U.S. Fish and Wildlife Service

Bull Trout Recovery Planning Activities

FY 2011 and 2012 Progress Report

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On the cover: *In Bighorn (Ram) Creek, in the Wigwam River drainage of British Columbia, the threatened bull trout complete their 50-mile cross-border international spawning migration from Lake Koocanusa in the Kootenai River drainage in Montana. National Geographic Stock photograph by Joel Sartore with Wade Fredenberg.*

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Abstract – During the 2011 and 2012 fiscal years, the Columbia River Fisheries Program Office (CRFPO) participated in planning and preparing the revised Draft Bull Trout Recovery Plan. The first draft Bull Trout Recovery Plan was completed in 2002 – 2004; however, bull trout recovery planning activities were placed on hold until bull trout critical habitat was finalized. Due to the need for improved recovery criteria and updated information, the bull trout Board of Directors determined that a new draft recovery plan was needed. CRFPO staff participated on the Bull Trout Technical Team and provided technical assistance for finalizing core area delineations and developing a recovery strategy and criteria. CRFPO proposed using the NatureServe status assessment tool, in conjunction with the recovery principles of resiliency, redundancy and representation, to develop a viability rule set by which individual recovery units could be assessed for viability as a function of threats and demographic criteria. CRFPO also provided scientific justification and rationale for this approach to the Board of Directors. Additionally, CRFPO assumed the lead for the Mid-Columbia Recovery Unit (MCRU) and worked with state and local partners within the region to update information about bull trout populations and core areas. The MCRU lead then took information gathered from across the recovery unit and compiled it in a MCRU chapter for the revised draft recovery plan. The Bull Trout Technical Team is currently waiting for guidance from the Board of Directors on how to move forward with developing the revised Draft Bull Trout Recovery Plan. Specifically, there is a need for a bull trout coordinator to organize the plan's development and monitor progress, and for the Board of Directors to provide detailed information regarding remaining concerns about the proposed recovery strategy. While a significant amount of progress had been achieved between Sept. 2010 and April 2012, guidance from the Board of Directors will be necessary to move forward and complete the revised Draft Bull Trout Recovery Plan.

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Introduction

Bull trout (*Salvelinus confluentus*) are a char species that historically inhabited streams, rivers and lakes in Oregon, Washington, California, Nevada, Idaho and Montana. These fish require relatively pristine habitat that is cold, clean, complex and connected. Primary threats to bull trout include habitat degradation and fragmentation, reduced fish passage, decreased water quality, non-native species such as brook and lake trout, climate change, and overharvest. Because of these threats, bull trout were listed as threatened under the Endangered Species Act throughout their coterminous U.S. range in 1999 (64 FR 58910).

The U.S. Fish and Wildlife Service (Service) published a draft recovery plan for the Klamath River, Columbia River and St. Mary Belly River Distinct Population Segments (DPS) in 2002, which included an introductory chapter and 24 additional chapters that divided the three DPS's into recovery units (67 FR 71439). For the Columbia River DPS, the Columbia River Fisheries Program Office (CRFPO) had lead responsibility for approximately 10 recovery unit chapters. These included, for examples, the Imnaha, Grande Ronde, Umatilla, Lower Columbia and Middle Columbia. In addition, CRFPO made substantial contributions to Chapter 1, specifically concerning the need for rigorous monitoring and evaluation necessary to assess recovery. Finally, CRFPO also shared GIS and map-making responsibilities associated with the Draft Recovery Plan. Draft recovery plans for the Coastal-Puget Sound and Jarbidge River DPS' were published in 2004 (69 FR 39950). All draft recovery plans were released for public comment and scientific peer review. Finalization of the draft plans was delayed by the need to complete a 5-year review (USFWS 2008) and revise the designation of bull trout critical habitat (75 FR 63898).

The goal of the Columbia River Fisheries Program Office's involvement in the bull trout recovery planning process is to ensure that the completed final bull trout recovery plan is technically sound, scientifically defensible, and will benefit the recovery needs of bull trout. To accomplish this goal, the CRFPO has two objectives: 1) provide technical assistance as part of the Bull Trout Technical Team during the recovery planning process, and 2) lead the development of the Mid-Columbia Recovery Unit recovery plan chapter. This progress report describes the activities of CRFPO during FY 2011-2012.

Relationship to the Fisheries Program Strategic Plan

Implementation of this project demonstrates application of the Pacific Region's 2009-2013 Fisheries Program Strategic Plan. The following National goals (NG) and Regional objectives (RO) have been addressed by this project:

NG1 Open, interactive communication between the Fisheries Program and its partners.

- RO1.1 Develop and maintain relationships with partners throughout the Pacific Region.
- RO1.2 Implement a means of providing feedback to ensure the long-term success of partnerships.

NG3 Self-sustaining populations of native fish and other aquatic resources that maintain species diversity, provide recreational opportunities for the American public, and meet the needs of tribal communities.

- RO3.1 Collaborate with Ecological Services (ES) Program, National Oceanographic and Atmospheric Administration Fisheries (NOAA Fisheries) and others, to recover fish and other aquatic resource populations protected under the ESA.
- RO3.2 Maintain healthy, diverse, self-sustaining populations of fish and other aquatic resources
- RO3.3 Support the research and fish culture needed to prevent listing or to recover native species listed or proposed for listing under ESA.

NG9 Science developed and used by Service employees for aquatic resource restoration and management is state-of-the-art, scientifically sound and legally defensible, and technological advances in fisheries science developed by Service employees are available to partners.

- RO9.1 Develop and share state-of-the-art, scientifically sound, legally defensible scientific and technological tools, including databases, with other Service programs and in conjunction with our partners.
- RO9.2 Use state-of-the-art, scientifically sound, legally defensible scientific and technological tools in formulating and executing fishery-related plans and policies.

Study Area

Bull trout are listed as federally threatened under the Endangered Species Act throughout their range in the United States. In 1999, the five coterminous DPS's (Coastal/Puget Sound, Klamath River, Columbia River, Jarbidge River Basin, and St. Mary/Belly River) were combined into one DPS (USFWS 1999). However, in that final rule, the Service stated "In recognition of the scientific basis for the identification of these bull trout population segments as DPS's, and for the purposes of consultation and recovery planning, we will continue to refer to these populations as DPS's. These DPS's will serve as interim recovery units in the absence of an approved recovery plan." In the 2008 Five-Year Review for bull trout (USFWS 2008), however, the Service listed several advantages of designating multiple bull trout DPS's within the coterminous United States, and recommended evaluating designation of multiple bull trout DPS's. Further, the Service recommended developing "a number of Recovery Units for bull trout (perhaps 5 to 10 for management purposes) that contain assemblages of core areas that retain genetic and ecological integrity, and allow potential future options to pursue regulatory relief/delisting on a recovery unit basis." Thus, each recovery unit is made up of a number of core areas, which are a collection of one or more local populations. If a core area has more than one local population, the core area can be seen as a metapopulation (see Figure 1 for an example).

By 2011, six bull trout recovery units were identified within the single coterminous bull trout "DPS": Coastal, Klamath, Mid-Columbia, Upper Snake, Columbia Headwaters, and St. Mary/Belly (Figure 2). Bull trout within each of these recovery units are currently believed to share a common evolutionary legacy and future which suggests there may ultimately be an opportunity to reclassify them into DPS's. As will be explained later in this report, CRFPO was designated as the lead for the Mid-Columbia Recovery Unit (Figure 3). The Mid-Columbia Recovery Unit was subsequently divided into five geographic regions (Figure 1) to better organize the Mid Columbia's recovery plan chapter, and ensure that adequate representation, resiliency, and redundancy was captured throughout the recovery unit. The five geographic regions are: 1) Lower Mid-Columbia (all core areas downstream from the confluence of the Columbia and Snake Rivers, including the John Day core areas), 2) Upper Mid-Columbia (all core areas on the Columbia River upstream of the confluence of the Columbia and Snake Rivers), 3) Lower Snake (all core areas (excluding those in the Clearwater Basin) on the Snake River between Hells Canyon Dam and the confluence of the Columbia River), 4) Clearwater (all core areas on the Clearwater River), and 5) Mid-Snake (all core areas above Hells Canyon Dam and below the confluence of the Snake and Burnt Rivers).

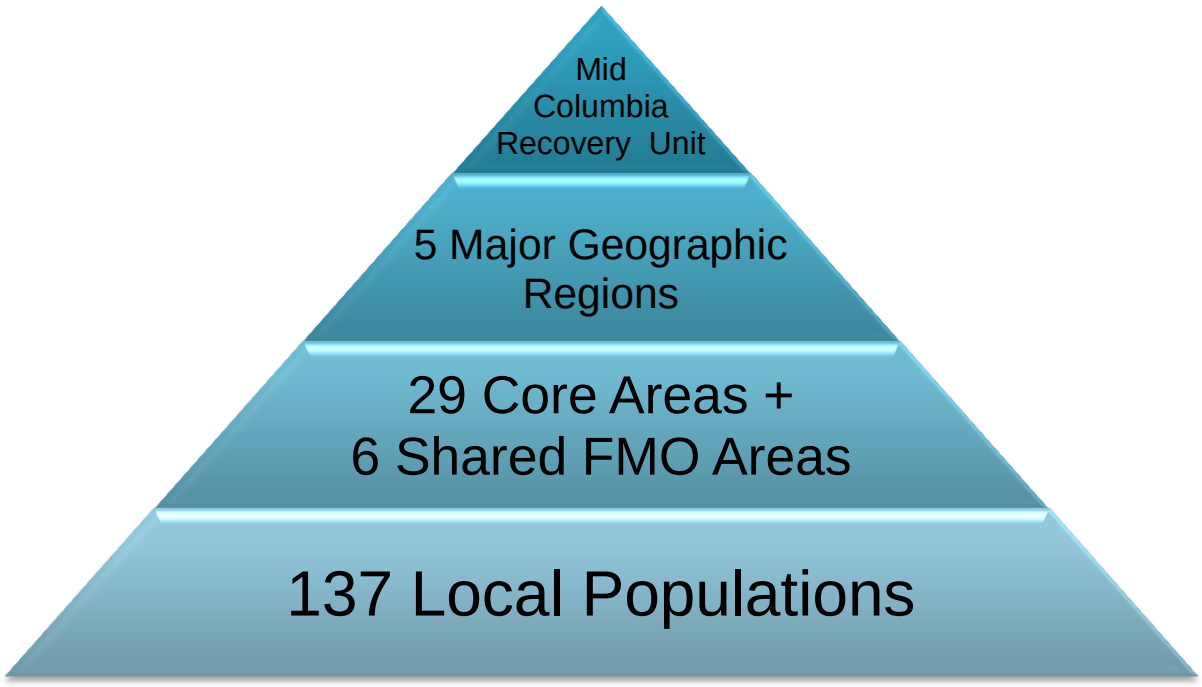

Figure 1. Hierarchical relationship of bull trout geographic classification units within the Mid-Columbia Recovery Unit. The 29 core areas include two unoccupied historic core areas, along with two unoccupied research needs areas.

