

# **Appendix F – Authors’ Responses to State of Oregon Independent Multidisciplinary Science Team (IMST) Review of Draft Clackamas River Bull Trout Reintroduction Feasibility Assessment (November 2006)**

**[Note to Reader: the numbering of appendices changed between draft and final reports.]**

At the request of the Oregon Department of Fish and Wildlife (ODFW, letter from Chris Wheaton dated September 18, 2006), the State of Oregon Independent Multidisciplinary Science Team (IMST) completed a review of *Draft Clackamas River Bull Trout Reintroduction Feasibility Assessment* (hereafter referred to as “draft Assessment”). The draft Assessment was prepared for the Clackamas River Bull Trout Working Group (CRBTWG) by seven authors representing the U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), and ODFW. ODFW asked that the IMST evaluate the document with respect to the following questions:

- Is the Assessment credible?
- Are the tools employed appropriate for addressing the questions posed in the Assessment?
- Are there tools more appropriate for addressing the questions posed in the Assessment?
- With respect to the feasibility of a bull trout reintroduction in the Clackamas River, are there other issues that should be addressed in the Assessment?

The IMST addressed these four questions from ODFW within the framework of its review, completed January 30, 2007.

The authors of the draft Assessment held two meetings in February and March 2007 to review the comments provided by the IMST. This document provides the authors’ responses to each general and specific comment made by the IMST. This document is organized in the same sequence as the IMST Review, outlining the particular IMST comment in italics followed by the authors’ response indented below.

## Scope of the Assessment

The authors believe it is important to restate the scope established for the draft Assessment since many of the IMST comments extend beyond its original scope. As stated on Page 11 of the draft Assessment:

*This assessment represents a collaborative, comprehensive examination of the various factors involved in determining whether or not a bull trout reintroduction into the Clackamas River is feasible. Inevitably, it is easy to quickly jump ahead to all of the various factors and issues involved in contemplating a potential reintroduction of bull trout into the Clackamas River. Some of these factors and issues include which is the best donor stock, where should bull trout be released, what method of translocation should be used, what are the ecological impacts of reintroduction, etc. The authors have focused this assessment very specifically on the feasibility of reintroduction – that is, “Can a reintroduction of bull trout into the Clackamas River be done?” This specific focus thereby determines the scope of the feasibility assessment. The assessment, itself, does not attempt to determine “Should a reintroduction be done?” or “How should it be done?” Once the feasibility of determining whether or not a reintroduction can be done is established, only then can a proposed action be developed in coordination with multi-agency policy and decision-makers to investigate the later two questions further through formal administrative and regulatory procedures. It is imperative that reviewers of this assessment understand its breadth and scope. The authors of this assessment explore, in detail, all of the facets of the first and most fundamental question: “Can a reintroduction of bull trout into the Clackamas River be done?” The assessment answers this question and goes even further to provide valuable baseline information that would be useful in addressing the later two questions should a reintroduction effort be pursued.*

## General Comments

**IMST Comment:** *Throughout, IMST advises CRBTWG to examine original documents to reduce the possibility of error (e.g., see the Murtagh et al. 1992 citation on p. 7 of the Assessment). ... For example, on page 46 of the Assessment, the authors have miss cited Tague and Grant (2004) on the relative ages of the High Cascades and Western Cascades.*

**Authors’ Response:**

The authors appreciate this advice and will make an effort to examine original documents referenced to reduce the possibility of error. A correction to the Tague and Grant (2004) reference will be made (e.g., High Cascades geology is younger than the Western Cascades geology, not conversely as stated incorrectly on page 46 of the Assessment).

**IMST Comment:** *Given that the USFWS bull trout recovery plan (USFWS 2002) remains a draft after four years, it would be helpful to provide assurance that a reintroduction plan could be approved in fewer than the four years it has taken for approval of the recovery plan. It would also be helpful to indicate how the lack of a final USFWS recovery plan may affect the conclusions reached in the Assessment and in subsequent actions by the CRBTWG.*

**Authors’ Response:**

This comment extends beyond the original scope set for the draft Assessment. The timeframes for completion of these two efforts are independent from one another and involve separate administrative processes. The draft recovery plan for bull trout has been published, and the authors are working within that guidance. The lack of a final recovery plan does not influence the conclusions reached in the draft Assessment. The draft Assessment is specifically focused on a determination as to whether or not a reintroduction is biologically feasible. Evaluating potential subsequent actions by the CRBTWG is also outside the scope of the draft Assessment. At the time when a final bull trout recovery plan is issued, any subsequent actions undertaken by a particular entity would have to be assessed to ensure consistency with the final plan.

**IMST Comment:** *... explain why effective population size ( $N_e$ ) recovery goals differ for coho salmon versus bull trout.*

**Authors’ Response:**

Effective population size ( $N_e$ ) for bull trout is not presented in the draft Assessment within the context of recovery goals identified in the draft recovery plan (USFWS 2002). The draft recovery plan goals and objective cited for the Willamette Recovery Unit (page 24 of the Assessment) do not specify  $N_e$ , nor was that done in the draft recovery plan.  $N_e$  is introduced in Chapter 3 of the draft Assessment only as it pertains to the 50-500 rule. Since the draft Assessment is focused on bull trout, the authors do not see the need or relevance of relating considerations for bull trout to coho salmon. Doing so may, in fact, create confusion.

## **Chapter 1 – History, Status, and Draft Recovery Plan Guidance for Bull Trout in the Clackamas River Subbasin**

**IMST Comment:** *Prioritization and Risk Assessment. The Assessment does not address if, why, or how the Clackamas River basin was prioritized for bull trout reintroduction in Oregon. ... it seems necessary to demonstrate that reintroduction to the Clackamas River basin is both feasible and is preferable to reintroduction and/or stock rebuilding in other parts of the Willamette River drainage... why should reintroduction into the Clackamas system be preferred to increased introduction efforts on the Middle Fork Willamette River or efforts to stabilize the declining McKenzie River population? An explanation of how the Clackamas River system compares to other areas where bull trout have been extirpated or reintroduced and whether it is the only (or one of several) area(s) under consideration for bull trout reintroduction would create a useful context that will help readers understand how this action fits within the larger recovery plan for bull trout in Oregon. What will the reintroduction of bull trout in the upper Clackamas basin contribute to the persistence of bull trout in the larger Willamette basin (other than spreading risks associated with catastrophic events)?*

### **Authors' Response:**

The authors of the draft Assessment were charged with developing a reintroduction feasibility assessment for the Clackamas River Subbasin. The authors were not charged with prioritizing subbasins within the Willamette River Basin or Lower Columbia River Basin where a bull trout reintroduction could be considered. Given the long standing history of the CRBTWG, there was a large amount of local interest and collaborative effort that enabled the completion of such an assessment for the Clackamas River Subbasin. In fact, the initial effort to pursue this effort came from the guidance provided in the draft bull trout recovery plan. By focusing the draft Assessment on the Clackamas River Subbasin, the authors are in no way inferring there is a lesser importance for considering bull trout reintroductions in other subbasins of the Willamette or Lower Columbia River basins. The fact that the Clackamas River Subbasin happens to be somewhat centrally located to other extant bull trout populations within the Lower Columbia River Basin does make it an appealing location for reintroduction from a recovery standpoint; however, this was not a factor taken into consideration when the authors began developing the draft Assessment.

The authors did not attempt to evaluate all areas within the State of Oregon and to prioritize them for consideration of bull trout reintroduction. Again, this extends beyond the scope established for the draft Assessment. Every recovery unit likely has the opportunity for and may in fact require reintroduction in order to achieve the number of recovered populations to meet delisting. The authors' focus was on the Clackamas River Subbasin, and they did not undertake an effort to evaluate or prioritize the need for bull trout reintroductions within the Willamette Recovery Unit as a whole or for that matter other recovery units within the State of Oregon. The two subbasins within the Willamette River Basin identified as "core habitat" within the draft bull recovery plan are the Clackamas and Middle Fork Willamette. Core habitat is contained in areas where bull trout were historically present, have been locally extirpated, and currently contain suitable habitat. An active bull trout reintroduction effort was begun in the 1990s for the Middle Fork Willamette. This effort is described in the draft Assessment. Page 25 of the draft Assessment provides the necessary background and information giving context for the Clackamas River Subbasin within the larger Willamette River Basin.

A bull trout reintroduction effort in the Clackamas River Subbasin, if undertaken, would pursue the longer range goals for achieving recovery within the Willamette River Recovery Unit. If a reintroduction is pursued in the Clackamas River Subbasin and population connectivity reestablished within the recovery unit, then recovery goals and objectives would be much closer to attainment. The authors of the draft Assessment did not attempt to evaluate the contribution of a reintroduction in the Clackamas River Subbasin within the context of recovery planning for the Willamette River Recovery Unit as a whole. Again, the scope for the draft Assessment is identified very clearly in the Introduction on Page 1: “Can a reintroduction of bull trout into the Clackamas River be done?” The draft Assessment does not attempt to address the questions of “Should a reintroduction be done?” or “How should it be done?” The authors also defined the scope of the draft Assessment with members of the IMST at its October 16, 2006 public meeting.

**IMST Comment:** *Prioritization and Risk Assessment. If this information exists in the federal bull trout draft recovery plan (USFWS 2002) [i.e., information that would provide the answers to the questions/comments listed in the previous IMST comment], it would be helpful if it were summarized in Chapter 1 of the Assessment, if it does not, it would be wise to address these questions so that the Assessment can stand alone.*

**Authors’ Response:**

Given the stated scope of the draft Assessment, the authors believe sufficient background information and discussion is provided in Chapter 1 to give the reader enough context for the Clackamas River Subbasin.

**Chapter 2 – Habitat**

**IMST Comment:** *Definitions. Although the authors may be clear about what constitutes a patch, a population, a population patch, a sustainable population, a river segment, a catchment/watershed/basin, or a subcatchment/subwatershed/subbasin, the meanings these terms are intended to impart is not sufficiently clear in the Assessment. Also in the habitat chapter, one comes across “critical habitat”, “core habitat”, “core area”, and “patch” or “patch habitat”. Perhaps the Glossary in the federal draft recovery plan (USFWS 2002) could be augmented and used in the Assessment to quantitatively define and describe these terms to aid the reader, provide consistent usage, and reduce contradictions.*

**Authors’ Response:**

The authors appreciate this suggestion and will review sections of text where all such terms referenced above are used and make necessary edits to avoid confusion and ensure consistent usage. Additionally, a glossary of terms will be developed for the final Assessment.

**IMST Comment:** *Definitions. ... what exactly is meant by the phrase ‘self-sustaining local population’ versus a sustainable population? Is this a minimum number of individuals or a minimum area, or both? How many bull trout adults per square kilometer constitute a self-sustaining population? What are minimum and maximum river segment lengths, patch sizes, or population areas for sustainable bull trout populations?*

**Authors’ Response:**

The authors did not attempt to define or categorize differences between a “self-sustaining local population” and a “sustainable population.” This, in fact, is likely where some confusion developed within the draft Assessment over the usage of different terms. The authors used the term “self-sustaining local population” in Chapter 2 of the draft Assessment to refer to a potential or hypothetical group of bull trout individuals within a local area of suitable habitat that would interbreed and persist over the long-term. The authors did not intend to equate this term with a “population” as might be defined in the draft bull trout recovery plan, since they are unaware of any data or published literature that would be used to answer the more specific questions raised by the IMST (i.e., How many bull trout adults per square kilometer constitute a self-sustaining population?, etc.). Given the amounts of habitat in spawning and rearing areas for nearby extant populations in the Lower Columbia River Basin, the authors are confident the habitat patches as defined in the Upper Clackamas either equal or exceed those (e.g., Anderson Creek in the McKenzie River, Pine and Rush creeks in the Lewis River, Clear Branch in the Middle Fork Hood River, etc.). In order to clear up any confusion, the authors intent to adopt the following terms in the final Assessment: “population” and “local population” as defined in the draft bull trout recovery plan and “sub-population” in parts of Chapter 3 only were its use pertains to the general discussion on population-level genetics.

**IMST Comment:** *Definitions. ... How are self-sustaining populations related to the 7<sup>th</sup> field hydrologic unit code (HUC)? The geographic divisions appear to be based on hydrologic units, not true catchments or drainages. Such artificial units are unlikely to be perceived by bull trout, and may be misleading to aquatic ecologists.*

**Authors’ Response:**

Somewhat similar to the last response, the authors did not draw a specific link to habitat areas and a “population” as is defined in the draft bull trout recovery planning sense. Chapter 2 assesses currently suitable habitat for bull trout spawning and rearing in the Upper Clackamas River (Figure 2.7 on Page 44 of the draft Assessment). The authors next segregated the total available suitable spawning and rearing habitat into areas termed “patches” which do in fact conform to watershed boundaries, except for Patch 1 Clackamas River Mainstem (Big Bottom) which does not qualify as a watershed. The authors’ defined “patches” simply as a means to better describe and differentiate the characteristics and conditions of the available suitable spawning and rearing habitat across the Upper Clackamas River landscape. The authors are not certain as to how introduced bull trout would specifically organize themselves into local, interbreeding groups within the various patches. Only through reintroduction and monitoring could this be determined. Unfortunately, the authors created confusion by their use of terminology in linking “self-sustaining local populations” to individual “patches.” This will be clarified in the final Assessment.

**IMST Comment:** *Definitions. ...What constitutes suitable habitat (or critical habitat, core habitat, core area, patch size, or patch habitat) quality and quantity, and over what catchment area and stream size (volume, length, area) is it evaluated?*

**Authors’ Response:**

The authors define suitable spawning and rearing habitat in a three-step process depicted in Figure 2.6 on Page 43 of the draft Assessment. Step 1 considered all streams accessible to bull trout as defined by the range of historical habitat accessible to anadromous fish (i.e., this is consistent with where historic and extant populations of bull trout have been/are found within the western Cascades portion of the Lower Columbia River Basin). Step 2 considered only those streams assumed to be large enough (i.e., watershed area greater than 1,700 acres) to sustain a group of interbreeding adult bull trout. Step 3 considered streams and rivers with water temperatures cold enough (less than 15 degrees Celsius) to support spawning, incubation, emergence, and rearing life stages. For reasons provided at the bottom of Page 38, the authors did not include two small tributaries (Farm and Dickey creeks) in the Collawash River in their further evaluation of suitable spawning and rearing habitat. The result from this three-step process yields the total available suitable spawning and rearing habitat (Figure 2.7 on Page 44). As stated in the previous response, the authors categorized the available suitable spawning and rearing habitat into patches for a more detailed characterization. The total amount of suitable spawning and rearing habitat is 70.1 miles as listed in Table 2.5 on Page 58 of the draft Assessment. For purposes of more detailed watershed and habitat characterizations, the authors used the “patch” boundaries (which largely conform to 7<sup>th</sup> field HUC boundaries) to display and contrast data and information pertaining to the quantity and quality of suitable habitat. The range of catchment areas for which this evaluation was conducted is presented in Table 2.2 on Page 47 of the draft Assessment (catchment size range = 4,104 to 25,572 acres). The range in stream size for this evaluation was not presented; however they range from a minimum summer low flow width of 10 feet to over 100 feet (Clackamas River mainstem at Big Bottom). The range in stream lengths is given in Table 2.5 on Page 58 of the draft Assessment (stream length range = 2.1 to 9.4 miles). More importantly, stream habitat surveys conducted on the majority of streams deemed as suitable for spawning and rearing further refine and breakdown each stream into smaller geomorphic reach segments for the purpose of a more detailed and meaningful analysis of stream channel and fish habitat conditions. The total lineal stream distance represented as suitable spawning and rearing habitat in Figure 2.7 on Page 44 of the draft Assessment is broken into several dozen individual geomorphic stream reaches. In order to aggregate stream survey data for a wide range of stream sizes in a given patch, fish habitat and stream characteristics (Pages 57 – 63 of the draft Assessment) are presented in terms of the total habitat area (square meters) available within a patch. The authors did not attempt to relate suitable spawning and rearing habitat with other components such as critical habitat, core habitat, core area, patch size, or patch habitat. See the Authors’ Response above on Page 7 explaining why patches were delineated.

