Draft Island County Watershed Plan: November 2004 Technical Feedback

Puget Sound Technical Recovery Team / Shared Strategy

This feedback has four components:

- Brief summary of results of our review concerning certainty, and discussion and recommendations of factors we believe are critical to address in order to improve certainty of your plan;
- Consolidation of technical reviewers' comments on your June 30th draft;
- A description of the methods by which we performed the certainty analysis (i.e., the probabilistic network analysis); and
- Page-specific comments.

I. SUMMARY OF CERTAINTY ANALYSIS

The content of this section summarizes the results of our probabilistic network analysis that determines the risk or uncertainty of achieving recovery given the proposed plan of action and monitoring (for description of the approach, see Section III of this document). We view using this certainty analysis in an iterative fashion to help in guiding plan revisions. This analysis also will help us strategically track the elements of your plan and how information at each step affects the overall certainty that the proposed actions in your plan will contribute to population and ESU recovery. The analysis was done separately for habitat, hatchery, and harvest elements of recovery plans. As your chapter only deals with habitat management, that is the only discussion given here. For watersheds with all three elements, several questions enquire about integration of the H's. As your plan does not deal with harvest or hatchery, and yet the response of salmon to habitat recovery within Whidbey Basin will depend in part on the number of hatchery fish utilizing the basin and changes in harvest patterns in the area, references to other chapters dealing with hatchery and harvest of populations utilizing Whidbey Basin should be references and actions followed by the Island County planners.

Habitat Strategy

Key Issues to Improve Certainty

The most important ways for this plan to improve the certainty of an effective habitat strategy in the near-term are to:

- Further develop explicit conceptual life stage specific linkages relating habitat conditions to responses in population viability characteristics. Habitat effects on abundance/capacity refer to spatial limitations to abundance at the various life stages. Habitat effects on productivity refer to conditions that affect survival at various life stages, and, therefore, returning abundance. Habitat effects on spatial structure refer to limitations of the habitat to provide a variety of habitat types that are used by the salmon and to extent of connectivity between critical habitats. Habitat effects on diversity refer to habitats limitations on survival of the various life history types or trajectories such that one or more life history type is eliminated.

- Better document the source of data used and the details of the conceptual model as information becomes available; apply Skagit System Cooperative data and other data sources on juvenile salmon utilization of nearshore habitat to help provide empirical support for the model you use.
- Further develop a detailed and specific habitat recovery strategy tiered down from more explicit hypotheses on conceptual linkages relating habitat conditions to salmon viability via life stage specific potential responses. Utilize information/hypotheses from the nearby watershed plans that deal with the populations that utilize Whidbey Basin and with the nearshore chapter.
- Develop an adaptive management plan for monitoring, evaluating, and potentially modify some habitat management actions.

Questions we (TRT) used to conduct probabilistic analysis

Did the analysis use one or multiple independent models to understand to understand potential fish status and responses?

- The Island County chapter utilized one conceptual model to assess the affects of habitat factors on potential fish status and responses. The use of two or more quantitative models (e.g., EDT, SHIRAZ) would help define the relationships used in the modeling effort and allow one to compare differences between models and assumptions used for those models.

How well supported is the understanding of the links between habitat actions and population viability (VSP) characteristics used in the planning (analytical support).

- Analytical support was low.
- A *qualitative* model was used to relate ecological processes, habitat conditions, and all four VSP. Documentation of qualitative model is from draft nearshore guidance documents (Kurt Fresh). General information on nearshore processes and some specific information on habitat conditions were provided to support the approach taken. No quantitative model was used. There is no explicit discussion provided of sensitivity testing, though it may be embedded in the lists of actions.
- The plan does not discuss empirical testing and validation of the model. However, we note that it would be unreasonable to expect local watershed groups to undertake this task given the current state of scientific understandings on the links between habitat actions and VSP characteristics or ESU persistence for nearshore ecosystems.

How well supported is the recovery hypotheses with watershed specific data (data quality)?

- Support for the recovery hypothesis using watershed specific data was low, but could be readily improved with documentation of basin specific available data. Cite the limiting factor studies and the habitat condition mapping (who was responsible for the maps?).
- This question asks if the watershed has used data from the local area to validate the recovery hypotheses. Data from the Skagit, Snohomish, and Stillaguamish on juvenile salmon estuary and nearshore utilization should be identified, cited, and used. Also data/estimates from terminal fisheries and CWT recovery could be cited to document use of basin by the various populations.
- Explicitly state assumptions used and any information/documentation that would help support the assumptions.

Is the recovery strategy consistent with the recovery hypothesis?

- No
- The overall strategy is to improve the condition of degraded nearshore habitat areas and to protect natural shorelines. The individual habitat strategies presented appear to be well thought out and developed and are consistent with the individual hypotheses. However, the hypotheses for the relationships between stressors and VSP characteristics could be further developed. Hypothesis specific to VSP characteristics or ESU persistence are needed to better defined habitat recovery strategies for protection and restoration that will, in turn, result in improvements in the VSP characteristics.
- Hypotheses related to responses of habitat actions as affected by hatchery and harvest actions should be developed and strategies to address these identified if needed.

Is the recovery strategy robust by preserving options for recovery?

- No
- Preserving options requires an adaptive management plan to respond to changes and uncertainty as they occur.

How well have the recovery actions been shown to work (empirical support)?

- Support for the proposed actions was determined to be moderate.
- General experience suggests that nearshore protection and restoration actions can work, although there are some conflicting results and uncertainty with some actions. Areas that are especially uncertain are 1) the effectiveness of shoreline regulatory protection programs, and 2) validation that habitat actions to rehabilitate or enhance the nearshore increase the capacity of the nearshore to support chinook and chum salmon life stages.
- In cases of uncertainty in results of action, a thorough adaptive management program is extremely important and will help fill in data gaps in our knowledge.
- The goal of protecting existing habitat is good. However, fee simple purchases and conservation easements along with public education are listed as the centerpiece habitat protections strategies. How certain is this approach and why is this approach taken? Can it be adapted in the future as more information is obtained?

Are the recovery actions consistent with the recovery strategy?

- Yes.
- More specific definitions of protection and restoration strategies are needed to better evaluate consistency; many of the actions listed could be applied as detailed strategy statements.
- Focusing the recovery actions through a more defined habitat recovery strategy could reduce uncertainties. The strategy seems to be to build on the success of a number of protections and restoration projects which obviously involve a lot of effort and have a lot of public support. However, specific projects are not well linked to the hypotheses presented in the plan, nor are they linked to the status of the target populations. See recovery strategy consistent with the recovery hypothesis question above.