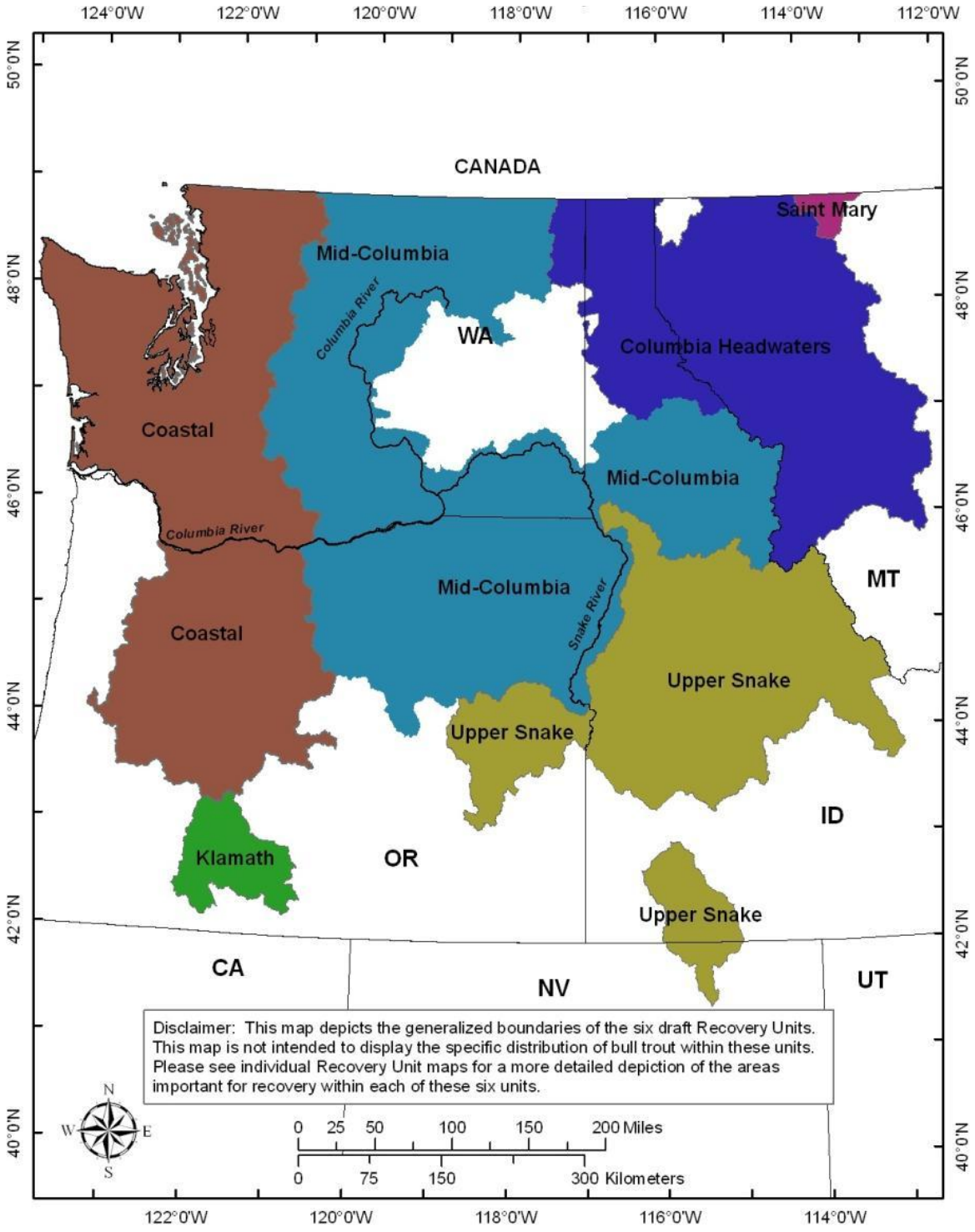

Figure 2. The six bull trout recovery units in their coterminous range within the U.S.

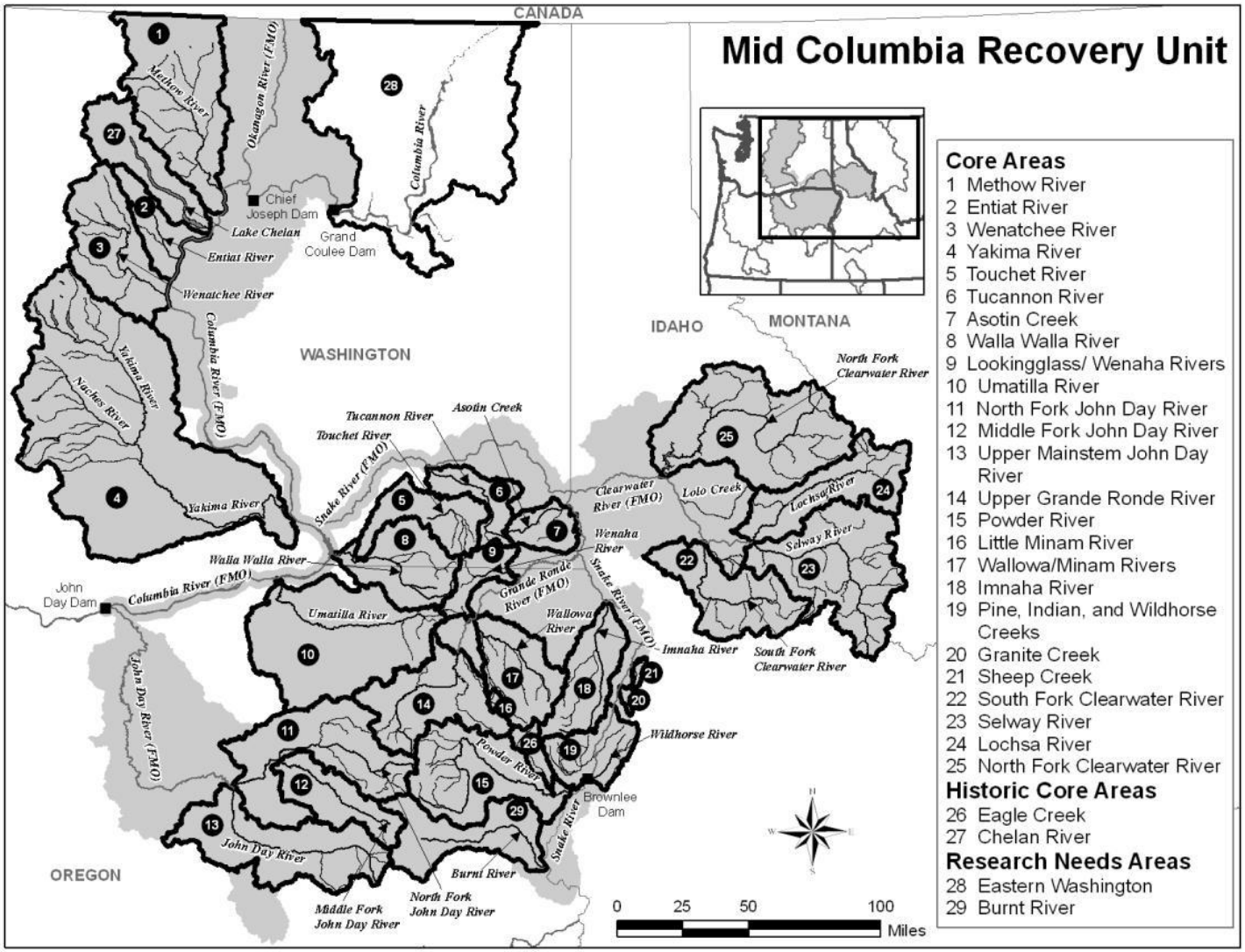

Figure 3. The Mid-Columbia Recovery Unit with core areas, historic (unoccupied) core areas, and research needs areas.

Methods

At the start of the 2011 fiscal year, the Service and the Bull Trout Technical Team ("BTTT") resumed recovery planning for bull trout following completion of most of the work required to finalize the revised critical habitat for bull trout. Primary needs for the recovery plan were to 1) finish delineating core areas, develop a recovery strategy and recovery criteria, and 2) revise the draft recovery plan, which would include one introductory chapter and six recovery unit chapters.

Objective 1 - Provide technical assistance during the bull trout recovery planning process

The BTTT is comprised of members from several Ecological Service offices and led by a bull trout coordinator. Staff from CRFPO (M. Koski and T. Whitesel) are the only Fisheries representatives on the BTTT and are there to provide technical assistance and ensure that the recovery plan is scientifically sound. Additionally, CRFPO staff serve as liaisons between the BTTT and the Bull Trout Recovery Monitoring and Evaluation Technical Group (RMEG). RMEG is chaired by USFWS fisheries technical staff and is comprised of 14 multi-agency members who are knowledgeable in population dynamics, char biology, field studies, biometrics, and experimental design (USFWS 2008). The tasks of RMEG are to: "1) summarize bull trout monitoring and evaluation needs, 2) review analytical methods of characterizing bull trout population and habitat status, 3) increase the utility of current data collection for recovery planning, 4) direct and prioritize future monitoring efforts associated with bull trout recovery, 5) develop and standardize design elements, and 6) foster coordination among monitoring programs" (USFWS 2008).

During FY 2011 and 2012, the BTTT had regular conference calls (approximately every two weeks) and several meetings (Table 1). Meetings were held to discuss the bull trout recovery planning process as a whole; identify critical tasks and methods needed to complete the recovery plan; and review current status, upcoming deadlines and goals. Specific aspects of tasks were usually addressed during conference calls, in addition to keeping BTTT members on schedule with assigned projects. Generally, the tasks assigned to the BTTT during these two years were to finalize core area delineations, develop a recovery strategy, and develop recovery criteria, along with drafting the recovery plan. The bull trout coordinator was responsible for writing the introductory chapter, explaining the recovery strategy and criteria developed by the BTTT, and Tech Team members were responsible for their respective Recovery Unit chapters.

Table 1. Bull Trout Tech Team and/or Board of Directors meetings held during FY 11-12.

Date, Location	Attending	Meeting purpose and key decisions
Oct. 8, 2010; Portland, OR	BOD	Identify bull trout recovery planning needs and an approach to meet them. Decided that using NatureServe, threats-based and demographic criteria are appropriate. Focus should be on establishing criteria; develop in-house, go to partners for feedback. Publish complete final recovery plan by April 15, 2012.

Date, Location	Attending	Meeting purpose and key decisions
Dec. 7-8, 2010; Spokane, WA	BTTT	Determine necessary tasks for each RU lead to complete draft recovery plan by May 1, 2011. Reviewed current activities and timelines for RMEG, and identified changes in delineating several uncertain core areas. Also discussed recovery unit criteria; threats- and demographics-based criteria were to be developed for each core area, and each core area would be evaluated using NatureServe scores and "percent of potential".
Nov. 28-30, 2011; Portland, OR	BTTT	Agree on recovery strategy details and further develop recovery criteria. Determined that threats- and demographics-based "targets" would be identified for all core areas, and would then somehow be rolled up to RU level recovery criteria. Much discussion regarding the use of NatureServe as the means to assess recovery; CRFPO staff led presentation on how Nature-Serve recovery criteria could be developed for the Mid-Columbia RU. Briefly went through other RUs; the rest of the BTTT seemed supportive of the approach, although details needed to be refined.
Jan. 12, 2012 Webinar	BOD and partial BTTT	After a conference call with the BOD (Dec. 20, 2011) during which the BTTT introduced the use of a rule set and NatureServe to assess recovery, the BOD requested more detailed information about NatureServe and its proposed use during a webinar. T. Whitesel, M. Koski and H. Schaller gave a presentation that outlined the previous and proposed use of NatureServe, using the Mid-Columbia RU as an example.
Feb. 15-16, 2012 Boise, ID	BTTT and Brian Kelly	Determine process for developing recovery criteria. The BTTT met with B. Kelly and discussed his proposed framework for recovery criteria, using the Upper Snake RU as an example. The BTTT was uncomfortable with the possibility that core areas with poor status may receive little attention. Members of the BTTT provided B. Kelly with background on the use of NatureServe in the five year review process, and presented again the viability rule set (described in sections b and c below), and how NatureServe is simply used to assess CA status; the rule set applies to the RU. Generally, B. Kelly supported the use of NatureServe, but had some unresolved questions. He tasked the BTTT with writing a one-page briefing paper to describe the rule set and flowchart for the process.
Feb. 22-24, 2012 Portland, OR	BTTT and BOD call-in	Develop briefing paper on the rule set and NatureServe status assessment for the BOD per B. Kelly's request. Discussed the viability rule set and supplemental information (i.e., definitions, details) in depth and developed recovery criteria for each recovery unit using the rule set.
April 10-11, 2012 Portland, OR	BOD and BTTT	BTTT presented the recovery strategy and criteria, and underlying rationale, to the BOD and answered questions about the viability rule set. The BOD agreed that the approach was valid; the BTTT was directed to finish the justification and rationale for the rule set and provide to S. Grunder for integration