**IMST Comment:** *Delineation of Suitable Habitat Patches. It would be very helpful to explain the rationale for assuming that bull trout perceive patch boundaries along the same variables used to delineate them in the Assessment. Depending on how one defines a patch, there may be only three patches (one small (Rhododendron) and two large (Big Bottom/Pinhead, Upper Clackamas/Cub/Hunter patches), which are hydrologically linked just as tightly as the proposed six patches. Is there any evidence that the proposed patches would produce 6 distinct populations vs. 1–3 populations (e.g., Whiteley et al. 2006)? In other words, are the patches sufficiently interconnected to facilitate panmiximal or indistinct populations, versus distinct populations? If Rieman and McIntyre (1993) are correct and fewer than five local populations are at increased risk of extirpation, it may be important whether one defines the Clackamas recovery unit as having one, three, or six populations.*

**Authors' Response:**

Patch boundaries in this case represent discontinuities in either flow regime or temperature that would likely be recognized by bull trout. The Upper Clackamas, Cub Creek, and Hunter Creek patches, for instance, differ from one another in both flow regimes and temperature regimes, as discussed in Chapter 2 of the draft Assessment. Each patch is separated from the other by a portion of the mainstem Clackamas River that did not meet the temperature requirement. Pinhead contributes to but has a distinct flow regime from the Big Bottom patch, which, in turn differs in temperature regime from the Clackamas River upstream of the Pinhead confluence. There is no reason to suspect that these discontinuities would impede bull trout movements between patches, but the purpose of the patch delineation is explained above on Page 7. In this context, the discontinuities between patches become meaningful.

The authors are aware of the source of this confusion with regard to linking “patches” to “self-sustaining local populations” and they intend to provide necessary clarifications in the final Assessment. Within the context of recovery planning, had the Clackamas Recovery Unit been inhabited, then the entire recovery unit would constitute a “population” derived from one or more “local population(s).” The authors do not intend to correlate “patches” to areas of habitat capable of supporting distinct populations as the IMST suggests. The authors are unaware of any existing data or available information to undertake such an analysis.

**IMST Comment:** *Delineation of Suitable Habitat Patches. The transparency of how habitat patches were delineated would be significantly increased if the criteria used to delineate patch boundaries were explicitly stated and explained. The authors identify six suitable habitat patches distributed within the upper Clackamas River basin. These patches differ dramatically in size and are superimposed on a highly interconnected river network. Are the patches identified in the Assessment evaluated by some comparison with habitat patches in other basins known to support stable bull trout populations? In the absence of explicit criteria used to delineate these patches it is difficult to understand why they vary so dramatically in size. Patch 3 is six times larger than patches 4 and 5. If these smallest patches are capable of supporting a ‘self-sustaining local population’ it would be helpful to explain why so much area is required to support a population in patch 3. Also, patches 1 and 2 and patches 3, 4 and 5 appear to be fully connected by suitable habitat (i.e., not separated by warmer stream reaches). It would aid the reader if the criteria used to determine the boundaries among these patches were explained. This section contains considerable descriptive information on fish habitat in the six delineated patches (pgs. 57–63 of the Assessment). Perhaps this information can be used to better describe how the patches differ and to justify boundary placements.*

**Authors’ Response:**

The authors believe the description of this process is quite transparent. Patch boundaries that largely conform to 7<sup>th</sup> field HUC boundaries were developed for the total available suitable spawning and rearing habitat displayed in Figure 2.7 on Page 44 of the draft Assessment. The authors understand the confusion in the draft Assessment making the link between “patches” and “self-sustaining local populations” as addressed in response to a similar IMST comment above on Page 7. This confusion will be rectified in the final Assessment. Given such, the authors do intend to organize the total available suitable spawning and rearing habitat into the patches identified for the purpose of characterizing and describing the conditions of particular suitable habitat areas within the Upper Clackamas River landscape.

**IMST Comment:** *Delineation of Suitable Habitat Patches. The justification for the CRBTWG determination that there is sufficient habitat available in the Clackamas River basin to warrant a bull trout reintroduction would be better supported if the authors provided additional discussion addressing: 1) the probability that all six patches can be recolonized, 2) why an intermediate extinction risk is acceptable, and 3) what constitutes, in a probability range, an intermediate extinction risk.*

**Authors’ Response:**

The probability that any of the suitable habitat areas within the Upper Clackamas River can be naturally recolonized is extremely low as the authors state in Chapter 1. Approximately 70 miles of suitable spawning and rearing habitat are available in the Upper Clackamas River. This amount of suitable habitat exceeds those amounts present in other neighboring river basins where extant bull trout populations are found in the Lower Columbia River Basin. Since the authors are not making a link between patches and populations per Rieman and McIntyre (1993), they are not attempting to assess the potential for patch colonization with range of extinction risk.

**IMST Comment:** *Bull Trout Dispersal and Migration. The amount of movement (if any) by bull trout between the upper Clackamas and the lower Clackamas, Willamette, and Columbia that is expected by the CRBTWG is unclear. The IMST recommends that the CRBTWG determine whether ladders designed for upstream passage of adult salmon are effective for upstream passage of smaller, weaker-swimming bull trout. IMST suspects that flow velocities in the ladders may be too high for bull trout. Also adult bull trout tend to move downriver during high fall flows. It would be useful to provide quantitative estimates of the effectiveness of migration of adult steelhead through the ladders and reservoirs as a possible model for bull trout.*

**Authors' Response:**

As described on Page 21 of the draft Assessment, the authors briefly describe the fish passage facility improvements for the mainstem dams on the Clackamas River owned and operated by Portland General Electric (PGE). Since the completion of the draft Assessment, PGE has finished construction of the new Rivermill Dam Fish Ladder to current NMFS fish passage standards and criteria for salmon and steelhead. Many fish passage studies and evaluations were completed during the process of Federal Energy Regulatory Commission (FERC) re-licensing of the PGE hydroelectric facilities and operations. Operational and facility improvements have been identified in the pending PGE license application to FERC to address upstream and downstream fish passage needs for all fish species evaluated. As stated on Page 21 of the draft Assessment: "The USFWS has not finalized passage and screening criteria specific to bull trout. In the interim, the criteria developed by the National Marine Fisheries Service (NMFS) for anadromous salmonids have guided fish passage facility improvements for the Clackamas River mainstem hydroelectric dams, and it is believed they should be effective for bull trout as well." Since this evaluation and determination was made by other state and federal agency fish biologists involved in the FERC re-licensing proceeding, the authors do not believe it is warranted to repeat such an evaluation for the reintroduction feasibility assessment.

**IMST Comment:** *Sufficiency of Present and Future Bull Trout Habitat. IMST questions whether sufficient high quality habitat is available in the upper Clackamas now and will be in the future. It would be very useful for the authors to indicate precisely what constitutes a sufficient amount of high quality habitat for a successful reintroduction. This would include data and information on whether or not winter water temperatures are low enough in all the catchments to allow successful reproduction and juvenile rearing.*

**Authors' Response:**

As stated above on Page 8, there are approximately 70 miles of suitable spawning and rearing habitat in the Upper Clackamas River. This is a larger amount of suitable habitat than exists in other neighboring basins containing extant populations of bull trout in the Lower Columbia River Basin. All of the available suitable habitat is contained on U.S. Forest Service lands which are managed under the Mt. Hood National Forest Land and Resource Management Plan as amended by the Northwest Forest Plan described on Pages 54-56 of the draft Assessment. The authors believe these management standards and guidelines (i.e., protective measures) are the most protective of any land management regulations in the State of Oregon pertaining to forest management related activities (including recreational and other related activities) and believe they are sufficient to

maintain high quality habitat conditions in the future. The authors are unaware of any available data or information that would suggest how much suitable habitat is required to ensure a successful bull trout reintroduction.

**IMST Comment:** *Sufficiency of Present and Future Bull Trout Habitat. Given the importance of an accessible large lentic water body to apparently sustainable bull trout populations in the Metolius and Lewis River systems, it would be helpful to estimate the likelihood of similar success in the upper Clackamas, which lacks such access. Inadequate lake or large river access and egress may be a limiting factor to a sustainable Clackamas bull trout population. The two identified donor stocks are associated with large reservoirs containing kokanee and rainbow trout that may serve as bull trout prey. The North Fork reservoir within the Clackamas River basin is smaller, lacks kokanee, and probably differs significantly in water residence time, stratification, nutrient regime, and primary and secondary productivity. It seems important to explain how these prey and limnological differences might affect potential reintroduction success. Given the requirement of bull trout for lakes or very large complex pools (e.g., Rieman and McIntyre 1993) and the frequent translocation failure of cutthroat trout due to insufficient habitat space (Harig and Fausch 2002), this issue would benefit from further explanation in the Assessment.*

**Authors’ Response:**

The Clackamas River system does differ from others being considered as potential donor populations in its connection to a large water body. Not all of the potential donor populations come from river systems that have a connection to a large water body. However, the two most likely sources do (e.g., Metolius and Lewis rivers). The authors are unaware of any available data or information upon which could be drawn to make a correlation between a river system’s lentic water body connection attributes and the success of bull trout reintroduction. In fact, the authors believe the life history plasticity of bull trout across the specie’s rang is broad enough for a reintroduced population in the Clackamas River to express itself however it might based on the river’s specific physical and ecological characteristics. While the authors hypothesize the historic bull trout present in the Clackamas River maintained a dominant fluvial life history type (Page 9 in the draft Assessment), they do not attempt to hypothesize what the dominant life history type of a re-introduced population might be nor what the controlling factors could be. Furthermore, it is important to realize that many of the river systems containing both historical and extant populations of bull trout did not historically contain lentic habitat connections. It was only after substantial hydroelectric dam developments in several river systems that such connections were artificially created. Additionally, other strong populations of bull trout exist in river systems without human-created reservoirs and nonnative fish (i.e., kokanee salmon). Two such examples are the bull trout populations in the Skagit and Middle Fork Salmon rivers.

**IMST Comment:** *Sufficiency of Present and Future Bull Trout Habitat. Given that upper Clackamas road densities exceed those associated with bull trout decline and extirpation elsewhere, the scientific credibility of the Assessment would increase if the authors provided scientific support for the likelihood of successful reintroduction in the upper Clackamas in the context of current road density. A brief discussion of stream crossings by roads is needed, especially the potential for barriers to upstream and downstream migrations by adult and juvenile bull trout. For example, Heller and Sanchez (2005) found that 90% of culverts in Oregon and Washington national forests impaired fish passage. It would aid this Assessment if scientific documentation were provided for why this is not a limiting factor in the upper Clackamas or the Mt. Hood National Forest.*

**Authors' Response:**

The authors did not intend to correlate the results of Quigley and Arbelbide (1997), an assessment conducted in the interior Columbia River Basin, with the current road densities in the Upper Clackamas River. Admittedly, the current road densities in most of the suitable spawning and rearing habitat patches within the Upper Clackamas River are higher than 1.7 miles/square mile. Quigley and Arbelbide (1997) did not conclude that road densities greater than 1.7 miles/square mile excluded bull trout, but that the probability of their presence declined. Road densities are associated with weaker bull trout populations in many areas; however, the mechanisms are not clear. In the case of the Metolius River which has a very strong and robust population of bull trout, the road network does not appear to have much of an influence in this stable, spring-fed dominated hydrologic setting. In a more sensitive watershed, a similar road density and network may have a more deleterious impact on the bull trout population. The authors believe the controlling suitable habitat attribute for the Upper Clackamas River is cold water. As stated in Chapter 2 of the draft Assessment, the geologic conditions of the Upper Clackamas River are quite stable and the negative impacts often associated with roads (i.e., landslides, surface erosion, interception of sub-surface flow, etc.) have not been detected through the detailed assessment completed as part of the watershed analysis procedure. The authors will provide a stronger basis and rationale for this conclusion in the final Assessment with appropriate citations to the 1995 Upper Clackamas River Watershed Analysis. The authors will elaborate on this further in the final Assessment.

The authors are familiar with all road-fish passage surveys completed in recent years by Mt. Hood National Forest staff, and surveys of all suitable streams found no road-related barriers that would affect potential bull trout fish passage in the Upper Clackamas River. The authors will disclose this finding and provide a reference to the source of that information in the final Assessment.

**IMST Comment:** *Sufficiency of Present and Future Bull Trout Habitat. The Assessment would profit from a discussion on the degree to which current habitat and catchment conditions differ from those occurring when bull trout were extirpated from the Clackamas, and how they compare with those in other basins where bull trout populations are healthy and increasing. It would be especially useful to document and compare habitat, landscape, and riverscape conditions in basins with increasing populations against those in the Clackamas.*

**Authors’ Response:**

The authors believe the 1995 Upper Clackamas River Watershed Analysis provides a sufficient assessment of changing watershed conditions from pre-European settlement (late 1800s) to the mid-1990s. In fact, the watershed analysis contains a complete chronology of management activities during this timeframe. While it may be informative to compare and contrast current conditions in the Clackamas River to other basins with increasing populations of bull trout, the authors do not believe this additional analysis is warranted or necessary.

