Stillaguamish Plan: Chinook Salmon Populations – 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 from Kit Rawson and George Pess.

I. Summary of Certainty Analysis

The content of this section summarizes the results of our probabilistic network analysis (for description of the approach, see *Section III* of this document.) We view using this certainty analysis in an iterative fashion, to help you in guiding plan revisions. This analysis also will help us strategically track the elements of your plans and how information at each step affects the overall certainty that the proposed actions in your plan will contribute to population and ESU recovery. This section is divided into separate discussions of the certainty in habitat, hatchery and harvest management elements of your plan. You will notice that several questions within each "H" encourage us to check how well the habitat, hatchery and harvest strategies are integrated in the plan. We fully expect that the certainty in your plan's outcomes can be increased by providing more information and documentation—we have highlighted areas we think would be particularly fruitful to focus on in near-term revisions in each section below.

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 plan are to:

- Highlight where multiple, independent lines of evidence were used to support analytical model linking habitat-forming processes, land-use and habitat condition to Chinook population responses.
- Document assumptions made and inputs to EDT for how habitat-related protection and restoration projects affected in-stream habitat conditions.
- Include habitat protection or restoration strategies that take into account the potential effects of floodplain structure and connectivity on in-stream habitat conditions such as flows and fine sediment.
- Provide a clear statement of the short- and long-term recovery goals for the SF Stillaguamish population.

- Provide a description for how the habitat recovery strategy is consistent with the strategies for hatchery and harvest management for the NF and SF Stillaguamish populations.
- Develop an adaptive management plan.

Based on our analysis, developing and implementing the key items above would greatly increase the likelihood of a "high" level of certainty for this plan.

1. *Did the analysis use one or multiple independent models to understand potential fish responses to actions? What is the nature of the analytical support for the model linking salmon population status to changes in habitat-forming processes and in-stream habitat conditions?*

One model was used for each of the NF and SF Stillaguamish populations to evaluate the potential responses of Chinook populations to changes in habitat conditions. The certainty in the analytical model used to link changes in habitat conditions to fish population response in the Stillaguamish plan is moderate.

The EDT model was used to estimate quantitatively the effects of changes in habitat conditions on all 4 VSP attributes of the NF and SF Stillaguamish populations. The EDT model did not incorporate quantitative estimates of the effects of changes in habitat-forming processes (e.g., sediment dynamics, riparian function, floodplain dynamics) or land use/land cover conditions on in-stream habitat conditions or on Chinook. The Stillaguamish plan did have a good qualitative model of the potential degrees of impairment of habitat-forming processes in the Basin, and how those might have affected in-stream habitat conditions relevant to Chinook. How the effects of modeled projects were translated into habitat conditions in EDT is documented in spreadsheets in the computer, but these methods are not yet summarized in the plan. No sensitivity analyses for EDT have been conducted, so it is not clear how modeled results of the effects of habitat restoration and protection projects on habitat conditions might change under different assumptions. Similarly, no analyses have been conducted exploring the sensitivity of the EDT model results to assumptions about how habitat conditions affect Chinook population status. A calibration of the EDT model in the Stillaguamish watershed was conducted for current habitat conditions and current Chinook abundance and productivity data. While the observed data and the EDT model for the NF Stillaguamish agree, the fit is poor between current habitat conditions in EDT and the modeled Chinook population status in the SF Stillaguamish. No calibrations of the model occurred for the effects of habitat restoration projects or for how Chinook diversity might respond to modeled actions.

Near-term steps to improve certainty:

- Highlight where multiple, independent lines of evidence were used to support analytical model linking habitat-forming processes, land-use and habitat condition to Chinook population responses.
- Document assumptions made and inputs to EDT for how habitat-related protection and restoration projects affected in-stream habitat conditions.

Longer-term steps to improve certainty:

- Conduct sensitivity analyses for EDT so that the relative importance of assumptions and model inputs for estimated effects of recovery actions can be understood.

2. *How well supported are the hypotheses for (1) what VSP attributes are most limiting recovery and (2) the habitat-forming processes or conditions that are limiting population response? What is the nature of the watershed-specific data to support either of those 2 hypotheses?*

There is moderate support in watershed-specific data for the habitat factors estimated to be limiting recovery of the NF and SF Stillaguamish populations.

The stated hypothesis in the draft Stillaguamish recovery plan is that 6 primary habitat factors are limiting recovery and if they are corrected, the Chinook in the NF and SF populations will recover. The current condition of the 6 habitat factors in the Basin is relatively well understood. Life-stage specific Chinook productivity data are not available for either the NF or the SF population. Information on the VSP status of the SF Stillaguamish population is not provided. In addition, there is very little information in the Basin on the interactions among habitat-forming processes and land use attributes and how they affect the in-stream habitat conditions used in their modeling.

Near-term steps to improve certainty:

- Summarize what is known in the Stillaguamish Basin about the mechanistic links between habitat-forming processes, land use, and in-stream habitat conditions.
- Document assumptions made about the VSP status of the SF Stillaguamish population.

Longer-term steps to improve certainty:

- Collect data on juvenile use of and survival in different habitat types.
- Monitor and study linkages between habitat-forming processes, land use, and in-stream habitat conditions so that mechanistic links among those can be better understood, protected and restored.

3. *Is the recovery strategy consistent with the recovery hypotheses for population status and key habitat factors limiting recovery?*

The habitat recovery strategy in the draft Stillaguamish recovery plan is not completely consistent with the hypotheses for what population status and habitat, harvest and hatchery problems are limiting recovery.

The habitat hypothesis stated in the plan is that flow and sediment problems in the lower Stillaguamish River are limiting recovery. The proposed habitat recovery strategy addresses potential sources of fine sediment and impaired flow hydrology. In contrast, the habitat recovery strategy does not address how changes in floodplain structure over time (e.g., channelization, bank hardening, loss of off-channel habitat) might affect flows and sediment levels in the lower river. Furthermore, it is not clear how the habitat strategy stated in the Stillaguamish plan relates to the hatchery and harvest management strategies for recovery of the 2 populations. This is especially important in the SF Stillaguamish population, where the goals for recovery are not clearly stated.

Near-term steps to improve certainty:

- Include habitat protection or restoration strategies that take into account the potential effects of floodplain structure and connectivity on in-stream habitat conditions such as flows and fine sediment.
- Provide a clear statement of the short- and long-term recovery goals for the SF Stillaguamish population.
- Provide a description for how the habitat recovery strategy is consistent with the strategies for hatchery and harvest management for the NF and SF Stillaguamish populations.

4. *Does the habitat recovery strategy preserve options for recovery in all 4 VSP attributes through all of the H's?*

The habitat recovery strategy in the draft Stillaguamish recovery plan does not have a well-developed adaptive management plan that preserves options for implementation of the overall recovery strategy.

The habitat recovery strategy protects existing VSP structure and opportunities for future improvements in the "all-H" condition for both the NF and SF Stillaguamish populations. In contrast, there is not a well-developed adaptive management and monitoring program that preserves options for implementation of the all-H strategy.

Near-term steps to improve certainty:

- Include an adaptive management decision framework in the plan that highlights where information from monitoring and evaluation of habitat projects and fish population responses will affect decisions about the overall recovery strategy.

Longer-term steps to improve certainty:

- Design and implement a comprehensive monitoring and evaluation program.
- Use information from monitoring over time to adjust the recovery strategy as needed.

5. *Are the habitat recovery actions consistent with the recovery strategy?*

There is moderate empirical support for the habitat recovery actions identified in the draft Stillaguamish recovery plan.

There is some empirical evidence of the effectiveness of the proposed habitat restoration actions in similar settings, but there are few tested applications of projects such as engineered log jams in the broader context of other restoration and protection actions. Although model predictions about the effects of individual actions are available, some conflicting empirical results occur. Very little is understood about how the cumulative effects of the actions interact to affect habitat-forming processes or in-stream habitat conditions. Furthermore, the analysis of the effects of habitat recovery actions does not incorporate uncertainty in assessments. In particular, evidence for the effects of habitat protection measures (e.g., critical areas ordinances, shoreline management plans) is not discussed.

Near-term steps to improve certainty:

- Summarize existing modeled or empirical support for the effectiveness of habitat protection and restoration actions identified in the plan.

Longer-term steps to improve certainty:

- Design and implement a comprehensive monitoring and evaluation program that can track the integrated, cumulative effects of habitat recovery actions over time.

6. *How well have the habitat recovery actions been shown to work?*

A clear and logical relationship exists between the "all-H" recovery strategy and the proposed habitat recovery actions in the draft Stillaguamish recovery plan.

The major habitat protection and restoration actions identified clearly reflect the major elements of the recovery strategy. The habitat recovery actions logically derive from the spatial and temporal elements of the recovery strategy, and the actions have clear and logical outcomes that are predicted to be consistent with achieving the recovery strategy.

Hatchery Strategy

The TRT used a qualitative, probabilistic analysis to estimate the certainty of an effective hatchery strategy and actions for recovery. This analysis focused on six key questions. The discussion below summarizes the TRT's conclusions for each of these questions. These details of the probabilistic analysis are in *Section III of this document: Analyzing Certainty of Biologically Effective Recovery Plans.*

Hatchery Strategy - North Fork Stillaguamish

Key Issues to Improve Certainty

The most important ways to improve the certainty of an effective hatchery strategy in this plan are to:

- Improve consistency of strategy with recovery hypothesis by identifying long-term VSP goals for the population (especially the proposed exit strategy) and justify the current program size or expected changes in program size.
- Develop and implement an adaptive management plan.

The N.F. Stillaguamish population faces a great deal of uncertainty because of the habitat conditions in the watershed and the opportunities to correct them. Based on our analysis, the hatchery strategy for the population does one of the better jobs of reducing uncertainty. However, by developing and implementing the key issues identified above, our analysis indicated the likelihood of a "high" level of certainty of effectiveness for the hatchery strategy and actions would be nearly eight-fold the current estimate.

How well supported is the understanding of the links between hatchery actions and population viability (VSP) characteristics used in the planning (Analytical Support)?

