, gradient 0.01
- Reach D , 30% drainage area, gradient 0.01

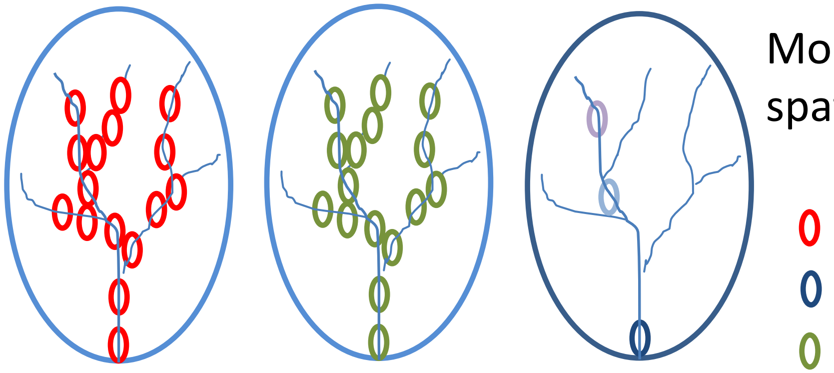
To determine: Are there improving trends in habitat quality expressed in key limiting factors that can be attributed to cumulative watershed restoration activities?

Study design: Find comparable stream reaches using classification system to reveal long-term performance trends in key habitat variables.

Compare reach performances annually and compare trends over the long term. Hypothesis: Performances expressed in selected reaches near each watershed mouth represent: (1) inherent reach classes and (2a) the cumulative performances resulting from historical and current restoration (e.g., road obliteration, riparian planting) as well as historical and current management (e.g., grazing, road building, timber harvest, existing road network) expressed at the reach, reach riparian, network, network riparian, and watershed scales. The inherent reach class is a function of its potential and that of its hierarchical environmental system. The immediate environment of the reach is the reach riparian system and then the upstream, upslope hierarchical environmental systems. Key habitat responses expressed in the reach are framed by the inherent potential of the reach, but also are influenced by the inherent potential of the encompassing hierarchical system and the historical and current performances in the hierarchically organized parts of the watershed system. Trends in performance may express lags due to factors such as the inherent structure of the network or watershed, but also due to the history of application of restoration/management effects.

Control issue. Do we need a watershed with comparable levels of ongoing management activity (e.g., grazing), but without the historical and current restoration?

Monitoring trends in key habitat quality on a spatially distributed basis in the watershed



The reach sample universe in the Grande Ronde River watershed

The reach sample universe in the Wenaha River watershed

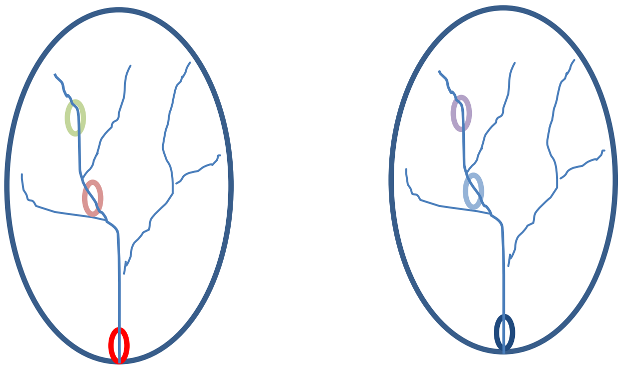
The reach sample universe in the Catherine Creek watershed

Grande Ronde   Catherine Creek   Wenaha

To determine: Are the Grande Ronde and Catherine Creek habitat conditions improving and achieving the expectations set in the BiOp. Habitat conditions to be monitored will be focused initially on key limiting factors identified in subbasin plans. With time, other important habitat conditions will be monitored that may have been overlooked in subbasin planning.

Study design: The GR and CC are the two primary study watersheds. Trends in improvement for key limiting factors (e.g., water temperature, surface and subsurface fine sediments, streamflows) will be monitored in relation to historical and ongoing restoration activities. Trends in selected reach types will be contrasted with similar reaches in reference watersheds.

Approximately 60-80 monitoring sites will be selected throughout the two key study watersheds. These sites will represent approximately 10 types of reaches. Reach types contrasted will be based upon reach class, where reach class is a function of the potential capacity of the reach and its environment. The reach environment is a hierarchically organized system of areal components of the watershed.
Having 10 reach types will allow intraannual replication. Overall restoration trends can be examined by reach type and individual site over the 10-year period. Restoration at an individual site can be explained in terms of the proximate and cumulative restorative and management actions (degrading) upstream. Interannual variations in key habitat variables can be compared for identifying shared environmental trends that may be due to regional patterns of precipitation and streamflow, or air temperature.