**IMST Comment:** *Sufficiency of Present and Future Bull Trout Habitat. It would be valuable to provide more information about why bull trout populations in other basins are decreasing and to indicate the degree to which these problems have been addressed in the Clackamas. The authors’ argument that negative effects stemming from forest management have been ameliorated is not convincing. The Assessment would benefit from an evaluation of possible forest wildfire and forest disease risks that may alter water quality in the upper Clackamas. New and more conservative riparian protection regulations will improve forest conditions in the future but do not address landscape alterations that still exist and may hinder the near-term success of a bull trout reintroduction. Riparian and upland forests in the upper Clackamas have been significantly altered by past forest practices. The current condition of the basin and the percentage managed as ‘matrix’ and subject to future road construction and timber harvest are well documented in Tables 2.3 and 2.4 of the Assessment. Quigley and Arbeldibe (1997) reported that bull trout are less likely to spawn and rear in streams where road densities exceed 1.1 km/ km<sup>2</sup>. Yet the lowest densities in the upper Clackamas are in this range. This conflicts with the Assessment statement that there is sufficient high quality habitat in the upper Clackamas. Road densities in the basin are higher than, and range up to double, those observed to limit the distribution of bull trout elsewhere. This contradiction could be clarified if the Assessment provided scientific evidence that, in the absence of fisheries management practices that facilitated bull trout eradication, continued timber harvest and road construction would not have produced the same result. In addition, inclusion of scientific evidence supporting the contention that future timber harvest, road building, and stream crossing activities on ‘matrix’ land in the basin will not inhibit successful bull trout reintroduction would strengthen the Assessment.*

**Authors' Response:**

The authors will provide additional information and details from the 1995 Upper Clackamas River Watershed Analysis that assesses both anthropogenic and natural disturbances at the landscape scale as recommended by Diaz and Apostol (1992) in their "Forest Landscape Analysis and Design: A Process for Developing and Implementing Land Management Objectives for Landscape Patterns" U.S. Forest Service Technical Publication (R6 ECO-TP-043-92). Tiering to the watershed analysis will provide insight into where watershed, riparian, and aquatic habitat conditions are mostly likely to trend in the future under current management direction as prescribed for the Upper Clackamas River under the Mt. Hood National Forest Land and Resource Management Plan as amended by the Northwest Forest Plan. While there is still a legacy of past timber harvest and road building impacts observable today across the watershed when viewed from a landscape perspective, the authors have concluded that approximately 70 miles of suitable spawning and rearing habitat currently exist that would support a bull trout reintroduction effort.

The IMST comment pertaining to current road densities in the Upper Clackamas as they relate to Quigley and Arbeldibe (1997) was addressed above on Page 13.

Since the Riparian Reserve land allocation under the Northwest Forest Plan occurs along all streams and water bodies throughout the Upper Clackamas River (even on lands designated as "Matrix"), the authors believe sufficient protections will be provided for future timber harvest and road building activities so as not to degrade currently suitable bull trout spawning and rearing habitat. There is little scientific evidence upon which to base this conclusion other than the general improving trend observed in watershed and riparian conditions in the Upper Clackamas River over the last decade during the implementation of the Northwest Forest Plan. As stated above on Page 11, the authors believe the management standards and guidelines (i.e., protective measures) contained in the Mt. Hood National Forest Land and Resource Management Plan as amended by the Northwest Forest Plan are the most protective of any land management regulations in the State of Oregon pertaining to forest management related activities. The authors believe these protections are sufficient to maintain high quality habitat conditions in the future.

**IMST Comment:** *Sufficiency of Present and Future Bull Trout Habitat. The federal draft recovery plan states that "to protect and recover bull trout, lands with the most influence on streams must be managed primarily for bull trout and the riparian-dependent resources that bull trout depend upon." (page 111, USFWS 2002) It would be useful if the Assessment presented evidence that this is feasible in the upper Clackamas.*

**Authors' Response:**

The authors will include a reference to this draft recovery plan guidance in the final Assessment, and will point out that the Mt. Hood National Forest Land and Resource Management Plan as amended by the Northwest Forest Plan contains management direction and guidance consistent with this guidance.

**IMST Comment:** *Climate Change. IMST sees a need for the Assessment to explicitly address how predicted changes in temperature and precipitation regimes during the period 2010 to 2040 (e.g., increased rain-on-snow events, lower snow packs in the Cascades, changes in high and low stream flows) might influence the likelihood of a successful bull trout reintroduction. A comprehensive analysis would also address how these factors might influence the status of potential donor populations. Specifically, it would be wise to evaluate the effect of a potential 1–2° C (33.8–35.6° F) increase in temperature due to global warming on the long-term success of a bull trout reintroduction. Preston (2006), modeling the loss of cold water fish habitat, predicted median impacts associated with different temperature distributions suggested habitat loss in years 2025, 2050, and 2100 of approximately 10, 20, and 30%, respectively, for the US and 20, 35, and 50%, respectively, in the Rocky Mountains. Because bull trout require very cold water for spawning and rearing and much of the Clackamas River system has water temperatures that approach or exceed summer temperature tolerances, climate change could be a major factor in the success or failure of bull trout reintroduction.*

*The Climate Impacts Group at the University of Washington has produced warming and precipitation predictions for the Pacific Northwest based on the latest available climate models. These can be found at <http://cses.washington.edu/cig/fpt/ccscenarios.shtml>. Table 1, below, summarizes these forecasts. Evaluation of how projected annual and seasonal precipitation and temperature changes, increased rain-on-snow events, and lower snow packs in the Cascades may affect critical temperatures and high and low flows for Clackamas bull trout is needed. Another useful analysis would be to forecast what the upper Clackamas landscape and the lower Clackamas riverscape will likely look like in 10, 50 and 100 years, and to assess how those conditions might affect sustainable bull trout populations (e.g. Van Sickle et al. 2004).*

**Authors’ Response:**

The majority of suitable bull trout spawning and rearing streams in the Upper Clackamas River are ground-water fed or spring-fed. As such, these streams are likely to be less susceptible to potential water temperature increases that may occur due to anticipated global warming effects. Patches 2, 3, 4, and 5 (Figure 2.9 on Page 49 of the draft Assessment) occur entirely within the High Cascades geology and contain streams that are ground-water fed and spring-fed. Suitable bull trout spawning and rearing habitat in these patches is less likely to be affected should global warming effects become realized in future decades. Patches 1 and 6 are dominated by Western Cascades geology. Streams within these two patches tend to contain streamflows largely derived from surface-land flow, and therefore are more likely to be susceptible to potential water temperature increases should global warming effects be realized in the future. The authors will provide a discussion on potential affects from anticipated global warming in the final Assessment.

### **Chapter 3 – Conservation Genetic Considerations and Donor Stock Suitability**

**IMST Comment:** *Vortex Modeling. The value and usefulness of the VORTEX simulation model would be significantly increased by showing and describing the VORTEX model, discussing how it was validated, and listing its assumptions. Also, an explicit description of the direction and magnitude with which these assumptions might bias the results (perhaps in a summary table) would be useful. For example, the strict order of life history events used by VORTEX (p. 80 of the Assessment) represents one such assumption that is identified but not completely addressed in the document. How does the assumption that introduced individuals are advanced to the next age class without any mortality bias the modeled probability of population persistence? Other assumptions inherent but not explicitly stated or discussed in this chapter include (but are not limited to) the absence of mortality associated with removal and translocation of propagules, absence of female mortality with the removal of eggs, the biological relevance of demographic schedules A and B as they apply to real bull trout populations, and the assumption that all propagules have unique genotypes. The substantial loss of heterozygosity and allelic diversity from donor populations when eggs are removed (compared to adults or juveniles; Figure 3.5, p. 86 in the Assessment) is not intuitive but would probably be more transparent if the assumptions underlying these models were more explicitly described.*

#### **Authors' Response:**

It is beyond the scope of the assessment to fully describe the theory and use of the VORTEX stochastic simulation model. The reader is referred to Miller, P.S., and R.C. Lacy. 2005. VORTEX: A Stochastic Simulation of the Extinction Process. Version 9.50 User's Manual. Apple Valley, MN: Conservation Breeding Specialist Group (SSC/IUCN). Appendix A contains "An Overview of Population Viability Analysis Using VORTEX" for model validation, assumptions, etc. and to Rieman and Allendorf 2001, for an example of the application of the model.

Because many of the results in Section 3.4 of the draft Assessment (Vortex Simulation Modeling) are derived from a manuscript that is still in preparation (Tallmon et al.), the authors recognize that it is somewhat premature to fully utilize this information. The VORTEX modeling exercise was performed to help provide insight into potential risks to donor populations, but these risks were explored by several other means as well. As such, conclusions made in the draft Assessment are supported by the VORTEX modeling results, but are not dependent on them.

Comments received from other reviewers of the draft Assessment have stated the VORTEX modeling exercise did not meet the stated intent or purpose because the modeling results were specific to implementation planning (i.e., numbers of fish to be used in reintroduction) and was not appropriate given the scope established by the authors.

For the above reasons, much of section 3.4 in the draft Assessment will be removed in the final version, with only brief mention of the preliminary results. As the manuscript by Tallmon et al. is peer reviewed and if the reintroduction effort moves into a planning stage, then it may then be appropriate to revisit the modeling exercise to provide an additional methodology to aid in specifying the number of propagules to be used in a reintroduction effort.

**IMST Comment:** *Vortex Modeling. ... further elaboration of the genetic considerations would be helpful given that the genetic variation between bull trout stocks appears to be quite site-specific and not driven by drift and gene flow as commonly assumed (Whiteley et al. 2006). These insights would also relate to determining adequate patch size for sustainable populations, the adequate  $N_e$  needed for the reintroduced populations, and probable effects on donor stocks.*

**Authors’ Response:**

As the IMST comment states, Whiteley et al. (2006) found low genetic variation within and significant differentiation among sample sites within the Boise River. Two groups of fish were associated with the two major subbasins in the system, which the authors attributed to long-term reduction of gene flow or distinct sources of colonization. They also observed a significant pattern of isolation by distance in one subbasin and not in the other; suggesting that the relative influences of gene flow and drift have differed between the two subbasins. Whiteley et al. (2006) hypothesized that the geometry and size of habitats may be important controls on the patterns of genetic variation within the subbasins sampled. The results provided little evidence of a patch-size effect, despite geographic isolation imposed by the discontinuity of thermally suitable habitats. Ecologically defined patches of suitable habitat were not good predictors of genetic variation among samples, hence the difficulty in relating adequate patch size or abundance to genetic population structure. Whiteley et al. (2006) did not presume that the physical and ecological processes influencing the genetic population structure of bull trout in one region will accurately reflect those in another region, thus they were reluctant to specify what constitutes an adequate patch as a function of genetic considerations, nor do they believe there is a rigorous or reliable way of predicting adequate population size for a given patch other than to specify the necessary genetically derived minimums (i.e., 50/500 rule). In relation to the Clackamas River, an attempt to address these questions could be made through implementation and monitoring if a reintroduction were to occur.

**IMST Comment:** *Vortex Modeling. The VORTEX modeling exercise is useful in that it allows the exploration of the range of donor population risk and reintroduction success under a restrictive set of assumptions and demographic schedules applied to the modeled population. However, the IMST believes that extreme caution should be exercised when using the results of these simulations to set absolute thresholds for propagule requirements or donor population size. Population viability analysis is more appropriately used to provide relative outcomes, not to predict absolute results (i.e., a minimum threshold for donor population size).*

**Authors' Response:**

The authors agree. VORTEX simulation results helped delineate broad risk categories for potential donor populations, but population viability analysis was not used as the sole source of information that defined potential donor populations or categories of risk. As detailed on Page 90 of the draft Assessment, broad risk categories were defined utilizing both Tallmon et al. model simulation results, the 50/500 rule, and the summation of the current status and trends of the five potential donor populations. The synthesis of these independent sources of information resulted in the three broad categories of risk to donor populations (i.e., low, intermediate and high). The authors also recognize that it is important to consider factors other than reproducing adult abundance or other surrogates of  $N_e$ . Adult abundance trends or trajectories observed for local populations are an important consideration. Trends in abundance help further refine the level of risk associated with the potential use as a donor stock. Information regarding risk can also be informed by examining the expected levels of heterozygosity for each local population (Spruell et al. 2003) found in Table 3.2 of the assessment, or by other metrics such as  $F_{st}$  (the reduction in heterozygosity of a local population due to genetic drift (Hartl 1988)), and can be used as an indicator of relative levels of gene flow. The use of this type of information can provide insight regarding the dynamics or interactions between local populations. The authors believe that this strategy is consistent with predicting relative outcomes and does not define absolute thresholds. As cautioned on Page 85 of the draft Assessment, the results from these simulations should be interpreted only as a means to compare the relative risks and benefits of the scenarios simulated.

**IMST Comment:** *Vortex Modeling. Using demographic schedule A on page 80 in the Assessment, 2500 eggs results in 1.1 adults in age class 4+. Over 5 years of stocking, this would result in 5.5 adults. Using schedule B, 2500 eggs results in 3.9 adults in age class 4+, and 19.5 adults in 5 years. This implies low probability of introduction success when using 2500 eggs, the need to use more donor eggs, the necessity of using another life stage, or to somehow increase survival rate. In any event it weakens the case for reintroduction and indicates a need to better estimate stocking needs and strategies. Although large numbers of eggs could provide the most alleles, with 99% mortality it will require a very large number, which is one reason few fishery agencies currently stock eggs in streams.*

**Authors' Response:**

The authors agree that the modeled results suggest that using life stages other than eggs will increase the probability of success. As stated above on Page 2, the draft Assessment only addresses the biological feasibility of a reintroduction and makes no attempt to specify strategies for implementation. When drafting an implementation plan should reintroduction be pursued, it may be determined that using a variety of different life stages would result in a high success rate. It may be determined that rearing fish in a captive environment to increase survival would be a valid strategy. There are likely a number of strategies that would be explored in an implementation plan. Chapter 3 on the draft Assessment only addresses the genetic criteria necessary to reduce genetic risk associated with small population sizes; it does not attempt to resolve demographic or abundance criteria. An implementation plan may specify significantly more fish be introduced than the necessary genetic criteria minimum.

As stated above on Page 17, much of Section 3.4 in the draft Assessment will be removed from the final version, with only brief mention of the preliminary results. As the manuscript is peer reviewed and if the reintroduction effort moves into a planning stage, it may then be appropriate to revisit the modeling exercise to provide an additional methodology to aid in specifying the number of propagules to be used in a reintroduction effort.

**IMST Comment:** *Vortex Modeling. It would be wise for the CRBTWG to determine if 5 years of stocking are enough, and whether the introduced bull trout populations can survive on their own without improbable immigrations from another population. Similarly, it is advisable that the CRBTWG determine whether stocking must be continuous, creating a dependent bull trout population. Also, it would be helpful to briefly explain why it was assumed that 2,500 eggs were added (and presumably that all survived to age 1). Would not 25–100 surviving eggs be more likely? Likewise, it might clarify the issue to briefly explain why it was assumed that 25 introduced adults would all survive and reproduce in year one, versus, for example, half that many.*

**Authors’ Response:**

Based on VORTEX modeling results, five years of stocking is sufficient to meet the necessary minimum genetic criteria to confer population persistence of the newly founded population. The authors are not aware of another way of determining whether five years of stocking will be enough. This issue is likely better addressed through a rigorous monitoring program and adaptive management strategies that adjust accordingly should reintroduction be pursued. The modeling effort provided relative outcomes based on a defined set of assumptions while attempting to maintain minimum genetic criteria. Similarly, the authors are unaware of a methodology which could be utilized to determine whether the newly founded population will be dependent on continual stocking. The authors believe that careful monitoring (both demographically and genetically) would reveal whether continued stocking must occur (to either boost abundance or increase genetic diversity) should reintroduction be pursued.