Date, Location	Attending	Meeting purpose and key decisions
		into the recovery strategy.
April 24, 2012 Portland, OR	Partial BTTT and NatureServe	H. Schaller, C. Luzier, T. Whitesel and M. Koski met with Bruce Young and Margaret Ormes of NatureServe to present the use of the NatureServe CA status assessment to evaluate the status of recovery units. They agreed that the CA is the proper scale to use, and stated that the rule set incorporates the principles of biodiversity and metapopulation theory.

a) Core area delineation

The 2002 Draft Bull Trout Recovery Plan (USFWS 2002) defines a core area as "the combination of core habitat and a core population constituting the basic unit on which to gauge recovery. A core area represents the closest approximation of a biologically functioning unit for bull trout." The delineation of certain core areas had a relatively high degree of uncertainty. In FY 2010-2011, W. Fredenberg proposed a screening selection to delineate core areas, a process that asked several questions for core areas (specifically for the uncertain ones) concerning: 1) barriers to migration, 2) genetics, 3) life history strategy, and 4) common sense. CRFPO and RMEG reviewed the approach to determine whether the screening process would adequately define core areas. The review included documenting criteria that were used previously to delineate core areas, analyzing how sensitive the NatureServe approach was to lumping or splitting core areas, providing feedback on an overall rule set to consistently delineate core areas, and specifically evaluating the uncertain core areas. By April 2012, core area delineations were finalized.

b) Recovery strategy development

Upon completing core area delineations, efforts shifted towards developing a recovery strategy for the recovery units. In FY2011, the BTTT worked with partners to identify the primary threats and demographic targets for each core area (henceforth referred to as "core area targets"), including historic core areas, research needs areas, and FMO habitat shared between core areas. Initially, all threats-based targets were categorized as "must-do" to reach recovery for the recovery unit. However, because it may not be realistic to address all primary threats, a proposal was put forth that 75% of core areas had to reach threats- and demographics based targets. The rationale behind this was based on common sense and professional judgment.

The parallel issue of how to assess core area status was also initially addressed at this time. NatureServe (NatureServe 2009) was used during the 5-Year Review process to assess each core area by ranking various demographic and threat categories (Table 2). Each core area received a score ranging from 0 to 5. These scores are dimensionless numbers and represent relative risk (5 highest risk, 0 lowest risk). By the convention used through NatureServe the risk associated with a 5 could be viewed as a secure core area whereas the risk associated with a 0 could be viewed as a critically imperiled core area (Table 3). Using the core area data from the 5-Year Review, the BTTT set threat scope and severity to "insignificant" and set population trend to "stable", resulting in one

possible, and hypothetical "maximum potential" NatureServe score for the core area. Dividing the 2008 NatureServe score by the maximum potential score yielded the percent of maximum potential for each core area. It was hoped that the percent of maximum potential could be used as a measuring stick by which to gauge recovery in a relative sense among core areas. However, determining the maximum potential of a core area may not rely solely on threats being minimized and population trend stabilizing; i.e., the maximum potential score may not be realistic, or indicative of a healthy, self-sustaining bull trout population in reality.

Table 2. NatureServe elements used to calculate core area status.

NatureServe Element	Lowest / Imperiled Category	Highest / Secure Category
Environmental Specificity[1]	A: Very narrow. Specialist species or ecological community with key requirements scarce.	D: Broad. Generalist species or ecological community with all key requirements common.
Linear Distance of Occupancy[2]	A: < 4 km	H: > 200,000 km
Number of Local Populations[2]	A: 1-5	E: > 300
Population Size (# of Adults) [2]	A: 1-50 individuals	H: > 1,000,000 individuals
Proportion of Area in Good Condition	A: No area with excellent or good viability or ecological integrity.	F: Excellent proportion (> 40%) of area with good viability or ecological integrity.
Short-Term Trend (the longer of the 10 past years or three generations)	A: Severely declining (decline of > 70% in population, range, area occupied, and/or number or condition of occurrences).	F = Increasing (increase of > 10%).
Threat Scope	High: > 60% of total population, occurrences, or area affected.	Insignificant: < 5% of total population or area affected.
Threat Severity	High: Loss of species population (all individuals or essentially irreversible destruction of habitat (> 100 years for recovery).	Insignificant: Essentially no reduction or degradation due to threats, or able to recover quickly from minor temporary loss (within 10 years).

[1] For bull trout, all core areas used a value of B = Narrow (specialist species or ecological community with key requirements common).
[2] For each of these elements, the lowest category could also be extinct (X) or zero (Z).

Table 3. NatureServe status assessment scores and risk status for core areas.

Calculated Rank Score	Risk Category Number	Risk Status
<= 1.5	S1	critically imperiled
1.5 < calculated value <= 2.5	S2	imperiled
2.5 < calculated value <= 3.5	S3	vulnerable
3.5 < calculated value <= 4.5	S4	apparently secure
Calculated value <= 4.5	S5	secure

Subsequently, the BTTT was directed by the BT Coordinator to calculate a single recovery-unit-level NatureServe score to compare the status of recovery units with each other. However, several BTTT members indicated that these recovery-unit scores may be artificially inflated (or misleading) because they didn't incorporate connectivity or geographic complexity within recovery units; inputs were simply additive (e.g., population size, number of local populations) or averaged (e.g., trend, threats).

Ultimately, staff at CRFPO proposed an alternative way of using NatureServe core area assessments and integrating this information to evaluate the status of the recovery unit. Essentially, the recovery unit had to have adequate spatial representation by a sufficient number of complex core areas (core areas with more than one local population) to ensure the three R's: resiliency, redundancy, and representation. CRFPO took the lead in drafting a briefing paper that was sent to the lead office for bull trout recovery planning (B. Kelly at the Idaho Fish and Wildlife Office), which included the relationship of a proposed recovery unit "viability rule set" to the three R's, and a flowchart that describes the steps a recovery unit would take to achieve a biologically viable condition. Although a recovered condition and delisting decision may require additional regulatory analysis, for a recovery unit to achieve a recovered condition it was considered necessary for the recovery unit to be biologically viable (Appendix A). The result of this strategy was the viability rule set, which was then applied to each recovery unit.

c) Recovery criteria development and justifications

The BTTT was directed to generate SMART recovery criteria for each recovery unit; i.e., criteria that was Specific, Measurable, Achievable, Realistic and Time-referenced. The proposal by CRFPO and subsequent development of the viability rule set generated SMART goals by which to gauge the recovery of recovery units. Recovery criteria were developed by tailoring the rule set to each recovery unit; i.e., applying the rule set to each recovery unit to determine if recovery could be achieved. The rule set provided for a number of possible ways in which each recovery unit could achieve recovery, maintaining flexibility in the application of recovery criteria.

In addition to the rule set, the BTTT was directed to provide a justification document to the lead bull trout office (B. Kelly) that provided the scientific rationale behind the rule set and its application to recovery units as recovery criteria. CRFPO staff, in addition to

three other members of the BTTT, crafted this justification paper and submitted it to the bull trout coordinator on May 3, 2012 per the direction of B. Kelly.

Objective 2 – Lead development of the Mid-Columbia Recovery Unit recovery plan chapter

a) Core area summary development

In June 2011, the Oregon Fish and Wildlife Office (OFWO) requested that CRFPO assume the lead responsibility for managing the Mid-Columbia Recovery Unit (MCRU) due to workload issues. CRFPO agreed to become the lead for the MCRU with assistance from staff at OFWO (Appendix B).

Generally, the CRFPO MCRU lead was responsible for gathering, organizing and assimilating information from across the recovery unit and incorporating the information into the MCRU Recovery Plan chapter, which was also drafted by the MCRU lead. Within the MCRU, various staff were responsible for meeting with recovery planning partners and providing the MCRU lead with information about their core areas (Appendix B): B. Strief was responsible for all Oregon core areas within the MCRU, B. Matibag was responsible for all Idaho core areas, J. Neibauer was responsible for Upper Mid-Columbia core areas in Washington, and M. Koski was responsible for the Umatilla, Walla Walla, Touchet, Toucannon and Asotin Creek core areas. M. Koski met with partners in her respective core areas in La Grande July 20-21, 2011. The information collected from the core area leads was then assimilated into core area summaries containing information about the current status of local populations within the core area, along with primary threats and demographic needs (i.e., the core area targets).

b) MCRU viability rule set and recovery criteria

After information for the core areas within the MCRU was updated (by talking with partners and reviewing other available information), the current and "potential" status of each core area was calculated using NatureServe, as described above. An overall NatureServe status score was also calculated for the entire MCRU by estimating each NatureServe input for the entire recovery unit.

Next, the viability rule set was applied to the MCRU to determine whether the recovery unit could achieve a recovered state, as defined by the recovery criteria. While there were many possible ways recovery could be achieved, one possible way was to start with baseline core area scores, then recalculate NatureServe scores with threats removed. For core areas that did not meet the viability rule set, a demographic response was applied by first increasing the population size by one NatureServe category, then increasing the number of local populations by one category, and/or then increasing the distribution by one category if necessary.

c) MCRU Recovery Plan chapter

Differing from the 2002-2004 Draft Bull Trout Recovery Plan, the revised draft was to include an introductory chapter with six subsequent chapters, one for each recovery unit. The CRFPO MCRU lead was responsible for drafting the MCRU chapter. This included updating and

combining information found in the applicable previous draft recovery plan chapters (i.e., management units), incorporating core area targets and summaries, and updating the implementation schedule for recovery actions. These updates and additions to the MCRU chapter relied heavily on information provided to the MCRU lead by the core area leads.

Results

Objective 1 - Provide technical assistance to the bull trout recovery planning process

a) Core area delineation

After reviewing and applying core area screening guidelines, the BTTT and RMEG finalized a total of 109 core areas in six recovery units. Previously (see USFWS 2012), approaches to delineating 118 core areas had been discussed in the draft recovery plan (USFWS 2002), various recovery unit chapters (USFWS 2002). In general, the delineations depended on professional judgment and the specifics of the approach were not clear. In addition, the Science Team report (Whitesel et al. 2004) provided a conceptual discussion on delineating core areas. Changes to core area delineation can influence recovery unit status assessments (Figure 4, USFWS 2012). Until a consistent approach is available, it seems prudent to consider the risk associated with improperly delineating core areas. In terms of risk management, it may be more conservative to make the error of dividing one metapopulation into multiple core areas than to combine different metapopulations into one core area (USFWS 2012). Building from

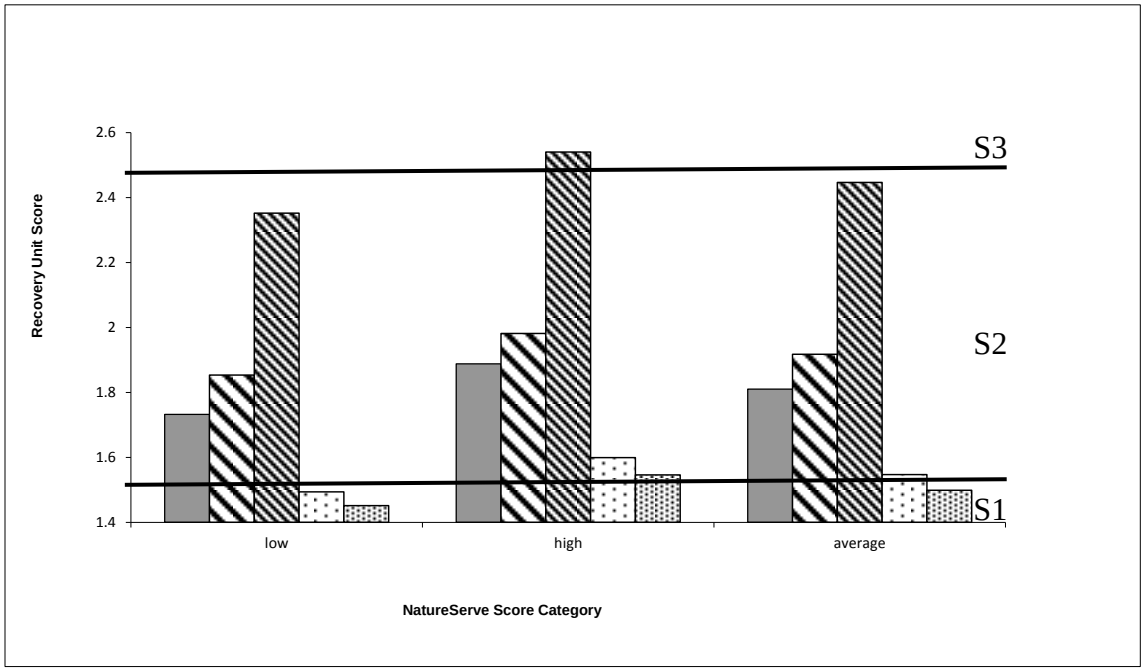

Figure 4. The potential impact to the Mid-Columbia Recovery Unit status assessment from combining or dividing existing core areas. Scores are derived from the NatureServe assessment approach and are relative measures. Recovery Unit scores are the mean of core area scores. The NatureServe assessment approach yields a low and high score category, which was also averaged. S1, S2 and S3 are NatureServe ranks. = original core areas, = minor combination, = major combination, = minor division, = major division.