- The analytical support was moderate.
- The co-managers used a qualitative model (e.g. the Benefit-Risk Assessment Procedure cited in co-managers' resource management plan) to understand the potential affects of hatchery actions on populations. The model addressed all VSP criteria. Documentation is available for the basic model structure but not for how local watershed data (as opposed to general information from the scientific literature and expert guesses) were used to calibrate the model for Stillaguamish River populations. The co-managers have good genetic and demographic data and this is one watershed where it should be possible to develop a qualitative model for the affects of hatchery actions on some VSP characteristics. This would allow the co-managers to examine how sensitive their decisions are to uncertainty in different variables.
- Key actions for this question are 1) better documentation of assumptions of how the analysis was used and 2) using models that will allow managers to assess how the certainty of the results and their decisions is affected by changes in different factors of the model (e.g. through a sensitivity analysis).

How well supported is the recovery hypotheses with watershed specific data? (Watershed Data Quality)

- Support for the recovery hypothesis using watershed specific data for was moderate.
- This question asks if the watershed has data that have been used to independently support the results of the qualitative analysis. The co-managers had good demographic information and some genetic information to support the hypothesis. Information to assess the effects of ecological interactions (e.g. competition, predation, and disease) and domestication on productivity and spatial structure is lacking.
- Key action for this question would be to use available data from other watersheds to increase the analytical support and to document the assumptions that would be part of that.

Is the recovery strategy consistent with the recovery hypothesis? (Consistent with Hypothesis)

- No, but could be Yes.
- Overall, the actions this program has taken to date and the proposed actions in the plan indicate a strategy that should be consistent with recovery. We had two questions about consistency with the recovery hypothesis, however. First, although the plan emphasizes using the hatchery strategy to protect current VSP characteristics, the primary emphasis of the program appears to be on maintaining abundance in the face of lack of productivity because of habitat degradation. This may be consistent with recovery in the short-term, but the long-term exit strategy for the program, for example, appears to be based only on achieving a level of abundance rather than all four VSP characteristics. We believe it should be possible to identify goals for other VSP characteristics as well. Given the thoughtfulness of the overall plan, these may actually exist, but they were not as well identified in the plan. Second, the size of the program appears to be based on the needs of the indicator stock program and not necessarily what is needed for recovery. Would the size of the program change without the needs of the stock indicator program?

- Key actions for this question are to 1) identify all VSP goals for the program and 2) explain why the current size of the program or another size is consistent with what is needed for recovery.

Is the recovery strategy robust by preserving options for recovery? (Preserves Options)

- Not yet
- The plan emphasizes protecting current VSP characteristics (see comment above), which is important for preserving future options for recovery. Preserving options also requires an adaptive management plan to respond to changes and uncertainty as they occur. The hatchery and genetic management plan (HGMP) lists some of the monitoring and evaluation criteria. An additional important piece is how decisions will be made given the results of monitoring and evaluation.
- The key action for this question is to develop an adaptive management plan.

Are the recovery actions consistent with the recovery strategy? (Consistent with Strategy)

- Yes
- The details of the strategy outlined in the recovery plan and associated documents, such as the co-managers' resource management plan and the hatchery and genetic management plan (HGMP) are consistent with the recovery strategy.

How well have the recovery actions been shown to work? (Empirical Support)

- Support for the proposed actions is moderate.
- Experience in other watersheds and the N.F. Stillaguamish River suggests the actions may be working to maintain abundance of the population, although there is considerable uncertainty about other VSP characteristics. Areas that are especially uncertain are 1) the long-term effect of domestications on productivity, and 2) the actions to reduce competition, predation, and other ecological interactions to the extent they are a problem.

Hatchery Strategy - South Fork Stillaguamish

Key Issues to Improve Certainty

The most important ways to improve the certainty of an effective hatchery strategy in this plan are to:

- Get better information on the status of the South Fork.
- Develop a better-defined hatchery strategy.
- Identify actions consistent with the strategy.
- Develop an adaptive management plan.

The South Fork Stillaguamish population faces a great deal of uncertainty because of the genetic status of the population is unknown, habitat conditions in the watershed are degraded, and there is a lack of focus on recovery planning for the population. The Stillaguamish watershed planning group has prioritized the recovery of the North Fork population, which represents important life history diversity in this region. Based on our analysis, however, by developing and implementing the key issues identified above, the likelihood of a "high" level of certainty for biological effectiveness would increase nearly 24-fold.

How well supported is the understanding of the links between hatchery actions and population viability (VSP) characteristics used in the planning (Analytical Support)?

- The analytical support was moderate.
- The co-managers used a qualitative model (e.g. the Benefit-Risk Assessment Procedure cited in co-managers' resource management plan) to understand the potential affects of hatchery actions on populations. The model addressed all VSP criteria. Documentation is available for the basic model structure but not for how local watershed data (as opposed to general information from the scientific literature and expert guesses) were used to calibrate the model for Stillaguamish River populations. Most of the focus of the analyses and the plan were on the North Fork population. Information for the affects of hatchery strategies on the South Fork population appears to be based on expert opinion or local knowledge. These assumptions need to be better identified and described.
- Getting better information on the status of the South Fork population is a key action for this population.

How well supported is the recovery hypotheses with watershed specific data? (Watershed Data Quality)

- Support for the recovery hypothesis using watershed specific data for was low.
- This question asks if the watershed has data that has been used to independently support the results of the qualitative analysis. A major issue for the South Fork population is the lack of information on the relationship of hatchery actions and the status of the habitat to the status of population. Allozyme data showed divergence of North and South Fork populations, which may reflect ancient hydrological relationships or it may reflect straying and release of non-native salmon.
- See recommendation above.

Is the recovery strategy consistent with the recovery hypothesis? (Consistent with Hypothesis)

- No.
- The plan does not identify a specific hatchery strategy for this population, which suggests that the default strategy is to ignore it.
- Key actions for this population are to develop a hatchery strategy that is consistent with recovery. This might include no program for this population or other options, but it needs to be based on information about the status of the population, goals for the population, and the existing habitat, harvest, and hatchery risks to the population.

Is the recovery strategy robust by preserving options for recovery? (Preserves Options)

- No
- There is no defined strategy and no adaptive management plan.
- Key action for this question is to develop an adaptive management plan.

Are the recovery actions consistent with the recovery strategy? (Consistent with Strategy)

- No.

- There is no defined hatchery recovery strategy for this population.

How well have the recovery actions been shown to work? (Empirical Support)

- Support for the proposed actions is low.
- See discussion above about the absence of a strategy and suites of actions to implement it.

Harvest Strategy – North Fork Stillaguamish

NOTE: This evaluation is based on the Stillaguamish Management Unit profile, pages 131-135 of the *Comanagers' Puget Sound Chinook Harvest Management Plan*, as well as material presented in the plan submitted by the WRIA 5 group.

The harvest management portion of the recovery plan is based on the hypothesis that the intrinsic natural productivity of the North Fork Stillaguamish population, under current habitat conditions and recently observed poor marine survival conditions, is sufficiently high to allow for the population to recover if adult the equivalent exploitation rate is less than or equal to the rebuilding exploitation rate (RER) that will guide annual management of this population. The RER for the North Fork Stillaguamish population is .30, which has been adjusted downwards to .25 to reflect the observed discrepancy between exploitation rates estimated directly from coded-wire tag analysis (which the RER calculations used) and exploitation rates estimated by FRAM. The comanagers fitted the observed spawner and recruit data (available in the TRT's Abundance and productivity tables) to a single, hockey-stick type, model and simulated population performance for 25 years with 1000 replications at each exploitation rate tested. The RER was the highest exploitation rate that showed both a smaller than 5% probability of going below the lower escapement threshold of 500 natural spawners in all years and a greater than 80% probability of the population showing positive growth in natural-origin escapement over the 25 year simulation.

Key improvements to the harvest management portion of the recovery plan include:

- Restate or clearly reference in the final plan those aspects of the comanagers' harvest management plan that are essential parts of the recovery plan.
- Expand the hypothesis and the recovery strategy to include the effects of harvest on diversity and spatial distribution.
- Include existing local data pertaining to spatial distribution and diversity to support the expanded hypothesis and the expanded strategy and actions based on it.

Specific ratings:

Was the analysis based on one or many models? One simulation model (VRAP).
The simulation model analyzed three spawner-recruit relationships and used the harvest single hockey-stick type function as best representing the behavior of the North Fork population in recent years.

- The analysis could be improved by including another simulation model that could incorporate spatial structure and diversity.

Analytical support for model: Moderate.
The model includes qualitative and quantitative descriptions of the link between harvest management and abundance and productivity. The effects of harvest on diversity and spatial distribution are not addressed. The documentation for the quantitative analysis is not presented in sufficient detail, and there was no sensitivity analysis performed. Empirical data from the North Fork Stillaguamish support the model conclusions for abundance and productivity.

- Documentation for previously-completed work should be fleshed out so that the conclusions can be evaluated.
- There should be some discussion, and analysis if possible, of the potential effects of harvest management on spatial structure and diversity.

Quality of data used to support recovery hypothesis: Moderate
The recovery hypothesis is supported by local escapement data for the whole population. Recent exploitation rates are well documented for this population by a local exploitation rate indicator stock. There are also local data available to support hypotheses regarding the effects of harvest on diversity and spatial distribution.

- This rating could be increased if the hypothesis were expanded to include diversity and spatial distribution using existing data pertaining to these factors.

Recovery strategy preserves future options: Yes
The harvest strategy appears to protect the existing VSP structure. This is demonstrated for abundance and productivity from recent spawner-recruit data and assumed for diversity and spatial structure because of declining exploitation rates. The harvest management plan has adaptive management built in to it and there is a local North Fork Stillaguamish indicator stock, which can be used to assess exploitation rates and productivity annually.

- The plan needs to include a definite schedule for implementing the adaptive management plan, including the conditions under which the RER would be modified.

Recovery strategy is consistent with recovery hypothesis: No
The harvest management strategy is consistent with the hypothesis regarding abundance and productivity. However, the hypothesis does not consider diversity and spatial distribution and therefore these are not included in the strategy.

- The plan's certainty of success would be increased if the hypothesis and the recovery strategy were expanded to include the effects of harvest on diversity and spatial distribution.