Grande Ronde   Wenaha

Comparison of spawning gravel quality in historically and currently used key spawning areas

- Reach A, 100% drainage area, gradient 0.005, historically used
- Reach B , 100% drainage area, gradient 0.005, currently used[1]
- Reach C , 30% drainage area, gradient 0.01, currently used
- Reach D, 30% drainage area, gradient 0.01, currently used
- Reach E , 15% drainage area, gradient 0.02, currently used
- Reach F, 15% drainage area, gradient 0.02, currently used

1. In currently used habitat, spawning gravel is sampled in GPS-located redds at end of incubation

To determine: Is the spawning gravel quality in recently occupied redds different between the Grande Ronde and Catherine Creek (representatives of heavily impacted watershed undergoing restoration) and other watersheds that are considered to have highly intact reach, reach riparian, network, network riparian, and watershed conditions (e.g., Wenaha River, Minam River)?

Study design: Compare a few select reaches having comparable intrinsic potential but differing levels of impact at the reach and higher levels in the habitat hierarchy up to the watershed scale.
Monitor selected reaches every year.
Control and reference issues. The Wenaha has very minor management impact and little to no restoration. Variation in spawning gravel composition in recently used redds represents close to a natural background level of variation. In a watershed with higher levels of ongoing management impact, but little restoration activity (e.g., Minam River), the variation in recently used redd composition represents to a greater extent the ongoing impacts from management, but with a small amount of restoration. Such a watershed is more a reference watershed.

Watershed class

1. Drainage area
2. Stream length
3. Elevation—at mouth, mean elevation, maximum elevation, mean of spawning distribution
4. Mainstem channel gradient from mouth to points upstream at 50% of relative relief and 75%.
5. Hypsometric integral
6. Watershed orientation
7. Mean annual precipitation
8. Topographic roughness index
9. Lithology
10. Soils

Network environmental class

1. Longitudinal pattern of major sediment sources– mass movement-prone sideslopes

Network class

1. Drainage density
2. Network volume
3. Hyporheic volume
4. Network structure—dendritic, trellis
    a. Index structure quantitatively using random risk approach

Network performance

1 Distribution of road crossings
2. Distribution of culvert inputs
3. Cumulative riparianroad length by road type

Reach environmental class

1. Valley gradient
2. Floodplain width
3. Riparian vegetation potential
4. Sideslope angle (L, R) above mean high water level or floodplain edge
5. Channel orientation
6. Valley soil depth, alluvial depth
7. Channel orientation
8. Vegetative potential
   a. Riparian vegetation composition

Reach environmental performance

1. Road area by road type, road density
2. Livestock AUMs
3. Riparian condition
   a. Species composition
   b. Percentage shade
   c. Percentage shade removed by timber harvest

Reach class

1. Channel gradient
2. Bankfull width
3. Channel orientation
4. Biotic potential
   a. Macroinvertebrate community potential
   b. Fish community potential

Reach performance

1. Riparian condition
   a. Species composition
   b. Percentage shade
2. LWD volume
3. Sinuosity
4. Pool frequency
5. Pool area
6. Channel capacity
7. Median particle size (d50)—or dominant particle size distribution (% cover by largest 50%)
8. Fine sediment concentration (< 6.3 mm, < 3.3 mm, < 2.0 mm)
9. Water temperature statistic (maximum summer temperature, max temperature with a certain recurrence, MWAT
10. Flow statistics (7-day low flow with 10- and 20-year recurrence interval)
11. Streambank stability
12. Macroinvertebrate drift—species composition, biomass flux

Draft rotating panel design for sampling of stream reaches.