Fredenberg's, a potential screening process was proposed to help delineate core areas consistently (USFWS 2012). "Fuzzy" core areas and their ultimate delineation was also discussed (USFWS 2012).

b) Recovery strategy development

The development of the recovery strategy for bull trout took several turns, but the BTTT ultimately decided to employ the NatureServe status assessment tool to gauge recovery in core areas, and ultimately, recovery units. To begin, viable local bull trout populations are necessary for viable core areas, which in turn are necessary for viable recovery units. To achieve a viable recovery unit, threats to bull trout must be identified and addressed to improve conditions for bull trout. Subsequently, a measurable demographic response should be observed as evidence that bull trout have responded to changes in their environmental conditions. The proposed viability rule set integrates well-vetted information from recent (2008-2012) core area status assessments into an assessment of recovery unit viability. First, core areas within a recovery unit must achieve a level of stability and attain a stability threshold (thus maintaining representation and redundancy). Second, certain core areas should serve as strongholds to support core areas in the rest of the recovery unit in the face of environmental or population stochastic change (thus maintaining representation and resiliency). Whether a recovery unit is composed of core areas that meet these conditions allows for the evaluation of whether the recovery unit is biologically viable and likely to persist into the foreseeable future. The strength of this process is that it is SMART (specific, measurable, achievable, realistic, and time-referenced), it is related to the principles of representation, redundancy, and resiliency, and it is technically sound and biologically defensible. At the point when a recovery unit is deemed to be in a viable condition, it may have achieved a recovered condition. The viability rule set is as follows:

Viability Rule 1—Half (50%) of the extant simple core areas in a recovery unit should achieve the *stability threshold* (represented by a NatureServe score of 2.5).

Viability Rule 2—All (100%) of the extant complex core areas in a recovery unit should achieve the stability threshold (represented by a NatureServe score of 2.5).

Viability Rule 3—At least one complex core area in each major geographic region of a recovery unit should achieve the stronghold threshold (represented by a NatureServe score of 3.5).

It should be noted that on April 24, 2012, members of CRFPO met with NatureServe staff and shared the bull trout recovery strategy. NatureServe staff agreed that in this application, NatureServe was applied at an appropriate scale (for example, at the core area scale rather than the recovery unit scale), and that it seemed like a novel and appropriate use of the NatureServe status assessment (Table 1).

c) Recovery criteria development and justifications

Recovery criteria for all recovery units are based upon the application of the viability rule set to each individual recovery unit, in addition to the development of a post-delisting monitoring plan. CRFPO developed justifications for using the NatureServe scores of 2.5 and 3.5 as stability and stronghold thresholds in the viability rule set (Appendix C); other BTTT members developed the justifications for applying the stability threshold to 50% of simple core areas and 100% of complex core areas. See below for an example of an individual recovery unit's recovery criteria (i.e., the MCRU).

Objective 2 – Lead development of the Mid-Columbia Recovery Unit recovery plan chapter

a) Core area summary development

Each core area summary contains a geographic area description, list and description of the local populations in the core area, demographic information, and major threats. Core area targets (threat- and demographic targets) and core area summaries were completed for the Umatilla, Walla Walla, Touchet, Tuccannon, Asotin, and all Idaho core areas within the MCRU. To date, revised core area summaries and targets have not been received from B. Streif (Oregon core areas) or J. Niebauer (Upper Mid-Columbia core areas).

b) MCRU viability rule set and recovery criteria

NatureServe scores were updated for all core areas in the MCRU in early 2012 while compiling information from partners and core area templates for the core area summaries. This updated score, or "baseline" score is the starting point from which recovery will be measured. Recovery criteria were developed for the MCRU based on the viability rule set as follows:

Mid-Columbia Recovery Unit Recovery Criteria:

1. Core areas within the Mid-Columbia Recovery Unit meet a minimum standard of demographic and threat conditions:

    a) Across the Mid-Columbia Recovery Unit, 22 complex core areas meet the stability threshold (2.5) for attaining recovery unit viability.

    b) Across the Mid-Columbia Recovery Unit, at least 2 of the 3 simple core areas meet the stability threshold (2.5) for attaining recovery unit viability.

c) One core area in each of the five major geographic regions in the Mid-Columbia Recovery Unit (Lower Mid-Columbia, Upper Mid-Columbia, Clearwater, Lower Snake and Mid-Snake) achieves the stronghold threshold (3.5).*

2. A post-delisting monitoring plan is developed for the Mid-Columbia Recovery Unit.

* Core area status can be supplemented if connectivity exists with other core areas. Reestablished core areas (e.g., Chelan Basin or Eagle Creek historic core areas) with reintroduced populations may contribute to meeting criteria.

Following the viability rule set as a guide and using the baseline 2012 NatureServe scores as a starting point, an example route to recovery for the MCRU was developed (Appendix D, and summarized in Figure 4). First, threats were hypothetically removed for all complex core areas that had a baseline score below 2.5. For each major geographic region, a stronghold core area was identified (i.e., the core area having the highest NatureServe score once threats were removed). Next, demographic categories were changed until each stronghold core area achieved a score of 3.5. For complex core areas and half the simple core areas that still did not achieve 2.5 after removing threats, demographic parameters were changed until all complex core areas attained a NatureServe score of 2.5.

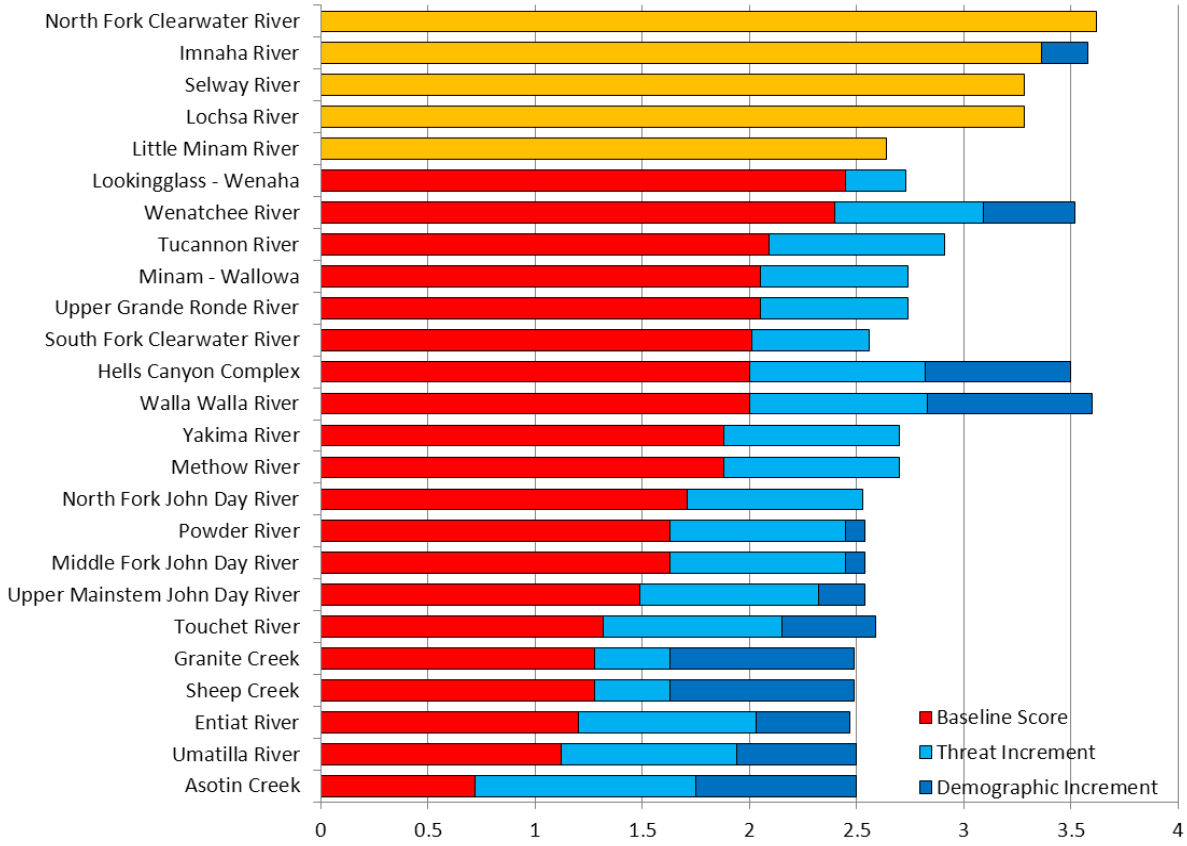

Figure 5. Mid-Columbia Recovery Unit core area status changes (NatureServe scores) by increment (threats removed and demographic response). Baseline scores above 2.5 are gold; baseline scores below 2.5 are red.

c) MCRU Recovery Plan chapter

A draft of the MCRU recovery plan chapter was submitted to T. Koch on October 4, 2011. However, revised and finalized core area summaries and targets were not included (still pending additional information). Since October, 2011, some revisions have been made to general sections of the MCRU chapter (e.g., introduction, demographics description, core area summaries and targets). However, to date, a recovery strategy has still not been approved, which is necessary to complete the chapter. Additionally, the finalization of core area summaries and targets is pending additional information from other BTTT biologists working on the MCRU. Without further direction and this additional information, further revisions to the MCRU recovery plan chapter have been postponed.

Conclusions

A great deal of progress was accomplished during FY 2011 and 2012 towards bull trout recovery planning, including delineating "fuzzy" core areas and developing a recovery strategy and recovery criteria that are SMART and incorporate the three R's. Use of the NatureServe status assessment tool to gauge current and future status of core areas throughout the coterminous range of bull trout provides a consistent method by which to assess recovery unit status when the viability rule set is applied. CRFPO was integral to developing the viability rule set, and the BTTT has applied this approach and recommended it to the BOD as a scientifically valid method for evaluating recovery consistently across the coterminous range of bull trout. Further, CRFPO took the lead in drafting several briefing and justification documents for the proposed reintroduction strategy for the BOD. CRFPO staff also took the lead in drafting the MCRU recovery plan chapter, working with regional leads within the MCRU to obtain information and organizing it for incorporation within the draft chapter.

The interim Bull Trout Recovery Coordinator's last day in position was May 4, 2012. No coordinator was named subsequently to facilitate continued progress. The BTTT is currently waiting for guidance from the BOD on how to move forward with the proposed recovery strategy and plan. The most recent conversation with the BOD occurred on August 22, 2012. It was apparent that the BOD still had questions and concerns about the recovery strategy and completion of the recovery plan. However, the specifics have not been provided to the BTTT. As such, the BTTT is waiting for further direction and guidance from the BOD on when and how to move forward with recovery planning.

Acknowledgements

The progress the BTTT was able to achieve during FY 2011-2012 could not have been possible without the dedicated work of all the BTTT members and support from the BOD. We are grateful for the help of David Hines (CRFPO) for help with mapping, and for our state and local partners for working with us to ensure that the most recent scientific information was available for recovery planning.