How certain is the empirical support for the effectiveness of the recovery actions: High
The recovery plan calls for reduction of the annual exploitation rate to the RER or below. Recent data, from the North Fork Stillaguamish and using a local indicator stock documents that the exploitation rates have been reduced and that these reduced exploitation have resulted in increased abundance on the spawning grounds. The plan discusses the FRAM model that will be used for annual implementation of the RER and the RER has been adjusted based on a comparison of the FRAM and CWT assessments of the exploitation rate.

- Use existing spawner survey and other data to document whether reduced exploitation rates have improved spatial distribution and diversity.

Are the harvest management recovery actions consistent with the plan's all-H recovery strategy: Yes
The harvest management strategy is based on an analysis that incorporates the abundance and productivity that results from existing habitat conditions. The strategy includes a discussion of how guidelines will be modified if improved or degraded habitat changes abundance or productivity. The plan also includes an implied hypothesis that harvest rates on hatchery fish will be low enough to allow hatchery supplementation fish to migrate to natural spawning areas in the numbers contemplated by the hatchery plan. However, with the advent of selective fisheries and the possibility of hatchery and wild fish being subject to different exploitation rates, this assumption may not be valid.

- Inclusion of a strategy for the marking or non-marking of hatchery fish and for management of the harvest of marked fish consistent with the goal of using hatchery fish for supplementation of spawning escapement would improve the plan's likelihood of success.

Harvest Strategy – South Fork Stillaguamish

NOTE: This evaluation is based on the Stillaguamish Management Unit profile, pages 131-135 of the *Comanagers' Puget Sound Chinook Harvest Management Plan*, as well as material presented in the plan submitted by the WRIA 5 group.

The harvest management portion of the recovery plan is based on the hypothesis that the intrinsic natural productivity of the South Fork Stillaguamish population, under current habitat conditions and recently observed poor marine survival conditions, is sufficiently high to allow for the population to recover if the adult equivalent exploitation rates is less than or equal to the rebuilding exploitation rate (RER) that will guide annual management of this population. The RER for the South Fork Stillaguamish population is based on the North Fork Stillaguamish analysis because there is no separate indicator stock for the SF Stillaguamish and observed data for the SF Stillaguamish did not fit any model well.

Key improvements to the harvest management portion of the recovery plan include:
- Restate or clearly reference in the final plan those aspects of the comanagers' harvest management plan that are essential parts of the recovery plan.
- Expand the hypothesis and the recovery strategy to include the effects of harvest on diversity and spatial distribution.
- Include existing local data pertaining to spatial distribution and diversity to support the expanded hypothesis and the expanded strategy and actions based on it.

Specific ratings:

Was the analysis based on one or many models? One simulation model (VRAP).

The simulation model analyzed three spawner-recruit relationships and used the harvest single hockey-stick type function as best representing the behavior of the South Fork population in recent years.

- The analysis could be improved by including another simulation model that could incorporate spatial structure and diversity.

Analytical support for model: Low
The model includes qualitative and quantitative descriptions of the link between harvest management and abundance and productivity. The effects of harvest on diversity and spatial distribution are not addressed. The documentation for the quantitative analysis is not presented in sufficient detail, and there was no sensitivity analysis performed. There are no empirical data from the South Fork Stillaguamish to support the model conclusions for any VSP measure.

- Documentation for previously-completed work should be fleshed out so that the conclusions can be evaluated.
- There should be some discussion of the potential effects of harvest management on spatial structure and diversity.

Quality of data used to support recovery hypothesis: Moderate
The recovery hypothesis is supported by local escapement data for the whole population. Recent exploitation rates are well documented for the North Fork Stillaguamish population by a local exploitation rate indicator stock. Escapement data from the South Fork could be used to support hypotheses regarding the effects of harvest on diversity and spatial distribution.

- This rating could be increased if the hypothesis were expanded to include diversity and spatial distribution using existing data pertaining to these factors.

Recovery strategy preserves future options: No
The harvest strategy appears to protect the existing VSP structure. This is demonstrated for abundance and productivity from recent spawner-recruit data and assumed for diversity and spatial structure because of declining exploitation rates. The harvest management plan has adaptive management built in to it. However the lack of a local South Fork Stillaguamish indicator stock, and the lack of fit of available data to spawner-recruit models, suggests that the adaptive management plan may be difficult to implement for this population.

- The plan needs to include a definite schedule for implementing the adaptive management plan, including the conditions under which the RER would be modified.
- The plan also needs to include a means by which exploitation rates specific to the South Fork Stillaguamish population will be assessed for monitoring and adaptive management.

Recovery strategy is consistent with recovery hypothesis: No
The harvest management strategy is consistent with the hypothesis regarding abundance and productivity. However, the hypothesis does not consider diversity and spatial distribution and therefore these are not included in the strategy.

- The hypothesis needs to be expanded to include the effects of harvest on diversity and spatial distribution and the strategy needs to be expanded to address these factors.

How certain is the empirical support for the effectiveness of the recovery actions?: High
The recovery plan calls for reduction of the annual exploitation rate to the North Fork RER or below. Recent data, from the South Fork Stillaguamish, documents that South Fork escapements have increased as North Fork exploitation rates have declined. The plan addresses the FRAM model that will be used for annual implementation of the RER and the RER has been adjusted based on a comparison of the FRAM and CWT assessments of the exploitation rate.

- Existing data should also be used to document whether reduced exploitation rates can improve spatial distribution and diversity.

Are the harvest management recovery actions consistent with the plan's all-H recovery strategy?: Yes
The harvest management strategy is based on an analysis that incorporates the abundance and productivity that results from existing habitat conditions. The strategy includes a discussion of how guidelines will be modified if improved or degraded habitat changes abundance or productivity.

- Inclusion of an assessment of the stock composition of the South Fork escapement would help determine whether the increased escapement that is correlated with reduced exploitation rates comes primarily from local stock or from strays from nearby hatchery and wild stocks.

REVIEW TEMPLATE FOR TECHNICAL REVIEW OF DRAFT WATERSHED PLANS

Reviewer's Name: **Puget Sound Technical Recovery Team**

Watershed Plan: **Stillaguamish**

Populations or ESUs considered: NF Stillaguamish Chinook
SF Stillaguamish

Summary

Overview of Shared Strategy questions and how well the watershed plans address the technical aspects of those questions. In particular, what is the watershed's technical basis to the answer to the questions from the Shared Strategy: (1) What are the major physical and biological changes necessary to meet the population planning targets? And (2) What are the expected changes in H's and fish population responses over the next 5-10 years?

The Stillaguamish plan states what biological change is expected. In addition, it also makes a genuine attempt to link harvest, hatchery, and habitat management. For example it discusses how goals cannot be met with habitat alone and goes through one example of how hatchery practices can be altered due to environmental condition. This is a major step towards a true integrated analysis.

Brief narrative of how well the plan addresses the following; including strengths and weaknesses:

1. **What biological and physical changes does the plan state are required for the population(s) 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?

The plan (p 43) states that PFC conditions (presumably throughout the basin) are required for the two populations to achieve their targets. This is based analysis with EDT, (see Table 9, p. 73 for results). The details of the EDT inputs and analysis are not provided. The Excel spreadsheets and EDT input tables in Access available from Snohomish County should be referenced in the plan. The May 14, 2004, Mobrand Biometrics report listed in the references is apparently not really a report, but rather a series of Excel spreadsheets and EDT model outputs. This should be made clearer in the plan.

The SIRC then used those EDT results to set PFC habitat condition performance targets for each of 6 categories of habitat limiting factors. The performance targets for each are: (1) riparian (8,000 acres needed planting and protection with specified buffer widths), (2) LWD (80 pieces LWD/mile = 3,700 more pieces or ~62 new ELJs), (3) floodplain (<10% streambanks/reach hardened), (4) estuary (3,500 acres of estuarine areas restored, (5) sediment (<12% fines, road instability, landslides and unstable banks contributing but not linked to fines), and (6) hydrology (37,639 acres of immature vegetation grows to maturity).

It is not clear how the quantitative performance targets were developed, what the link is between target and condition (e.g., how does acreage of mature vegetation relate to flows?), nor what assumptions were made about what the rest of the watershed's conditions are in each of the habitat categories. Performance targets for sediment were not developed. These items should be addressed in the final plan.

The plan does not address in detail the physical process that will have to be modified in order to PFC habitat conditions to prevail in order for the long-term recovery goal to be achieved. In general, the specific actions that will have to occur in order to achieve PFC conditions are not addressed. Although it may not be possible to describe these long-term actions in detail at this time, the final plan should indicate how actions that will take place after the first ten-year period will be developed.

2. **What biological goals does the plan aim to achieve (in 5-10 years and over longer term)**
See answer to 3 below.

3. **What are fish-based and habitat, hatchery or harvest management-based goals?**

The long-term planning targets and 10-year goals (p 73-74) are clearly stated and graphed in terms of average population performance. However, there is no expected time period given for achieving the planning targets. The final plan should address this to the degree possible.

The 10-year goals are stated as habitat performance targets for each of 6 categories of habitat condition: riparian, estuarine, large wood, floodplain, sediment, hydrology, water quality (see pp. 23ff for details.) The performance targets are very quantitative and specific (p. 58ff). The predicted resulting VSP parameters if those 10-year habitat milestones are met are presented in Table 9 (approx. 30% of abundance targets are predicted).

The goal section mentions the spatial structure and diversity but does not state what the plan's goals are for these 2 population attributes. The EDT analysis addresses diversity and spatial distribution together as the "life history diversity" output. Has the group adopted any other goals for spatial structure and diversity or attempted to separate these two population attributes? If so, those goals should be in the plan.

4. **What is the biological RATIONALE for identified actions in all of the H's (i.e., is the "hypothesis-strategy-action" logic presented in the watershed guidance document used?)**

(a) What is the population's current status for all 4 VSP (this should come out under the hypotheses)?

The plan (p 7) states that the current status is about 8% of historical levels. Table 9 (p 73) shows numbers indicating that the NF is at 13%, 18%, 6%, and 45% of the target levels for productivity, capacity, equilibrium abundance, and life history diversity, respectively, and the South Fork population is currently 23%, 20%, 14%, and 58% for those same measures. The plan (p 7) says that average recent adult escapement numbers are about 1600-1700, which would be about 5% of the target equilibrium abundance. The plan provides some information on diversity in terms of stream type and ocean type juvenile outmigrants (p 7) suggesting that 91-96% are ocean-type. Some information on spatial distribution of spawners is provided (p 11) suggesting that 80% of NF Chinook spawn in mainstem NF. Information for the South Fork population is not provided separately even though it is available in TRT databases. The final plan should include separate data for the South Fork population.