In regard to the IMST questions concerning the mechanics of the model, because many of the results in Section 3.4 (Vortex Simulation Modeling) of the draft Assessment are derived from a manuscript that is still in preparation (Tallmon et al.), the authors recognize that it is somewhat premature to fully utilize the information. The VORTEX modeling exercise was performed to help provide insight into potential risks to donor populations, but these risks were explored by several other means as well. As such, conclusions made in the draft Assessment are supported by the VORTEX results, but are not dependent on them.

**IMST Comment:** *Vortex Modeling. Given the stream lengths, widths, gradients, and habitat complexities of the 6 patches, it would be useful for CRBTWG to estimate the potential carrying capacities for bull trout in each of the 6 patches. This could help evaluate the survival potential of this metapopulation if the transplants are successful. Also, it might improve estimates of the stocking sizes and propagule types needed. Using the Assessment's genetic risk information, are 50 or 100 adults in each of 6 patches a reasonable and sufficient target? If habitat is limiting for some unknown reason, the number of fish stocked to create a desired  $N_e$  might create an unrealistic drain on donor populations. On the other hand, if half the propagules die because of unaddressed compensatory or density independent limiting factors, the CRBTWG might wish to stock twice as many. This also could have a serious negative effect on the donor populations without increasing the  $N_e$  in the Clackamas, or it could create the need for the reintroduction attempt to be abandoned midway.*

**Authors' Response:**

Given that bull trout have been extirpated from the Clackamas River Subbasin, the authors are unaware of any reliable methodology to predict the carrying capacity of the habitat patches described in Chapter 2 of the draft Assessment. The authors described the supporting evidence to suggest the necessary habitat elements are present within the Clackamas River Subbasin to support a bull trout reintroduction. The authors do not view the habitat patches as distinct, isolated, independently functioning habitats, but rather as a loosely defined series of interconnected habitats that can all support bull trout. Although the habitat elements are present in the patches, the authors have no reliable way of predicting which patches are most likely to be utilized by reintroduced bull trout. The authors make no prediction that 50 or 100 adults will utilize each of the six patches. Further, the authors do not assert that 50 or 100 adults are sufficient abundance targets. The authors do not specify abundance targets as it is not germane to answering the question of biological feasibility as the defined scope for the draft Assessment described above on Page 2. Fifty adult bull trout is the necessary minimum effective population size ( $N_e$ ) to confer a lower risk of the immediate effects of inbreeding depression or genetic drift. This criterion is solely a genetic risk parameter and in no way is to be considered demographic or abundance criteria.

The authors agree that if habitat is limiting for some unknown reason, the number of fish stocked to create a desired  $N_e$  might create a significant drain on donor populations. The authors also agree that if half the propagules die because of unaddressed compensatory or density independent limiting factors, there may be a necessity to stock twice as many. These situations are most appropriately addressed in a proposed action or an implementation plan and as a central component of the monitoring and adaptive management strategies.

**IMST Comment:** *Bull Trout Donor Stocks. Like the CRBTWG, the IMST is concerned about donor stocks. The Lewis River stock may be more suitable than the Metolius stocks because no individual Metolius stream appears to have greater than 500 bull trout. Also the Metolius stocks are unlikely to have been exposed to whirling disease or Type 2 strain infectious hematopoietic necrosis (IHN) and will be vulnerable when introduced to the Clackamas where the pathogens for these diseases exist. The Lewis River system has a large bull trout population that has not been bottlenecked and possibly has had exposure to these two pathogens. On the other hand, it would seem wise to evaluate the likelihood of introducing diseases and parasites from the Metolius or Lewis to the Clackamas. In general, it is best that disease and parasite issues such as these be carefully examined before implementing any introductions.*

**Authors’ Response:**

In terms of suitability of donor stock based on population size, the authors believe the Metolius River bull trout population is as suitable as the Lewis River population. There is evidence that bull trout in the Metolius River function as complexes, or intermingling spawning aggregates, and there are several that exceed 500 adults. The authors could have made this information more evident in the draft Assessment, and will do so in the final version. In addition, there is currently a genetic analysis underway conducted by the U.S. Fish and Wildlife Service (expected to be completed in 2008) that will further clarify the level of discreteness between populations of bull trout in the Metolius River. Relevant new information from this study should be taken into consideration should a reintroduction effort be pursued.

The authors agree with the IMST that the issue of disease susceptibility and transfer is significant. To that end, the authors have engaged the U. S. Fish and Wildlife Service’s Lower Columbia Fish Health Center to provide a disease analysis for further assessment. The primary objective of the analysis will be to assemble known information on disease presence in the Clackamas, Lewis and Deschutes rivers. Information gaps will be addressed by field surveys and subsequent lab analysis by Fish Health Center staff. Their analysis and report are expected to be completed and submitted to the CRBTWG in 2007.

**IMST Comment:** *Bull Trout Donor Stocks. It would be helpful for the CRBTWG to evaluate the degree to which Metolius bull trout that are locally adapted to east side conditions will do well on the west side. The Assessment does not resolve whether the Metolius patches are interconnected in such a way as to allow substantial genetic mixing (p. 91). A detailed map showing the Metolius catchments would be helpful, as would discussion of genetic analyses on the putative populations (with citations). It would also be helpful if the number of donors required to establish a viable population were reexamined and clearly supported in a scientifically rigorous manner. Lastly, we caution the CRBTWG to confirm and quantify the bull trout metapopulation dynamics of the Metolius River basin before removing bull trout from these populations.*

**Authors' Response:**

The authors agree that there are likely differences between East-side Cascade and West-side Cascade bull trout populations based on environmental conditions. However, the headwaters of the Clackamas River and Metolius River, despite being situated on opposite sides of the Cascade Crest, share the same parent geology (New Cascade) and their close proximity to each other likely results in similar hydrologic conditions. In the absence of a more detailed analysis, the authors believe the environmental differences between the upper basins of these two watersheds are not so great as to negate the consideration of Metolius River bull trout for consideration in a Clackamas River reintroduction.

The draft Assessment provided little analysis regarding the interconnectedness of bull trout from the various spawning streams in the Metolius River because there is little information available. The bull trout spawning “complexes” described in the draft recovery plan for the Deschutes River Basin are based on very limited data collected in a radio-tagging study conducted in 1993 and 1994. As noted above, there is a genetic analysis underway conducted by the U.S. Fish and Wildlife Service (expected to be completed in 2008) that will further clarify the level of discreteness between populations of bull trout in the Metolius River. Relevant new information from this study should be taken into consideration should a reintroduction effort be pursued.

The authors are unaware of any scientifically rigorous manner or any translocation/reintroduction example that specifically attempts to determine the number of individuals required to successfully found a new population. Section 3.3 of the draft Assessment, provides a comprehensive discussion of the genetic considerations that should be addressed in a reintroduction attempt. Rather than specify a number of individuals required for translocation, the authors believe it is more appropriate to define goals in the context of minimum genetic criteria, namely the 50/500 criteria. The minimum number of individuals that would be required must be sufficient to found a new population (over a given number of years) that would result in an effective population size ( $N_e$ ) of 50 so as to substantially reduce the effects of genetic drift and/or inbreeding depression. This may be 50 adults or any number/combination of other life stage individuals that would be equivalent to 50 adults (with specified mortality rates for selected life stage). This approach is consistent with taking a risk-adverse approach in regard to effects to the donor stock. Monitoring and adaptively managing a reintroduction effort would be paramount to successful reintroduction and ameliorating any potential adverse impacts to the donor population as a result of unnecessarily over-extracting donor stock. Additionally, the VORTEX stochastic simulation model was employed to help elucidate the number of individuals of different age classes that would be required to found a new population in the Clackamas River Subbasin and confer long-term persistence and high levels of heterozygosity. As explained above, due to the preliminary nature of the VORTEX modeling effort, the authors believe that the modeled results lend support to the conclusion of biological feasibility, but are likely more appropriately presented in an implementation plan should a reintroduction effort be pursued.

## **Chapter 4 – Ecological Interactions and Food Web Considerations**

**IMST Comment:** *Brook Trout Interactions. The assessment too easily dismisses brook trout predation, competition, hybridization, and potential dispersal to other catchments. Oregon bull trout have been outcompeted by other salmonids in warmer water temperatures (Ratliff 1992; Dambacher et al. 1992). An explanation of why or why not the same might have occurred in the past and its likelihood of reoccurring in the upper Clackamas would be useful. One conservative approach would be to eliminate patch 3 or cut it in half and not stock bull trout where brook trout are apparently self sustaining. Another option might be a brook trout eradication program.*

**Authors’ Response:**

Brook trout are localized in a portion of Patch 3 only (Figure 4.1 on Page 95 of the draft Assessment). Efforts to curtail high lake stocking in those lakes with tributary outlets began in 2003. The authors believe the brook trout present in Squirrel Creek may be self-reproducing. A more detailed response and explanation is provided under the second IMST question below for Chapter 4.

**IMST Comment:** *Brook Trout Interactions. IMST suggests that the CRBTWG evaluate brook trout introgression in the potential bull trout donor stocks.*

**Authors’ Response:**

The authors agree that brook trout introgression with potential bull trout donor stocks is an important consideration. However, no information exists on introgression for the two most likely donor populations (Metolius River and Lewis River). Information exists suggesting brook trout are present in several of the spawning streams in the Metolius River (Abbot, Brush, Canyon creeks), and they have been documented in tributaries of Pine Creek, a primary spawning tributary in the Lewis River. However, presence of brook trout does not necessarily mean the two species are hybridizing.

Several studies have shown that bull trout and brook trout partition themselves in a watershed based on water temperature and stream gradient, with brook trout preferring warmer water temperatures and lower gradient stream reaches than bull trout (Rich et al. 1997, Paul and Post 2001, Dunham and Rieman 1999, Dunham et al. 1999).

Other studies suggest hybridization is most common where isolated or remnant bull trout populations overlap with brook trout (Cavender 1978; Leary et al. 1983, 1991; Markle 1992). Small resident bull trout populations are particularly susceptible to hybridization from co-occurring brook trout because individuals of spawning age are similar in size, and both spawn in the fall utilizing similar spawning habitat.

Although brook trout distribution overlaps some areas within the two most likely donor populations, available information suggests introgression is likely occurring at a low level, if at all. Both the Metolius and the Lewis rivers contain an abundance of cold water spawning habitat as well as large, healthy, fluvial populations of bull trout.

**IMST Comment:** *Brook Trout Interactions. Is there any evidence of recent range extension or population increases by brook trout in the upper Clackamas? If such evidence does not exist, has it been evaluated? Providing explicit scientific reasons why brook trout in the upper Clackamas will not threaten bull trout through competition, predation, and hybridization as it has elsewhere would help convince readers that brook trout would not affect success of the plan in the Clackamas system. In comparing successful and failed greenback cutthroat trout reintroductions, Harig et al. (2000) determined that 48% were reinvaded by nonnative salmonids and 43% had unsuitable habitat.*

**Authors' Response:**

From interviews with early U.S. Forest Service employees, it is known that high lake stocking goes back to at least the 1920s and perhaps earlier in some locations. Brook trout were often a favored species (Murtagh et al. 1992). Many lakes in the Olallie Lakes Scenic Area and lakes feeding Squirrel Creek in the uppermost headwaters of the Clackamas River have been stocked with brook trout for many decades. Other high lake areas in the Clackamas River Subbasin that also had long histories of brook trout stocking were the numerous lakes of Bull of the Woods Wilderness Area, Round Lake in the Collawash River Watershed, and Hideaway Lake in the Oak Grove Fork Watershed (Pederson 2003; USFS 1995). In some of these lakes, naturally reproducing populations of brook trout exist, have apparently been in existence for some time, and have often been bolstered with additional aerial stocking of brook trout. Despite this, naturally reproducing brook trout populations appear to be restricted to the same foothold areas such as Round Lake and Hideaway Lake areas that they have been populated for years and do not appear to be pioneering additional habitat away from these areas (Zimmerman 1999; Strobel 2005; USFS 1995).

For instance, during bull trout validation snorkel surveys performed in 1992 in the Collawash River, no brook trout were observed during the effort, despite many adjacent high lakes upstream within the Bull of the Woods Wilderness or from nearby Round Lake that could have supplied numerous, straying brook trout. A similar situation exists in the Upper Clackamas River headwaters where many lakes containing brook trout or stocked heavily with brook trout could have facilitated an expansion of brook trout. Despite this opportunity, during presence/absence bull trout night snorkel surveys in 2004, brook trout were only observed in the very uppermost reaches of the Clackamas River and in Squirrel Creek. These distributions of brook trout are very similar to those observed during snorkel surveys in the early and mid-1990s (Eberl and Kamakawa 1992; Strobel 2005; USFS 1995; Zimmerman 1995). Many nearby and accessible streams in this area support coastal cutthroat but not brook trout (Strobel 2005, USFS 1995). In 1994, a large scale survey effort of 111 streams using electroshockers in the Clackamas River Subbasin was initiated to verify resident fish distribution against earlier “best guess” mapped fish distributions in 1990. The original 1990 “best guess” brook trout distributions were found to be overestimated. Only five out of 111 streams sampled were found to have brook trout – Sluice, Fish, Shellrock, Bump, and Squirrel creeks. Bump Creek is a tributary to Squirrel in the Upper Clackamas River headwaters (Baker et al. 1994). On the mainstem Clackamas River, about two miles downstream of Patch 1, a rotary smolt trap was operated for a number of years (1999 -2002) by the U.S. Forest Service, Pacific Northwest Research Station for the Clackamas River Fisheries Working Group. This smolt trap captured large

numbers of steelhead and coho smolts, as well as lesser numbers of rainbow and cutthroat trout, mountain whitefish, and sculpin. Brook trout were never captured (Clackamas River Fisheries Working Group 1999-2002).

From most observations, naturally reproducing brook trout populations in the Clackamas River Subbasin typically appear to be limited to low gradient streams, often with beaver dam habitat, or habitat that was originally fishless (above barriers) and/or with little or no competition from native fish (Strobel 2005, USFS 1995; SWCA Environmental Consultants 2004). Very few lakes in the Clackamas River Subbasin originally supported coastal cutthroat trout and where brook trout have been introduced into high lake and pond habitat they have thrived. Are brook trout better adapted to lake habitat in this subbasin but less adapted to higher gradient stream environments, where native cutthroat and rainbow trout dominate? In Patch 3, brook trout were observed in low abundance only in the uppermost reaches of the Clackamas River, often where the gradient was low, and August/September temperatures were very cold (4 - 6 degrees C.). Much of this low gradient, very cold stream habitat appeared structurally ideal for trout but large sections had no evidence of any fish species when it was night snorkeled in 2004, except for three reaches with brook trout (Strobel 2005; SWCA 2004). Even in the reaches with brook trout present, apparently ideal complex habitat was often void of fish. A short distance downstream of this reach, where temperatures were somewhat warmer, native cutthroat were numerically dominant with only one brook trout observed (Strobel 2005; SWCA 2004). Strobel (2005) speculated that the apparent lack of overlap between brook trout and cutthroat trout in the headwaters of the Clackamas River above Rkm 125, may be an example of interspecific competitive exclusion of one species by another with the brook trout taking refuge in less hospitable frigid headwaters.