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Appendix A: Feb. 24, 2012 BOD Briefing Paper and Flowchart for BOD

Listing and Population Organization

From 1998-1999, bull trout were listed as threatened under the Endangered Species Act (ESA). Draft recovery plans were developed in 2002 and 2004. In 2008, a 5-year review was completed and found that bull trout remained threatened. Currently, bull trout are listed as one, coterminous Distinct Population Segment (DPS) but have been organized into six draft Recovery Units (RUs) that, ultimately, may be determined to represent DPSs. Each RU is composed of a variable number of Core Areas (CAs). In general, CAs are defined as core habitat plus a core (local) population. When multiple local populations (LPs) exists within a CA, CAs are considered complex and are intended to represent a metapopulation of bull trout. When a single LP exists within a CA, CAs are considered relatively simple. Core Areas are the closest approximation of a biologically functioning unit and the basic unit on which to gauge recovery within a RU.

Core Area: Status Assessments

Given that CAs have been defined as the basic unit on which to gauge recovery, it was necessary to develop a method to assess the status of CAs. For this purpose, the FWS and its partners adopted and adapted the NatureServe (NS) assessment protocol which had been developed by the IUCN's, Natural Heritage program. The application of this process allows for a relative risk assessment. In general, NS is widely adopted and well-supported, has previously been applied to a variety of species, uses criteria identified as important for bull trout, uses data generally available, and was designed for relatively data poor (as opposed to data rich) situations (such as that generally found for bull trout). With this in mind, the FWS and its partners developed a template of standard questions regarding the threats and demographic conditions of bull trout in CAs. For each CA, the FWS has worked with partners to complete a CA template. Information from this template is, in turn, used to inform a NS assessment of the CA. For the purposes of assessing bull trout CAs, the NS process is transparent, was applied consistently across all CAs, was used in the 5-year review, and has been vetted with the FWS' partners. There is agreement between policy and technical members of the FWS that NS is a useful and appropriate process by which to evaluate the status of CAs. As mentioned above, the recent application of this process (5-year review, 2008) resulted in bull trout remaining listed as threatened under the ESA.

Recovery Unit: Viability

Recently, policy and technical members of the FWS discussed and agreed that viable populations are necessary to produce viable CAs which, in turn, are necessary to produce a viable RU. Furthermore, there was agreement that a viable RU was necessary to achieve a recovered condition. To achieve a viable RU, most have agreed that the order of the process is to identify threats to bull trout that must be ameliorated, use this information to improve conditions for bull trout, and determine the demographic responses that need to be observed as evidence that bull trout respond to changes in their conditions. Conceptually, removed or reduced threats should result in viable populations that will be evidenced by a demographic response. To evaluate whether threats are reduced and a demographic response occurs it is

necessary to develop RU Viability Criteria. These criteria should be specific, measurable, achievable, realistic, and time-referenced (SMART). These criteria should also be driven by the principles of basic conservation biology and biodiversity, ensuring representation, redundancy and resiliency (Table 1). As such, the FWS has proposed a method (Rule Set) to integrate the well-vetted information from the CA status assessments into an assessment of RU viability. The basic rules are that: 1)(a) a certain proportion of all simple CAs achieve a certain threshold NS score; 1)(b) all complex CAs achieve a certain threshold NS score; 2) at least one complex CA in each major watershed achieve a certain threshold NS score; and 3) the connectivity between CAs should be considered. Whether a RU is composed of CAs that meet these conditions allows for the evaluation of whether the RU is biologically viable and likely to persist (rather than go extinct) in the near future. The strength of this process is that it is SMART, related to the 3 R's, technically sound and biologically defensible. A current limitation of this process is that the specific thresholds have not been finalized with explicit reasoning.

Recovery Unit: Recovered Condition

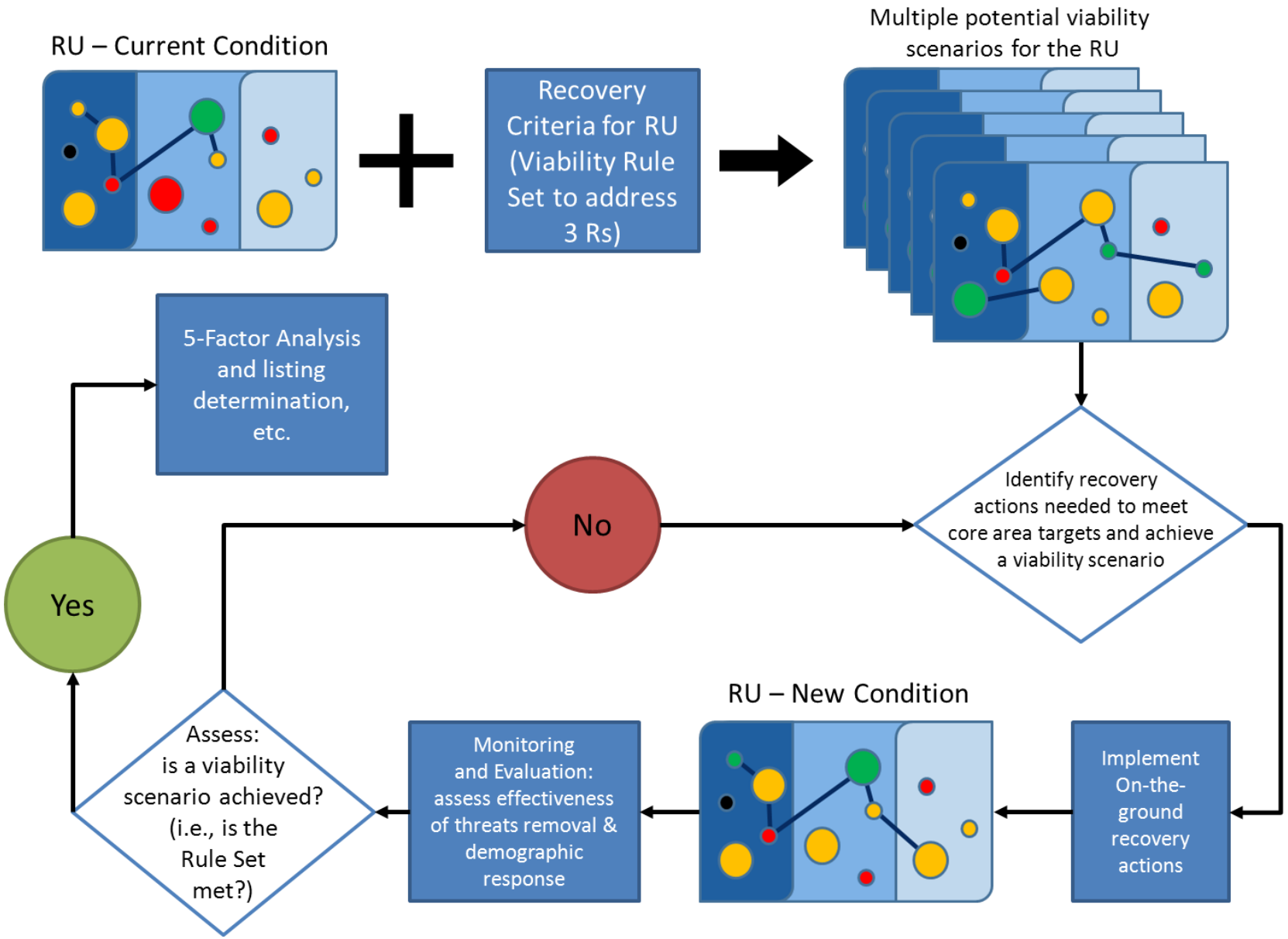
Recovery Unit viability criteria (biological condition) are designed to reflect a recovered condition (policy condition). At the point when a RU is deemed viable, presumably, the RU will have achieved a recovered condition. The achievement of a recovered condition could prompt a 5-factor analysis.

Recovery Unit: Listing Decision

Conceptually, recovery and delisting should be related. If a RU exists in a recovered condition, a 5-factor analysis should result in a recommendation to delist.

Table 1. Relationship of RU Viability Rule Set and 3 R's.

Recovery Unit Viability Rule Set (example)	Representation	Redundancy	Resiliency
1. CAs meet a minimum standard of demographic and threat conditions. a) proportion of simple CAs b) all complex CAs	✓	✓	
2. Some CAs achieve a higher standard of demographic and threat conditions (i.e. strongholds). a) One CA per major watershed/region within recovery unit	✓		✓
3. Consider the benefit of additional connectivity between core areas: a) Genetic or population interchange allows improved conservation status among connected core areas	✓	✓	✓


RU – Current Condition
Recovery Criteria for RU (Viability Rule Set to address 3 Rs)
Multiple potential viability scenarios for the RU
Identify recovery actions needed to meet core area targets and achieve a viability scenario
Implement On-the-ground recovery actions
RU – New Condition
Monitoring and Evaluation: assess effectiveness of threats removal & demographic response
Assess: is a viability scenario achieved? (i.e., is the Rule Set met?)
No
Yes
5-Factor Analysis and listing determination, etc.

Appendix B: Draft Bull Trout Recovery Plan, Mid-Columbia RU Development

Bull Trout Recovery Planning Guidance

Developed for use by Mid-Columbia / Snake RU staff

Prepared by B. Streif and Marci Koski

June 2011

Two components of BT Recovery planning:

1) Core area level information (targets, actions, etc.) for input to Recovery Unit chapter
2) Recovery Unit chapter, criteria, etc. for inclusion in the overall Recovery Plan

Overall Timeline

- May – July: Meet with BT working groups (or correspond via email) to discuss and refine core area targets (from draft Recovery Criteria Table)
- June 30: Finalize any core area delineation changes
- August 1: Final core area products submitted to respective state lead
- August 15 (no later than): State lead submits information to Marci Koski
- September 15: Marci Koski sends draft RU chapter to Ted Koch
- October 15: Ted sends plan, incorporating all RU chapters, to the RO
- January 2012: Draft Recovery Plan published in FR
- August 1, 2012: Final Recovery Plan published

Responsibilities

BT Coordinator – Ted Koch
Chapter 1: Rangewide – Ted Koch
Chapter 4: Mid-Columbia – Bianca Streif / Marci Koski
CA inputs - Judy Neibauer, Marci Koski, Ben Matibag, & Bianca Streif

Core Area Products

1. Evaluation and refinement (if needed) of core area delineation
2. Core Area Target Table filled out for demographic and threat targets (see below for details)
3. A summary document (less than 2 pages) of the core area, local population(s), threats, and demographic information. It will also include a summary of changes in status, the core area etc. from the previous 2002 draft recovery Plan.
4. Recovery Actions Table – list of key recovery actions that correlate with the primary targets identified.

Core Area Product detail

1. *Evaluation and refinement of core area delineation*

   Leads will review core area delineations and identify those areas where adjustments may be warranted based on genetics and geographical distance.

2. *Core Area Target Table filled out for demographic and threat targets*

   Each CA lead (as appropriate), in coordination with Marci and state lead (as appropriate), will meet or connect (via email, webex, or other means) with working groups to give an overview of new recovery plan strategy and guidance on setting new recovery targets for each core area. At this time we are only soliciting scientific input from local biologists and our tribal partners; other partners will have the ability to provide input during the public comment process.

   All targets (threats and demographic): Use the best data available including information from the previous recovery plan and core area templates (2008). Targets can be written in a Word document and do not need to be filled out in table format. All targets need to be concise and **SMART**: **S**pecific, **M**easurable, **A**chievable, **R**ealistic, and **T**ime-referenced.

   Targets will be developed for:

   - Core areas (CA)
   - Core habitat (CH)
   - Foraging, migratory, and overwintering habitat (FMO) outside of core area boundaries such as the mainstem Columbia, Snake, and John Day rivers

   Threat targets should only be high priority threats that are limiting recovery e.g., abundance, distribution, reproduction. Threats should be summarized at the core area level but can be tied to specific local populations within the core area. There should be some level of confidence that removal of the threats identified would result in a positive response in bull trout abundance and distribution. The list of primary threat targets can be none to five or so.