There is a statement that “growth during river and estuarine residence is critical to marine survival of Chinook” (p. 24)—that should be stated as an hypothesis, and evidence/basis for statement should be included in the final plan.

There is a good discussion of the potential historical status of VSP—especially the likely life history diversity that existed in the Basin (e.g., spring-run? P. 30 in STAG.) It isn’t clear how this information is used later in the document to identify recovery actions.

(b) What is the population’s predicted status for all 4 VSP over the short- and long-term?

The plan reports results from the EDT modeling of the implementation of 10-year habitat performance goals (Table 9 p. 73) : the NF Stillaguamish is predicted to produce approx. 6,000 equilibrium abundance spawners (relative to 17,800 target equilibrium abundance), 5.4 intrinsic prod (11.9 target), and 86% diversity (100 target). The SF Stillaguamish is predicted to produce 3,000 equilibrium abundance (15,000 target), 3.4 intrinsic prod (10.7 target) and 79% diversity (100% target). The final plan should state the assumptions made for harvest and hatchery management, and how habitat conditions were translated into population effects, so it is not possible to evaluate the confidence in these results.

(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? Be explicit about each threat or potential factor limiting recovery.

As in other plans, the potential habitat, hatchery and harvest problems (limiting factors) are stated as facts, rather than as hypotheses throughout the document. It improves both the plan’s treatment of certainty in what is known and its vision for implementation to treat information on threats as hypotheses (see TRT Watershed guidance document.) Phrasing H factors potentially limiting recovery as hypotheses acknowledges that such a judgment is based on best available (but imperfect) information, and also forces plan authors to treat H factors as potential effects on VSP that need to be monitored to that we can learn over time about the nature and magnitude of the actual effects.

Habitat limiting factors are grouped into six categories: riparian, estuarine,
large wood, floodplain, sediment, and hydrology, which is a useful organization. Forest practices affect most of these and are presented as a principal factor contributing to the decline of Stillaguamish Chinook. Forest practices, agriculture, and residential development all affect hydrological function, which is given as a key critical threat to these populations. Most all of the 6 factor descriptions should refer more to the STAG report discussions, since the information presented in the main plan is too general and sparse to provide a rationale for the proposed effects. The nearshore description is stated as hypothesized effects of habitat changes, which is a good model for the other factors. The list of limiting factors in the STAG 2000 report is much more precise (e.g., mentions loss of side channels, high summer temps), and I don’t see the same factors addressed explicitly in the main plan (e.g., p. 45 STAG nice detail on water quality problems—these are not treated explicitly in the plan.)

The rationale for the choice of the 6 habitat factors as being the critical ones is not well stated in the plan and should be (exception: flow). The STAG report does a better job of justifying their importance (pp. 42ff).

Primary habitat threats needing improvement are described in this plan as a combination of instream habitat conditions and the landscape-forming processes that affect some of those conditions. To answer the question of what are critical 'threats', a discussion of both current habitat conditions and processes is needed, and then in turn, what land use or other actions affect the state of the instream conditions or processes (e.g., is sediment a critical problem? Temperature?)

It is a good feature of this plan that "other" factors potentially affecting Chinook (i.e., ocean conditions, predation, NIS, climate) are included. However, there is no attempt to estimate the relative importance of these factors to Stillaguamish Chinook, so it is hard to know how the plan uses this information in designing a recovery plan.

The harvest management plan is presented in terms of its goal to not impede the ability of the populations to recover if other factors are adjusted so that they can recover. There is a clear section on potential harvest effects. The potential effects of harvest should be stated as hypotheses for past and present effects on the Stillaguamish populations (p35-6).

The hatchery program is presented as a means to maintain the North Fork population which otherwise might severely decline due to potentially high mortality rates during egg incubation, emergence, and early rearing. The potential effects of hatchery practices (generally and specifically for the Stillaguamish) are fairly well described in the plan (p.36) and in the STAG document (p. 59ff). The fraction of hatchery fish in the NF Stilla is reported to be about 30% in the plan, but the STAG document points out that this fraction is highly variable, ranging up to 90%. The plan also states that the NF supplementation program is necessary for that population's persistence, but it is not possible to tell from the document what the rationale for that statement is. It is not stated how well the hatchery management practices fared in the HSRG review and whether any changes in hatchery management suggested by the HSRG are anticipated in the future.

Critical threats:
1. Forest practices ---→ Hydrologic function ---→ peak flows, sedimentation, temperature
2. Agricultural practices --→ Loss of riparian areas, wetlands, side channels, and estuary & restriction of natural floodplain processes
3. Conversion to residential/urban uses ----→ Hydrologic function ---→ peak flows, water quality, bank hardening, disruption of floodplain processes
4. Harvest and hatchery management are not seen as potential critical threats in this plan based on current management plans.

(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 strategies are well expressed for addressing the primary habitat, hatchery and harvest factors (although hatchery and harvest factors are not expressed as potential threats; pp. 50ff). The rationales for the strategies are not linked to potential problems in population status (ie., VSP) or the stated habitat factors limiting recovery.

The habitat strategy consists of a series of guidelines in each of the six categories identified for habitat limiting factors, followed by a list of geographically-specific and factor-specific potential actions. These actions are quantified in terms of numbers of engineered logjams, numbers of acres restored, miles of roads improved, etc. However, specific projects with specific actors carrying out the projects are not given. This way of describing the actions facilitates analysis of costs and of potential effects (using EDT), but it does not provide any information regarding actual implementation. It is possible that there is a more detailed list of projects with this information, but I couldn’t find it or a reference to it. The way that the actions are organized by category and geographic area provides a link to the discussion of critical threats. However, it is not clear how priorities, which are given, were set. Although the nearshore habitat is discussed, actions in this area are not in the plan.

The general approach linking habitat factors to actions is to categorize habitat indicators into 6 types and to list potential project types that could be used to address each factor (e.g., p. 58ff). A set of geographic criteria (based on current Chinook use, potential to restore function, upper watersheds that are most likely to contribute positively to downstream conditions for Chinook) are used to determine where project types would be most beneficial to the Stilla pops. More deatail should be provided regarding how quantitative levels for each restoration project are determined, or what the rationale for those is. The lists of actions under each habitat factor are almost exclusively restoration actions—why are no protection strategies included? Consideration of the certainty that proposed restoration projects will be successful should encourage a mix of restoration and protection strategies. (e.g., 62 additional ELJs are suggested in the plan for a 10-year habitat milestone—how well have the existing ELJ’s worked to produced improvements in VSP?) Furthermore, with the focus on currently productive Chinook areas, the future potential (based on historical potential) is not considered. The overall strategy would be strengthened by indentifying areas that were productive historically and indicating how restoration of these will be part of the recovery plan.

It is not possible to evaluate the strategy for harvest and hatchery management, given the detail presented in the plan. The plan should document how are harvest levels or hatchery release numbers (or other practices) determined (e.g., p. 54--why is the NOR goal for the NF Stillaguamish 700 and how does this relate to the harvest management guidelines?) How well have targeted RERs, escapements matched observed? How was the 220,000 targeted sub-yearling hatchery release number determined? A concise statement of how harvest levels or hatchery management practices are adjusted based on desired salmon population goals should be included (or referenced).

(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.

Hypotheses for how habitat factors affected (or are affecting) VSP parameters in the 2 populations should be made more explicit; these hypotheses should come out of the results of the diagnosis phase of EDT modeling. The plan should summarize an important missing link in its logic: what are the current and desired states of salmon population status, what habitat factors are most critical in limiting recovery to VSP goals, and what actions will effectively improve habitat factors so that VSP targets can be achieved?

The "other" factors potentially affecting Chinook (i.e., ocean conditions, predation, NIS, climate) are not linked to potential effects on VSP in the 2 Stilly pops, so it is difficult to see how such information affected decisions in the plan.

There is a general discussion of how harvest may have affected (or is affecting) VSP of the Stillaguamish Chinook in the STAG document (p. 26). A good example of how harvest could have affected diversity is illustrated by an example of the potential effect of harvest on the age distribution (p. 26).

Hatchery effects on VSP are stated in very general terms—not specific to VSP parameters or magnitude of predicted effects.

(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)?

Other than acknowledging general marine survival variability, here are no assumptions for habitat conditions outside of WRIA 5. Assumptions for conditions outside of the watershed proper should be stated. The plan does acknowledge other factors, such as mammalian predators, climatic shifts, and non-native species, but the potential effects of these on the effectiveness of the actions are not discussed. The analysis underlying the harvest management plan does include an empirical estimate of whole life cycle survival under current conditions and therefore implicitly assumes that future conditions will remain the same as current.

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

Future options depend upon including a strong component of effectiveness monitoring for the first set of actions implemented under the plan. It is not clear that this is part of the plan.

5. What is the empirical or modeled SUPPORT for the answers to question #3? How well do the assessment data for the population status and the H's support the hypotheses proposed?

(a) What is the population's current status for all 4 VSP (this should come out under the hypotheses)?

The population status is based on spawner surveys. It is not clear why information from the SF Stillaguamish population is not presented separately. Since there are no explicitly stated hypotheses for what VSP status is, it's not possible to tell how well the hypothesis is supported by data or models.

The numbers in Table 9 (p 73) are based on a recent EDT analysis. The recent spawning escapement numbers cited in the plan are confusing and do not match up with number I have for total escapement or for natural origin natural escapement. I provided my numbers in Appendix A of my (KR) notes on this plan. Recent average estimated natural origin part of natural escapement to the NF Stillaguamish is 673 (from my numbers), which is 78% of the EDT-modeled current equilibrium abundance and 4% of target equilibrium abundance. Recent average SF natural origin escapement is 263, which is less than 10% of current conditions equilibrium abundance form EDT and about 1.5% of target equilibrium abundance. Clearly the escapement data and EDT analysis are not saying the same thing for the SF population. Also, there is an independent analysis of spawner capacity of the Stillaguamish, done by NWFSC that should be included as backup.

