Jim Scott and Bill Gill

Washington Department of Fisheries

Dear Jim and Bill:

Many thanks to both of you and to the Department for the opportunity to review the WDFW draft science paper on steelhead titled: *Oncorhynchus mykis: Assessment of Washington's State's Anadromous Populations and Programs***.** Our review of this paper finds it a good review of the biology and general status of wild steelhead metapopulations in Washington and the presently operated segregated and integrated- type hatchery programs. The paper will stand as a reference document for most of the subjects included and as a set of recommendations for research.

The WSC comments regarding limitations and issues of the paper can initially be discussed in four categories: 1) a lack of specific analysis of the VSP criteria in general, and specifically for each management area/ESU; 2) an almost total absence of a review of the present management strategies and new management recommendations that will assist Regional Managers in developing and applying new strategies; 3) the apparent strong recommendation to change the present hatchery programs to the integrated type of hatcheries without a through scientific evaluation of **the impacts to wild populations from** the existing isolated hatcheries and of on- line integrated hatcheries, such as the present rate of introgression of each, 4) the overlay of hatcheries on wild stock management strategies without establishing PNI, stray**, reproductive fitness, life history and genetic**

diversity and distribution criteria. Without such criteria, hatchery production can both escalate at an undesirable rate and also obscure wild stock management and recovery needs for what appears to be increased production and harvest reasons.

The report also suffers greatly from a lack of synthesis of information and critical evaluations of past, present, and future management practices. This deficiency can be addressed by adding a chapter on “integration and synthesis” that explicitly links findings from the report. As example, there are clear dynamics between wild fish harvests and hatchery practices and between wild fish survival and hatchery production that poses risks to the life history diversity, abundance and productivity of the wild steelhead populations, yet these topics are not discussed in this draft.

Here are the WSC general comments and recommendations for additional analysis, evaluations and management recommendations that we believe should be included before this report is completed:

1. The lack of specific analysis of VSP criteria, especially phenotypic and genetic diversity traits, necessary for wild stock **health**, recovery and management. We suggest you return to each chapter and analyze each recognized diversity trait for change that has occurred for the period (s) in which data is available and describe the reason (s) for that change. Each change should be quantified, when possible, as a positive or negative impact on wild stock productivity and resilience. As example, Chapter 2, Biology, discusses many biological characteristics of the wild stocks that may have changed through time due to management actions, hatchery production,

habitat loss, cyclic environmental conditions, and other anthropogenic activities such as dams.

Diversity traits that could be analyzed for change, and the amount of change, include: changes in the abundance and the spawning population of the resident form (rainbow trout) due to harvest management and other reasons; changes in the anadromous form (steelhead) spawning population size and characteristics due to the reductions in the abundance of the resident form (due to trout harvest program, incidental catch, etc); changes in growth rates; changes in the time of freshwater and salt water residency; changes in ecological interactions, including competition due to hatcheries, increases or decreases in other salmonid species, etc; changes in the winter run timing (early winter vs. late winter) due to mixed stock fisheries (hatchery and wild); and changes in the % kelts in the annual runs. These are only examples of the diversity analysis that could be done in this chapter or in chapter 6 that would provide new tools for management and help in the recovery of wild fish.

We recognize completing this analysis for all Management Regions or for each ESU in Washington is probably not feasible for this report and suggest you concentrate efforts on Puget Sound for inclusion in the PS RMP. The information and the techniques used will serve as examples of the type of information needed for these plans and assist managers in other WDFW Regions perform similar evaluations for stocks in their area.

2. The SCPAG suggested to Bob Leland and Bill Gill during an evening meeting where we provided comments to WDFW on the first draft of this

paper that WDFW should evaluate the present management policy, including the harvest model and run prediction methods, to determine why most steelhead populations have not remained viable in the last decade... The key question that we asked to be evaluated was how the present management system (s) has affected the abundance and productivity of wild steelhead (and the WSC would add the life history and genetic diversity and resilience). The WSC (2006) completed an evaluation of major factors affecting the accuracy and quality of the MSH model and grouped them into five factors: Atmospheric and Ocean Cycles, Management Error, Flawed Theory, Life History and Population Diversity and Ecological Needs in Fresh Water. These may be of help to you in the above analysis, although we recognize that other VSP criteria, **hatchery production and habitat condition** are important in evaluating the present management policy.