Where brook trout are found in potential spawning and rearing habitat for bull trout in the upper Clackamas River, competition, predation, and hybridization cannot be ruled out. Since night snorkel surveys and earlier daylight surveys found low numbers of brook trout in suitable spawning and rearing habitat for bull trout, the threat from potential brook trout competition and predation would appear to be at low risk but would not be entirely absent. Juvenile bull trout would likely encounter higher predation risk from the more abundant coastal cutthroat and rainbow trout found in these stream reaches. The brook trout encountered were also small in size (usually under 200 mm) which also may greatly limit but not rule out hybridization with bull trout (SWCA 2004). The authors will include pertinent components of this more robust discussion contained herein within the final Assessment.

**IMST Comment:** *Bull Trout Transfers. More concern seems warranted about the effect of introducing bull trout on top of existing salmon populations. Specifically, IMST suggests that CRBTWG evaluate the potential maximum loss of anadromous salmonids to predation and competition by bull trout. Similarly, IMST advises the CRBTWG to consider how it will educate stakeholders who might view bull trout as a scapegoat for declining salmon populations. The CRBTWG would be wise to explain how it plans to approach federal Endangered Species Act concerns and permitting issues related to the reintroduction of one threatened species regulated by the USFWS on top of another that may serve as prey and that is regulated by the NMFS.*

**Authors' Response:**

The IMST suggests inclusion of a more detailed analysis of potential effects to anadromous salmonids from predation and competition. While the authors agree this issue is an important one, especially from a socio/economic perspective, they do not believe it is necessary to further address this issue in the Assessment as the scope for it is specifically spelled out above on Page 2. The authors' intent in the draft Assessment was to focus on the biological feasibility of reintroduction, while only touching on related subjects such as potential effects of reintroduction on other species.

Should a reintroduction proposal be pursued, consideration would have to be given by the appropriate state and federal management agencies to potential interactions between bull trout and anadromous salmonids in the Clackamas River. This would likely be done as part of the environmental analysis and regulatory/procedural requirements. Such consideration would need to occur in a Section 7 ESA consultation between the U.S. Fish and Wildlife Service and National Marine Fisheries Service (NMFS) to assess effects to listed salmon and steelhead under the jurisdiction of NMFS.

While the authors believe it is necessary to explore the means of assessing impacts to anadromous salmonids from competition and predation, a meaningful analysis may be exceedingly difficult to conduct. Food web interactions can dramatically alter the net effect of a predator on prey. For example, bull trout eat not only salmon, but predators of salmon, including northern pikeminnow, resident trout, and sculpins. Given that bull trout eat these fish, as well as salmon, what is their net effect on salmon? It is hard to tell with a simplistic modeling exercise that addresses only a limited number of species in the ecosystem. By consuming other predators of salmon, or in changing their behavior, bull trout could have a net positive effect on juvenile salmon survival. Regardless of the method used to assess potential predation/competition effects on anadromous salmonids, there would have to be further assessment of this subject in consultation with NMFS if a reintroduction effort is proposed.

The IMST advises the authors of the importance of education and outreach on the issue of bull trout competition and predation with salmon and steelhead. The authors acknowledge outreach on this issue will be paramount to moving forward with implementation of a reintroduction should it be pursued. However, it is not the intent of the authors to address outreach and education within the Assessment since that would best be undertaken at the time a proposed action for reintroduction is developed.

Along the same line, the authors did not intend to address ESA and permitting concerns in the Assessment. At the time when a proposed action is developed, these issues would be dealt with and coordinated by the appropriate state and federal management agencies.

**IMST Comment:** *Bull Trout Prey. The assumption that the native fish assemblage in the Clackamas River is healthy, diverse and abundant is testable and it would make sense to test that assumption. At the very least it is advisable to monitor it before and after reintroduction should it occur. In addition, the CRBTWG appears to assume that there are ample prey fish, particularly non-salmonids, to support adult bull trout in the upper Clackamas. However there are insufficient data presented to support this assumption. It would be useful for the CRBTWG to provide scientific survey evidence that the Clackamas and upper Clackamas fish assemblages are healthy. That would include how the CRBTWG defines a healthy versus an unhealthy fish assemblage. An additional valuable piece of information is to determine the size and composition of a fish forage base required for adult and sub-adult bull trout in a healthy bull trout population. An adequate prey base to support bull trout maturation and successful reproduction is best evaluated rather than assumed.*

**Authors’ Response:**

The authors agree that the assumption – the native fish assemblage in the Clackamas is healthy, diverse and abundant – is a testable one. However, data are not currently available to test this. Instead, the authors believe information available on the relative health and current management of the Upper Clackamas River, combined with first-hand knowledge from local biologists, provides enough evidence that the native fish assemblage is likely healthy. The IMST advises monitoring the health of the native fish assemblage before and following a possible reintroduction. While the authors support the notion of monitoring, the collection of pre- and post-project information on forage base is outside the scope of the Assessment and would be more appropriately addressed in an implementation plan.

The IMST also suggests the authors determine the size and composition of a fish forage base required for adult and sub-adult bull trout in a healthy bull trout population. The authors are unaware of any available information, published or unpublished, to help address this comment.

**IMST Comment:** *Bull Trout Prey. If the lower Clackamas and Willamette are expected to provide prey for adult bull trout, an evaluation of their ability to freely pass the mainstem dam complexes is called for.*

**Authors’ Response:**

The authors addressed the potential for bull trout passage impediment at the mainstem Clackamas River dams in Section 1.7 of the draft Assessment. This comment was addressed previously on Page 11 above.

Depending on the success of a potential reintroduction, some bull trout may migrate through the dams into the lower Clackamas and mainstem Willamette River. However, based on the migratory habitats of other lower Columbia River bull trout populations that exist above dams (e.g., McKenzie, Lewis, and Metolius rivers), the authors would not expect a significant portion of the adults to do so.

**IMST Comment:** *Bull Trout Prey. ... IMST advises an evaluation of the degree to which the high levels of toxic chemicals in the lower Willamette River might reduce the fitness of bull trout that feed there.*

**Authors' Response:**

As noted in the response to the comment above, the authors do not expect a significant portion of a re-established bull trout population in the Clackamas River to migrate below PGE's dams into the lower Willamette River. In addition, based on age of maturity and probable low population size at the onset of a reintroduction program, potential use of the lower Willamette River by bull trout from the Clackamas would likely not occur for over a decade. Given this combined with the fact that the lower Willamette River constitutes such a relatively small portion of potential habitat for bull trout associated with a potential reintroduction into the Clackamas River Subbasin, the authors do not see the utility of conducting a lower Willamette River water quality evaluation at this time.

**General Conclusions**

**IMST Comment:** *General Conclusions. In conclusion, the IMST believes the Assessment is a serious, well considered review of the feasibility of reintroducing bull trout into the Clackamas basin that addresses the pros and cons associated with such an activity. In our review, we have stressed areas where we believe it would be wise to increase the Assessment's scientific credibility. However, our review should not be taken to imply that the IMST does, or does not, endorse bull trout reintroduction into this system; IMST does not express an opinion on this point, nor was it asked to. If the precautionary principle is followed and no or minimal harm to local species or donor stocks are probable, then a reintroduction may make sense. In any case, it would be wise to view a reintroduction as a scientific experiment that would include adequate pre- and post-introduction effectiveness monitoring of both target and non-target species and their immediate and landscape-scale environments.*

**Authors' Response:**

The authors agree with the IMST that a reintroduction effort should be accompanied by adequate pre- and post-introduction effectiveness monitoring of both target and non-target species and their immediate and landscape-scale environments. The authors emphasize the need for monitoring within an adaptive management framework in Section 5.3 of the draft Assessment. The development of monitoring and adaptive management strategies would be most appropriate at the time a reintroduction proposal is developed should it be pursued.

**IMST Comment:** *General Conclusions. IMST strongly endorses the intention articulated in the Assessment to use an adaptive management approach if a reintroduction is attempted. There are three scenarios that warrant consideration for adaptive management if a reintroduction plan is developed. 1) The reintroduction is successful with no harm to donor or resident fish assemblages. What near-field and far-field factors insured or aided that success and how can they be continued? 2) The reintroduction failed and the donor stock was harmed. What are the possible adaptive management scenarios to avoid its extirpation? 3) The bull trout reintroduction was successful but negatively affected the native fish assemblage. What is the adaptive management recourse? Another consideration for a reintroduction plan is a thorough review of the trout reintroduction literature (e.g. Harig et al. 2000; Harig and Fausch 2002) which documents variables associated with successes and failures.*

**Authors’ Response:**

The authors appreciate the IMST’s effort in framing three potential scenarios that warrant consideration for adaptive management if a reintroduction proposal is developed. These scenarios and questions posed would be further evaluated at a later date should a reintroduction plan be developed and could be tailored specific to the donor population(s) used in a reintroduction effort. With regard to determining the biological feasibility of reintroduction (i.e., Can a reintroduction of bull trout into the Clackamas River be done?), the authors believe there are no major uncertainties. The three scenarios identified for adaptive management have to do with potential ecological interactions and donor stock impacts.

## Specific Comments

### Executive Summary

**IMST Comment:** *Bullet three might read: “Is suitable habitat reasonably expected to be recolonized through natural processes if conditions are improved?”*

**Authors’ Response:**

This editorial correction will be made in the final Assessment.

**IMST Comment:** *Question in quotes at bottom of page might be expanded to include “successfully and without harm to current resident fish and donor stocks”.*

**Authors’ Response:**

The authors will consider making this suggested editorial change.

**IMST Comment:** *Is fishing pressure included in socio-economic impacts? Explain why or why not changes in fishing regulations must be considered prior to bull trout reintroduction.*

**Authors’ Response:**

The authors have not yet identified all of the potential socio-economic impacts to be considered for evaluation should a proposed action for reintroduction be developed. A review of existing fishing regulations might be warranted during evaluation of a reintroduction proposal; however, the authors do not consider such a review as essential prior to an actual reintroduction. The Oregon Department of Fish and Wildlife reviews sport angling regulations throughout the state, including the Clackamas River, on a regular basis and frequently makes changes or adjustments as deemed necessary and based on public input and review.

**IMST Comment:** *p. 1. Specify here how many bull trout adults and how many per square kilometer constitute a self-sustaining population.*

**Authors’ Response:**

As stated above on Page 6, the authors are unaware of any available data or information that could be used to help answer this question. To their knowledge, no such data or information exists.

**IMST Comment:** *p. 2. Multiple reintroduction strategies are worthy, versus “may be” worthy of consideration.*

**Authors’ Response:**

This editorial correction will be made in the final Assessment.

**IMST Comment:** *p. 3 & 110. The fact that no data were found indicating that bull trout predation limited anadromous salmonids does not indicate whether it does or not, or even if it was studied. Such statements raise the specter of type-2 error.*

**Authors’ Response:**

This statement will be clarified in the final Assessment.

**Chapter 1 – History, Status, and Draft Recovery Plan Guidance for Bull Trout in the Clackamas River Subbasin**

**IMST Comment:** *p.1. The CRBTWG states that the Assessment is focused “very specifically” on the feasibility of reintroduction, yet the document is more than that. There are four main questions addressed in the document as listed on p. 3 and two relate to reintroduction.*

**Authors’ Response:**

Although two of the four main questions do not specifically address “biological feasibility of reintroduction,” the authors believe they naturally fit into the assessment and serve an important role in providing background information justifying the development of feasibility study. The authors acknowledge that other sections of the document also address issues beyond the primary intent of addressing “biological feasibility of reintroduction.” For example, Section 5 on monitoring was developed to highlight the authors’ belief in the importance of monitoring and to acknowledge that it should be a significant component of a future reintroduction. The authors’ intent was to introduce important subjects that will be addressed in more detail in a future proposal for reintroduction or an implementation plan should reintroduction be pursued.

**IMST Comment:** *p. 3. Specify the percents of BLM, USFS, and private lands in the upper basin, and indicate their locations.*

**Authors’ Response:**

The entire Clackamas River Subbasin encompasses 243,103 hectares (607,758 acres). Approximately 71 % of the total watershed is in U.S. Forest Service or Bureau of Land Management (BLM) federal ownership. Approximately 2.8 % is in tribal ownership on the extreme eastern edge of the watershed (Confederated Tribes of Warm Springs ownership).

In the Clackamas River Subbasin within the National Forest boundary (171,051 hectares), there are 165,540 hectares (413,850 acres) of National Forest ownership or 96.8 % of the land base, 1,602 hectares (4006 acres) BLM or 1 % of the land base, and 3,909 hectares (9,772 acres) of private or 2.2 % of the land base approximately.

The Upper Clackamas River which consists of the entire watershed upstream of the river’s confluence with Collawash River and where all suitable bull trout spawning and rearing habitat is located, encompasses 40,624 hectares (101,560 acres). This 5<sup>th</sup> field watershed is largely Forest Service ownership at 38,105 hectares (95,263 acres) or 93.8 % Forest Service. Private land encompasses 64.4 hectares (161 acres) or 0.2% and 2,240 hectares (5,600 acres) or 6% are tribal ownership (outside of the Forest boundary).

**IMST Comment:** *p. 9, half way down. If possible, provide a citation for the statement beginning “This assumption is consistent with...”*

**Authors’ Response:**

A review of current distribution and presence/absence survey information on bull trout populations in tributaries of the Lower Columbia River Basin on the western side of the Cascades Range suggests there are no known populations outside the zone of anadromy (upstream of known fish barriers). If above barrier habitat was occupied by bull trout in the past, there is a high likelihood it would be occupied at present (at least in moderate to low abundances) since these areas are often high in the watershed and offer protection from land management activities, angling, and nonnative species. Based on this information it is logical for the authors to assume bull trout did not occupy above barrier habitat in the Clackamas River Subbasin. No citation necessary.

**IMST Comment:** *The CRBTWG confirmed the historical presence of bull trout in entire river segments if ‘enough’ confirmed sightings were documented within close proximity. How many confirmed sightings constitute ‘enough’ to determine historical presence throughout a river segment and what length of river constitutes a segment to which this index was applied?*

**Authors’ Response:**

As shown in Figure 1.4 on Page 11 of the draft Assessment, the authors developed a map depicting the historical distribution of bull trout in the Clackamas River Subbasin from available data and information. The authors state on Page 9 of the draft Assessment: “In the upper portion of the subbasin, enough confirmed sightings within close proximity of one another were determined to be sufficient ... to map entire segments of river as confirmed for historical bull trout presence.” The authors relied only upon one confirmed sighting as a point source of data. If the confirmed sightings were within close proximity of one another (within four to five miles), then the authors mapped the adjoining segment of river as “confirmed presence” instead of “probable historic distribution.”

**IMST Comment:** *p.10. Indicate the causes of warmer water temperatures since 1850, as well as steps being taken to reverse the trend.*

**Authors’ Response:**

The “Tier Four” streams and sections of streams were mapped as within the probable historic distribution of bull trout. It was assumed that these streams and segments of streams were in better condition for bull trout rearing in the mid to late 19<sup>th</sup> Century before large scale settlement and development occurred. Warmer water temperatures are just one example of less desirable conditions that may have impacted their suitability for bull trout today.