The assertions regarding stream type vs. ocean type breakout (p. 7) apparently come from outmigrant trapping in the North Fork. We did not have time to consult the reference, but we are concerned that potential differential catchability of stream type and ocean type outmigrants may not have been taken into account. There was no reference to support the assertion regarding spawner spatial distribution (p.11), but this probably comes from WDFW escapement surveys. The source should be cited.

(b) What is the population’s predicted status for all 4 VSP over the short- and long-term?

All predictions of future status are based on EDT. Detailed documentation is not provided in the plan itself. However, Snohomish County can provide this in the form of computer files.

(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? Be explicit about each threat or potential factor limiting recovery.

The draft chapter discusses the threats from the various habitat categories in detail, but does not provide analysis to support the listing of these particular threats. The mass of facts seems to make the case, however. Since EDT analysis has been done, the results form the diagnosis phase should be presented to support these conclusions. The hypothesized effects of the main habitat factors considered are bolstered by a narrative argument, and a summary of previous studies conducted in the Basin (mostly contained in the STAG document.) Some statements about impacts are made with no evidence presented (e.g., that forestry practices have “contributed significantly to the decline” (p. 17)….these should be stated clearly as hypotheses, and their basis should be included.

There is no referenced rationale for the reasoning underlying the harvest hypothesis—either that past rates likely contributed to declines or that present rates should allow for recovery. The comanagers’ harvest management plan is designed so that harvest management will not be a threat to the recovery of populations like the NF and SF Stillaguamish. This plan is cited in the draft chapter, but there is insufficient detail presented to evaluate this claim. There are some important details left out, such as the fact that the minimum exploitation rate can be exceeded if Canadian interceptions are sufficiently high or how the lower escapement threshold is used in the harvest plan. Reviewers would have to go through at least the Stillaguamish Management Unit Profile, and perhaps the entire harvest management plan, to adequately evaluate it relative to these populations. Some of the discussion of the harvest management plan could be made more specific to the Stillaguamish populations to better communicate its details to readers of this chapter.

The hatchery hypotheses are supported mainly by literature for the general possibilities of effects. There are narrative arguments for how local hatchery programs might affect Chinook through various means (e.g., competition, predation) and some more detailed Stillaguamish-specific information provided in the STAG document, which should be referenced in the plan. The discussion of the hatchery supplementation program could be improved as well to better communicate with readers. There are some confusing points that need to be cleared up, for example the statement that the escapement “goal” is 700 Chinook. In addition, the discussion accurately enumerates a number of potential hazards of Chinook hatchery programs without addressing the ways in which these hazards are being ameliorated in the specific case of the Stillaguamish program. There are also some remaining questions about the effectiveness of the hatchery supplementation program, such as potential competition between hatchery and wild fish in natural spawning or rearing areas that could be addressed through monitoring and research.

(b) 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.

There is a common understanding of the threats that underlies the proposed actions in all three h’s. The desired future status in 10 years is based on an EDT analysis of the effects of the proposed habitat actions, so they are necessarily consistent. It is obvious that the plan writers had in mind the processes that affect the habitat attributes, but the link between processes and attributes is not clear or part of a formal analysis. The harvest plan is designed to allow the populations to respond rapidly to habitat improvements, although proof of this is not presented in this draft plan. The writeup of the hatchery supplementation program recognizes the same threats that the habitat plan does, and is designed with the intention of maintaining the NF population while those threats are still here. However, there is no analysis showing why this program is the size it is, how its effectiveness in overcoming those threats will be evaluated, and what the balance between the benefits and costs (to the resource) of this program are.

The strategies aimed at addressing each habitat factor are described in a narrative form in the STAG document. It is very difficult to know how to consider the lists of existing and possible projects in specific areas within the Basin. It appears that these lists were made based on a combination of biological principles, EDT results, and opportunities.

(c) How are actions in the H’s linked to fish population status? Are these links based on empirical or modeled estimates or both? Be explicit about each threat or potential factor limiting recovery.

The links between habitat and population status all depend on an EDT analysis. The link between harvest management actions and population status are based on VRAP, although this isn’t adequately documented in this plan. The links between the hatchery supplementation program and population status are based on a discussion of the habitat limiting factors and how the hatchery program may overcome these during the period of rebuilding. There is no quantitative analysis presented to support the relationship between the hatchery program and the population status other than the empirical observation that hatchery-produced fish continue to make up an increasing fraction of the natural escapement to the North Fork Stillaguamish.

It is important for users of EDT results to be aware of the explicit links between actions and habitat conditions that are missing, and to take that into account when interpreting results from EDT. For example, which actions are most likely (to least likely) to be successful in producing the predicted habitat condition or VSP results? (see discussion in Watershed Guidance Document re; protection-restoration continuum). In addition, considering HOW a specific number of acres will be restored in different areas is important—what restoration technologies/techniques are fairly well established and known to work, which are more experimental and therefore uncertain in their outcomes? How likely are protected areas to function well, given their surrounding matrix of land and water conditions? Another important question for those interpreting EDT results to ask is what habitat conditions are assumed to occur in areas outside of project locations? (e.g., existing levels of protection in certain areas, regulation, effects of forest practices, rates of development, etc.?) Are certain assumptions more/less likely or risky? Finally, the PFC values input into EDT (e.g., p. xii in STAG document) should be stated as hypotheses.

(d) 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)?

Other than acknowledging general marine survival variability, here are no assumptions for habitat conditions outside of WRIA 5. The plan does acknowledge other factors, such as mammalian predators, climatic shifts, and non-native species, but the potential effects of these on the effectiveness of the actions are not discussed. The analysis underlying the harvest management plan does include an empirical estimate of whole life cycle survival under current conditions and therefore implicitly assumes that future conditions will remain the same as current. No rationale is given for the watersheds mentioned as probably contributing salmon that use the Stillaguamish estuary.

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

6. **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?**
   Be sure to make note of the assumptions the plan makes about the effects of hatchery and harvest management, existing habitat actions, and survival in the nearshore/ocean, for ex.

The interactions of the h's are acknowledged. It is clear from this plan that the people developing actions in each of the h's were talking to each other, and some of the interactions are addressed in the individual h-discussions. The hatchery supplementation program was clearly designed with habitat limiting factors in mind, for example. The harvest management plan is based on an empirical analysis (not documented in this plan but described in the comanagers' harvest management plan) of the performance of the NF population under current habitat conditions, as another example. Appendix B to the plan answers a number of question addressing linkages among the h's. This is useful for reviewers not familiar with the Stillaguamish system. In addition, there are some good ideas presented for how one might approach an integrated analysis of the action in all h's to assess the likely future performance of the populations. However, such an analysis has not been completed as part of this plan. Building on the existing EDT analysis as well as the VRAP model used for assessing the harvest management plan, it seems that such an analysis could be done for the Stillaguamish.

Although other factors such as ocean survival, mammalian predators, climatic shifts, and non-native species, are acknowledged, there is no discussion or analysis of the potential effects of these factors on the status of the populations during the lifetime of this plan.

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

(a) Uncertainties in data and information?

It is difficult to evaluate any of the analyses with the information presented in the draft plan. However, the details of the inputs to the EDT are available from Snohomish county, along with notes on levels of proof, sources of input data, etc. Documentation of the EDT rules is available in draft form in a report by Mobrand, Lestelle, and McConnaugh (2004). There is detail regarding the sources and uncertainty of the data used in deriving the harvest management guidelines in the Stillaguamish Management Unit Profile (not referenced or included in the plan), which is part of an appendix to the comanagers' Chinook harvest management plan. There is great detail regarding the sources and uncertainties of the information underlying the hatchery supplementation program in the Stillaguamish HGMP. However, there are remaining uncertainties, regarding for example, the interaction of supplementation and wild fish that bear directly on the effectiveness of this program, which can only be resolved through the collection of new data.

In general, there is not much use of the "multiple lines of evidence" approach to designing the recovery strategies in this plan. (e.g., several different estimates of historical population abundance exist—EDT, Sanderson et al., ratio estimates provided in STAG p. 22—why aren't these compared/contrasted and used to provide a rationale for choosing actions or predicting their effects?) A clearer description of how uncertainties (in data, model/analysis interpretation) affected or will affect decisions about projects and where to prioritize effort is needed.

(b) Uncertainties in environmental conditions in the future?

These are not addressed in the steady-state EDT analysis used for the habitat actions. These are addressed to a degree in the VRAP analysis used to develop the harvest management guidelines (but not well documented in the plan). These are not addressed in the discussion of the hatchery supplementation program.

(c) Uncertainties in effectiveness of actions?

There is a passing discussion of an adaptive management plan that will be developed. Especially in areas where uncertainty in VSP or H factor problems exist, and what actions will address those problems (e.g., nearshore is very uncertain), the monitoring and evaluation plan should be clearly stated. The discussion is pretty theoretical, so how uncertainty is actually factored in to decisions will be the real test.

Effectiveness of actions are less certain. The Stillaguamish report does identify and focus are the correct types of actions. Uncertainty in restoration actions is not really discussed in detail, so it is difficult to understand what those who wrote the report believe are the biggest uncertainties. The Stillaguamish report does touch upon uncertainty due to regulations.

8. **Reviewer: 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?**

The probabilistic network analysis should help inform the answer to this question.

Even if the 10-year plan is implemented as stated and the results are as predicted, the risk remains high since the abundance, productivity, and life history diversity of the two populations will still be far below the planning target levels (see Table 9, p. 73). A formal analysis of the integrated effects of the h's is possible (see comment under 5 above) and probably useful for evaluating the risk after this 10-year plan has been implemented as well as for determining the appropriate next steps after the first 10-year plan.

Reference Cited

Lestelle, L. C., L. E. Mobrand, et al. (2004). Information Structure of Ecosystem Diagnosis and Treatment (EDT) and Habitat Rating Rules for Chinook Salmon, Coho Salmon, and Steelhead Trout. Vashon Island, WA, Mobrand Biometrics, Inc.: 1-27.

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).

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*.