   Demographic targets must include at least three targets: (1) minimum # of local populations, (2) minimum # of stream miles/habitat (which can be further subdivided by use type, e.g., spawning, rearing, migratory), and (3) "sufficient number of adult bull trout to maintain long-term population viability." The third target may be answered with site-specific, long-term trend data (e.g., 50 redds per year per local pop), recruitment values, or with consensus (e.g., maintain or increase current NatureServe abundance score). Demographic targets can also include factors such as (but not limited to) specific areas of occupancy, genetic objectives, age class structure, and life history types maintained.

3. A summary document (~ 2 pages) describing the core area, local population(s), threats, and demographic information.

   This information will go into the recovery plan which is expected to be a brief document summarizing each area and utilizing a table that contains the targets. It will also include a summary and rationale of changes in status, the core area etc. from the previous 2002 draft recovery Plan.

4. Recovery Actions Table – list of high priority recovery actions needed for the core area that correlate with the primary targets identified. The Recovery Implementation Tasks Table from Draft Recovery Plans can be used as a starting point. It may be useful to identify the tasks that have been completed and reevaluate those tasks that still apply and relate to the targets and listing factors.

Information that can be used in completing products

Draft Recovery Criteria table
Core area templates (reference these to minimize document size)
2002 and 2004 draft BT Recovery Plans
Draft outline for 2012 Recovery Plan
Available literature, recent genetic studies, and other published information
Professional judgment from biologists
Nature Serve model information
SMART criteria for targets

Recovery Unit Products

1. Draft BT RU plan chapters including assembled CA information
2. Draft RU criteria in collaboration with field offices
3. Recovery Unit maps

Recovery Unit Product detail

1. *Draft BT RU chapters including assembled CA information*

Complete text in a standardized format; review and edit text drafted in collaboration with the Bull Trout Coordinator and field office staff. Consolidate a recovery action table, collate CA write-ups and insert into RU plan chapter.

2. *Draft RU criteria in collaboration with field offices*

   Identify recovery criteria for each recovery unit, based on core area targets, threats and NatureServe or other tools.

3. Coordinate development of maps with David Hines – work with staff in developing maps at recovery unit scales that correlate with recovery criteria, e.g., geographic regions within RU.

Mid-Columbia/Snake CA and RU Assignments

Bianca Streif

- Assist in coordinating regional meetings with partners to refine CA targets
- Manage process, timeline and inputs to RU plan in coordination with Marci Koski
- Coordinate with Judy, Ben, and Marci to insure consistency in CA products
- Coordinate CA development and complete assigned CAs for Oregon
- Develop recovery action table that correlate with CA targets

Marci Koski

- Lead regional meetings with partners to refine CA targets
- Coordinate development of CA and complete assigned CAs
- Develop recovery action table that correlate with CA targets
- Develop recovery unit criteria in coordination with staff
- Collate CA write-ups and insert into RU plan chapter
- Draft MCS RU chapter
- Submit draft plan to Ted

Mid-Columbia / Snake Recovery Unit Assignments

(note: Bianca will serve as contact for all Oregon CAs)

#	Core Area	Lead	Office
1	Fish Lake	Ben Matibag	ID
2	Lochsa River	Ben Matibag	ID
3	Middle-Lower Clearwater River	Ben Matibag	ID
4	North Fork Clearwater River	Ben Matibag	ID
5	Selway River	Ben Matibag	ID
6	South Fork Clearwater River	Ben Matibag	ID
7	Grande Ronde River	Gretchen Sausen	OR
8	Little Minam River	Gretchen Sausen	OR
9	Pine-Indian-Wildhorse Creeks	Ben Matibag	ID
10	Imnaha River	Gretchen Sausen	OR
11	Asotin Creek	Marci Koski	CRFPO
12	Tucannon River	Marci Koski	CRFPO
13	Powder River	Paul Bridges	OR
14	Granite Creek	Ben Matibag	ID
15	Sheep Creek	Ben Matibag	ID
16	Touchet River	Marci Koski	CRFPO
17	John Day River (Upper Mainstem)	Shivonne Nesbitt	OR
18	Middle Fork John Day River	Shivonne Nesbitt	OR

19	North Fork John Day River	Shivonne Nesbitt	OR
20	Umatilla River	Marci Koski / Paul S.	CRFPO
21	Walla Walla River	Marci Koski	CRFPO
22	Yakima River	Judy Neibauer	WA
23	Entiat River	Judy Neibauer	WA
24	Methow River	Judy Neibauer	WA
25	Wenatchee River	Judy Neibauer	WA
26	Snake River FMO	Bianca Streif	OR
27	Mid-Columbia River FMO	Judy Neibauer	WA

Appendix C: Justification and Rationale for using NatureServe scores of 2.5 and 3.5 as stability and stronghold thresholds, respectively

Why 2.5 and 3.5?

May 3, 2012

Introduction

The six recovery units within the coterminous range of bull trout are each made up of a collection of core areas, which in turn contain one or more local populations. If a core area contains more than one local population, the core area functions as a metapopulation and its local populations likely interact at some level. The core area is the closest approximation of a biologically functioning unit within the bull trout population structure, and is the basic unit on which to gauge recovery within a recovery unit.

Determining bull trout core area conservation status (i.e., the relative risk of extirpation) is an important part of assessing recovery unit viability. The NatureServe Rank Calculator (NatureServe 2009) is a tool that integrates demographic and threat-based information about each bull trout core area to calculate its relative risk of extirpation. However, recovery viability does not depend alone on the status of bull trout within core areas; the spatial arrangement of core areas and connectivity between them must also be evaluated to determine whether or not the recovery unit as a whole is viable. A viable recovery unit should demonstrate that the principles of biodiversity have been met (i.e., the three Rs):

- **Representation** involves conserving the breadth of the genetic makeup of the species to conserve its adaptive capabilities.
- **Resiliency** involves ensuring that each population is sufficiently large to withstand stochastic events.
- **Redundancy** involves ensuring a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events.

To ensure that the 3 Rs are preserved within each recovery unit, we developed a method to assess recovery unit viability that integrates the information we have about the status of each core area and the ways in which they interact. The "viability rule set" we developed preserves representation, resiliency and redundancy across each recovery unit and is our best estimate of what recovery units must minimally maintain to be viable. The rule set incorporates core area status as measured using NatureServe, and requires that thresholds be met for general core area stability and the maintenance of representative strongholds.

Using The NatureServe Methodology To Assess Risk

The primary purpose of the NatureServe tool is to conduct status assessments which can be used to evaluate the potential risk of extinction or extirpation. The NatureServe conservation status assessment methodology considers all data collectively when assigning a status, can produce a range of ranks, is transparent, explicitly considers threats in the assessment, and can

be used to assess conservation status for both species and ecosystems (Master et al. 2009). The NatureServe methodology can use inputs from data rich circumstances resulting from relatively rigorous and quantitative assessments as well as inputs from data poor circumstances, or information based on expert opinion (see Faber-Langendoen et al. 2009). For a given unit (i.e. species, state, core area of bull trout) the NatureServe methodology yields a rank score which ranges from 0-5.5. Associated with the rank score are five categories of risk categorization (see Table 1). Rank scores of 0-1.5 are categorized as critically imperiled, 1.51-2.5 are categorized as imperiled, 2.51-3.5 are categorized as vulnerable, 3.51-4.5 are categorized as apparently secure and 4.51-5.5 are categorized as secure (Faber-Langendoen et al. 2009, Master et al. 2009).

Using The NatureServe Methodology To Assess Bull Trout Core Areas

NatureServe can be applied at many scales, including global, national, and subnational scales. Bull trout core areas are assessed at the subnational scale, which is appropriate considering the large range in size across core areas (515 ha – 1,587,950 ha); in fact, some core areas are larger than entire countries (e.g., the Yakima core area is almost twice the size of Puerto Rico).

As stated above, NatureServe uses inputs that reflect a core area's demographic and threat conditions. If information about a particular parameter is unknown, NatureServe can still generate a rank score. NatureServe inputs for each bull trout core area include: linear distance of occupancy, number of local populations, adult population size, proportion of occupied area in good condition, short-term trend, threat scope, and threat severity. For each demographic parameter, inputs are chosen from multiple bins that increase in size. For example, the bins for population size are: 1-50 adults; 50-250; 250 – 1000; 1000 – 2500; 2500 – 10,000; 10,000 – 100,000; 100,000 – 1,000,000; and greater than 1,000,000 adults. Threat scope and severity are measured by bins having high, moderate, low and insignificant conditions. During the bull trout 5-year review process (U.S. Fish and Wildlife Service 2008), bull trout experts reviewed the bin sizes for each input and determined that the bins were suitable for characterizing bull trout core areas, so the bin sizes were not changed from the original NatureServe tool.

The NatureServe tool uses the inputs to generate one rank score for each core area. Rank scores can be anywhere between 0 and 5.5, and correspond to a risk category number (the "S-rank", or subnational rank) and risk status category (Table 1).

Table 1. NatureServe rank scores and conservation status ranks for core areas.

Calculated Rank Score	Risk Category Number	Risk Status
Calculated value <= 1.5	S1	critically imperiled
1.5 < calculated value <= 2.5	S2	imperiled
2.5 < calculated value <= 3.5	S3	vulnerable
3.5 < calculated value <= 4.5	S4	apparently secure
4.5 < calculated value <= 5.5	S5	secure

NatureServe's conservation status ranks describe the relative risk of extirpation for the entity assessed. Bull trout core area extirpation risk can be defined by using NatureServe's description of each risk status category (Faber-Langendoen et al. 2009):

- Bull trout are **critically imperiled** in core areas where they are extremely rare or where some factor(s) such as very steep declines makes them especially vulnerable to extirpation from the core area.
- Bull trout are **imperiled** in core areas where rarity is caused by a very restricted range, there are very few local populations or occurrences, steep declines, or other factors that make them very vulnerable to extirpation from the core area.
- Bull trout are **vulnerable** in core areas where range is restricted, there are relatively few local populations or occurrences, there have been recent and widespread declines, or if there are other factors that make them vulnerable to extirpation.
- Bull trout are **apparently secure** in core areas where they are uncommon but not rare; in these core areas, there is some cause for long-term concern due to declines or other factors.
- Bull trout are **secure** in core areas where they are common, widespread and abundant.

A Bull Trout Core Area Assessment

A recovery unit status assessment must consider 1) the status of the core areas it contains, and 2) the interaction between core areas. For a recovery unit to be deemed viable, most core areas should be at least minimally stable (i.e., a somewhat low risk of extirpation), and the spatial arrangement and connectivity between core areas should be preserved such that the entire RU can withstand both environmental and demographic stochasticity. These two considerations are measured in comparison to two thresholds: the stability threshold, and the stronghold threshold.

First, the "stability" threshold captures the minimum conditions that a core area needs to be considered stable. Core area conditions are assessed using NatureServe, and the stability threshold has a NatureServe score of 2.5; i.e., "vulnerable" as defined by the rank calculator. The demographic values that these minimum conditions represent fall within the range of those identified within the bull trout literature and best available science as those mostly likely to allow a bull trout core area to persist (see below for inputs and support). The persistence of these core areas ensures the minimum necessary representation and redundancy in the recovery unit. Below a NatureServe score of 2.5 (i.e., imperiled or critically imperiled), individual demographic values begin to be eroded to such a point that the probability of persistence of individual core areas significantly declines.

Second, the "stronghold" threshold captures the minimum conditions that some core areas (one per major geographic region within an RU) need to achieve to preserve spatial integrity of the recovery unit and serve as source populations for other connected core areas. Core areas that achieve the stronghold threshold have a NatureServe score of at least 3.5 (i.e., apparently

secure). These core areas have a lower risk of extirpation than core areas that achieve the stability threshold, and have the potential to serve as a source for dispersal, recolonization, and support to other core areas in each major geographic region within the recovery unit, thus ensuring representation and resiliency across the RU.