It was the SCPAG and WSC expectation that WDFW would focus this chapter on the actual WDFW steelhead management strategies and system (s) including:

1. An in depth description of the constant escapement model and the constant harvest rate strategy presently used by WDFW to manage the wild runs in Washington,

2 An evaluation of the impacts, both positive and negative, that these strategies have had on wild fish **abundance**, diversity, **distribution, productivity** and viability,

3. A review of new models or adaptions of the present models that are under consideration by WDFW for future management.

None of the above information or evaluations was met in this paper. In fact, the generalized description of the present management strategies without any suggested management strategy changes suggests that WDFW is planning to continue to use these strategies or change without SCPAG, public or scientific review. It further implies that WDFW remains committed to high harvest rates on all the remaining healthy rivers until they fail, irregardless of the impacts of the productivity cycles, the condition of the phenotypic or genetic traits or changes in fishing pressures.

4. The management chapter (Chapter 4) and the chapter on artificial production (Chapter 3) provide more inferred steelhead program management recommendations for future hatchery type and production than this entire paper provides in terms of recommendations for improved wild fish management. In an inferred manner it gives the paper the read as an endorsement for moving directly and immediately into integrated hatcheries and a "things are going to be OK" attitude for wild stocks.

Chapter 4 further indicates moving to the All-H Hatchery Analyzer (AHA), the hatchery/habitat/harvest concept of management, creating a synthesized system of wild fish management and recovery with an integrated hatchery production system. This topic continues to suggest the direction to make the steelhead program harvest driven. It seems that WDFW has fully embraced the theoretical concepts of the little understood integrated steelhead hatchery system, with a scientific protocol of managing recruits on the spawning grounds far different than that of the HSRG.

We have the concern that integrated programs will begin without actual scientific information on their impacts to wild fish and without monitoring and evaluation programs to further understand these impacts to the life history and genetic diversity, productivity and future abundance of wild fish.

This report has not specified hatchery production and introgression/genetic change criteria that would help avoid major risks of the hatchery programs. We believe, that as a science paper, you should recommend maximum accepted stray rates for isolated and integrated hatcheries, a minimum PNI for integrated hatcheries, **criteria for reproductive fitness, life history and genetic diversity, distribution and productivity of Washington wild steelhead populations.**

Our memory and continuing vision is that the original intent of this science paper was improved wild fish management. After waiting for this final draft for an excess of two years, including two reviews of earlier drafts, we feel that the sport fisher and the wild fish have not realized the values and recommendations this paper was originally planned to provide.

The WSC general recommendations on evaluating future hatchery systems and operations include the following:

1. Make specific suggestions for gaining the information needed to determine the impacts of integrated hatcheries on the fitness, productivity and life history diversity of wild steelhead. This should include suggestions for research, monitoring and evaluating impacts that have occurred from existing on-line installations and for proposed new hatcheries. This paper should state the potential risks of integrated hatcheries and the knowledge needed before the state implements a statewide change to this hatchery system.

2. Investigate the impacts that segregated hatcheries and the Chambers Creek and Skamania River stocks have had on wild fish. This analysis should discern between introgression/genetic changes that occurred during the first 5 to 10 or so generations of these stocks and changes of recent origin. We need to know the current rate of introgression after approximately 17 generations of hatchery production of these foreign stocks.

3. Evaluate the competition impacts that hatchery smolts and growing adults have on wild steelhead. You should strive to determine at what level hatchery production (competition) begins to impact wild fish survival and what the impacts are from the large number of smolts presently released into Puget Sound waters. It seems paramount to understand these impacts and the differences that may occur during good and poor ocean survival periods. This evaluation should also include impacts from the production of the other hatchery salmon.

Without completing the above studies and analysis, the synthesis of wild stock management with hatchery production (the AHA model) will potentially cover over the problems, negative interactions and production losses of each and prevent recovery and sound conservation of Washington's wild steelhead.   .

Chapter 2.
Scientific Section.

A recent paper by John McMillan was recently accepted for publication by the AFS (sent earlier to you) that provides considerable new information on the spawning interaction of anadromous and resident O. mykis in the Quillayute River system. A summary of the results was given at the West Coast Steelhead Meeting in Port Townsend, WA in 2004. The abstract and presentation are online at: http//www.psmfc.org/meetings/steelhead_present.html. This study was done on one of the healthiest steelhead populations in WA, based on it's annual reconstructed runs, and provides us probably the best picture of the historical structure of the *Oncorhynchus mykis* population composition of the two forms and of the mating system of O. mykis before both the anadromous and resident form (s) were depleted in many Western Washington rivers.