II. REVIEW OF TECHNICAL CONTENT

Reviewer's Name: **Puget Sound TRT and one outside reviewer**

Watershed Plan: **Island County Salmon Recovery Draft Plan - Spring 2004**

Populations or ESUs considered: **Primary populations: Skagit, Stillaguamish, & Snohomish Chinook**
Puget Sound Chinook ESU, Hood Canal Summer Chum ESU, Puget Sound Bull Trout DPS

Summary

This watershed has no Chinook populations spawning in its basin, but recognizes that the estuaries and nearshore are probably used by all populations of two listed salmon (Puget Sound Chinook and Hood Canal summer chum) and one listed bull trout (Puget Sound) as well as by forage fish and predators of the salmonids.

The recovery plan deals primarily with the nearshore habitat, but recognizes importance of the freshwater tributaries to ecosystem functioning. The plan takes a multispecies, ecosystem approach, a good approach for Island County. The ultimate goal of the plan is to have "abundant, naturally-spawning Pacific salmon using Island count's nearshore and coastal streams". More specifically, the goal is to "achieve a net increase in salmon habitat through protection and restoration of naturally-functioning ecosystems that support self-sustaining salmon populations and the species that depend on salmon".

This plan, as a chapter of the Puget Sound Chinook recovery plan, should reference the Skagit, Stillaguamish, Snohomish, and other chapters for identification of biological goals for chinook populations. These other chapters may also identify nearshore conditions needing protecting/restoration for recovery of their populations and could be referenced by this chapter. As this watershed has no Chinook populations or hatchery programs of its own, it addresses habitat management, but as important, it addresses human management in the form of educating the public about salmon restoration and healthy environments.

Specific well defined strategies and a very thorough listing of action items and timelines are identified for habitat protection and restoration. Improvements are needed in quantitatively defining the level of actions to be taken and in determining an adaptive management approach to relate actions to the VSP characteristics of populations and ESU persistence.

1. **What biological and physical changes does the plan state are required for the populations in the watershed to achieve their targets?** *For watersheds without targets, what biological and physical changes are needed for the habitat to be considered functioning for anadromous fish?*

   As there are no Chinook or summer chum populations within the watershed, goals focus on preserving and restoring healthy salmon habitat with priority on the nearshore and some work on freshwater systems.

   The concept that needs to be emphasized is that protection and restoration of Island County's nearshore habitats is necessary for some (at least the 10 Skagit-Stillaguamish-Snohomish populations) of the PS Chinook populations to reach their planning targets. This can be demonstrated by EDT modeling, even given the very rough manner in which EDT addresses the nearshore. Independent of modeling, strong evidence from Eric Beamer's work, that certain life history trajectories of Skagit Chinook depend on pocket estuaries at some distance from their natal rivers, also makes this point. Undoubtedly other arguments could be made here, and it's important to make them. Look at the nearshore chapter for more ideas and references.

   Biological goals, e.g., population specific goals for abundance, productivity, diversity, and spatial structure could be taken from (i.e., referenced to) the chapters that are home to the populations using the waters around Island County. Habitat goals should be stated in a quantifiable way that can be monitored and assessed for success.

2. **What goals does the plan aim to achieve in 5-10 years versus over the longer term?**

Goals are stated in terms of increasing public awareness and involvement and in increasing salmon friendly habitat. The long-term goal is to achieve a net increase in healthy salmon habitat. Is this goal sufficient for salmon restoration? If this is not known, how can Island County monitor the effect and success of their habitat preservation/restoration? Should preservation actions be a short-term goal since preservation helps preserve future options? Can you set up prioritizations and short v long-term goals for restoration actions? It wouldn't have to be for specific projects, but could be for types/amounts of restoration sites.

The overriding goal over 100 years to have a "net increase in salmon habitat" should be quantified in terms of how much habitats of different types currently exists and how much is expected to be restored (and protected). Also, the importance of forage fish is highlighted in the plans, and forage fish goals could be better quantified and better related to salmon population goals.

As much of the habitat is under private control, a major short-term goal is outreach and education to get the citizens interested in maintaining and restoring healthy habitats for salmon and their ecosystem. Again it is necessary to keep some record (measure of success) on these activities.

The Island County plan makes the amount of habitat restoration done depend on what is voluntarily allowed by landowners. Also, a strategy to improve the success of voluntary actions is wrapped in a public education/outreach program. If a specific amount of habitat (by type and location) is needed to achieve the biological recovery of listed salmon (something the plan should identify, or at least say how it will identify, then how can we judge whether this method will work to achieve salmon recovery? Using voluntary restoration as the preferred means for habitat restoration might be a logical "Plan A" because it is politically favorable, but what is "Plan B" in case you don't restore enough habitat through the means of Plan A? Even if the content of plan B is not known, the possibility of having to develop a plan B should be stated.

3. **What is the biological RATIONALE for identified actions (i.e., "hypothesis-strategy-action" logic as presented in the TRT watershed guidance document)? What is the empirical or modeled SUPPORT for the identified rationale?**

(a) What are the populations' current statuses for all 4 VSP?

The plan addresses the ESU rather than a specific population, although the Skagit, Stillaguamish, and Snohomish populations are mentioned as the primary chinook populations for this area. Table 7 is a good format and start on identifying habitat limiting factors and their hypothesized impacts on salmon populations. More work needs to be done to complete the last column of information, itemizing effects on the VSP factors. Separating factors is not always easy. When thinking about the VSP factors, think of abundance as abundance capacity; what limits a population's ability to achieve a larger abundance (this usually is limited space at some stage of development). Productivity is related to survival and to the general health of the environment (clean adequate water, refuge areas, amount of predation, etc.). Diversity relates to the genetic and life-history traits expressed in the population (or ESU), e.g., are conditions favorable for all segments of run timing? Spatial diversity is the diversity of types of environment available, even if it is not all used each year.

In many cases, specific references are lacking. Information can be obtained from the nearshore group (PSAT) and from other watersheds.

(b) What are the populations' predicted status for all 4 VSP over the short- and long-term?

As the predicted status for any given chinook population is highly dependent on what happens in the watershed where the population spawns, identifying at changes in status as a result of habitat actions in Island County will require an integrated assessment with other watershed actions.

(c) What are critical threats affecting the populations? Have all been identified and considered in the stated hypotheses? Are there potential threats that are missing from the plan?