Bull trout core area status assessments in the entire coterminous range were updated in 2011, and current NatureServe scores were calculated for each. Core areas that are generally considered stable by the Bull Trout Technical Team and our partners have current NatureServe scores near 2.5 (or above), and core areas that are considered to be stronger have higher scores closer to (or above) 3.5; hence, there is an intuitive match between core area scores and status (imperiled, vulnerable, and apparently secure).

The Characteristics of Bull Trout Core Areas: An Empirical Assessment

It is possible to understand the types of conditions, and combinations of conditions, that actually (and currently) characterize core areas with various rank scores. The following is an assessment of what rank calculator inputs are associated with the overall NatureServe rank score from existing core area status assessments. We used existing NatureServe rank scores and characterized the conditions that were associated with those conditions.

In the range of bull trout, most core areas differ from the hypothetical average core area described previously. For example, most core area short term trends are not rapidly declining (the hypothetical average), they are either moderately declining, stable, or even increasing (i.e., most are better than average). Further, most core areas do not have between 21 and 80 local populations (the hypothetical average); most have between 1-5 or 6-20 (i.e., most are less than average). So, where a core area is deficient in one respect, another attribute might make up for the deficiency and still result in a score that meets a given threshold.

We characterized 109 core area assessments (Table 2). Of these core areas, 32 of 87 had a rank score of 2.51 or greater (C3 and C4 in Figure 1). Of those core areas with rank scores 2.51-3.5 (C3 above), the linear distance of occupancy was never worse than category B, the number of local populations was never worse than category A, the proportion of area in good condition was never worse than category D, the population size was never worse than category B, the short term trend was never worse than category CE, The threat scope was never worse than category high and the threat severity was never worse than category moderate. Only four core areas had a rank score of 3.5 or greater. Thus, the sample size of these core areas was too low to make any significant inference about their characteristics. However, of those core areas with rank scores of 3.5 or greater (C4 above), linear distance of occupancy was never worse than category DE, number of local populations was never worse than category B, proportion of area in good condition was never worse than category F, population size was never worse than category DE, short term trend was never worse than category E, threat scope was never worse than category low and threat severity was never worse than category low. For a given core area

rank score category, there tended to be a large range in input values, emphasizing that there are many ways for a core area to achieve a given condition.

Table 2. Median (± Range) of rank calculator input category and associated core area rank score category.

	Core area rank score (number of core areas)											
	0-1.5 (N=17)			1.51-2.5 (N=60)			2.51-3.5 (N=28)			3.51-4.5 (N=4)		
	Rank calculator input			Rank calculator input			Rank calculator input			Rank calculator input		
	best	med	worst	best	med	worst	best	med	worst	best	med	worst
Lin. Dist. Occ.	E	C	AB	E	D	B	F	D	B	E	E	DE
No. loc. pop.	A	A	A	B	A	A	C	A	A	C	B	B
Prop. Area	F	CD	AC	F	DE	C	F	F	D	F	F	F
Pop. Size	C	B	A	E	B	A	E	CD	B	E	DE	DE
Short trend	D	D	CD	F	E	C	F	E	CE	EF	E	E
Long trend	-	-	-	-	-	-	-	-	-	-	-	-
Threat scope	m	h	h	i	h	h	i	l	h	l	l	l
Threat severity	m	h	h	i	m	h	i	l	m	l	l	l

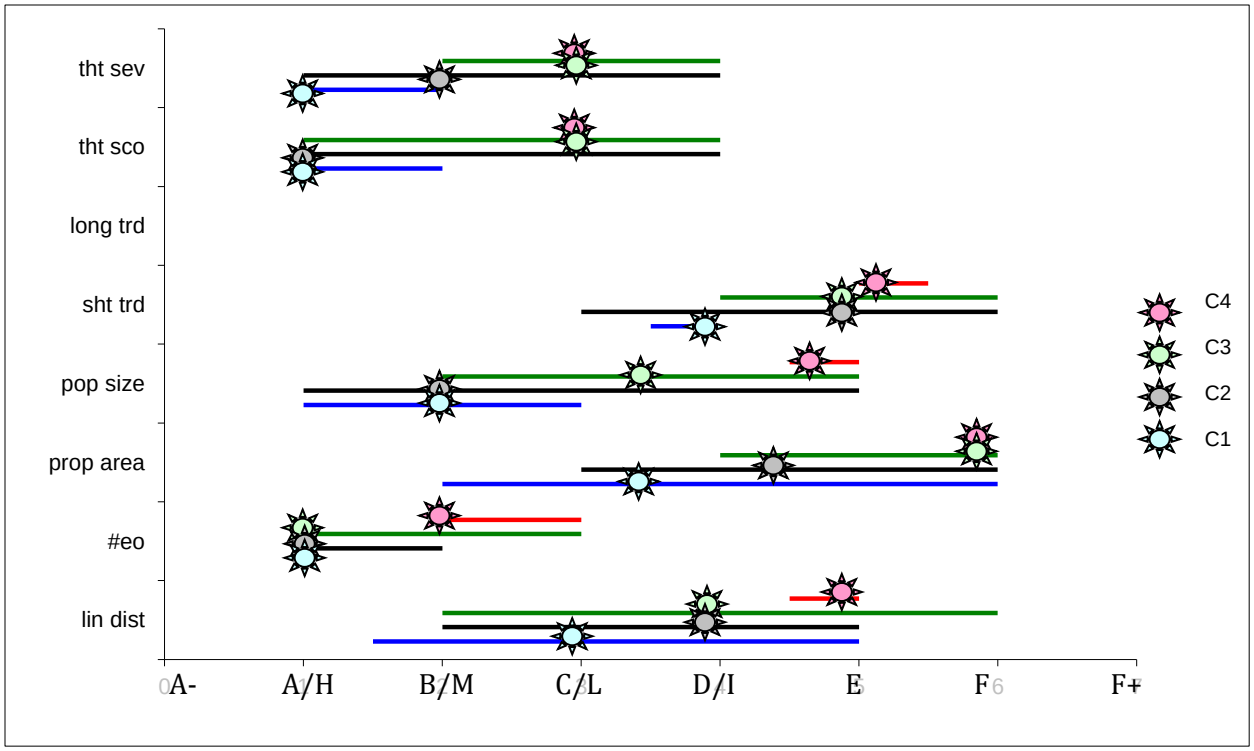


Figure 1. Median (± Range) of rank calculator input category and associated core area rank score category. C4 = rank score of 3.51-4.5, C3 = rank score of 2.51-3.5, C2 = rank score of 1.51-2.5, C1 = rank score of 0.0-1.5.

The Characteristics of Core Areas: A Hypothetical Assessment

It is possible to understand the types of conditions, and combinations of conditions, that could characterize core areas with various rank scores. The following is an assessment of how changes in NatureServe inputs affect the overall NatureServe rank score for a hypothetical core area. This assessment can be viewed as a basic sensitivity analysis. We calculated the overall NatureServe rank scores for three core area conditions. 1) A core area in poor condition, where all inputs to the rank calculator were set to the lowest or worst bins (Table 3). 2) A core area in average condition, where all inputs to the rank calculator were set to an approximation of average input bins (Table 3). 3) A core area in good condition, where all inputs to the rank calculator were set to the highest or best bins (Table 3).

Table 3. NatureServe element inputs for poor, average and good core area conditions (intrinsic vulnerability and environmental specificity were not used in the bull trout assessments, so they are not included below).

NatureServe Element	Core Area Condition		
	Poor	Average	Good
Lin. Dist. of Occup.	A (< 4 km)	D (200 – 1000 km)	H (> 200,000 km)
No. of Local Pops	A (1-5)	C (21 – 80)	E (> 300)
Prop. of Area Good	B (very small, <5%)	D (moderate, 11-20%)	F (excellent, >40%)
Pop. Size	A (1 – 50)	D (1000 – 2500)	H (> 1,000,000)
Short-Term Trend	A (severe, > 70%)	C (rapid, 30 – 50%)	F (increasing, > 10%)
Long-Term Trend	A (hi. decline, > 90%)	C (subs. decl., 50-75%)	F (increase, > 25%)
Threat Scope	High (> 60%)	Moderate (20 – 60%)	Insignificant (< 5%)
Threat Severity	High (> 100 yr to recovery)	Moderate (50 – 100 yr to recovery)	Insignificant (< 10 yr to recovery)

Table 4. NatureServe rank scores of hypothetical core areas under poor, average, and good scenarios. For a given core area scenario (e.g. poor), when all rank calculator inputs the same (e.g. poor) the rank score is consistent (e.g. 0.12). Other combinations of inputs for each of the three core area conditions were also calculated (the black numbers in table 3). These were achieved by changing one of the inputs to a different condition and leaving all other inputs the same. For example, in the poor core area condition scenario, the rank score was 0.63 if all inputs were set to poor, except for linear distance of occupancy, which was set to average. Similarly, in the good core area condition scenario, the rank score for the core area was 5.16 when all inputs were set to good, except for population size, which was set to average.

Rank Calculator Categories	Core Area Scenario								
	Poor			Average			Good		
	Poor	Avg	Good	Poor	Avg	Good	Poor	Avg	Good
Lin. Dist. of Occup.	0.12	0.63	1.31	1.92	2.43	3.12	4.30	4.82	5.50
No. of Local Pops	0.12	0.72	1.31	1.84	2.43	3.03	4.31	4.90	5.50
Prop. of Area Good	0.12	0.36	0.60	2.20	2.43	2.67	5.02	5.26	5.50
Pop. Size	0.12	0.37	0.72	2.18	2.43	2.77	4.90	5.16	5.50
Short-Term Trend	0.12	0.34	0.67	2.21	2.43	2.76	4.95	5.17	5.50
Long-Term Trend	0.12	0.34	0.67	2.21	2.43	2.76	4.95	5.17	5.50
Threat Scope	0.12	0.26	0.67	2.30	2.43	2.85	5.23	5.36	5.50
Threat Severity	0.12	0.26	0.67	2.30	2.43	2.85	5.23	5.36	5.50

Core area rank scores ranged from 0.12 to 5.50. The average core area condition resulted in a rank score of 2.43 (Table 4), very close to the 2.5 threshold (stable). The rank score for an average core area was characterized by a core area having a linear distance of occupancy of 200-1000 km, 21-80 local populations, a moderate proportion (11-20%) of area in good condition, a population size of 1000-2500 individuals, short term trend of rapidly declining (30-50%), long term trend of substantial decline (50-75%), and threat scope and severity both moderate. In general, the most obvious way for a core area to achieve a rank score near 2.5 was to have all inputs approximate average conditions. However, some inputs could be poor

and, with the appropriate combination of other inputs being average and good, a core area could also achieve a rank score near 2.5. It appeared that, in general, inputs would need to be some combination of average to good for a core area to achieve a rank score of 3.5 or better. However, it was possible for a core area to achieve a rank score of 3.5 with some inputs being bad. If some inputs were bad, a relatively high proportion of good inputs were necessary for a core area to achieve a rank score of 3.5. Overall, the rank scores appeared most sensitive to the number of local populations and the linear distance of occupancy. In summary, there were several ways for a core area to reach both the 2.5 (stable) and 3.5 (stronghold) rank score thresholds. This assessment conducted here represents only a small number of the possible combinations of rank calculator inputs, but this provides a basic understanding of the population and habitat characteristics that core areas will generally have for any given rank score.

The Relationship Between Core Area Thresholds and Bull Trout Biology

Knowledge of bull trout biology can be applied to inform the NatureServe rank score thresholds being used to reflect core area status. In particular, specific examples of the hypothetical evaluation, described above, can inform the identification of rank score thresholds which characterize moderate and low risk of core area extirpation. We conducted such evaluations by using information associated with the biology of bull trout to determine the various inputs to the categories being used in core area status assessments.