On page 7 the scientific section states that "in coastal drainages, trout are often more abundant above artificial barriers such as dams than in drainages below them". This is probably the case on rivers where dams were constructed in the past that cut off anadromous fish access to the upper watersheds and where fisheries have depleted the trout populations below the barriers (probably most WA rivers). However, it may not be the case on many of the more pristine rivers on the Olympic Peninsula where the rivers and their tributaries do not have barriers. The upper watersheds of these rivers contain both cutthroat and rainbow trout populations that have not been subject to the lower river fisheries. In Puget Sound, rainbow trout are subject to retention trout fisheries and hooking mortality throughout much the year during bait fisheries for steelhead and salmon. The catch and release mortality is high in fisheries using bait and barbed hooks. WDFW should talk with some of the older and retired biologists/managers such as Curt Kraemer to better understand the abundance of rainbow trout prior to the increase in fishing pressure in the 1960's. The WDFW paper should discuss management techniques for rebuilding rainbow trout populations and protecting juvenile steelhead by reducing incidental mortality and eliminating trout fisheries on anadromous rivers.

The information contained in section 2.4.1: Multiple Adult Run Times, provides a graph of the runs from1976 to 1996. This information is misleading and does not represent the historical picture of Puget Sound or the Olympic Peninsula prior to the large early winter (December and January) hatchery fisheries which commenced in the early 1960's. WDFW for some reason is neglecting the literature, information in Department files, and the longer term historical run/landings picture which shows those early runs were significant and often the largest runs of the year. There seems to be an issue with some WDFW managers or possibly a problem with commercial gill net issues, that you are avoiding this information, as it will shed some dark light on the impacts of the large (Chambers Creek Brood stock) segregated hatchery runs. However, the literature contains far too much information (WDFW Bulletins from the 1940's and 1950's; landing information in WDFW files which Peter Hahn had access to when writing the 1996 report to the WDFW Commission; Royal, 1972; Deshazo, 1985; WDFW, 1996; Hooton, 1983; Withler, 1966; WSC, 2006, Bill McMillan, 2006, draft report) on these early runs to continue to brush aside the problem. Also, recent studies on the Dean River, British Columbia, found that the early and late summer runs were distinct populations. If this is the case for Washington early and late winter runs, it would be very important to recover the early run (December and January) as they would clearly be an important component of the genetic diversity of wild steelhead and a separate piece of the total run which is now depleted. For a review of the literature and this diversity trait, see WSC, 2006, pp 46-50.

Recommendation Section:

Recommendation 2-1. It is important for this document to provide a list of the life history traits that are important to wild fish productivity and resilience and establish criteria for their monitoring and maintenance. Methods to monitor and recover lost or depleted traits should be recommended to provide standards for statewide management programs.

Recommendation 2-2. WDFW must determine ways to predict upcoming positive and negative productivity levels and new models or adaptive methods to maintain necessary population abundance levels during low productivity periods. If predictive tools are not available, managers should develop alternative criteria to manage conservatively and routinely for the low periods to assure populations are not depleted and jeopardized when low productive periods occur.

Finding 2-3. WDFW should conduct surveys of resident trout and resident steelhead and develop management methods to rebuild and protect these forms. These forms need protection during the steelhead and salmon fisheries as well as trout fishing closures year-round. Discussions with retired biologists such as Curt Kramer and good observers such as Bill McMillan may help gain some good insight of the abundance levels that existed in the pre 1960 period.

Chapter 3. Artificial production

On page 5 the description of integrated hatcheries states ‘this requires natural origin adults in the hatchery broodstock, <u>and hatchery origin adults in the natural spawning areas</u>.   This is not the description of integrated stocks as provided by the HSRG; the HSRG states that the number of hatchery origin stocks on the spawning grounds should be kept at a minimum to minimize the risk of reducing the fitness of the natural origin spawners and their life history and genetic diversity. If WDFW intends to use their definition and employ this hatchery production technique, this paper should first provide the HSRG definition for comparison and then explain the differences in risk of each type of integrated program.

Table 3-2. This is a valuable reference of WDFW hatchery programs. However, it would be much more useful if it included the rivers planted by each facility. Presently, one cannot easily find in WDFW documents the source of hatchery smolts to any river in the state.

On page 17 in discussing discrete populations, the paper states "However, it is highly probable most of the natural-origin fish had at least one hatchery origin parent". This may be true for the highly integrated/natural broodstock programs in Eastern Washington, but highly unlikely for the major rivers on the West Side. If there is a basis for this statement, the authors should cite the documents with this information and indicate which rivers it relates to.