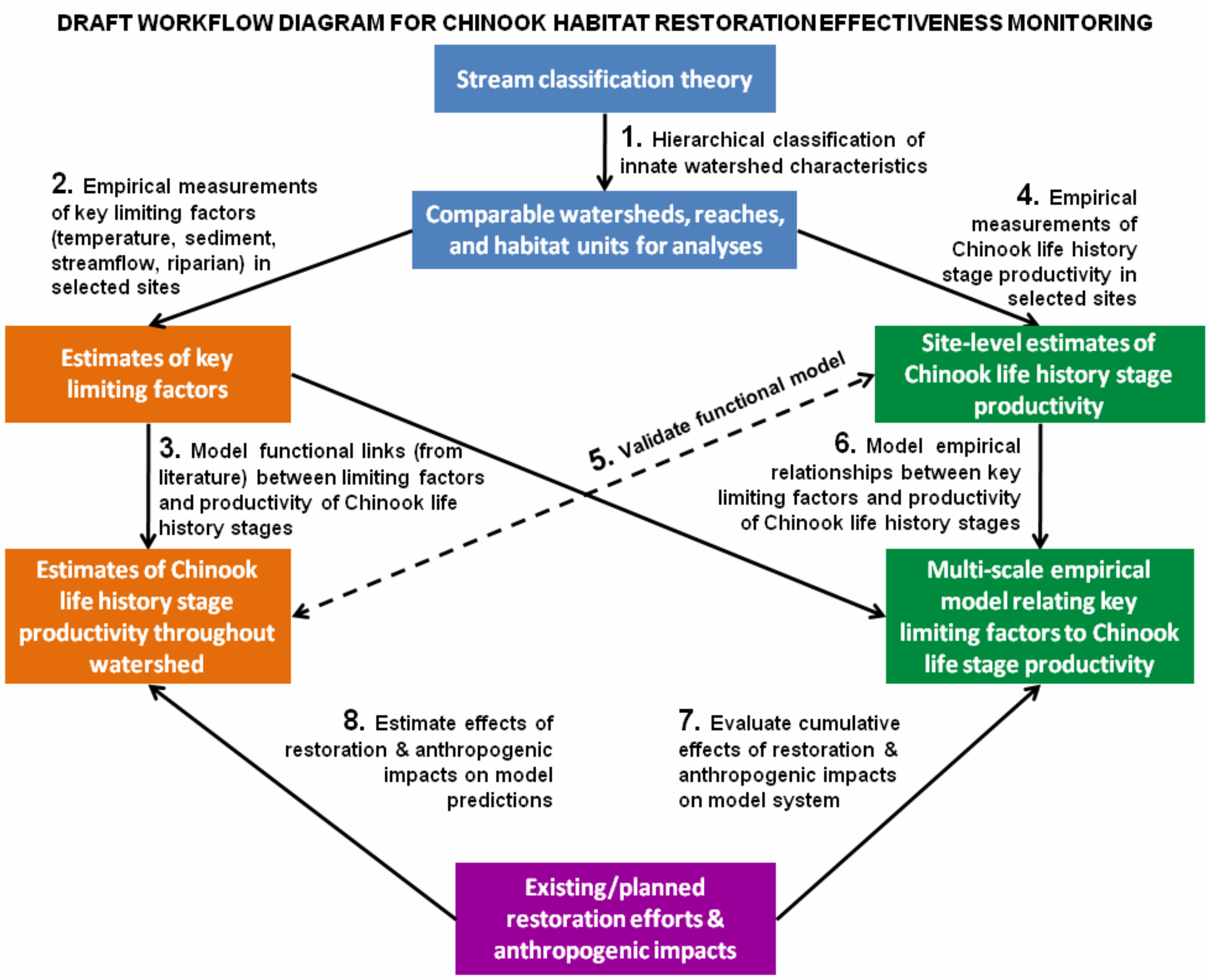
Rotating sites will include approx. 10 reach classes. Each reach class will be represented by 1 site per year that is sampled every 2 years, for a total of 10 sites.
Sentinel sites will include approx. 10 reach classes. Each reach class will be represented by 3 sites per year. Each site is sampled every year.
This table represents sampling on the Upper Grande Ronde. A similar design will occur on Catherine Creek.
On the Wenaha or other reference basin, we may employ a design such as the rotating panel with 10 reach classes, represented by a single site per class with resampling on a 2-year basis.