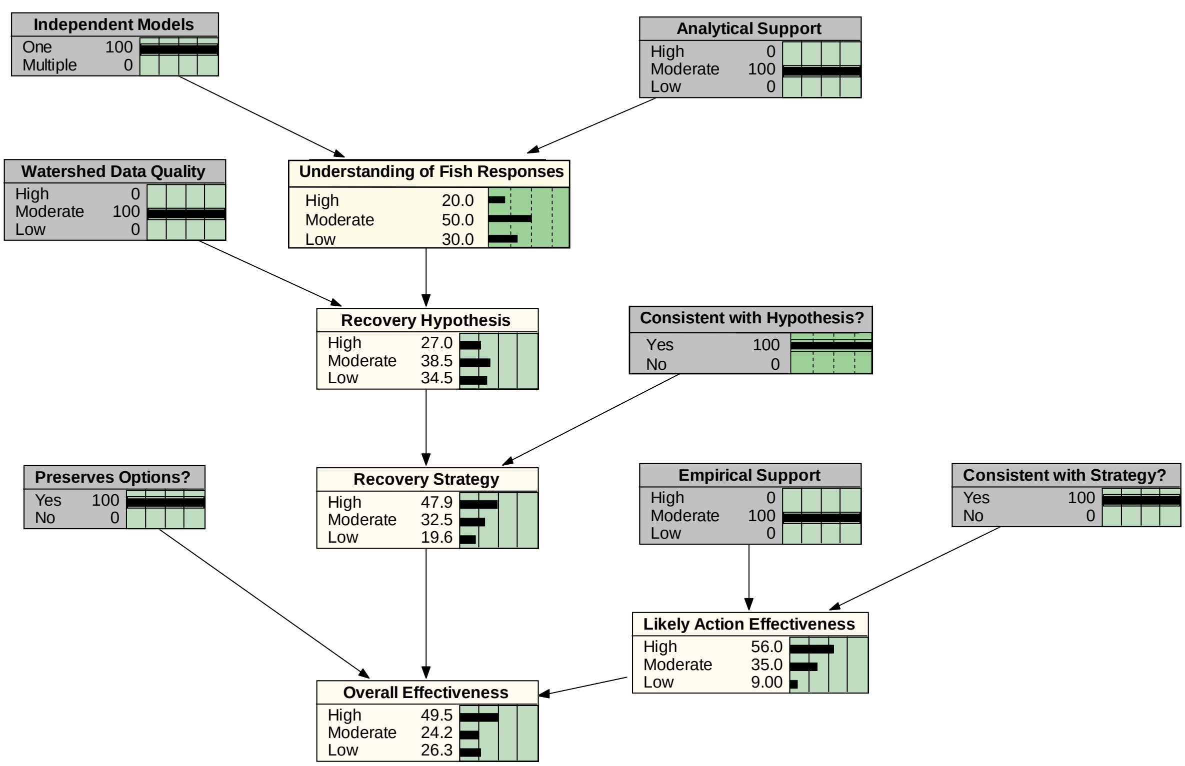

Figure 1. Probabilistic network for evaluating the biological certainty of effective recovery plans illustrating the results of a hypothetical review. Diagnostic nodes are shaded. Numbers at each node are the probabilities for each and the bars show the distribution of the results.

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 Plan

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

Stillaguamish Plan Notes (KR)
Kit Rawson
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This font is direct quotation from the plan.
`This font is my comment or note.`

`/p 1/ Objective:` The overall objective of the Stillaguamish Watershed Chinook Salmon Recovery Plan is to help salmon populations recover to sustainable and harvestable levels.

`/p 1/ Who:` The Stillaguamish Implementation Review Committee (SIRC) is a broadbased watershed stakeholder committee with 25 members representing local municipalities, tribes, state and federal government agencies, agricultural and forestry interests, flood control districts, environmental groups, and citizens.

`/p 3/ Watershed description: Concise and informative.` Land use within the Stillaguamish watershed is 76% forestry, 17% rural, 5% agriculture, and 2% urban (Snohomish County 1995). Federal, state, and private forest land uses occupy the majority of the watershed.

Precipitation and streamflows are highest in late autumn and winter as a result of rainstorms and rapid snowmelt during warmer rainstorms (called rain-on-snow events). The lowest flows occur usually during the summer dry period from July through October.

`/p 7/ Current Status of Chinook Populations.`

Juvenile Chinook salmon rear throughout the river system. `(What's the basis for this statement?)`

Approximately 91-96% of Stillaguamish Chinook salmon smolts reside in freshwater habitat for less than one year and outmigrate as ocean-type, while the remaining 4-9% are streamtype that rear for one year in freshwater before outmigration (Griffith et al.2003). `(This is from smolt trap?? What about different catchabilities of stream vs. ocean type?)`

Habitat modeling suggests that current populations are at about 8% of historical levels (Mobrand Biometrics 2004). `(What does 8% mean. This should be expressed in terms of reference points on a spawner-recruit curve if it's based on EDT.)`

Combined North and South Fork population adult escapement (fish that survive and return to their watershed of origin) is currently 1600-1700 fish (STAG 2000). `(I couldn't easily find these numbers in the STAG report. I believe, however, that these are total escapement and not just NOR. See Appendix A to these notes for what I have for NF and SF Stillaguamish escapement numbers. Recent 8-yr. Average is 1,326 total, 936 NOR).`

Historic estimates of Stillaguamish Chinook salmon abundance may well have exceeded 40,000 fish based on the capacity of the system estimated by habitat modeling. `(This number is, I believe, based on a WDF analysis from the 1960s that is briefly described in the STAG report, p.`

21-22. Should also cite NWFSC spawner capacity analyses here as well as EDT historical conditions results.)

/p 11/ On average, 60 to 85% of the Chinook salmon production for the watershed is believed to be North Fork Chinook salmon (PFMC 1997). (Recent years 81% of escapement is NF, see these notes Appendix A.)

The escapement goal of 2,000 fish for the watershed has not been met since 1976. (Fig. 3 shows that 2000 has only been met twice since 1965. Need to see original WDF report (Ames and Phinney 1977)for the basis for the 2000 goal. Clearly either the system has not been able to produce that many fish for years or escapements have been seriously underestimated.)

In addition, escapements since 1993 have not shown significant improvement, especially when the escapement of naturally produced fish is examined independently. (Fig. 3 seems to show continued increase. NOR information is not presented here, but it is available in A&P tables.)

The majority (80%) of the North Fork Chinook salmon spawn in the middle and upper sections of the North Fork Stillaguamish, with limited numbers of fish using the larger tributaries Boulder, Squire, Deer, and French Creeks) for spawning. (What's this based on?)

North Fork Chinook salmon females typically lay 3,000 to 5,000 eggs in one or more nests (redds). (Is this and the rest of the paragraph general Chinook salmon life history or is it NF Stillaguamish specific? Either way the source should be cited.)

/p 12/ South Fork Chinook salmon can be found in Jim Creek, Pilchuck Creek, and the lower portion of the South Fork Stillaguamish. South Fork Chinook salmon are also infrequently found in Canyon Creek. (Is this spawners or all life stages? How do we know this information?)

Hatchery releases- South Fork: The discussion of this is split into 2 paragraphs. It should be combined into one paragraph and there should be a table showing releases into the South Fork area with stock origin. Most of this information is already in Appendix A of STAG-2000).

Sources for South Fork run timing information need to be documented where possible.

Bull Trout – I am not qualified to review this material, so I didn't.
/p 13/ Habitat requirements: This is useful for general freshwater habitat requirements of Chinook salmon. It doesn't discuss nearshore and estuary habitat, though.

/p 14/ Land use in anadromous zone: 61% forestry, 22% rural, 15% agriculture, and 2% urban.

Key habitat hypotheses start on p. 17

/p 17/ The scale of historic forest harvest activities and how forestry was historically practiced have contributed significantly to the decline in local salmon populations. (This is one of the key hypotheses underlying this plan.)

/p 18/ Relationship of agricultural practices to salmon decline is not as well developed as the forestry discussion.

Currently, Snohomish County has a human population of nearly 637,500 and is growing at an annual rate of 2.7%. (Is it possible to get the population for just the Stillaguamish watershed? Also, see Appendix B.)

Continued population growth will place increasing pressure on hydrologic function, water quality and habitat quality through the residential development of forest and agricultural lands. (Does this mean that this plan will call for no more growth in the human population? If the plan envisions allowing for human population growth in a way that reduces of eliminates these impacts, then this statement should be removed.)

/p 19/ A common objective of this regulatory framework is to protect freshwater habitat and water quality, which is intended to help salmon populations recover to sustainable and harvestable levels. (I thought that water quality regulations were designed with human health objectives in mind, as opposed to fish recovery objectives. The difference is important in my opinion. Since environmental regulations have been in place in the US human lifespan and health have improved but fish populations have not.)

/p 24/ Landcover data from 2001 show that just over half (52%) of the area within 300 feet of streams in the Stillaguamish watershed is forested with hydrologically mature vegetation,
as shown in Table 1 (Purser et al. 2003). (The table also shows large differences in this percentage among watersheds. That non-homogeneous distribution is surely significant because the different watersheds have different functions intbe Chinook salmon life cycle.)

Chinook salmon fingerlings generally enter the estuary in the late winter or early spring and may reside in this environment until early fall. (Is this Stillaguamish-specific information or general Chinook lore. Need a source.)

/p 29/ Landslides – historical conditions. What I was looking for here was an assessment of what the landslide picture was like without human disturbance rather than how much is happening now due to human disturbance.

Landslides – factors for decline. Again a factor for decline in the VSP of the fish population would be something that has changed form the historical to the current period. So I'm a little confused as to why bank erosion is a factor for decline, when it seems that unconstrained floodplains would have more bank erosion than riprapped banks would. Also, formally, it is the increase in sediment load under the current condition of both natural and anthopogenic landslides as compared with the historic condition of natural landslides only, that could be a factor for decline. I'd like more information on what is know about the difference between historic and current sediment load, if possible.

/p 33/ Ramps and groins have a negative effect on sediment transport, (I'm not sure I know what a "negative effect on sediment transport" is. Concrete boat launching ramps and other hard structures that extend into the beach certainly block natural sediment transport process, which affects nearshore habitat to some distance away form the actual structure.