The literature presently describes three categories of the types of impacts that hatchery stocks may have on wild fish. These include: 1- impacts on freshwater carrying capacity from hatchery recruits spawning (such as the latest K. Kostow paper), 2- impacts of introgression and loss of reproductive fitness (such as the paper by Phelps), and 3- impacts of hatchery smolts competing in the marine environment (papers by Fred Utter and others). This last category should be evaluated in this paper for Washington Rivers as the large hatchery steelhead (and other salmon) plants appear to be at least partially responsible for wild steelhead declines in Puget Sound rivers. WDFW should provide in this paper an evaluation (linear or curvilinear regression analysis, or other) of the hatchery plants vs the wild stock total runs for major rivers. Note that the recent graph by Bill McMillan sent earlier shows a definite correlation of wild stock declines with increasing hatchery production. History may show this correlation is most pronounced during periods of low ocean (or Puget Sound) productivity, but that will provide additional hatchery management options through time.

Finding 3-4. "Chambers Creek Winter and Skamania River Summer Steelhead programs pose a high potential genetic risk". This statement is misleading, and in fact, not precise given the information presented in this chapter and the statements on page 38 where you state in regard to genetic changes from introgression from Chambers Creek stock “it is also not as wide spread or prononunced as one might expect, considering the numbers and distribution of hatchery stocking----.” One observation that is evident from the data presented is that introgression seems to occur in small coastal rivers (in this case the Pysht, Twin and the Hoko Rivers) but is not (near) as evident in the larger coastal and Puget Sound rivers. In fact, the analysis indicates genetic separation in the Sol Duc, the Sauk and the Nooksack. Another observation may be that introgression has run its course, given that few hatchery fish are fit or even successful in spawning in the wild together or with wild fish. Further, that non volitional hatchery plants, which put fish in the river that do not migrate that year and are composed of a high percent of males, may be more responsible for any present rate of introgression than hatchery (adult) recruits.

I am not stating strongly that what I have observed is true, only that there simply is not strong evidence of harm being done to wild stocks from segregated hatchery fish as has been stated through genetic theory and your analysis of the Phelps study. Chambers stock may have run its course and be less harmful now to wild stocks via introgression than integrated hatcheries will be**. This should be considered a high priority question by this paper with a recommendation that further field studies are needed to determine the present (after about 17 generations) impacts (introgression, in river competition, etc) of the Chambers Creek stock on wild fish reproductive fitness and their life history and genetic diversity. Lets not throw this baby out with the bath water until we**

know its present impact rates. This study can be dove-tailed with recommendation 3-1, provided it is based on field research and not genetic theory.

Finding 3-7 states in reference to integrated production that “the long-term effectiveness of these programs has not been conclusively demonstrated**. In fact, the long term impacts of integrated programs has not been field studied and the impacts to wild stocks is scientifically not known.** When I say impacts I mean:

Impacts to the reproductive fitness of wild stocks including the anadromous and resident components (there is only one near-completed study ((Blouin, Hood River)) and it will describe these impacts only to the F-2 generation when published. We clearly need fitness impacts out to 10^{th} or even 20^{th} generation to understand long term impacts.

Impacts to the highly adapted life history diversity that provides abundance and resilience to steelhead populations,

Impacts to the genetic diversity which is implied due to the many populations each river contains. Recent research now shows us that the various run times (such as summer, early and late winter) and runs to each tributary are normally separate populations. Yet integrated programs have not determined how to deal with this diversity: you may take fish for hatchery production from the entire run timing, or you may take fish from only one time and one area. Either practice produces risks to genetic diversity. The first implies homogenizing of all the genetic variation which will have one impact on wild fish. The second implies releasing one hatchery grown population (one run timing, one tributary) which may overwhelm the other wild populations through straying and spawning with wild fish. It certainly will overwhelm it's parent population.

Recommendation 3-6 should therefore be indicating the need for a careful approach to any new or change to integrated hatcheries until we know a lot more about their impacts. It should recommend that only a few pilot integrated hatcheries should initially be planned and operated that are designed with the intent to conduct the scientific Monitoring and Evaluations needed to understand all of their their potential impacts. One pilot hatchery in each ESU should be sufficient for these studies; any additional integrated programs will provide substantial risk to the ESU stocks until the impacts are know.