Rotating sites

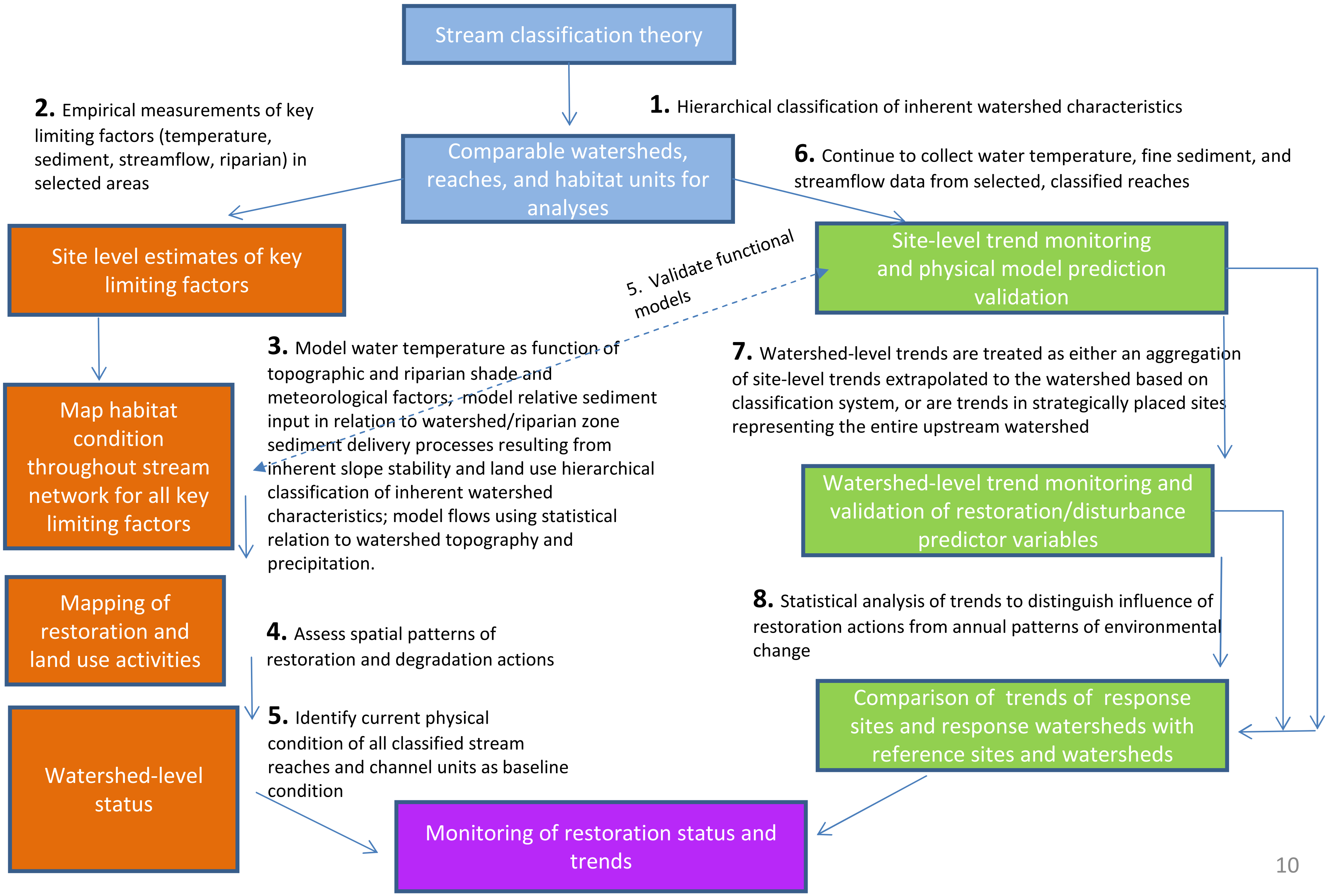
Reach Class	Year 1 prelim	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
2		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
3		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
4		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
5		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
6		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
7		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
8		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
9		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
10		A-1	B-1	A-1	B-1	A-1	B-1	A-1	B-1	A-1
Total Samples		10	10	10	10	10	10	10	10	10