The previous and potential future loss of nearshore habitat function in Island County is a critical threat to a number of Puget Sound Chinook populations, especially the 10 from Skagit-Stillaguamish-Snohomish. This point should be emphasized.

The plan does a good job of laying out the threats to the chinook and summer chum populations. The threats from nearshore habitat degradation presented in Table 7 represent general threats. Which of these are most important, or have the biggest impact on fish in Whidbey Basin? Support for the noted missing elements in the rationale will need to be added.

The plan does not explicitly include a model for relating salmon VSP to habitat condition, yet it is clear the authors used such a conceptual model in laying out the limiting factors table and strategies. Explicitly presenting the model is important documentation for future reference and uses of the plan.

The role of large woody debris (LWD) as part of the nearshore model for habitat and habitat forming processes is weak. For example, the role of LWD in forming high intertidal debris jams along protected shorelines that trap and hold organic debris mats and sediments forming micro habitat "hotspots" for organisms such as amphipods, isopods and insects that are very important nearshore prey species needs to be incorporated.

There is no specific mention of nearshore carrying capacity for salmonids. An action should be added to cooperate with state and federal agencies on development of tools to relate habitat conditions to populations VSP characteristics. Whidbey Basin would be an ideal area within Puget Sound for this type of study.

(d) Is the strategy for H management changes consistent with the identified hypotheses for current population status, desired future population status, and primary threats? What elements of the strategy are missing? Be explicit about each threat or potential factor limiting recovery.

The habitat strategies presented appear well thought out and developed and are consistent with the hypotheses. The habitat hypotheses are specific and ecological process based approaches, which is a very important base to start from to help increase the certainty that management actions will have sustainable results.

The hypotheses for the relationships between stressors and VSP characteristics is very well laid out, but need development. The relationships to VSP are general as is expected at this time. An adaptive management plan to better develop the specifics for the relationship between habitat and each of the VSP characteristics should be part of the plan.

The strategy seems to be to build on the success of a number of protection and restoration projects which obviously involve a lot of effort and have a lot of public support. However, specific projects are not well linked to the hypotheses that are developed in the plan, nor are they linked to the status of the target populations. The goal of protecting existing habitat is good. However, fee simple purchases and conservation easements along with public education are listed as the centerpiece habitat protection strategies. How do we know whether this strategy will work and remain habitat will not be lost? How long will it take to protect the remaining habitat under this strategy?

The plan acknowledges the value and importance of maintaining healthy forage fish populations as an essential element of the recovery strategy. A habitat management strategy for supporting healthy forage fish stocks will need to consider all stressors, not just spawning area, that may be limiting the abundances of these forage fish. This is not to say protection of spawning areas is not important, it is a specific action known to be necessary to protect documented adverse impacts on forage fish. However, forage

fish are known to be adversely affected by many other factors and it appears unlikely the proposed strategy will succeed if these are not considered. In setting the goals-strategies-actions for forage fish as part of this plan, there is a need for further consideration as to how habitat management actions to protect and restore the forage fish prey base supporting salmon may be linked to the viability of salmon populations. While the capability to accomplish this in any quantitative sense is not likely for some time, it is important to lay the conceptual framework now.

The watershed group will probably need substantial state and federal agencies' technical support to analyze effects of management plans and determine more specific effects of local actions on VSP characteristics.

(e) How are actions in the H's linked to fish population status? Both existing and future/planned H actions should be addressed. Are these links based on empirical or modeled estimates or both? Be explicit about each threat or potential factor limiting recovery.

Although the actions are well described and the general model for linking actions to nearshore processes to habitat to effects on salmon are well developed, these two aspects (actions and processes leading to fish status) of the plan are not linked.

(f) What are the plan's stated assumptions about existing habitat conditions or actions outside of the WRIA jurisdictional boundaries covered in the plan (freshwater and estuarine/nearshore)?

The plan states that Island County nearshore habitats, although degraded, are less degraded than nearshore habitats in surrounding areas, but there doesn't appear to be support for this statement. This plan definitely recognizes that salmon in their nearshore areas are spawned and incubated somewhere else. The plan implicitly assumes that the rivers producing the fish will be implementing recovery plans, but there is no specific linkage if Island County actions to specific recovery efforts in other watersheds. It might be possible to do this, for example, with Skagit Chinook because of the research that links particular life history trajectories coming out of the river to use of particular habitats in the nearshore.

The plan should stress the need to work collectively with the other watersheds, especially Skagit, Stillaguamish, and Snohomish, in determining which habitat actions would be most beneficial to the populations from those areas.

(g) Are future options preserved in the proposed strategy-action links? How so? Be explicit about each threat or potential factor limiting recovery.

This plan includes a large component of research and planning. The actions that are proposed now are not likely to preclude future options relative to the identified threats. One thought - Are current protection policies sufficient to maintain current good habitat?

4. How are the individual and interacting effects of the H's on the 4 VSP parameters considered for each population? How likely is it that the proposed suites of H actions will achieve the short- and longer-term stated goals? How certain are we in their translation into effects on salmon population VSP?

The certainty as to how the proposed actions will affect VSP and ESU persistence is moderate/low. The technical basis for actions is good but needs to be more developed for specific relationships. The list of action items is thorough, but level of actions are too general and are not quantified. The processes described for implementation of protection in particular are general statements. Priorities for types of actions proposed are related at least conceptually back to the population characteristics, which is an important first step in reducing uncertainties for this area. Addition of a set of quantitative habitat milestones and goals would reduce the uncertainty of success significantly.

This plan includes a short general discussion of hatchery programs. This should be expanded, with particular reference to the quantity of hatchery fish using Island County's nearshore habitats and possible

effects of these hatchery fish on wild stock restoration goals. It will be very important to determine whether the benefits of nearshore habitat protection and restoration are accruing mainly to hatchery or to wild fish. This is critical for assessing whether recovery actions are leading to the goal of wild stock recovery. Island County would need to work with the entities producing hatchery fish in the area.

5. How does the plan acknowledge uncertainties and how are they factored into decisions, future actions?

(a) Uncertainties in data and information?

Uncertainties in data are recognized as information gaps and short and longer term goals include addressing these data gaps.

A discussion on the historic baseline for nutrients specific to the role of salmon as a nutrient transport vector is an important missing element of the habitat forming processes technical basis for the plan. Little is currently known about what changes may be needed in the present nutrient loadings relative to historic conditions to support viability and it is important to note this uncertainty in the analytical basis for the plan.