In the lower Clackamas River Subbasin, downstream of the National Forest, elevated summer water temperatures from removal of riparian vegetation for farms, house sites, sewage treatment plants, golf courses, etc. have greatly contributed to loss of shade and greater solar warming of tributary streams. Other impacts from these human developments to some of these same streams include increased sedimentation, increased nutrient inputs, pesticide residue in runoff, water withdrawals, etc. Historically, these same areas mostly had intact riparian forests or native prairie vegetation and in many cases probably better

water quality compared to the present. They may not have been cold enough even historically to provide bull trout spawning or early rearing habitat but during the cooler months these same streams may have provided sub-adult and adult rearing habitat. On the National Forest lands in the Clackamas River Subbasin, riparian reserves protect remaining forested riparian areas from clearing activities. Previously harvested riparian areas on the National Forest are recovering and providing increasing shade to stream habitat and lowering thermal inputs. These riparian forests are managed for late seral forest development. “Tier Four” streams that are still largely forested land, have good water quality, and with mostly intact riparian zones, may still provide good quality habitat for bull trout. This is a reasonable assumption since migratory bull trout currently rear in the mainstem Snake River and bull trout have been occasionally reported from the mainstem Columbia River, even though these major rivers support large human population centers and receive their runoff (Buchanan et al. 1997).

**IMST Comment:** *Clarify the apparent contradiction in bull trout distribution described here with that on page 3.*

**Authors’ Response:**

The authors were unable to find the stated contradiction based on the detail provided in this comment.

**IMST Comment:** *pp.12-17. With one cottid exception, all the fish survey results reported indicate that only cutthroat and rainbow trout and coho and Chinook salmon are likely present in the upper basin. Yet elsewhere it is implied that healthy populations of cyprinids and catostomids are present and potential bull trout prey. Clarify this contradiction.*

**Authors’ Response:**

The authors do not believe there is a contradiction. The surveys noted on Pages 12-17 of the draft Assessment occurred in areas thought to be potential bull trout spawning and early juvenile rearing habitat. Typically these areas are too cold and unproductive to produce abundant and diverse fish fauna. These are good areas for egg laying, incubation, and early juvenile rearing where the primary forage is invertebrates. In the case of fluvial bull trout populations, older juveniles and adults depend on larger, warmer, more productive areas lower in the watershed to produce the abundant and diverse forage base necessary to grow large and fecund.

**IMST Comment:** *p.14. It is best to confirm presence above barriers as well as below barriers via surveys.*

**Authors’ Response:**

See the authors’ response to a similar IMST comment above on Page 34.

**IMST Comment:** *p. 15. The IMST applauds the CRBTWG for recognizing that surveys conducted before 2004 lacked the statistical rigor required to confirm the absence of bull trout and for conducting additional surveys in 2004. The conclusion reached from the analysis of this survey effort would be better supported if the implications of survey methods and assumptions for bull trout detection were discussed. Specifically, the authors state that streams ‘too large’ to snorkel safely at night were not sampled. Briefly indicate what constitutes ‘too large’ and estimate the likelihood that these larger stream harbor undetected bull trout that would be detected in the smaller, sampled streams.*

**Authors’ Response:**

The Peterson et al. (2002) sampling protocol employs a probabilistic sampling framework to determine the probability of bull trout presence (or absence). Large river segments that were too large, swift, and hazardous to snorkel at night were not sampled for safety reasons. The determination of “too large” was not associated with a particular, predetermined width or velocity, but rather with the surveyors’ familiarity with the selected river segments and their personal judgment. Excluded segments, however, tended to be greater than 10 meters wide with current too swift to swim against or easily withstand by clinging to the substrate. Approximately less than 10 percent of the stratified random samples drawn from the total population of 200-meter stream segments within the area of Upper Clackamas River surveyed were determined “too large” and hazardous. These random draws were chosen again until a desired number of 200-meter stream segments could be safely sampled to achieve the desired high level of probability of detection in accordance with the protocol.

It is true that this method could inject a level of unavoidable bias, but this bias would tend to make the conclusions of the survey more conservative. The likelihood of finding members of a resident local population of bull trout in very large, swift riffles is undoubtedly less than in habitats with lower water velocities.

**IMST Comment:** *p. 17. Estimate or at least discuss the detection efficiencies for bull trout in deep pools and large streams, and for electrofishing versus snorkeling and how these efficiencies influence the habitat analysis.*

**Authors’ Response:**

The surveys and sampling conducted to determine bull trout presence are not related to how the authors conducted their suitable habitat analysis in Chapter 2 of the draft Assessment. These two efforts are unrelated.

**IMST Comment:** *p. 20. Provide information about the extent of forest disease or unhealthy forests, and the likelihood of catastrophic wildfire in the upper Clackamas.*

**Authors’ Response:**

Most of the Clackamas River Subbasin on National Forest lands appears to support healthy forests with only localized pockets and scattered mortality from native disease and pests. In the Olallie Lakes Scenic Area and north of that location along the Cascade Crest, greater mortality is being seen in these high elevation forests. Much of the wide spread browning evidenced in these forests is from pine beetle attacks on older lodgepole pine stands (approximately 100 years old). This area has a history of large fires and may explain the greater abundance of the fire adapted lodgepole pine. This area is also known as “lightning

alley” since it attracts greater summer storm patterns that generate lightning strikes. Large scale or catastrophic fire is always a potential depending on year to year climate conditions. Historic evidence points to large scale stand replacement fires occurring on an infrequent basis in the western hemlock-Douglas fir forest that makes up most of the Upper Clackamas River Subbasin. The high elevation forests with an abundance of lodgepole pine have a more frequent fire regime and may be experiencing stand replacement by fire every 100 years or so. (Goodwyne 2006, personal communication with Clackamas River Ranger District silviculturalist)

**IMST Comment:** *p. 25. Clarify whether adult bull trout abundance criteria are met with 900 individuals in the entire Willamette River Unit. This could mean very few individuals in each of the basins (upper Willamette, McKenzie, Santiam, Clackamas), which are fundamentally fragmented by mainstem dams.*

**Authors’ Response:**

At this time, current abundance criteria in the draft recovery plan are 900 to 1,500 adults in the Willamette River Basin. It is expected that these numbers will be refined prior to finalization of the recovery plan and as new information becomes available through monitoring and research.

**Chapter 2 – Habitat**

**IMST Comment:** *p. 25, first sentence. Briefly explain why 3 patches will meet the distribution criteria. Also, justify the 900-1,500 abundance criterion.*

**Authors’ Response:**

The distribution criteria in the draft bull trout recovery plan for the Willamette Recovery Unit will be met when “bull trout are distributed among three or more local populations in the recovery unit: two in the Upper Willamette River core area and one in the Clackamas River core habitat.” The authors highlighted pertinent recommendations and guidance contained in the draft recovery plan for the Willamette Recovery Unit in the draft Assessment. They did not provide an explanation for these recommendations or guidance, nor do they believe it is necessary or relevant to the Assessment. The IMST comment pertaining to the 900 – 1,500 abundance criterion is addressed in the previous response above on Page 37.

**IMST Comment:** *p. 28. Given the 5-9 degrees Celsius required for bull trout spawning and juvenile preference, explain why 15 degrees was set as a temperature criterion for suitable habitat. Also indicate the suitability of winter habitat requirements.*

**Authors' Response:**

The authors conferred with members of the CRBTWG in establishing the 15 degrees Celsius temperature criterion for determining suitable bull trout spawning and rearing habitat. The authors recognize there is a range of water temperatures (from less than 9 degrees Celsius to greater than 15 degrees Celsius) in which bull trout spawning, egg incubation/emergence, and rearing take place. In order to err more on the conservative side of not underestimating potential suitable habitat, the CRBTWG selected the higher criterion of 15 degrees Celsius. It is important to remember; however, that this applies strictly to the period of summer temperature record (June through September) when the daily maximum temperature for a single hourly temperature reading is reached. This metric is much more discriminating towards delineating colder water streams than is the Oregon Department of Environmental Quality bull trout spawning temperature criterion which uses the rolling seven-day average of maximum daily temperatures. Winter water temperatures in the predominantly ground-water and spring-fed streams identified as suitable bull trout spawning and rearing habitat in the Upper Clackamas River are quite low (lower than for the period from June through September) during the fall, winter, and spring months based on a review of year-round water temperature data collected in past years at one site located along the Clackamas River near Big Bottom at Forest Service Road 4650 (Patch 1). Based on review of these data, the authors do not believe winter water temperatures are relevant to determining bull trout spawning and rearing habitat suitability.

**IMST Comment:** *p. 27. Add a bullet: 'What is the likelihood that the habitat will persist and improve?'*

**Authors' Response:**

This question is answered above under "General IMST Comments" for Chapter 2.

**IMST Comment:** *p. 29. There are an infinite number of watersheds and patches in a basin. Use quantitative areas versus "watershed scale" and "patches". The same goes for basin and subbasin. p. 30, first line. Bull trout are actually distributed over a small proportion of the conterminous USA. Perhaps modify to Pacific Northwest, USA.*

**Authors' Response:**

This comment is noted and editorial corrections as suggested will be made in the final Assessment.

**IMST Comment:** *There is usually an inverse correlation between slope and roads, and a positive one between roads and temperature. The site-scale stressors (e.g., sediment, temperature, prey, pool volume, wood) should be evaluated as well as the landscape-scale disturbances.*

**Authors’ Response:**

The authors evaluated the following stressors: temperature, three pool metrics, and large wood; on Pages 57 – 62 of the draft Assessment. These are the primary stressors for which a consistent data set from U.S. Forest Service Level II stream surveys is available for analysis.

**IMST Comment:** *Briefly describe the floodplain and riparian functions and how roads decrease them.*

**Authors’ Response:**

A brief discussion of the influence of roads on floodplains and riparian functions will be added in Section 2.1 of Chapter 2 under “Road Density” on Page 30 of the draft Assessment.

**IMST Comment:** *p. 31. In the sentence, “Survival of bull trout embryos planted in stream areas of groundwater upwelling used by bull trout for spawning were significantly higher than embryos planted in areas of surface-water recharge not used by bull trout for spawning (Baxter and McPhail 1999).” clarify that this statement is comparing springs to hyporheic flows.*

**Authors’ Response:**

The authors will clarify this statement in the final Assessment.

**IMST Comment:** *A patch is defined here and on p. 42 differently, but neither definition is sufficient.*

**Authors’ Response:**

As stated earlier on Page 7, the authors will more clearly define the term “patch” and will review all such references to this term throughout the final Assessment to ensure its consistent usage.

**IMST Comment:** *p. 32. The Assessment focus on spawning and rearing habitat includes insufficient analysis of cover, volume, and prey for several hundred bull trout to mature and achieve sufficient size to produce high numbers of eggs.*

**Authors’ Response:**

The authors believe the analysis of large wood provides the necessary level of analysis for cover. Additional data on cover are lacking. The authors also believe the analysis of pool habitat (based on the three metrics investigated in Chapter 2 of the draft Assessment) sufficiently assesses the volume of habitat. Again, the authors are limited to relying upon available data for analysis. The IMST comment pertaining to sufficiency of analysis for prey is addressed above on Page 29.

**IMST Comment:** *Specify that the 15° C criterion is for summer water temperatures. What are fall and winter water temperatures in the proposed catchments? What was the study design for temperature recorders (number, placement)? (also p. 38).*

**Authors' Response:**

The authors state the 15 degrees Celsius criterion does apply to the period of time during which streams are their warmest – i.e., the summer months (see Page 38 in the draft Assessment). The authors will review other sections of text referring to this temperature criterion to provide clarification as needed in the final Assessment. The IMST comment pertaining to fall and winter temperatures is addressed above on Page 38. Additional text will be provided in the final Assessment to explain the approach (i.e., study design) for analyzing available water temperature data collected prior to 2004 and collecting additional data in 2004 where gaps were identified.

**IMST Comment:** *p. 36, figure 2.3. Indicate whether the line presented is the best fit for the data or simple linear regression. Briefly explain why pooling the data across basins is appropriate. Units should be shown on axes for clarity. Provide the R value to indicate the significance of this regression. Since the X-axis is a log, a slight difference in slope can result in a large change in the predicted Y value. Also, the figure title is missing an f from (summer low-flow width).*

**Authors' Response:**

The line in question is the result of simple linear regression. The data were pooled across neighboring basins, subjected to similar climate and, in many cases, similar geology. Differences in both of these factors likely contributed to the observed variability in the relationship. Because the relationship was still a very strong one, it was considered useful for the purpose of prediction of summer low-flow widths. Although a small change in slope can result in large changes in Y, when the X value is a log, this is much less true at the lower end of the relationship, which is the portion considered by the authors.

**IMST Comment:** *Solving the regression equation for a stream width of 10 feet yields a catchment area of 2199 (and a log of 3.34), not 1742 acres. The log of 1742 is 3.24, which multiplied by 29.8 is 96.58, if 89.6 is then subtracted, that yields 6.98 feet for stream width—not 10 feet. Because exclusion of streams and stream segments from consideration as suitable habitat was based on the assumption, of 1742 acres, it is critical to resolve the discrepancy between the text and Fig. 3 with respect to stream width vs. watershed size. IMST recommends that the CRBTWG evaluate exclusions based on a critical watershed size of 2199 acres if streams less than 10 feet wide are limiting.*

**Authors' Response:**

An error was made in stating that 10 feet was the desired minimum summer low flow width. In fact, a minimum width of 2 meters was used. This error will be corrected in the final Assessment.

**IMST Comment:** *p. 38. Are there no cold water refugia? Explain the methods behind temperature data collection and how these might bias delineation of habitat.*

**Authors’ Response:**

Local areas of cold water refugia may exist; however, the authors do not believe these areas comprise large enough quantities of suitable spawning and rearing bull trout habitat to have biased the delineation of suitable habitat as shown in Figure 2.7 on Page 44 of the draft Assessment.

**IMST Comment:** *p. 42. It seems preferable to list patches as water bodies vs. catchments. Fish occupy water bodies, and patches are defined as stream segments.*

**Authors’ Response:**

This comment is noted, and the authors will consider re-titling specific patches in the final Assessment.

**IMST Comment:** *p. 43. Although the captions use greater than 1700 acres for an apparently incorrect catchment size of 1742 acres, this process should be corrected based on a critical watershed size of 2199 acres.*

**Authors’ Response:**

This comment is addressed above on Page 41. The authors made an error in stating that 10 feet was the desired minimum summer low flow width, when in fact it is two meters. This will be corrected in the final Assessment.

**IMST Comment:** *p. 45-46. The patches appear arbitrary and based on HUC mapping conventions, versus ecology, biology, or hydrology.*

**Authors’ Response:**

As stated above on Page 7, the authors did not attempt to presuppose how reintroduced bull trout might actually utilize different stream segments or patches for that matter. In an attempt to provide a more detailed analysis of watershed, riparian, and fish habitat conditions throughout the Upper Clackamas River area mapped as suitable bull trout spawning and rearing habitat, the authors relied primarily on 7<sup>th</sup> field HUC boundaries to delineate patches. Doing so is not arbitrary, but in fact the most logical way to define watershed, riparian, and fish habitat conditions across the landscape.