Sentinel sites

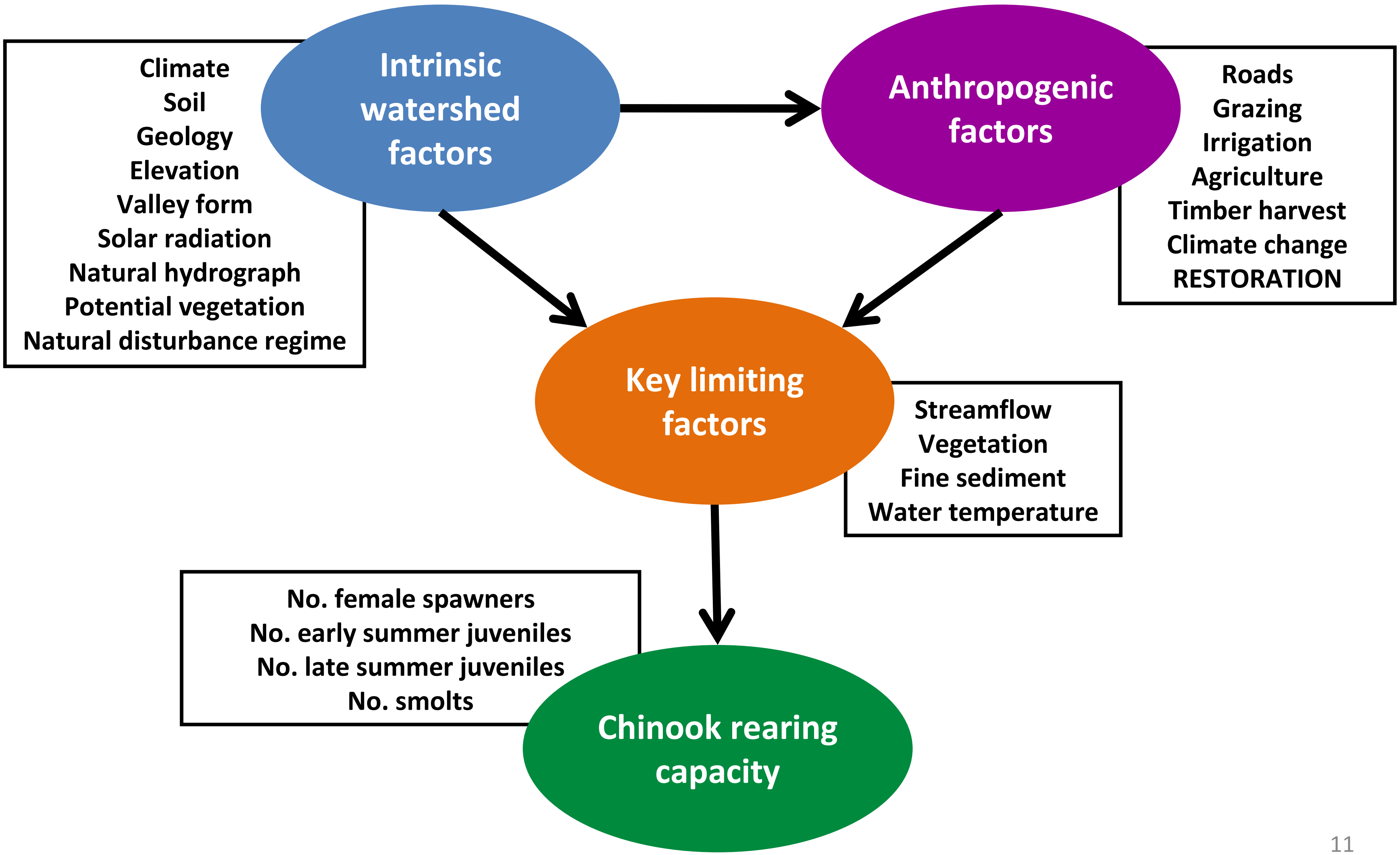
Reach Class	Year 1 prelim	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
2		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
3		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
4		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
5		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
6		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
7		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
8		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
9		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
10		A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3
Total Samples		30	30	30	30	30	30	30	30	30


DRAFT WORKFLOW DIAGRAM FOR CHINOOK HABITAT RESTORATION EFFECTIVENESS MONITORING
Stream classification theory
1. Hierarchical classification of innate watershed characteristics
Comparable watersheds, reaches, and habitat units for analyses
2. Empirical measurements of key limiting factors (temperature, sediment, streamflow, riparian) in selected sites
4. Empirical measurements of Chinook life history stage productivity in selected sites
Estimates of key limiting factors
Site-level estimates of Chinook life history stage productivity
3. Model functional links (from literature) between limiting factors and productivity of Chinook life history stages
5. Validate functional model
6. Model empirical relationships between key limiting factors and productivity of Chinook life history stages
Estimates of Chinook life history stage productivity throughout watershed
Multi-scale empirical model relating key limiting factors to Chinook life stage productivity
8. Estimate effects of restoration & anthropogenic impacts on model predictions
7. Evaluate cumulative effects of restoration & anthropogenic impacts on model system
Existing/planned restoration efforts & anthropogenic impacts