My comments on segregated and integrated hatcheries are not intended to infer that one type is much better than the other; rather, to show that we don't know at this time when and where to use each and making changes from segregated to integrated hatcheries in a wholesale movement to help recover depleted/listed stocks (and provide harvestable fish) may cause more negative impacts to the wild fish in future generations than continuing with segregated hatcheries..

Finding 3-8 discusses only one reason, the condition of Puget Sound during early marine rearing, for the low survival rate of Puget Sound hatchery smolts. This seems a very poor scientific evaluation of the hatchery smolt survival problem, as marine competition with all steelhead smolts, smolt density barriers from other salmon releases, pollution and many other factors may be responsible, or have contributed impacts. Designing special hatcheries (conservation, integrated) to solve this problem may exacerbate this problem. You need a much better analysis of this problem, and that analysis should be the papers recommendation, not new hatchery programs.

Chapter 4 Management

The figures presented in this chapter of the catch data and reconstructed runs for Washington Rivers would be more valuable to managers if the data series was extended back in time as far as data is available. Focusing on the last decade of data provides a very short time perspective and feeds directly into what some fisheries scientists have dubbed the “shifting baseline syndrome”. Data is available back as far as the 1940’s in the WDG bulletins and additional data is housed in WDFW files. For example, Peter Hahn was able to obtain monthly and yearly data for the 1950’s from department files for his analysis of the Quillayute System monthly landings and their changes through time (WDFW, 1996). There is also some information on earlier landings in Bureau of Commercial fisheries Bulletins. This earlier data (pre 1940’s), while not exact, can provide managers a concept of what the carrying capacity of Washington rivers may have been at the time of pre-settlement. Without an understanding of historical populations (1900’s, 1950’s) managers will have no actual pre 1980 targets for rebuilding steelhead abundance. Where-as WDFW is not responsible for the resource declines from these earlier periods, the record will bring visibility to impacts that land and riverine developments have had on the steelhead resource and prompt managers and agencies to work harder to maintain the remaining habitat. It will further show the public, other agencies and the legislature how far we have declined from pristine conditions.

Figure 4-3 provides natural origin catches only to 1987. Data back to at least 1980 is available for almost all rivers and should be included in this graph as it will show what, if any, natural cycles have occurred in wild fish populations in comparison to the total run of wild plus hatchery fish. Also, a graph, by area (such as Puget Sound, Coastal, and E. WA.) and total wild fish reconstructed runs from the late 1970's until present would be valuable to show the recent cycles and the present condition of the runs. If the above discussed recent and historical information is not included in this report, it will probably be lost for future management decisions and evaluations and compound the problem of the "Shifting Baseline Syndrome".

The limited description of the three harvest management strategies presently in use in Washington on page 34 serves to indicate that there is no present strategy presently employed that will conserve and perpetuate the essential needs (abundance, diversity, distribution and productivity) of wild steelhead through the productivity cycles. During low productive periods, all strategies may fail to conserve the necessary spawning population and drive the populations toward extirpation.

The existing constant escapement management strategy, presently used in Western Washington on most rivers, has not maximized the fisheries or the population (s) viability. The three criteria of Ricker you listed are not met in practice for Washington steelhead: 1. the population is not a single homogenous unit. The state has many populations and each river may have more than one population returning at different periods and to different tributaries (see Narum, et al,. 2006 and Hendry et al. 2002) , 2. the impending run size predictions are inexact estimates, normally either underestimating or overestimating the run by large percentages, and the stock recruitment is highly variable and beyond present predictive abilities. And 3. The theory of compensation is not apparently met at either end of the population size, either at low numbers or at the identified equilibrium points. If compensation was active in these populations, we would have seen rivers such as the Puyallup and the Nisqually rebound quickly from higher productivity at their low levels.

The state has practiced MSH harvest on its healthy runs, especially in Western Washington. Ricker stated in a 1958 publication that harvesting at the maximum yield will mean closure of some fisheries on an intermittent basis. Early modelers, such as Ricker, were not aware of the decadal scale marine oscillations in temperature and productivity that can reduce survival and productivity for long periods. These marine oscillations, along with similar cycles in Washington watersheds, such as short and long periods of drought and of flooding, can reduce populations to low, depleted levels for long periods.