(b) Uncertainties in environmental conditions in the future?

What are the uncertainties (or certainties?) in the future trend of environmental degradation dues to human population growth? The plan acknowledges that human population growth in Island County will have an impact on protecting habitat even with GMA and Shoreline Master Plan regulation updates. What is the human population forecast for Island County over the time period this salmon recovery plan and how will this plan ensure protection of existing habitat given this issue?

(c) Uncertainties in effectiveness of actions?

Not much about this is addressed yet. Some volunteer actions by private citizens may not produce immediate or guaranteed increases in salmon abundance but may be very important in the goal of public awareness and desire to maintain clean, healthy habitats for the ecosystem. Identify these in the plan.

6. What is the estimated overall level of risk for the population(s) included in this plan, relative to low-risk (i.e., viable) population criteria? What is your rationale for this risk estimate? How certain are you in the estimation for each VSP parameter?

Information from the TRT's probabilistic network analysis addresses this question and is given in section I.

Fish from most of the Chinook populations in the ESU spend significant time rearing in this nearshore or benefiting from the production that occurs within this Puget Sound sub basin. Yet we have a very limited understanding of how the streams and nearshore environments relate to the VSP characteristics of the populations and the persistence of the ESU. The plan lays out a good rationale for proceeding. Specific quantified milestones and commitments to achieve them and an aggressive adaptive management strategy to relate those to all four VSP characteristics for a small set of the populations could reduce that risk to moderate/low or even low.

Increasing the amount of connected, healthy nearshore habitat both for salmon and for other species they interact with will increase abundance, productivity, spatial structure and diversity. How much these are affected depends on what happens in the other watersheds. For watershed without their own spawning populations, the affects of their actions will need to be considered integrated with the actions of the other watersheds.

7. Suggestions for approaches or methods for addressing concerns mentioned above or reducing gaps in the plan.

Developing a monitoring plan is essential to salmon restoration. For Island County, without a staff of researchers, developing a monitoring plan will take some innovative thought. One idea is to use the exiting habitat maps to map changes in habitat over time and to identify the cause of the change (specific restoration projects, effects of human development, etc). To monitor the reaction of fish (forage fish and salmonids) to habitat changes, one could think about using public census, something like the annual bird censuses. This could also work into the goal of increasing public awareness of environment restoration and the visible results to the ecosystem.

Regarding public involvement and monitoring: How are you going to evaluate GMA and Shoreline Master Plan for their ability to protect existing habitat? What is the Public Benefits Rating System that will be used in a private lands protection strategy? How does the Precautionary Principle work in protecting habitat? Will it work if it is a recommendation to the citizens of Island County? A specific example of how the county works with the developer would be helpful.

The plan has a thorough technical and policy framework to succeed given sufficient additional state and federal support to better develop the linkages to the viability characteristic of populations.

III. ANALYZING CERTAINTY OF BIOLOGICALLY EFFECTIVE RECOVERY PLANS

All watersheds in the Puget Sound are unique. Not surprisingly, different watershed planning groups identify different long-term and short-term goals and propose different suits of actions to achieve those goals. The certainty that the actions in every watershed will be biologically effective in moving the populations towards recovery is a key factor in the recovery of the whole evolutionarily significant unit (ESU). Consequently, the Puget Sound Technical Recovery Team (TRT) has focused its analysis of watershed recovery plans on identifying ways to increase the certainty of the plans. The TRT hopes that these analyses will encourage watershed groups to improve the certainty of plans before the TRT does it analysis of the final plans next year.

To provide these analyses, the TRT used a probabilistic network (PN). A probabilistic network is a graphical model that shows how different states of the world of interest—in this case the scientific factors that provide certainty of biologically effective actions—are related (Figure 1). The basic approach is to assess certainty by applying conditional probabilities, which can be expressed as "Given event *b*, the likelihood of event *a* is *x*." In Figure 1, for example, the states of the variables in boxes that point to another variable (e.g. "Use of Independent Models" and "Analytical Support") are the events that condition the likelihood of the states for the latter variable (e.g. "High", "Moderate", and "Low" in the Certainty of the General Fish Response Model). Users provide evidence for the initial conditioning events (or diagnostic nodes); software for PNs use a set of sophisticated algorithms for recalculating the joint probability distributions for all the potentials based on tables of conditional probabilities provided by the analyst (Jensen 2001). Using a PN gave the TRT a rigorous, transparent, repeatable method of analyzing certainty across watershed plans and habitat, harvest, and hatchery management sectors.

Methods

The Puget Sound Technical Recovery Team (TRT) used the PN in Figure 1 to assess separately the certainty of biologically effective actions for each plan in four management sectors, 1) freshwater habitat, 2) nearshore habitat, 3) hatchery production, and 4) harvest. Each assessment also considered how well integrated actions were across categories and how the actions affected characteristics of viable salmonid populations (McElhany et al. 2003). The network graphically shows the logic of how different scientific variables affect the biological certainty of effective recovery plans. The model is based on the TRT's *Integrated Recovery Planning for Listed Salmonids: Technical Guidance for Watershed Groups in the Puget Sound* (http://www.sharedsalmonstrategy.org/files). The network shows that the overall biological certainty of an effective recovery plan depends on the certainty of the recovery strategy (Recovery Strategy), the robustness of the strategy (Preserves Options), and the expected effectiveness of actions chosen to implement the strategy. The certainty of the recovery strategy in turn is conditioned by the certainty of how well we understand the biological, physical, and chemical processes that affect the population (i.e. Recovery Hypothesis), which depends on well recognized sources of scientific uncertainty (Lemons 1996), such as model uncertainty (Use of Independent Models), framing uncertainty and stochasticity (Analytical Support), and empirical support for the hypothesis (Watershed Data Quality). After identifying the model structure, the TRT identified and defined different states of the variables (Tables 1-6).