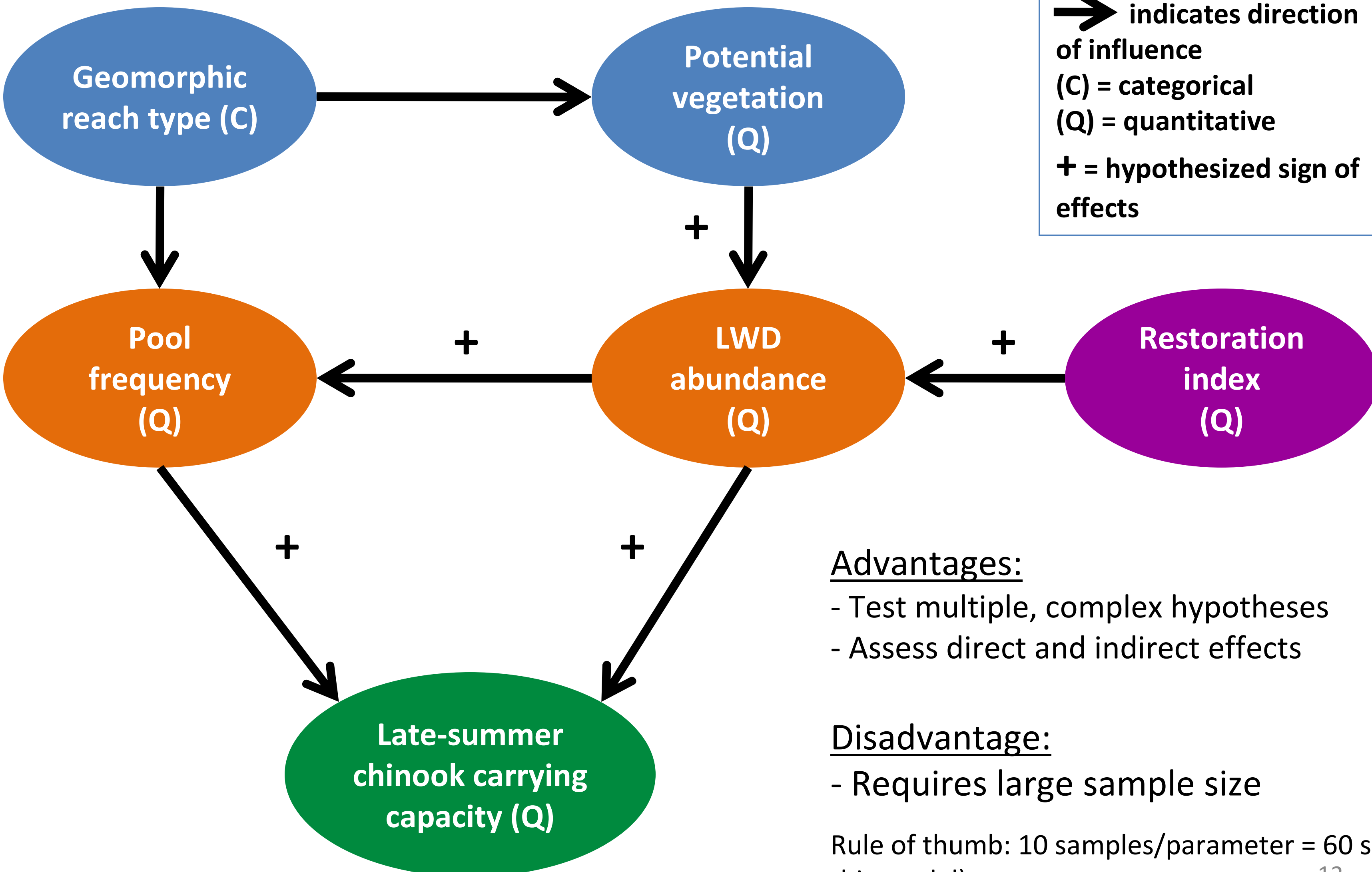
MONITORING AND MODELING OF STREAM PHYSICAL HABITAT VARIABLES
DRAFT WORKFLOW DIAGRAM FOR CHINOOK HABITAT RESTORATION EFFECTIVENESS MONITORING



A CONCEPTUAL FRAMEWORK FOR EMPIRICAL MODELING OF CHINOOK REARING CAPACITY



EXAMPLE *SEM* MODEL RELATING KEY LIMITING FACTORS TO A CHINOOK LIFE STAGE



Legend

→ indicates direction of influence
(C) = categorical
(Q) = quantitative
+ = hypothesized sign of effects

Advantages:
- Test multiple, complex hypotheses
- Assess direct and indirect effects

Disadvantage:
- Requires large sample size

Rule of thumb: 10 samples/parameter = 60 sites this model)