The above discussion clearly brings to focus that a new management strategy is necessary for steelhead in Washington that satisfies long term sustaining population values and meets sport fishers and tribal goals. The excess of 60% of sport fishers that believe we should be practicing Wild

Fish Release prefer to forego harvest in preference for maintaining robust, healthy wild populations that provide full season fisheries every year. The concept of having to sit on the bank for many years only so there can be a high harvest fishery during years of good recruitment are not now acceptable to the Washington's public and should not be a current goal of WDFW. The goal described on page 35 of this document should state new goals for the states sport fishery that include steelhead runs that have robust populations that are resilient to short and long term environmental changes and annual fisheries that can remain open full term.

The formation and discussions that start in section 4.7.1 contain graphs for which there is not enough information such as hatchery survival rates to evaluate their values or use in management. I have asked several WDFW bios to explain these graphs and discussions to me and they are no closer to understanding them than I. Where-as many readers many not understand this section, this would suggest that Regional managers and their staffs would have the same problem, both understanding and applying the principles of this part of chapter 4 to their local management situations.

Possibly most important, these are hypothetical cases that have limited correlation to actual situations in the Washington management regions or ESU's. It would be more valuable to again take the Puget Sound ESU and use its rivers, as examples, to create these graphs and discussions for the real world. This would bring these graphs and their evaluations closer to reality, using the past 20 or so years of productivity and harvest levels. These evaluations should also consider the impacts of competition from large hatchery fish releases. This would allow the reader and manager to evaluate their purpose, use and function. It will also help the preparation of the first RMP now in progress for Puget Sound.

Chapter 6.

Section 6.1.1 speaks to three main reasons to consider diversity when assessing the viability of a population. Those reasons (McElhany, 2000) include the need for variation in traits (basically phenotypic variation), their values for persistence, or resilience, and the importance of genetic diversity. This is an excellent discussion that is far too short and too general due to its importance in the maintenance of healthy stocks and the fact that diversity, and the publications on diversity (such as WDFW, 1996), have been neglected by managers. Table (6-1) is then provided to asses changes in the diversity of a population. The report does an excellent job of pointing out the importance of maintaining these factors, as well as abundance, for maintaining the productivity and resilience of populations.

Beyond these good points, there is very little information or discussion on diversity in terms of the three reasons listed above or in terms of actual phenotypic and genotypic diversity factors and their changes that have occurred in Washington (or in specific ESU's) or impacts to the productivity and persistence of each population. This should be one of the most valuable and powerful sections and evaluations for management in this report. The paper should identify the important steelhead life history (generally phenotypic) and genetic diversity factors, determine the condition and long and short term changes in these factors, the reasons for these changes (management, hatcheries, dams, logging and other anthropogenic factors) and evaluate the impacts of these changes to on each population. (This is a repeat of comments from the introduction, but because this chapter is on diversity, it is repeated). Without an evaluation of these changes in diversity, other than the few comments in the tables and estimates, most of which have limited biological data backgrounds, this report suffers greatly in its lack of completion of this VSP character. The values of biological diversity is well recognized by this paper, by NOAA and many other sources for it's importance in maintaining the resilience of populations and abundance during short term and long term changes.

The chapter discusses spatial structure guidelines with special attention to five reasons listed by McElhaney, 2000, and additional five spatial structure guidelines to assure the spatial structure of a population is consistent with viability. Developing pre-settlement estimates of spawner distribution had to be a very difficult and time consuming exercise to gain some reasonable estimates of original populations and their spatial distributions. Although a general view of the problem of spatial loss, it is never-the-less a reasonable and valuable approach to initiate a look at the overall picture of each ESU. (I have not been able to find in the text why there is a range in spatial loss, i.e., a river is listed generally as 0 to x percent loss and this does not give the reader a clear picture of the actual value).

It is reasonably clear that this analysis is very limited by the present biological knowledge of where fish spawn today and not 50 years ago for determining loss. Further, it does not identify or quantify tributaries, sections of tributaries, or mainstream areas where partial loss has occurred.

Another set of information that can be provided in this report are the reasons why spatial structure is lost. As example, in the results for Puget Sound, there is a listing of some rivers and their loss of spatial structure due to dams. However, there is no other information on the other reasons for spatial structure loss to these rivers such as logging, land development, farming, etc. Understanding the areas of habitat loss and reasons for loss will be of vital importance in the future for the recovery of important steelhead habitat.

These comments complete my review of Chapters 2, 3, 4 and 6. I'm hoping to find time when I return from California next week to look at Chapters 5 and 7.

Sincerely,

Richard Burge
VP of Conservation, Wild Steelhead Coalition
Washington Council Trout Unlimited