**IMST Comment:** *p. 46. Tague and Grant (2004) are miss cited; their paper indicates that the High Cascades are geologically younger not older than the Western Cascades. Also check the other attributes listed for both. Also see p. 127 of the Assessment for accuracy and needs a reference to Tague and Grant (2004). The citation for Tague and Grant (2004) is also incomplete in the reference section.*

**Authors’ Response:**

Corrections will be made in the final Assessment.

**IMST Comment:** *If possible, the Assessment should elaborate on the legacy effects of the 1996 storm event relative to these differing geological types.*

**Authors' Response:**

The authors do not believe this is necessary or relevant to the Assessment.

**IMST Comment:** *p. 47. Some numbers are incorrect. For example, Upper Clack Austin acreage should probably be 7488, not 748.8. Acreage numbers and square miles are not always consistent; i.e. Olallie Creek. Check all entries and column sums. Right, or decimal, justifications of numbers makes tables easier to read. Some column headings are redundant; i.e., acres/acres, Sq. miles/mi<sup>2</sup>*

**Authors' Response:**

All data contained in the summary tables for the Patch Characterization section in Chapter 2 of the draft Assessment will be proofed. Corrections will be made in the final Assessment.

**IMST Comment:** *p.48. Although it is stated here that Patches 3 and 4 are the most geologically stable, Table 2.2 indicates that patches 3 (92%) and 5 (86%) have the highest % of low landslide potential, rather than patches 3 and 4 (81%).*

**Authors' Response:**

A correction will be made in the final Assessment.

**IMST Comment:** *p. 49. Although parent geology is related to flow regime, this figure depicts geology not flow regime. If it does depict flow regime, it would be preferable for the Assessment to indicate flow regime is in terms of flow, runoff, or base flow to bank full flow ratio.*

**Authors' Response:**

Figure 2.9 on Page 49 of the draft Assessment does indeed depict parent geology and will be re-titled accordingly in the final Assessment.

**IMST Comment:** *p. 51. Only one catchment in Table 2.3 has road density less than 1.1km/km<sup>2</sup>. This indicates widespread disturbance and potentially many migration barriers. Indicate how the lack of migration barriers was determined, in terms of study design and indicators.*

**Authors' Response:**

This comment was addressed above on Page 13.

**IMST Comment:** *Some criteria used to select suitable habitat patches may not be as discriminating as the CRBTWG would have readers believe (Table 2.3). For example, Aggregate Recovery Percentage (ARP) seems more procedural than scientifically based. Use of ARP may be required in this Assessment by the Draft FWS Recovery Plan, but it and the Equivalent Clearcut Area (ECA) methodology produce indices, rather than actual changes in peak flows. The Assessment considers ARP an indicator of “hydrologic impairment”, but there is little explanation provided for why that is the case. Explain how it is related to changes in peak flow quantity or timing, preferably with biplots, and provide correlations between bull trout habitat suitability and these indices, road density, and stand structure.*

**Authors’ Response:**

The authors did not rely on Aggregate Recovery Percentage (ARP) results as a criterion used to select suitable habitat patches. ARP was used as one of several watershed condition metrics to characterize the current conditions of each patch. A further explanation of ARP is not necessary.

**IMST Comment:** *pp. 52 & 55. The column headings are redundant, as are units in cells if provided in headings.*

**Authors’ Response:**

The authors will consider re-titling the column headings in the final Assessment.

**IMST Comment:** *p. 55. The percentages of catchments classified as matrix suggest widespread disturbance in all but the upper Clackamas. In Lemiti, S.F. Lemiti, Olallie, and Patch 3, the sums are far less than 100%.*

**Authors’ Response:**

The percent of watershed in matrix is not an indicator of widespread disturbance. The percentage of watershed in various Northwest Forest Plan land allocation categories for each watershed listed in Table 2.4 on Page 55 of the draft Assessment will be reviewed and corrected if necessary.

**IMST Comment:** *p. 57. What design and indicators were used in the habitat surveys? Define the reach scale at which data were collected. Reach is an undefined term that can vary by several orders of magnitude.*

**Authors’ Response:**

Data from U.S. Forest Service Level II stream surveys were collected in accordance with an inventory and data collection protocol originally developed for the USDA Forest Service Pacific Northwest Region in 1989. The original 1989 protocol has been reviewed annually and updated as necessary. The latest version is: Stream Inventory Handbook, Level I and II, Pacific Northwest Region, Region 6, 2006, ~Version 2.6. A reach is a unique segment of stream channel that differs from that just downstream or upstream based on stream size or flow, change in channel type or geomorphology, or biotic assemblage. The minimum stream reach length recommended is 0.5 miles. No maximum reach length is suggested.

**IMST Comment:** *Explain how and how many individual reaches were selected for assessment in each catchment. Explain whether the unlabeled bars in figures 2.13 – 2.18 represent only the sampled reaches or all reaches in each catchment. Unless the reaches were randomly selected, they can only represent the limited number of reaches actually surveyed—not entire catchments.*

**Authors' Response:**

The number of individual reaches identified in the draft Assessment for each watershed is based solely on those that have been surveyed to date and how a particular stream channel was categorized into reaches during the survey effort. The survey coverage for most suitable bull trout spawning and rearing streams within each patch is quite thorough; however, is lacking on the mainstem Clackamas River along Big Bottom and Ollalie Creek as indicated in Table 2.5 on Page 58 of the draft Assessment.

As explained on Page 57 of the draft Assessment, “Survey data are collected at the reach scale for individual streams; however, the habitat summaries and comparisons aggregate all data for the various reaches and streams surveyed within each patch and are reported as a function of the total habitat area (meters<sup>2</sup>) available within the patch. The bars shown in Figures 2.13 – 2.18 represent the total square meters of habitat surveyed within a particular patch by habitat metric category. For example, the first graph presented in this section of Chapter 2; Figure 2.13 “Channel Gradients;” roughly 81,000 square meters of the total habitat that was surveyed in the Pinhead Patch is in the 2.5 – 4.9% channel gradient category.

**IMST Comment:** *p. 59. Briefly explain (in figure titles) the origin of the multiple bars for each catchment. Briefly explain in the text what each of the metrics measured means to bull trout.*

**Authors' Response:**

This issue is explained in the response to the preceding comment. As explained on Page 57 of the draft Assessment, “Survey data are collected at the reach scale for individual streams; however, the habitat summaries and comparisons aggregate all data for the various reaches and streams surveyed within each patch and are reported as a function of the total habitat area (meters<sup>2</sup>) available within the patch.”

**IMST Comment:** *p. 63. Cub and upper Clackamas have more area than Pinhead in the stable flow categories.*

**Authors' Response:**

The conclusion as stated on Page 63 of the draft Assessment is correct. There was likely some confusion in interpreting this graph and the others like it (Figures 2.13 – 2.18) based on what the individual bars represent for each patch. The Pinhead Creek patch has less habitat overall by surface area than either the Upper Clackamas or Cub Creek patches. It has less area in the most stable flow category, but has more as a percent of the total (72% compared to 67% for the Cub Creek patch and 53% for the Upper Clackamas patch). Additional clarification will be provided in the final Assessment in order to avoid confusion in interpreting these figures.

**IMST Comment:** *p. 64. The Assessment need not give miles in each box if already provided in the table title, nor must it provide redundant values above the diagonal.*

**Authors’ Response:**

The authors will consider revising the table title and format in the final Assessment.

**IMST Comment:** *p. 65. Briefly explain why each selected patch can support a self-sustaining bull trout population. Indicate whether each patch also includes over wintering habitat for large adults, or whether this must be provided in the lower Clackamas. Support these explanations with data or references.*

**Authors’ Response:**

The issue of relating each individual patch to a self-sustaining population has already been addressed by the authors under IMST General Comments for Chapter 2. Each patch does contain habitat for over-wintering adult bull trout, and the authors stated earlier in response to a separate IMST comment that they are uncertain as to what dominant life history pattern a reintroduced population would exhibit despite the particular donor stock used. The authors expect large over-wintering adult bull trout could occupy habitat within the identified suitable spawning and rearing patches as well as areas downriver in the middle reaches of the Clackamas River downstream from the Collawash River confluence to North Fork Reservoir.

**IMST Comment:** *p. 66. Add a fourth bullet beginning with “What is the appropriate. .”*

**Authors’ Response:**

This formatting correction will be made in the final Assessment.

**Chapter 3 – Conservation Genetic Considerations and Donor Stock Suitability**

**IMST Comment:** *p. 70. Based on the evidence herein, donor stocks from the lower Columbia River portion of the coastal evolutionary group appear appropriate and scientifically defensible.*

**Authors’ Response:**

The authors will make a text revision in the final Assessment.

**IMST Comment:** *p. 72. Briefly explain why bull trout populations are highly isolated within catchments. Define highly isolated and what it means in terms of watershed/basin structure. Provide scientific reasons why four microsatellite loci are sufficient to determine the substructure of bull trout populations in the Pacific Northwest. That is, indicate what phenotypic characteristics those loci represent and how they relate to bull trout fitness.*

**Authors’ Response:**

Taylor et al. (2001) concluded that bull trout populations are highly isolated from each other genetically and demographically within watersheds. This conclusion is made in part because “These microsatellite data are consistent with earlier studies of allozymes (Leary et al. 1993) and mtDNA (Taylor et al. 1999) that reported relatively low levels of within-population variation at these independent loci.” “Low variability may stem from demographic processes that have reduced effective population sizes in bull trout historically

during and following postglacial dispersal (e.g., Hewitt 1996). Reduced population sizes through bottlenecks or founder events would have eliminated considerable allelic variation which has not yet recovered via mutation (Schug et al. 1997).” A more thorough and rigorous examination of the topic can be found in Taylor et al. 2001 and is beyond the scope of this Assessment.

The authors relied, in part, on Spruell et al. (2003) to provide information regarding the substructure of bull trout populations. The authors do not have a position in regard to whether four microsatellite loci are sufficient to determine sub-population structure. The reader is referred to Spruell et al. (2003) for an examination of the topic. The findings are consistent with a growing body of evidence (see references contained in Spruell et al. 2003) that explore the topics of evolutionary lineage or bull trout sub-population structure.

Microsatellite loci are by definition, non-coding sequences of DNA that are composed of two to five base pair repeats. As such, no gene products are encoded by microsatellites. Therefore, no phenotypic traits or performance/fitness related characteristics are the result of the transcription and translation of DNA found at microsatellite loci. Microsatellite regions tend to be highly variable and thus useful in population genetic studies as the repeated sequences are often mismatched and deleted during DNA replication. These mutations are selectively neutral because the random repeated DNA sequences are “junk” DNA (i.e., non-coding sequence). It is the high variability of the sequence that often allows microsatellite analysis to assign individuals to certain populations and even parents.

**IMST Comment:** *p. 75. Briefly explain why 5,000 individuals are sufficient for a species as completely, and potentially permanently, fragmented as bull trout. Does this many individuals suffice for other salmonid species to be viable over evolutionary time frames? Also explain why 50 is a sufficient population size.*

**Authors’ Response:**

The authors do not advocate that abundance criteria of 50 or 5000 adult bull trout in a population is either sufficient or insufficient. As stated on Page 78 of the draft Assessment, guidelines on effective population size appear to apply reasonably well to bull trout (Rieman and Allendorf 2001). The recommendation that  $N_e$  exceed 50 to avoid inbreeding depression appears to be most closely related to the short-term genetic viability of local bull trout populations. The recommendation that  $N_e$  exceed 500 to avoid the loss of genetic and phenotypic variation through drift appears to be most closely related to the long-term persistence of groups of local populations among which gene flow occurs to form a metapopulation of bull trout. Since few local populations may support a  $N_e$  greater than 500 (Rieman and Allendorf 2001), effective populations of this size may often require the possibility of gene flow between local populations. It also appears reasonable that effective population sizes that exceed 5,000 may be required to ensure the evolutionary persistence of bull trout conservation units. The risk of extinction for a population is clearly related to its size and its variance in abundance relative to its mean size over time. More specifically, theoretical evidence suggests that inbreeding and genetic drift are likely to occur in populations when  $N_e$  less than 50 and 500, respectively. When detailed information is lacking for bull trout populations, these guidelines would be the most useful tool for managers to apply for avoiding loss of genetic variation and trying to ensure population persistence. These numbers represent relatively straightforward and defensible, theoretical

minimums. While theoretical  $N_e$  can reflect the minimum number necessary to alleviate certain genetic risks, it does not necessarily reflect the most appropriate population size. Detailed information for a population may allow the justification of effective population sizes larger or smaller than 50 or 500. If possible, when estimating the population size necessary for persistence, managers should consider, for example, demographic risks and selective pressures as well as stochastic and historical events in addition to genetic risks.

It is clear that a sufficient  $N_e$  is a necessary consideration for conserving bull trout populations. Except for well-documented exceptions, the 50, 500, and 5,000 values should be considered necessary minimums and viewed as generalizations. For any given population the specific  $N_e$  necessary for conservation purposes will depend on characteristics of the population such as the ratio of  $N:N_e$ , the dominant life history form present, and the frequency of spawning.

**IMST Comment:** *p. 75-79. Reducing the length of section 3.3 would increase the clarity of the overall document. This could be achieved by limiting this discussion to issues of immediate relevance to the proposed bull trout reintroduction.*

**Authors’ Response:**

This comment will be considered in preparing the final Assessment.

**IMST Comment:** *p. 80. Justify the necessity of setting  $K$  at 30,000. This seems very high for small catchments.*

**Authors’ Response:**

The carrying capacity of each population was set at 30,000 individuals, because 30,000 is the maximum parameter that can be entered into the simulation program, thus 30,000 is a large enough population to result in little loss of genetic variation or increased risk of extinction over 50 years. Because the authors are assessing relative outcomes and not attempting to model specific populations (i.e., there is no information available in regard to the carrying capacity of any potential donor population or the Clackamas River Subbasin), the authors did not want the carrying capacity to be so low as to result in additional modeled deaths or loss of alleles.

**IMST Comment:** *p. 81. The two point scenarios in Table 3.1 produce straight lines. Is VORTEX a linear model, even though few populations show linear trends? Employ various propagule numbers and types to yield more realistic patterns and options.*

**Authors’ Response:**

VORTEX models population dynamics as discrete, sequential events (e.g., births, deaths, catastrophes, etc.) that occur according to defined probabilities. The probabilities of events are modeled as constants or as random variables that follow specified distributions. Since the growth or decline of a simulated population is strongly influenced by these random events, separate model iterations or “runs” using the exact same input parameters will produce different results. Consequently, the model is repeated many times to reveal the distribution of fates that the population might experience under a given set of input conditions.