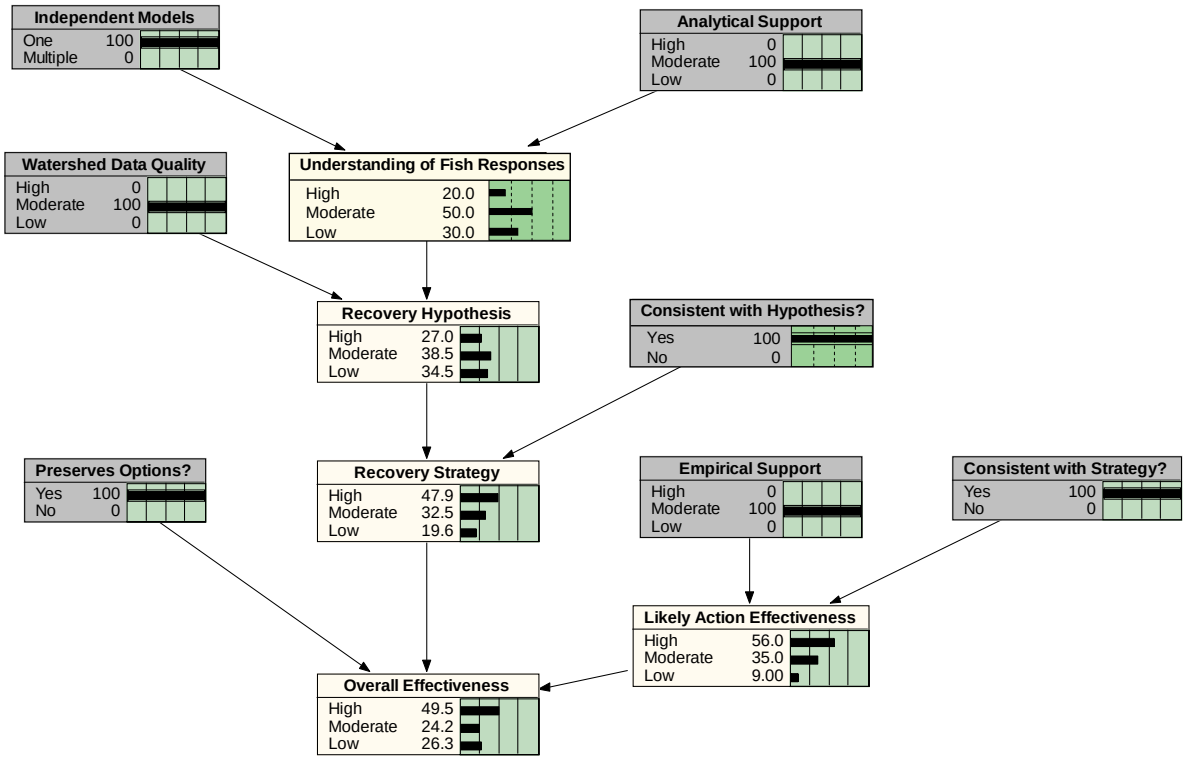

Figure 1. Probabilistic network for evaluating the biological certainty of effective recovery plans illustrating the results of a hypothetical review. Diagnostic nodes are shaded. Numbers at each node are the probabilities for each and the bars show the distribution of the results.

Conditional probabilities may be derived from frequencies from empirical data, simulation results, or subjective probabilities. When data are too few to parameterize simulation models, use of subjective probabilities is important (Bedford and Cooke 2001) and analysts have developed methods for estimating these (e.g. Ayyub 2001). Using experts to estimate subjective probabilities has inherent biases that can be difficult to control (Kahneman et al. 1982, Otway and von Winterfeldt 1992). Using estimates of conditional probabilities within a logical, transparent model such as a PN may reduce these problems compared to asking experts to provide absolute certainty estimates directly without a model. The TRT estimated conditional probabilities using a Delphi process (Helmer 1968, Ayyub 2001) in which TRT members iteratively estimated conditional probabilities individually; the distributions of the results were compiled and shared; and new estimates were generated. Sensitivity of the model was evaluated using the mutual information index (Pearl 1988) which measures the reduction in entropy of variable *A* due to a finding at *B*.

The TRT qualitatively assessed the states of seven diagnostic variables (box titles in parentheses) that address these questions:

1. Did the analysis use one or multiple independent models to understand potential fish responses to actions? (Independent Models)
2. How well supported is the model? (Analytical Support)

3. How well supported is the recovery hypotheses with watershed specific data? (Watershed Data Quality)
4. Is the recovery strategy robust by preserving options for recovery? (Preserves Options)
5. Is the recovery strategy consistent with the recovery hypothesis? (Consistent with Hypothesis)
6. Are the recovery actions consistent with the recovery strategy? (Consistent with Strategy)
7. How well have the recovery actions been shown to work? (Empirical Support)

The possible answers to these questions are in Tables 1-6. Reviewers usually choose one state, but if this is not possible because of uncertainty, reviewers could assign probabilities to different states (e.g., "Low" = 10%; "Moderate" = 90%). Analyses were performed using Netica (Norsys Software Corporation, Vancouver, BC; http://www.norsys.com).

Interpreting the Results

Even the best recovery plan is inherently uncertain because the future is so difficult to predict. Consequently, the quantitative estimates of certainty generated by the TRT are less important than the relative improvement that watershed planners need to make. For similar reasons, the quantitative estimates of certainty generated by the TRT are not relevant to analyses of certainty performed by regulatory agencies, which depend on a different interpretation and standard of certainty. Based on the TRT analyses, watershed planners may be able to increase the certainty of biological effectives several fold by focusing on several key factors. These are described in individual watershed analyses.

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Table 1. Attributes for different states of analytical support for models.

Analysis	Total Score	Attributes (Maximum Possible Score)
Habitat Models High Moderate Low	 0.60 -1.00 0.21 - 0.60 0 - 0.20	• Qualitative and/or quantitative description of the relationship landscape processes, landuse, and habitat condition – (0.1 for each analysis) • Qualitative and/or quantitative description of the relationship between habitat condition and population viability (VSP) characteristics – (0.1 for each analysis; 025 for each VSP characteristic) • Model structures and parameters for each VSP characteristic documented; assumptions discussed and defended – (0.2) • Sensitivity of model to changes in parameters known – (0.2) • Model tested empirically and calibrated to watershed – (0.2)
Harvest Models High Moderate Low	 0.60 -1.00 0.21 - 0.60 0 - 0.20	• Qualitative and/or quantitative description of link between demographic processes, harvest effects, and population viability (VSP) characteristics– (0.2 for each analysis; 0.05 for each VSP characteristic) • Model structures and parameters for each VSP characteristic documented; assumptions discussed and defended – (0.2) • Sensitivity of model to changes in parameters known – (0.2) • Model tested empirically and calibrated to watershed – (0.2)
Harvest Models High Moderate Low	 0.60 -1.00 0.21 - 0.60 0 - 0.20	• Qualitative and/or quantitative description of link genetic and ecological processes, hatchery effects, and population viability (VSP) characteristics – (0.2 for each analysis; 0.05 for each VSP characteristic) • Model structures and parameters for each VSP characteristic documented; assumptions discussed and defended – (0.2) • Sensitivity of model to changes in parameters known – (0.2) • Model tested empirically and calibrated to watershed – (0.2)

Table 2. Attributes for different states of the quality of watershed data (support for hypotheses)

States	Attributes
High	• Used empirical population, habitat, and management data from the local watershed at multiple spatial scales to support hypotheses; sources clearly documented; assumptions explained
Moderate	• Used empirical population, habitat, and management data for watersheds or populations within the species' range OR used local watershed data but data highly uncertain or assumptions not well explained
Low	• Used theoretical support for hypothesis or expert opinion based on biological principles and local knowledge of the watershed

Table 3. Attributes for different states of consistency of recovery strategy with recovery hypothesis.