/p 34/ Water quality – There is research documenting non-lethal, but highly detrimental, effects on fish of chemical contamination of water. These issues are likely significant in the Stillaguamish and are important to highlight because water quality standards deal either with human health or direct fish mortality, but not with declines in fish abundance and productivity. It would help this section if someone could review all the Stillaguamish water quality studies mentioned (but not cited) and draw some general conclusions. I think water quality may be a very important factor in this basin, but that doesn't come out in this section.

/p 35/ Harvest Management – This section should also discuss that reduced harvest rates apparently have coincided with reduced productivity so that escapements have remained fairly constant.

/p 36/ The current tribal natural stock restoration program contributes an estimated one-third of the returning adults to the spawning habitat within the North Fork of the Stillaguamish River. (Is this consistent with A&P Tables. The NOR and hatchery origin natural escapement data should be in this plan somewhere as a reference.)

/p 37/ The potential hazards from hatchery production are listed accurately. However, the risks from many of these has been reduced in the hatchery and harvest management plans.

/p 40/ Planning targets for NF and SF stated in terms of equilibrium abundance, which is defined with a figure.

Current 861 South Fork Target 15,387
Current 2,430 North Fork Target 17,795

/P 43/ Properly functioning conditions (PFC) have been modeled by EDT for the Stillaguamish watershed. These results are shown in chapter 5. The estimated Chinook salmon populations levels associated with PFC are robust and generally achieve the Shared Strategy population target levels. (This answers the question of what will it take to achieve the planning targets, at least in terms of habitat conditions, but not actions.)

/p 47/Integration: The plan shall address water quality and salmon recovery issues in an integrated manner, consistent with the intent of the 1990 Watershed Action Plan and the origins of the SIRC. (Because this statement is in here, it would be good to mention the water quality related origin of the SIRC in the beginning of the document.)

/p 48/ Watershed vision: Within the Stillaguamish watershed, the primary goal is to restore healthy, viable populations of Chinook to a level where natural population production is healthy enough to support recreational and commercial fisheries. The relative health and viability of the population will be judged by its VSP parameters: abundance, productivity, population structure, and diversity (NMFS 2000). These factors are essential to a viable salmon population and depend on properly functioning habitat. (Very clear vision statement.)

/p 48/ Where are we going to be in 10 years?: The benefits of individual habitat management actions have been modeled using EDT to generate estimated Chinook population gains that will result in achieving 30% of the TRT planning targets . (Is this 30% of the way from current to the target or 30% from 0 to the target? I think it's the latter, and since we are at 8% now it represents a fairly big move anyway.)

/50/ Harvest Strategy. The overall goal of the harvest management plan is to place a larger portion of Puget Sound Chinook runs towards escapement rather than harvest. (This isn't accurate. It implies that a harvest rate of .49 is acceptable. The harvest strategy goal is stated in the plan, and it is approximately "that harvest related mortality will not impede the ability of populations to grow towards recovery targets when other factors have changed to allow this."

/51/ was chosen by the co-managers because model runs indicated a high (93%) probability of recovery, while not severely restricting Washington-based fisheries. (The probability of recovery depends on habitat actions; harvest management alone will not accomplish recovery, as the harvest managementplan itself states. I believe the probability of reaching he UEL at the RER is 80%. The effect on Washington fisheries was not a consideration in deriving the RER.)

Lower threshold escapement levels are an additional tool used by fishery managers to regulate commercial and recreational fisheries. (This doesn't say how the lower threshold is used. The driving rate is further reduced if the low escapement threshold is likely to be reached, thus providing a safety valve.)

(The harvest management plan discussion also needs to mention the fact that the RER can be exceeded if fisheries regulated by the US/Canada treaty are sufficiently high. This could cause the rates to go high enough so as to affect the recovery potential, but the comanagers have no authority, beyond the limits in the 1998 annex of the treaty, to affect this. This is a key point that could affect all recovery plans.)

(I also suggest that the Stillaguamish management Unit Profile, in Appendix A of the Comanagers' Plan, be attached to this recovery plan as an appendix. There is more information there.)

/p 51-52/ Objective 2 says to increase the abundance and 3 says to maintain it. Which is it?

Based on the NOAA Fisheries and co-managers assessment of population declines and habitat degradation, the Stillaguamish Chinook populations would likely further decline and go extinct without the intervention of the natural stock restoration program. (Should cite a reference for this assertion.)

(Should also cite a reference for the risks. Some of this material is repeated form an earlier section.)

Improve genetic integrity. What is "genetic integrity"?

/52/ for the Harvey Creek Hatchery program. (This is a little confusing because I don't think Harvey Creek has been mentioned yet.)

The HGMP may or may not call for immediate changes in hatchery practices or production objectives. (This is confusing. Above it says the HGMP is done, so what does it say?)

NOAA Fisheries is expected to review the co-managers' Hatchery Management Plan, of which the HGMP is an integral part, with respect to conservation criteria established by the ESA's 4(d) rule. (Right, but we need to know what it says for the purpose of this review of the recovery plan. Can a copy of the HGMP be provided to the TRT?)

/54/ The natural origin recruit escapement goal for the North Fork Stillaguamish is 700 fish per year for four consecutive years. (This is very confusing. It doesn't match the "old" goal of 2000, it doesn't match the current harvest management plan, and it doesn't seem to be related to the recovery target in any way. I don't think it is the 10-year goal – a 30% increase. Obviously this is a part of the hatchery management plan and is a trigger for changes in the hatchery program. But stated as it is here, it's very confusing.)

(The section on integration includes part of the written material and 2 of 4 or 5 graphs included in a document that Curt Kraemer and I wrote for the Stillaguamish group to use as background for writing a section on integrating the h's. It also includes a couple of other paragraphs form other people. As a result, it doesn't flow very well.)

/57/ The Lead Entity Strategy organized habitat restoration projects into six main categories (riparian, estuary, large woody debris, floodplain, sediment, and hydrology), corresponding to the limiting factors for Chinook salmon populations in the Stillaguamish watershed. (This means, then, that each project addresses principally a single limiting factor? Also, this implies that we have mainly a restoration strategy, but the language just below seems to indicate that protection is a part of the strategy too. It would help if this distinction were clarified.)

/57/ These criteria designate the best locations for habitat protection or restoration projects throughout the Stillaguamish watershed. ("Best" in what sense? Increase in VSP per dollar spent, faster time for increase in VSP, or what?)
/58 ff./ There is information under each category describing how that category affects the Chinook salmon life cycle. Some of this information is repeated form the earlier section on limiting factors and some of it is new. For example, I don't think the importance of the estuary to a particular size of fish was noted in the earlier section. All this information should be together in one place, preferably in the earlier section on limiting factors. The fact that the actions are organized by limiting factors makes it easy for the reader to refer to the earlier section for information on the importance of the factor.

/73/ Table 9 presents EDT model results for current conditions, the SIRC watershed goal, properly functioning conditions, the Shared Strategy target, and historical conditions (Mobrand Biometrics 2004). (The actions are listed first and then the expected result of the actions is given in this table. That's an excellent presentation. The reader needs to know exactly where to go for detailed documentation of the EDT inputs as well as the EDT model itself.)

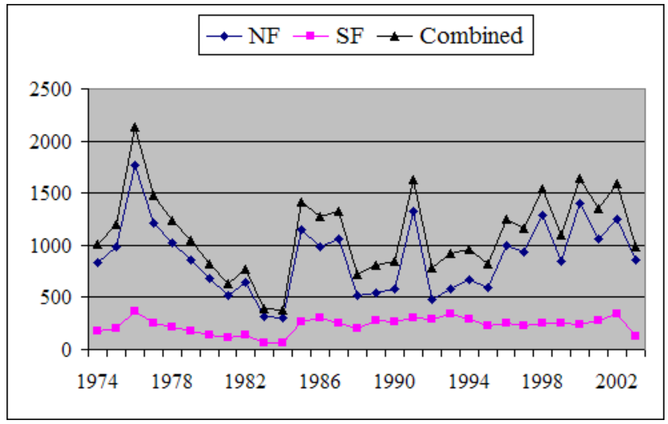
/74/ From these graphs it appears that a non-standard Beverton-Holt S-R curve is being used. Is that documented in the Mobrand Biometrics reference?)

/Appendix B/ These were questions that Jim Scott developed, with some editing by the rest of the TRT, for watershed groups to address in the sections of their plans dealing with integration of the h's. The answers for the Stillaguamish were provided by me and Kip Killebrew. The original intent was for the watershed groups to consider this in the main plan narrative, but I think it is informative to have this as an appendix.

Appendix A. Stillaguamish Chinook escapement estimates

Stillaguamish Natural Chinook Escapement

	NF	SF	Total	
1974	**837**	**176**	1013	
1975	**990**	**208**	1198	
1976	**1768**	**372**	2140	
1977	**1218**	**257**	1475	
1978	**1018**	**214**	1232	
1979	**861**	**181**	1042	
1980	**678**	**143**	821	
1981	**520**	**110**	630	
1982	**638**	**135**	773	
1983	**320**	**67**	387	
1984	**309**	**65**	374	
1985	**1148**	**261**	1409	
1986	**980**	**297**	1277	
1987	**1065**	**256**	1321	
1988	**516**	**201**	717	
1989	**537**	**274**	811	
1990	**575**	**267**	842	
1991	**1331**	**301**	1632	
1992	**486**	**294**	780	
1993	**583**	**345**	928	
1994	**667**	**287**	954	
1995	**599**	**223**	822	
1996	**993**	**251**	1244	0.798
1997	**930**	**226**	1156	0.804
1998	**1292**	**248**	1540	0.839
1999	**845**	**253**	1098	0.770
2000	**1403**	**243**	1646	0.852
2001	**1066**	**283**	1349	0.790
2002	**1253**	**335**	1588	0.789
2003	**856**	**132**	988	0.866
96-03avg	1080	246	1326	0.814