The results from these simulations should be interpreted only as a means to compare the relative risks and benefits of the scenarios simulated. With 500 or 1,000 adults in the donor population, none of the modeled scenarios reduced genetic variation or persistence of the donor population. It is not until the donor population adult abundance was dropped to approximately 200 that the modeled scenarios result in potential affects (these are the figures presented in the draft Assessment). Because the authors concluded that the most appropriate populations to use as donor populations are larger than 1,000 adults, there is little value added by modeling additional propagule numbers at the 200 adult abundance level, as any patterns observed will not be entertained as a viable option for implementation should a reintroduction be pursued. Stated another way, the authors believe the only biologically feasible outcome is one in which no affects can be modeled in VORTEX, because the donor population is sufficiently large.

**IMST Comment:** *p. 82-86. Presentation of the modeling results may be misleading for some readers. Two propagule sizes were modeled for each propagule age class. Plotting the results for the two propagule sizes and drawing a line between them indicates that the shape of the relationship between propagule size and heterozygosity, allelic diversity, or population persistence is understood, but this has not been modeled. p. 84. Indicate which plots are from demographic schedules A versus B, and add Probability to the y-axis of the second plot.*

**Authors' Response:**

The authors agree that the graphs may be misleading for some readers. The authors intend to significantly modify Section 3.4 in Chapter 3 of the draft Assessment to provide increased clarity and highlight that scenarios in which 500 or 1,000 adults are present in the donor population, none of the modeled scenarios reduced genetic variation or persistence of the donor population. Because many of the results in Section 3.4 (Vortex Simulation Modeling) are derived from a manuscript that is still in preparation (Tallmon et al.), the authors recognizes that it is somewhat premature to fully utilize the information in the Assessment as explained above.

**IMST Comment:** *p. 88-89. Provide the areas and discharges of these potential donor catchments, and their connectivity to over-wintering water bodies for adults. Provide means and ranges of adult abundance so that the reader has some notion of variability. Is there any evidence that the populations are independent or dependent?*

**Authors' Response:**

Data on area and discharge of potential donor catchments are not readily available for incorporation into the Assessment. Ranges, trends, and additional information regarding potential bull trout donor stock abundance is contained within Appendix C - Population Characteristics of Potential Donor Stocks of the draft Assessment. Table 3.2 on Pages 88-89 of the draft Assessment is only a summary of the available information.

**IMST Comment:** *It is misleading to specify that Jack Creek has 466 adults without some estimate of variability.*

**Authors’ Response:**

As suggested, it would be more appropriate to provide the number generated in Table 3.2, which provided adult abundance estimates based on a five year average (2001 to 2005), rather than a one year estimate. The authors will make this revision in the final Assessment. Additionally, trends and variability for each of the potential donor stocks can be found in Appendix C - Population Characteristics of Potential Donor Stocks of the draft Assessment.

**IMST Comment:** *p. 91. Provide a large scale figure sufficiently detailed to indicate stream (population) proximity and the possibility that the populations listed in Table 3.2 are interbreeding and dependent. Provide evidence that the populations are independent or dependent.*

**Authors’ Response:**

The authors do not believe a detailed map showing all the individual populations is necessary to address the question of whether populations are independent from each other. To the degree that information is available, it is included in the narrative of the draft Assessment, and included in Table 3.2. The majority of information on population designations (i.e., local populations, spawning complexes) was derived from the draft recovery plan. At this time there is no additional information on population discreteness beyond that presented in the draft Assessment.

**IMST Comment:** *p. 92. Indicate the current protective measures provided for persisting bull trout populations, and whether these measures are appropriate or ineffective for reintroduced populations.*

**Authors’ Response:**

The causes for decline of bull trout in the Clackamas River Subbasin (Section 1.6 of the draft Assessment) and the curtailment of the causes for decline explore the effectiveness of the protective measures currently implemented. Results of the protective measures are exemplified in Chapter 2, which details the current habitat conditions of the upper Clackamas River and major tributaries.

Bull trout are listed threatened under the federal ESA and as such fall under the protections afforded listed species (primarily Section 7 and Section 9 of the ESA).

It is unknown at this time what the “listing status” will be of a reintroduced bull trout population in the Clackamas River. Bull trout could be reintroduced under Section 10(j) of the ESA, whereby the reintroduced population would be deemed “experimental, non-essential.” Under this designation, the fish would have less ESA protections than provided under the designation threatened or endangered. However, federally listed anadromous salmonids are present in the Clackamas River and land and resource management activities designed to be protective of these species would also be protective of reintroduced bull trout and bull trout habitat.

## **Chapter 4 – Ecological Interactions and Food Web Considerations**

**IMST Comment:** *p. 96, 106 & 110. The survey results on pp. 12–17 provide no support for warmwater fish populations in the upper Clackamas. Provide survey results here indicating the fish species and their abundances and size ranges in the upper Clackamas. Two sucker species does not equate with “several” sucker species. Explain why several sucker species are expected in the upper Clackamas, if they are, i.e., indicate which suckers besides *C. macrocheilus* and *C. platyrhynchus* might exist there. List the sculpin species occupying the upper Clackamas. Explain the importance to the upper Clackamas of a diverse warm water fish assemblage in the lower Clackamas. Such an assemblage seems unlikely in the upper Clackamas at water temperatures less than 15°C. and mainstem dams may preclude seasonal bull trout migrations.*

**Authors’ Response:**

The survey results on Pages 12 – 17 of the draft Assessment dealt largely with surveys for bull trout or other cold water species higher in the watershed. Few surveys have been completed on the mainstem Clackamas River above North Fork reservoir because of the large size of the river. Long-nosed dace, sculpin species and suckers appear to be common in some locations above North Fork Reservoir. Approximately 32% (7,963) of all fish counted in a snorkel survey of the mainstem Clackamas River funded by PGE in 2000, were suckers (Cramer S.P. and Associates 2001). The survey reports did not indicate size ranges for the non-salmonids. Since the surveys have not usually identified fish to the species level, the assumption was these were large scale sucker, *C. macrocheilus*. The ODFW Clackamas River Subbasin Fish Management Plan also identifies mountain sucker, *C. platyrhynchus* as present in the Clackamas River (Murtagh et al. 1992) but this wasn’t determined in the surveys. The use of “several” in the report for sucker species is incorrect and will be dropped in the final Assessment.

**IMST Comment:** *Use official AFS/ASIH fish names throughout (Nelson et al. 2004). *Catostomus* not *Catastomus*, *pikeminnow* not *pike minnow*, *P. oregonensis* not *P. aregonensis*, *chiselmouth* not *chisel mouth*, *redside shiner* not *red-sided shiners*, *threespine stickleback* not *three-spine stickleback*, *L. tridentata* not *L. tridentate*, *pumpkinseed* not *pumpkinseed sunfish*, *brown bullhead* not *brown bull head catfish*.*

**Authors’ Response:**

The authors will make these suggested edits in the final Assessment.

**IMST Comment:** *In terms of disease, competition, prey, etc. discuss how hatcheries present in the basin may be expected to have, or not have, negative effects that might compromise the success of the reintroduction effort.*

**Authors’ Response:**

In recent years, the upper Clackamas River above North Fork Reservoir is managed for wild fish only, except for the annual release of catchable rainbow trout in the North Fork Reservoir. The fishery surrounding planted trout in North Fork Reservoir could increase the mortality of adult bull trout using the reservoir for foraging, even if caught and released. Hatchery trout could also serve as an additional food source for bull trout. There is no longer a riverine hatchery trout stocking program in the primary portion of the watershed in which the authors expect bull trout to spawn and rear. In addition, no hatchery anadromous

salmonids are passed above North Fork Reservoir into the upper Subbasin. In short, the authors do not believe that hatchery operations in the Clackamas will have any measurable negative effects on a bull trout reintroduction effort. Potential disease issues were addressed above on Page 22 under a previous comment.

## **Chapter 5 – Summary**

**IMST Comment:** *p. 108. Add another bullet: Indicate whether or not there is sufficient habitat to support one or more populations of 500 adult bull trout.*

### **Authors’ Response:**

The authors are not aware of any information quantifying the amount of habitat needed to support a population of 500 bull trout. While the authors believe there is a substantial amount of suitable spawning and rearing habitat available in the Upper Clackamas River, they do not know whether it is enough to support a population of 500 adults.

**IMST Comment:** *p. 109. Briefly and precisely describe what constitutes a self-sustaining local population of bull trout. Provide number of adults, key habitat complexes, catchment area, and drainage volume.*

### **Authors’ Response:**

The authors agree that the Assessment needs to better define a self-sustaining local population of bull trout. This issue was discussed above on Page 6. Again, the authors’ intent is to be consistent with the usage of “population” and “local population” in the U.S. Fish and Wildlife Service’s Draft Bull Trout Recovery Plan. The authors are unaware of information quantifying the amount of habitat, catchment area, and drainage volume needed to support a bull trout population.

**IMST Comment:** *p. 110. If brook trout are already established in the upper Clackamas, briefly explain why they are assumed to be an insignificant factor for bull trout, given that they are a significant factor elsewhere.*

### **Authors’ Response:**

This comment was addressed earlier under a General IMST Comment made on Chapter 4.

**IMST Comment:** *p. 111. Adaptive management and the success of past reintroductions have been discussed, but the negative impacts on donor stocks have not been thoroughly addressed. For example, see tables on bull trout population status and the apparent reduction in Anderson Creek (McKenzie) stocks associated with Middle Fork Willamette introductions (pp. 135 & 136).*

### **Authors’ Response:**

The authors dedicated a significant portion of the draft Assessment (Chapter 3) to addressing donor risk and thus they do not believe it needs to be addressed further in Section 5.3. In the case of the McKenzie River bull trout population, there are no data to support or refute the notion that fry removal (to the Middle Fork Willamette) is or is not contributing to a decline in adult spawners in the McKenzie.

**IMST Comment:** *The potentially limiting factors are believed to be remedied. Indicate precisely what has been remedied in the upper Clackamas as regards harvest, habitat, brook trout, and dam/road barriers.*

**Authors' Response:**

The Clackamas River above North Fork Dam is now managed by ODFW as a catch and release fishery only and with a limited fishing season to protect native fish species from harvest. Also, all hatchery salmonids (fin clipped) are sorted at North Fork Fish Ladder and are not allowed to pass upstream. The upper subbasin is managed as a wild fish sanctuary.

With the advent of the Northwest Forest Plan in 1994, riparian reserve protections were implemented on all intermittent and perennial streams on National Forest land in the Clackamas River Subbasin. Riparian reserves are managed for late successional old growth development and enhancement and to protect all fish habitat. Where earlier decades sometimes saw complete harvest of riparian tree cover in harvest units, such activity is now prohibited. Existing older riparian forest is protected under the Northwest Forest Plan and younger previously harvested riparian forest is managed for promotion of late seral forest characteristics. With less emphasis on regeneration harvesting of timber stands, many existing roads are now superfluous and are being obliterated and returned to a vegetated condition. In the late 1990s, over 100 miles of logging road were obliterated and revegetated in the Fish Creek drainage alone. This work continues today.

Regarding dam/road barriers, PGE just recently completed a new, state-of-the-art fish ladder on its River Mill Dam on the Clackamas River as stated previously. This replaced an antiquated, 1911 era fish ladder that was believed to delay anadromous fish passage. Additional upstream and downstream fish passage improvements have been identified in the current relicensing effort underway with PGE for its Clackamas River hydroelectric facilities. The U.S. Forest Service has also replaced most of the anadromous fish passage barriers on Forest roads in the last decade with fish-friendly culverts (e.g., open-bottom arch culverts). Perhaps four additional anadromous range culverts need replacing and these are lesser priority sites that are planned for replacement – all of which occur on streams in other portions of the Subbasin different from those identified as suitable bull trout spawning and rearing habitat.

The IMST comments pertaining to brook trout competition and hybridization were addressed previously under the authors' responses to General IMST Comments for Chapter 4.

**IMST Comment:** *Add a ninth factor to the first list of bullets: Quantitatively determine the fish prey base and compare it with the prey base sustaining putatively healthy bull trout populations such as those in the Metolius and Lewis systems.*

**Authors' Response:**

See the authors' previous response above on Page 29 regarding prey base. The authors do not believe it necessary to conduct a comprehensive "prey base" analysis in the Clackamas River should a reintroduction be pursued. The authors are aware of the prey base information that has been collected in Lake Billy Chinook (Metolius bull trout), but are unaware of any such information for the Lewis River system.

**IMST Comment:** *Alter the third bullet in the second list: Evaluate the possibility of hybridization, competition, and predation with brook trout, as well as the extirpation of brook trout.*

**Authors’ Response:**

IMST comments pertaining to brook trout competition and hybridization were addressed previously under the authors’ responses to General IMST Comments for Chapter 4.

**IMST Comment:** *p. 112. For emphasis, list the reintroduction plan phases as bullets versus paragraph text. IMST supports expanding and detailing this information should a recovery plan result from this Assessment.*

**Authors’ Response:**

The authors will make the suggested revision in the final Assessment.

**IMST Comment:** *Add explicit mechanisms for sharing knowledge learned about proposed bull trout reintroductions in the Clackamas with scientists planning or conducting bull trout reintroductions elsewhere.*

**Authors’ Response:**

The authors will add a paragraph stating their intent and desire to share “knowledge learned,” as they strongly hope this effort can be used as a future template for appropriate investigation of reintroduction. However, the authors believe the explicit “sharing” mechanisms would be better suited in a future reintroduction proposal or implementation plan should the effort be pursued.

**Appendix A – A Decline of Bull Trout in the Western United States: Causes for Decline of Bull Trout**

**IMST Comment:** *p. 113. Retitle to: Causes for Decline of Bull Trout in the Western United States*

**Authors’ Response:**

This comment will be incorporated into final Assessment.

**IMST Comment:** *p. 114. It is very important to assess upriver and downriver adult passage past dams multiple times.*

**Authors’ Response:**

This comment is addressed above on Page 11.

**IMST Comment:** *p. 116. Provide the road density of the Swan River basin.*

**Authors’ Response:**

The authors do not understand the relevance of including this information in the final Assessment.

## **Appendix B – Hypothesis for Local Extirpation**

**IMST Comment:** *p. 127. Indicate the amount and location of private forest land on the appropriate tables and figures.*

**Authors' Response:**

The authors cannot find the above reference tables and figures on or close to Page 127 of the draft Assessment. A breakdown of land ownership within the Clackamas River Subbasin is provided in the authors' response to an IMST Comment above on Page 33.

## **Appendix C – Population Characteristics of Potential Donor Stocks**

**IMST Comment:** *p. 135-136. Emphasize that propagule removal was associated with marked declines in the number of redds of the donor population.*

**Authors' Response:**

There are no data to support or refute the notion that fry removal (to the Middle Fork Willamette) is or is not contributing to a decline in adult spawners in the McKenzie.

## **Appendix D – Overview of Reintroduction Strategies: Artificial Propagation, Captive Rearing, and Transplantation.**

**IMST Comment:** *p. 153. Emphasize that propagule removal was associated with marked declines in the number of redds of the donor population.*

**Authors' Response:**

See authors' response to preceding IMST comment.

## **Editorial Comments**

**Authors' Response to all IMST Editorial Comments:**

The authors appreciate the extra time IMST members took to note suggested editorial changes. The authors will take these into consideration when finalizing the Assessment to improve its overall clarity and presentation.