States	Attributes
Yes	Clear and logical relationship between the recovery hypothesis based on processes and conditions for habitat, harvest, and hatcheries and the recovery strategy as evidenced by • Main elements of strategy organized around dominant recovery hypotheses • Elements of strategy reflect spatial attributes of recovery hypotheses • Elements of strategy reflect temporal attributes and action sequencing of recovery hypotheses
No	No clear and logical relationship between recovery hypotheses and strategy; one or more of attributes listed above missing

Table 4. Attributes for different states of preservation of options in the recovery strategy

States	Attributes
Yes	• Strategy protects existing population viability (VSP) structure and opportunities for future improvement in habitat, harvest, and hatchery conditions; adaptive management & monitoring program maintains options for implementing strategy
No	• Strategy does not protect existing VSP structure or opportunities for future improvement in habitat, harvest, and hatchery conditions; adaptive management & monitoring program does not maintain options for implementing strategy

Table 5. Attributes for states of consistency of actions with recovery strategy.

States	Attributes
Yes	• Clear and logical relationship between the short-term and long-term actions and recovery strategy recovery hypothesis • Elements of strategy reflect spatial attributes of recovery hypotheses • Elements of strategy reflect temporal attributes and action sequencing of recovery hypotheses • No strong relationship between fish response models and recovery hypothesis
No	• Actions generally consistent with recovery strategy but major actions are missing or staging of major is inconsistent with recovery hypothesis • Little relationship between actions and strategy; major short-term and long-term actions do not follow from the recovery hypothesis and strategy

Table 6. Attributes of empirical support of recovery actions.

States	Attributes
High	• Evidence for effects of suites of actions (in habitat, harvest, or hatcheries) is clear and unambiguous; broad applications have been tested with similar results; uncertainty incorporated in assessments
Moderate	• Some empirical evidence of effectiveness in similar settings; few tested applications; some conflicting results; predictions of effect do not incorporate uncertainty
Low	• Little or no empirical evidence of the action being effective or appropriate

IV. PAGE SPECIFIC COMMENTS ON WATERSHED PLAN

These include specific comments and questions by identified reviewers. Questions or clarification may be obtained from the reviewer.

Reviewer 1: Kit Rawson

/p 4/ The purposes of this plan are to identify the actions necessary to recover the salmonid populations which use the nearshore areas of WRIA 6, especially listed species, and to outline the framework for implementation of recommended actions that have been agreed to by community stakeholders and local, state, tribal, and federal governments in WRIA6.

The Watershed's Vision /p 5/ On a regional scale, the ultimate goal of salmon recovery efforts in WRIA 6 and Puget Sound as a whole is healthy, self-sustaining runs of salmon which are robust enough to support sport and commercial harvest.

We envision:
- Abundant, naturally-spawning Pacific salmon using Island County's nearshore and coastal streams
- Diverse, viable populations of salmon coexisting with the human population and supporting human harvest
- Strong community participation in ecosystem conservation and restoration

For thousands of years before Europeans arrived in Puget Sound, salmon were a staple of the Coast Salish peoples who harvested them primarily from traps in the nearby river systems.
(In-river traps were not the only, or necessarily primary, method of salmon harvest by the tribes in aboriginal times. Also, tribal fishing remains culturally important today; it isn't just historical.)
/p 6/ Our overriding goal over the next 100 years … (This is the most realistic estimate of the time frame I have seen in any plan.)

Our overriding goal over the next 100 years is to achieve a net increase in salmon habitat through voluntary protection and restoration of naturally-functioning ecosystems that support self-sustaining salmon populations and the many species that depend on them.
(But how much increase, and how does this relate to the goals for the populations that use the waters. And what about forage fish goals and how they relate to salmon population goals?)

/p 8/ Table 1 caption should make it clear that this is for juvenile salmon and that the conclusions are somewhat speculative.

Table 2 shows the decline in chinook sports catches preceeding listing in 1999. (This is of some interest, although catch = abundance * effort * catchability, so catch data alone don't mean too much without noting changes in seasons, effort, etc.)

/p 9/ It isn't clear that Island County has adopted the Shares Strategy planning targets, and there doesn't seem to be a 10-year target for the WRIA. It would be very difficult for them to adopt a 10-year target compatible with the individual watersheds' 10-year

targets unless they had previous seen and understood those targets, however.

/p 10/ Table 3 – recent average escapements are not directly comparable with planning targets, since planning targets are equilibrium abundances. Therefore the percentages given to compare current abundances with planning targets aren't strictly accurate. I went into this in more detail in Stillaguamish and Snohomish notes.

/p 12/ The summer and fall runs, although smaller, provide genetic diversity
(This was probably meant to read "summer and winter".)

/p 13/ Table 4 lists the abundance and escapement goals for these populations. (Need the source of these goals. Whose goals are they? These aren't related to the new TRT summer chum population delineation.)

Summer chum do not spawn in Island County streams but like chinook the summer chum juveniles likely utilize the extensive nearshore habitats found along Island County shoreline. This assumption is supported by thirty years of survey work completed by WDFW, which has documented the consistent use of the entire nearshore area of WRIA 6 by juvenile chum.
(True, but there is no proof these are summer chum. In fact the majority on the east side of Whidbey and both sides of Camano are form the large Skagit, Stillaguamish, and Snohomish fall chum runs.)

/p 14/ Figure 2 does not reflect our current HC SC population delineation.

/p 15/ I skipped bull trout parts.