SOURCE: A&P Tables 6/14/2004 for 1974-2002

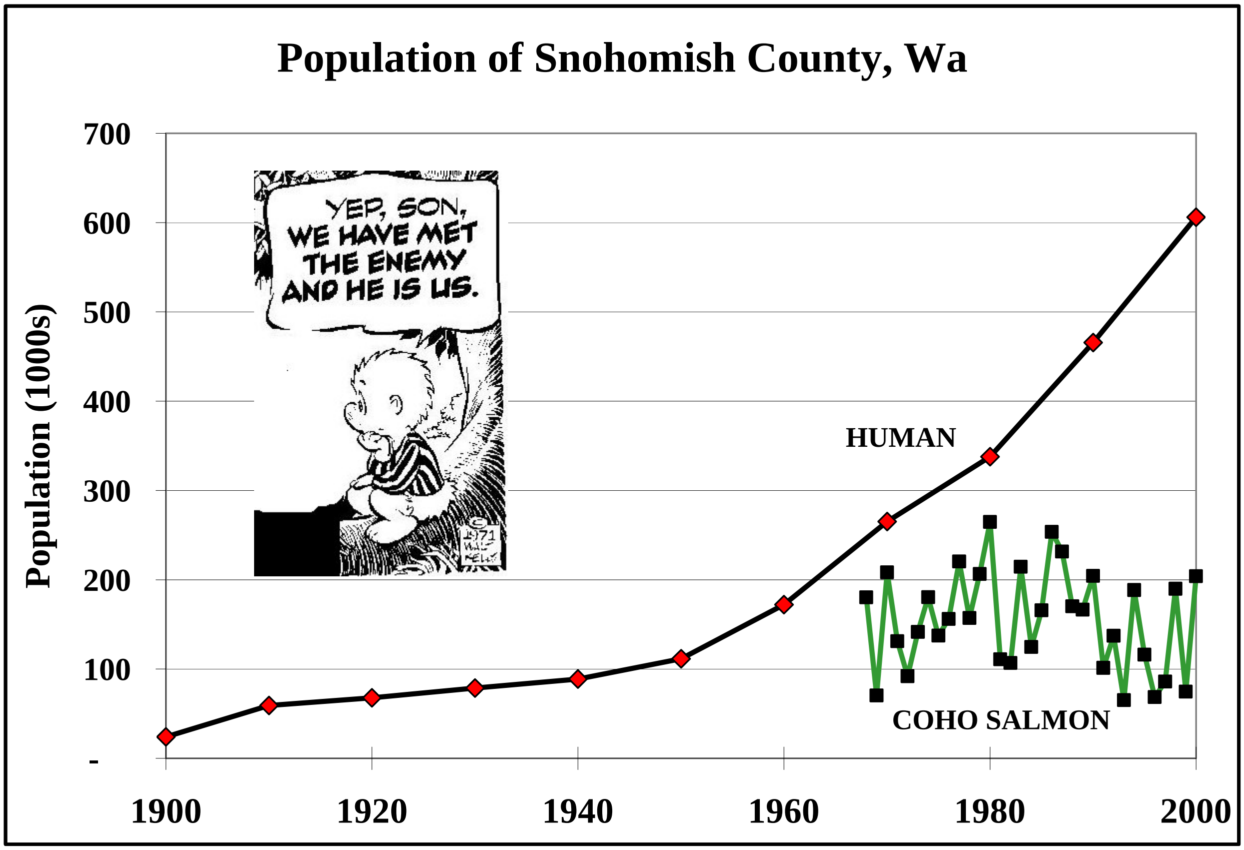
Pete Verhey WDFW for 2003

Stillaguamish Natural Origin Natural Chinook Escapement

	NF	SF	Total

1974	**837**	**176**	1013	
1975	**990**	**208**	1198	
1976	**1768**	**372**	2140	
1977	**1218**	**257**	1475	
1978	**1018**	**214**	1232	
1979	**861**	**181**	1042	
1980	**678**	**143**	821	
1981	**520**	**110**	630	
1982	**638**	**135**	773	
1983	**320**	**67**	387	
1984	**309**	**65**	374	
1985	**1148**	**261**	1409	
1986	**980**	**297**	1277	
1987	**1065**	**256**	1321	
1988	**506**	**201**	707	
1989	**483**	**274**	757	
1990	**434**	**267**	701	
1991	**978**	**301**	1279	
1992	**422**	**294**	716	
1993	**380**	**345**	725	
1994	**456**	**287**	743	
1995	**431**	**223**	654	
1996	**684**	**251**	935	0.732
1997	**613**	**226**	839	0.731
1998	**615**	**248**	863	0.713
1999	**514**	**253**	767	0.670
2000	**884**	**243**	1127	0.784
2001	**653**	**283**	936	0.698
2002	**748**	**335**	1083	0.691
2003				
96-03avg	673	263	936	0.719

SOURCE: A&P Tables 6/14/2002 for 1974-2002



SOURCES: Human – United States Bureau of the Census
Coho Salmon – Comanagers' run reconstruction for wild coho salmon returning to the Stillaguamish and Snohomish basins.

APPENDIX C. Reaches used in Stillaguamish EDT

ReachName	Description
Armstrong-1	Mouth of Armstrong Creek to upper extent chinook utilization (CM 0 to CM 0.9)
Boulder-1	Mouth of Boulder River to upper extent chinook utilization (RM 0 to RM 2.9)
Canyon-1	Mouth of Canyon Creek to cascades and low falls (partial chinook obstruction) (CM 0 to CM 1.1)
Canyon-2	Cascades and low falls (partial chinook obstruction) to CM 5.1 (CM 1.1 to CM 5.1)
Canyon-3	CM 5.1 to confluence with NF Canyon Creek; upper extent chinook distribution (CM 5.1 to CM 8.9)
CanyonNF-1	Mouth of NF Canyon Creek to upper extent chinook utilization (CM 0 to CM 0.1)
DeerCreek-1	Mouth of Deer Creek to upper extent chinook utilization (CM 0 to CM 2)
French-1	Mouth of French Creek to upper extent chinook utilization (CM 0 to CM 2); length was revised to reflect chinook range
Grant-1	Mouth of Grant Creek to upper extent chinook utilization (CM 0 to CM 1.3)
JimCreek-1	Mouth of Jim Creek to CM 3.8 - transition from confined to moderately confined, upstream of Siberia Creek confluence (CM 0 to CM 3.8)
JimCreek-2	CM 3.8 to CM 9.3; reach breaks based on confinement classification (SSHIAP)
JimCreek-3	CM 9.3 to upper extent chinook utilization (CM 9.3 to CM 13.4)
Mainstem-1	Top of estuary to bottom of South Slough (Rm 3 to RM 6.1)
Mainstem-3	Top of South Slough to Cook Slough (RM 6.1 to Rm 10.8); Pilchuck Creek enters upper end of this reach.
Mainstem-4A	Cook Slough to confluence Armstrong Creek (RM 10.8 to RM 15.8)
Mainstem-4B	Confluence Armstrong Creek to North and South Stillaguamish (RM 15.8 to RM 17.8)
NorthFork-1	Mouth of NF Stillaguamish River to confluence unnamed tributary 05.0136 (RM 0 to RM 2.4)
NorthFork-2	Confluence unnamed tributary 05.0136 to confluence Grant Creek (RM 2.4 to RM 9.4)
NorthFork-3	Confluence Grant Creek to confluence Deer Creek (RM 9.4 to RM 14)
NorthFork-4	Confluence Deer Creek to confluence Rollins Creek (RM 14 to RM 19.4)
NorthFork-5	Confluence Rollins Creek to confluence Boulder River (RM 19.4 to RM 23.9)
NorthFork-6	Boulder River to Fortson Ponds RM 23.9 to 28.2
NorthFork-8	Confluence Squire Creek to beginning of confined reach (3.5 miles)
NorthFork-9	Confined reach to upper extent chinook utilization (Cascade Creek; 1.9 miles)
Pilchuck-1	Mouth of Pilchuck Creek to approx unnamed trib 05.0064 (CM 0 to CM 2.6); change in reach confinement
Pilchuck-2	Confluence unnamed trib 05.0064 to approx Highway 9 crossing (CM 2.6 to CM 6.3); change in reach conn.
Pilchuck-3	Approx Highway 9 crossing to upper extent chinook utilization - CM 9.4 (CM 6.3 to CM 9.4)
Siberia-1	Mouth of Siberia Creek to upper extent chinook utilization (CM 0 to CM 0.2)
SouthFork-1	Mouth of SF Stillaguamish River to confluence Jim Creek (RM 0 to RM 4.4)
SouthFork-2	Confluence Jim Creek to confluence Jordan Creek (RM 4.4 to RM 8.4)
SouthFork-3	Confluence Jordan Creek to Granite Falls (RM 8.4 to RM 16.9)
SouthFork-4	Granite Falls to top of gorge (RM 16.9 to RM 20.4)
SouthFork-5	Top of gorge to RM 24.1 (RM 20.4 to RM 24.1)
SouthFork-6	RM 24.1 to RM 34.9
SouthFork-7	RM 34.9 to upper extent chinook utilization (RM 34.9 to RM 38.4)
Squire-1	Mouth of Squire Creek to confluence with Furland Creek (CM 0 to CM 1.0)
Squire-2	Confluence with Furland Creek to upper extent chinook utilization (CM 1.0 to CM 5)
Canyon Cr Obstr	Obstruction reach in Canyon Creek (cascades and low falls at CM 1.1)
Granite Falls	Granite Falls on SF Stillaguamish River
NorthFork-7	Fortson Ponds to Squire Creek

49 Total reaches.

Comments on Stillaguamish Report

George Pess
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1. Page 22 – habitat limiting factors
    a. Can you please cite the source of reference for the following:
        i. Spawning habitat is limited for Chinook in the Stillaguamish due to poor gravel stability and high fine sediment levels resulting from extensive landsliding and flooding in the watershed.
2. General comment
    a. Please list references for specific comments such as high temperature in the estuary.
3. Page 36 – hatchery
    a. Reference for one-third the population being hatchery origin.
4. Page 51 – hatchery strategy
    a. **If the chinook are an indicator stock , do you visually tag all the hatchery chinook? In not, why?**
5. Page 55 – integrated strategy
    a. It seems to me that you already have the environmental variables to estimate freshwater survival data to tag and release the number of smolts to attempt to meet outmigration goals?
6. Page 62 – please label figures in the order you identify them
7. **Page 65 – what are forest protection strategies to restore hydrologic maturity?**
8. Page 82 – research gaps
    a. Forgot to include the following:
        i. Temperature impacts in the lower river on chinook survival and fecundity
        ii. Proportion of hydrologic change due to natural v. anthropogenic causes
9. No monitoring or adaptive management plan.