/p 24/ Today, harvest of anadromous salmon in Puget Sound is controlled by the principles of the 1986 Puget Sound Salmon Management Plan (PSSMP) which lays out the legal basis for the conservation and allocation of salmon between treaty Tribes and non-treaty harvesters.
(Thank you for mentioning the PSSMP. The correct citation for it is *Puget Sound Salmon Management Plan.* 1985. United States v. Washington (1606 F. Supp. 1405). (from the Snohomish plan)

In the chinook component of the PSSMP, harvest is constrained to the extent necessary to enable rebuilding of natural chinook populations in the Puget Sound evolutionarily significant unit (ESU), provided that habitat capacity and productivity are protected and restored.
(Actually these principles are in Puget Sound Indian Tribes and Washington Department of Fish and Wildlife. 2004. *Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component.* Northwest Indian Fisheries Commission, Olympia, Washington, USA. March 1, 2004. 1-247.
But the concepts presented here are accurate.)

/p 25/ Each tribe exercises authority over enforcement of tribal commercial fishing regulations,
(Actually tribes enforce all their regulations, whether commercial, ceremonial, or subsistence.)

/p 26/ The hatchery sections reads a little bit like WDFW propaganda.

/p 26/ Island County has no hatchery operations. However, hatchery management programs in surrounding watersheds are likely to be more successful to the degree that Island County conserves and restores the nearshore habitat on which these salmon rely for survival at various life stages.
(Actually there are a few net pen programs in Island County, e.g. Oak Harbor coho and Langley coho. These generally rear fish from WDFW hatcheries, Skagit and Wallace River for the above two examples. The second sentence is accurate and important. Hatchery fish need habitat too.)

/p 27/ Coastal streams in Island County are too small to support commercial runs of salmon,
(I'm not sure what a "commercial run of salmon" is.)

/p 32-33/ habitat limiting factors – threats – listed,
/p 33/ It should be noted that while Island County freshwater and marine ecosystem processes and habitats have been degraded over time, the impacts are not yet as far reaching as those in many of the surrounding watershed areas.
There isn't any information presented to support this statement.

/p 46 ff/ The Strategy section states that the focus is on the nearshore, and therefore on non-local populations. There is an acknowledgement that all populations use the county's waters to some extent, but that, due mainly to geographical proximity, three rivers systems are likely the main contributors, except on the west side of Whidbey, which is a migration corridor for many PS populations. The strategy also acknowledges the importance of forage fish and the habitats that support them. The is all clearly laid out and logical. However, the question of "what will it take?" is not answered. The concept that needs to be added here is that protection and restoration of Island County's nearshore habitats is NECESSARY for some (at least the 10 Skagit-Stillaguamish-Snohomish populations) of the PS Chinook populations to reach their planning targets. I think this can be demonstrated by EDT modeling, even given the very rough manner in which EDT addresses the nearshore. Independent of modeling, I think the strong evidence from Eric Beamer's work, that certain life history trajectories of Skagit Chinook depend on pocket estuaries at some distance from their natal rivers also makes this point. Undoubtedly other arguments could be made here, and it's important to make them.

/p 47/ A recommendation that the citizens of Island County apply the Precautionary Principle in dealing with salmon habitat issues. Under this principle, development activities should be judged against the potential of those activities to harm to human health or the environment. If there is a threat of harm, then precautionary measures should be taken, even if some cause-and-effect relationships are not fully established scientifically. In this context the proponent of a development activity, rather than the public, should bear the burden of proof that the activity doesn't harm the environment.
(What happens when the public is the proponent? For example, Clinton ferry terminal expansion.)

/p 49/ Tribal fishing is also a beneficial use that has been broadly curtailed in Island County waters in recent years.

/p 53/ This strategy does not address project sequencing. Opportunity is still a significant driver in the development of WRIA 6 Salmon Recovery Funding Board projects.
(This is definitely a combined Shared Strategy – SRF Board plan.)

Reviewer 2: Eric Beamer

Referencing - Many statements or results presented throughout the document should be referenced. It is difficult to accept these as "truth" without referencing the source. Also, there are numerous times where references are cited in the text but not listed in the reference list (e.g., page 15 – what is Kraemer 1994, or page 20 – what is Sinclair and Tremblay, 1984 or Trumble 1983?). I did not conduct an exhaustive cross-reference as part of my review but I did find the omissions and lack of referencing made review difficult. Please check and complete.

Page 8 – (a readability issue) You start discussion that includes the term "nearshore" but you have yet to define it specifically. Later (page 26), nearshore is defined. Content between the two sections are somewhat difficult to review without knowing specifically what you mean by nearshore.

Page 8 – This section appears to be the section describing Chinook distribution and the importance of nearshore habitat under Island County's jurisdiction. SRSC has data that can help shape the temporal and abundance picture for wild and hatchery Chinook.

Page 8 – Table 1 is a good table and something to begin building the rationale to justify specific plan actions that relate to VSP parameters for the various Chinook populations and their life history types. However, this idea is not well developed later the document. How are you planning on doing this? There should be direct linkages between the populations (and life history types) shown in Table 1 and the ideas in Tables 6 and 7 that lead to specific (on a map) restoration and protection actions.

Page 8 – Table 1 should be treated as a hypothesis and it could potentially be tested with cwt data on juveniles captured within the Whidbey Basin. SRSC has data from hatchery origin Chinook captured in Whidbey Basin habitat that could be used as a first cut at testing Table 1.

Page 9 – What is the purpose of Table 2? Is the decline in Chinook catch based on a lack of fish or a lack of opportunity to fish (or both)? Should this table be presented in this section of the document?

Page 13 – ESA listed summer chum use of Island County nearshore has yet to be documented. It should be treated as a hypothesis and an action to fill this data gap should be added to the plan. It seems that your examples of chum use are for the Whidbey Basin side of Whidbey Island where three large rivers with healthy fall chum runs empty. It is possible that sufficient sampling is planned for both the Whidbey Basin (e.g., SRSC and others) and the west side of Whidbey Island (Washington Trout) that some juvenile chum could be collected for genetic analysis.

Page 15 (and 38) – What is meant by "enhancement" and could it be in conflict with your stated goals of protecting and restoring processes as a first means of dealing with habitat?

Page 16 – Explain the rationale that the nearshore/estuarine habitat restoration work necessary for Chinook salmon in Island County will benefit bull trout as well? Is this idea true for ESA listed summer chum? Is it your opinion that necessary Chinook work will meet Island County's bull trout and summer chum ESA objectives, or just help out?

Page 20 – Northern Anchovy are not mentioned in this document. NOAA's tow net and SRSC's beach seine efforts have documented both larval and adult Northern Anchovy in Skagit Bay and Saratoga Passage (sometimes dominated catches). What are your hypotheses regarding their importance as forage fish in this plan?

Page 21 and 22 – Maintenance (protection) of existing herring, smelt, and sand lance spawning habitat is stated as the primary forage fish objective. Herring are subtidal vegetated substrate spawners, smelt and sand lance are intertidal beach spawners (but spawn in different seasons), and anchovy are pelagic spawners. How do you intend to protect these habitats? How do you expect the respective forage fish populations will respond (increase, decrease, remain the same) to this plan's goal of protection? What is your rationale that the spawning life stage is the single focus in this plan for forage fish?

Page 22 – This section's text (Puget Sound Food Webs) doesn't really match the title. The section seems more like introductory "global" statements of how salmon are part of the energy flow in a larger ecosystem (ocean, estuary, and freshwater) and how recovery of salmon will benefit other species. What is more important for your plan are hypotheses regarding how food webs operate (or should operate) within the habitats under the jurisdiction of Island County. Certainly, the context is within the larger ecosystem, but what are these food web hypotheses and how might these hypotheses relate to specifics in your plan?

Page 23 – Reference? Do we know that Orcas focused on Chinook salmon?

Page 23 – How will you determine whether any of the four listed NMFS criteria for marine mammal predation on salmon have been met at a given site? It seems you should add specifics to Table 12, Goal 5, Objective 3 (page 51).

Page 25 – What is Island County's role in harvest for this recovery plan? For example, under the hatcheries and hydropower sections (page 26), you state that Island County has no role since there are no hatcheries (which is not entirely true since there are net pen activities within the county) and no hydropower facilities under your jurisdiction or within your landscape. The same sort of "closure" statement is not found in the harvest section.

Page 27 – Coastal streams may also attract juvenile salmon fry to pocket estuaries as well as influence nearshore (or pocket estuary) temperature regimes and productivity. These are true even if no salmon originate from within the costal stream itself. SRSC has data to support these ideas.

Page 28 – The idea of Table 6 is excellent, but it needs more detail to fully review. For example, what criteria breaks an "upper reach" from a "lower reach" in a coastal stream? Where are tidal channels and lagoon water bodies listed as a habitat? How can the beach face definition work if it is defined as extending from "median high water to the intertidal zone"? Also, there are numerous specifics that could be commented on in Table 6 when the habitats have been finalized. For example, herring also spawn on kelp substrate – should this be added to "kelp beds"?

Page 31 and 32 – What is the quantitative difference between "open exposed" and "protected" shorelines? This is a good idea, but I suggest you link it with Table 6 and consider revising Table 6 to nest geomorphically with larger scale landscape features possibly following the ideas presented by PSNERP or SRCS.

Page 31 – What is a "mature juvenile"? These words don't go together.

Page 32 – This is a good statement (intro statement to Habitat Limiting Factors section) and the foundation rationale for habitat actions in this plan.

Page 33 – Channel extension, compounding or rerouting are also important disturbances to hydrology. These commonly occur as landscapes with small streams are developed.

Page 33 – You note that ecosystem processes and habitats have been degraded but it is not as bad as other areas. The statement is not supported. What is the change in processes and habitats in Island County? What is the spatial pattern of this change within Island County? How does it compare to other areas within Puget Sound?

Page 34 – I like the idea of Table 7 and look forward to reviewing it as it becomes more completed. Regarding the last column, if a disturbance reduces salmon survival, it influences both productivity and abundance.

Page 34 – What is meant by "stream impoundments" (as a water quantity stressor)?

Page 40 – How are the WA Conservation Commission (2000) and Shelton and Associates (1999 and 2001) assessments used in this document?

Page 41 – There are ten protection projects listed but it is not obviously that all these protect habitat that listed salmon or bull trout would use. Please clarify which ones fit the goals and strategy of this plan (and why).

Page 43 – Enhancement and Restoration: How much fish habitat (area by type) will be restored by the projects listed in the text? What is the spatial pattern? The same questions are relevant for Appendix B. This information is needed to evaluate the restoration and protection actions in terms of VSP parameters.

Page 44 – The text says that significant fisheries science data gaps exist, yet Appendix A suggests that many of the basics are done for comparing current and historic habitat and identifying protection/restoration opportunities in a comprehensive way. Which is true? What are your plans for doing these analyses?

Page 44 – The plan acknowledges that human population growth in Island County will have an impact on protecting habitat even with GMA and Shoreline Master Plan regulations. What is the human population forecast for Island County over the time period this salmon recovery plan and how will this plan ensure protection of existing habitat given this issue?

Page 47 – How does the "Precautionary Principle" protect habitat? Will it work if it is a recommendation to the citizens of Island County? Places where this kind of principle might already be practiced include pocket estuary sites: Sunnyshore Acres, Elger Bay, and Race Lagoon because development is actively underway. Specific examples of how the county works with developers would be helpful in understanding how this idea works to protect habitat.

Page 49 – How are you going to evaluate GMA and the Shoreline Master Plan for their ability to protect existing habitat?

Page 49 – What is the "Public Benefits Rating System" that will be used in a private lands protection strategy?

Pages 52 – How is this discussion about prioritization of projects related to Appendix C? They don't seem to match. For example, in Appendix C, what is "critical fish habitat"? Is it only habitat that is related to VSP parameters of listed salmon? Does it link directly to Tables 6 and 7? The "Direct Benefits to Salmon" portion is only weighted up to ~16% of the possible score (equivalent to the weight given to partnering potential). This factor seems under weighted. Appendix C also seems to give more credit to restoring habitat than protecting it. This doesn't seem to be consistent with other statements within the plan (protection is a priority). Is this intended?

Regarding prioritization criteria for this plan (a recovery plan for listed salmon), it is my opinion that "science" needs to be separate from "non-science" in your prioritization system. Both are important factors, but first you should develop a system that prioritizes projects from a biological recovery (VSP) perspective. This should be reported as a product. Then, analyze the other (non-science) factors separately so that you can sort out the biological consequences of adopting specific non-scientific factors.

Page 53 – The plan states that "regulation is necessary to maintain ecosystem processes and habitats" and that "habitat restoration activities are voluntary and require landowner approval". Under this strategy, how long will it take (years) to protect and restore the amount and arrangement of habitat needed to achieve listed salmon recovery?