As discussed previously, the number of local populations in a bull trout core area can range from one isolated population (simple core area), to many connected populations (complex core area) that function as a metapopulation. The risk of extirpation for a simple core area is largely associated with the dynamics of a single population. In general, small, isolated populations can have an inherently higher risk of extirpation than multiple, well-connected populations (see Hanski and Gilpin 1991). Alternatively, the risk of extirpation for a metapopulation (complex core area) is inversely associated with the number of local populations in that metapopulation (Fagan 2002). For bull trout, approximately 10 local populations within a core area appears to be the minimum necessary for it to function reasonably well as a metapopulation (see Rieman and Dunham 2000, Whitesel et al. 2004). The minimum catchment area to support each of these populations is approximately 400-500 hectares (Rieman et al. 1997). Converting this catchment area to linear stream distance (the variable used in core area status assessments) suggests that a reasonably well functioning population of bull trout would occupy a minimum of 4-200 km of stream. The risk of core area extirpation can also be related to the availability of high quality habitat (see Higdon et al. 2006). To be at moderate or low risk of extirpation, it is reasonable to suggest that at least a substantial proportion of the core area would have good viability and ecological integrity (see Rieman and McIntyre 1993). In addition, to be at moderate or low risk of extirpation, it appears that the threats to bull trout persistence (such as harvest, degraded habitat, introduced species, and climate change) would be low or insignificant (see Staples 2006, Rieman et al. 2007). Each population would require a minimum of approximately 100 spawners to avoid significant demographic and genetic risk (Schultz and

Lynch 1997, Rieman and Allendorf 2001, Allendorf and Ryman 2002, also see Whitesel et al. 2004). Growth rate and trend, both long and short term, are also important factors in determining a core area's risk of extinction (Lande 1993, Fagan 2002). A core area at high risk of extirpation would be characterized by a chronically low population growth rate or a negative trend in abundance whereas a core area at moderate risk of extinction would have a stable trend (Caughley 1994, See McElhany et al. 2000).

Based on the information associated with bull trout biology, we determined the minimum conditions that would combine to reflect a core area at moderate risk of extirpation (stable). Using these conditions, we derived inputs for the NatureServe Rank Calculator. Specifically, we input: linear distance of occupancy (4-200 km), number of local populations (6-20), proportion of area in good condition (11-20%), population size (250-1,000), short term trend (-30 to +10%), long term trend (-50 to +25%), threat scope and severity (low). The rank score that resulted from this input ranged from 2.48-2.87. Thus, a rank score of at least 2.5 appears to be a reasonable estimate of the minimum necessary for a core area to be at a moderate risk of extinction.

Based on the information associated with bull trout biology, we also determined the minimum conditions that would combine to reflect a core area at low risk of extirpation (stronghold). Using these conditions, we derived inputs for the NatureServe Rank Calculator. Specifically, we input: linear distance of occupancy (40-992 km), number of local populations (21-80), proportion of area in good condition (21-40%), population size (1,000-2,500), short term trend (-10 to +100%), long term trend (-25 to +100%), threat scope and severity (insignificant). The rank score that resulted from this input ranged from 3.37-3.76. Thus, a rank score of at least 3.4 appears to be a reasonable estimate of the minimum necessary for a core area to be at a moderate risk of extinction.

We specifically evaluated rank scores that could be associated with moderate or low risk of core area extirpation. The rank scores that resulted from this exercise corresponded well with categories already developed for use with the NatureServe approach (Faber-Langendoen 2009). As such, it appears that the biology of bull trout is consistent with the categorizations developed by NatureServe. Thus, we recommend using the existing rank scores thresholds developed by NatureServe (i.e. 2.51-3.5, 3.51-4.5) and having those reflect the relative risk of extirpation (moderate and low, respectively). In addition, it is important to note that the conditions we used are only one subset of possible inputs that would generate such a rank score. Ultimately, it is the rank score (not the individual inputs) that are recommended for characterizing the risk of core area extirpation.

Conclusion

NatureServe is a useful tool that can be used to describe the status of core areas across the range of bull trout in a consistent and transparent manner. Hypothetical and empirical analyses suggest that scores between 2.51 and 3.5 correspond well with conditions that characterize

relatively stable core areas, and that scores between 3.51 and 5.5 correspond well with conditions that characterize core areas that could serve as strongholds within recovery units. Additionally, these scores are an intuitive match between the calculated risk status and that perceived by bull trout experts and partners. Core area stability in addition to connected strongholds will result in recovery unit viability. Having core area stability throughout most of a recovery unit (i.e. all complex core areas and half the simple core areas) ensures that the recovery unit can maintain representation and redundancy of bull trout biodiversity. Providing stronghold core areas that are spatially arranged to serve as source populations to other core areas ensures that the recovery unit can maintain representation and resiliency.

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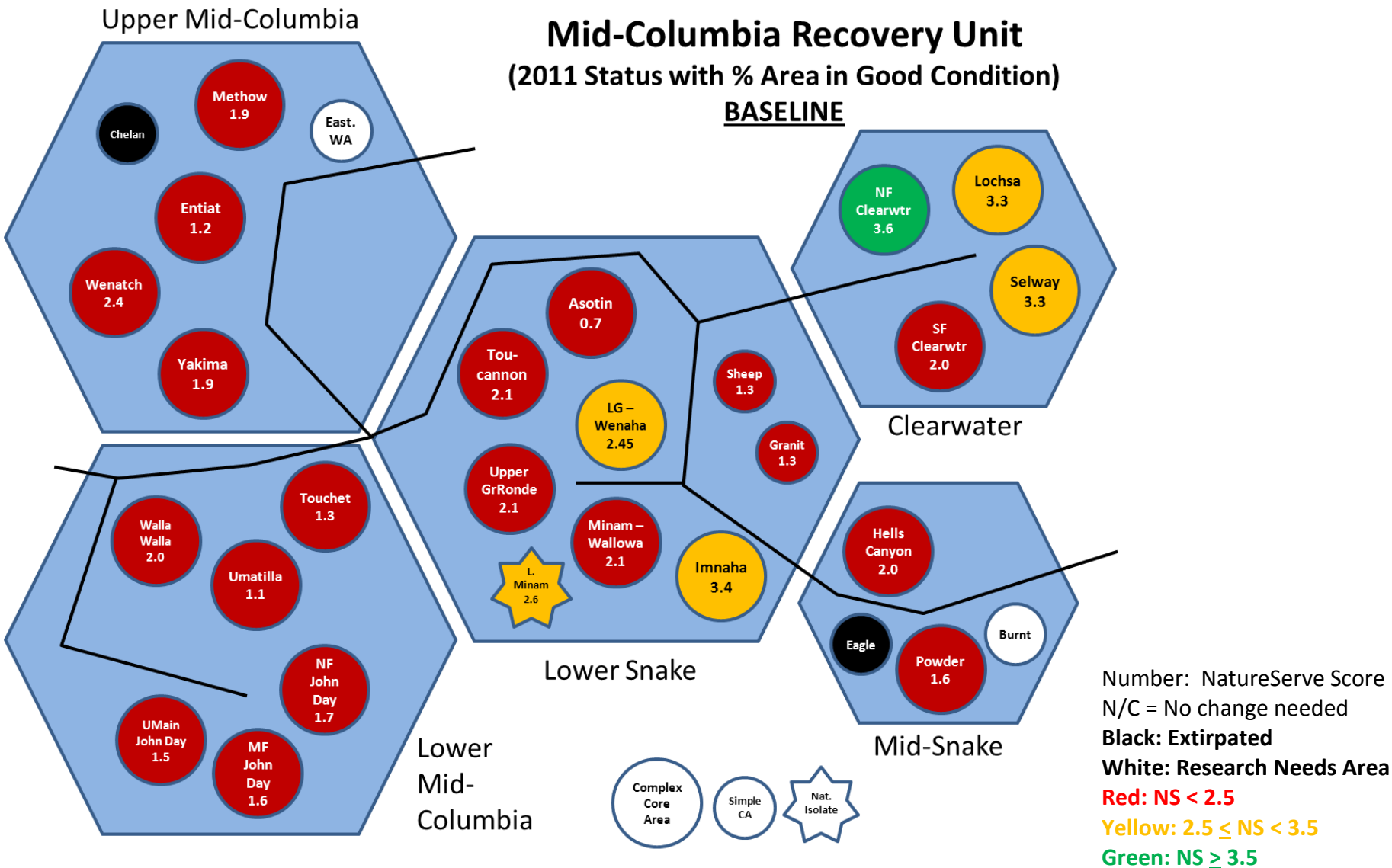
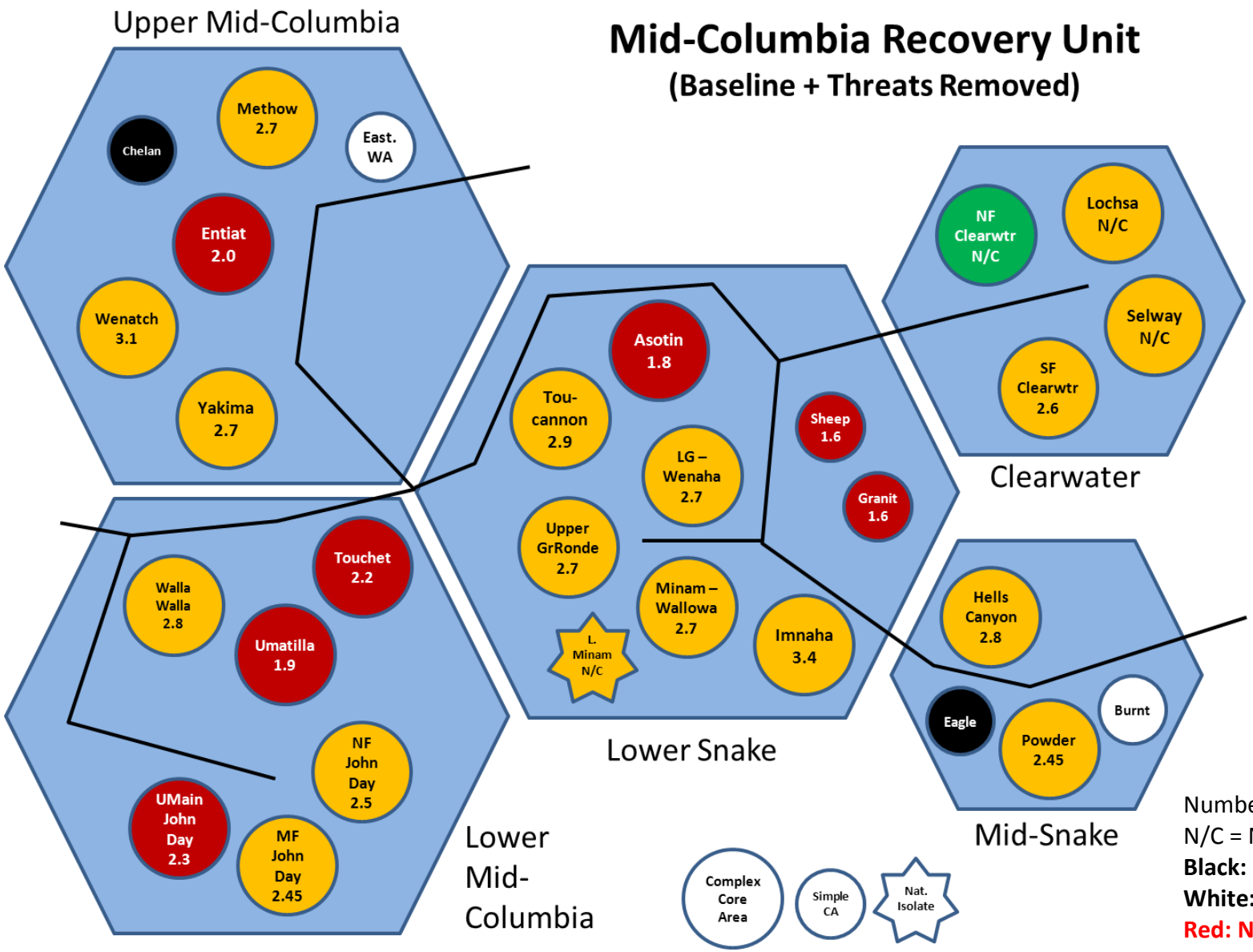
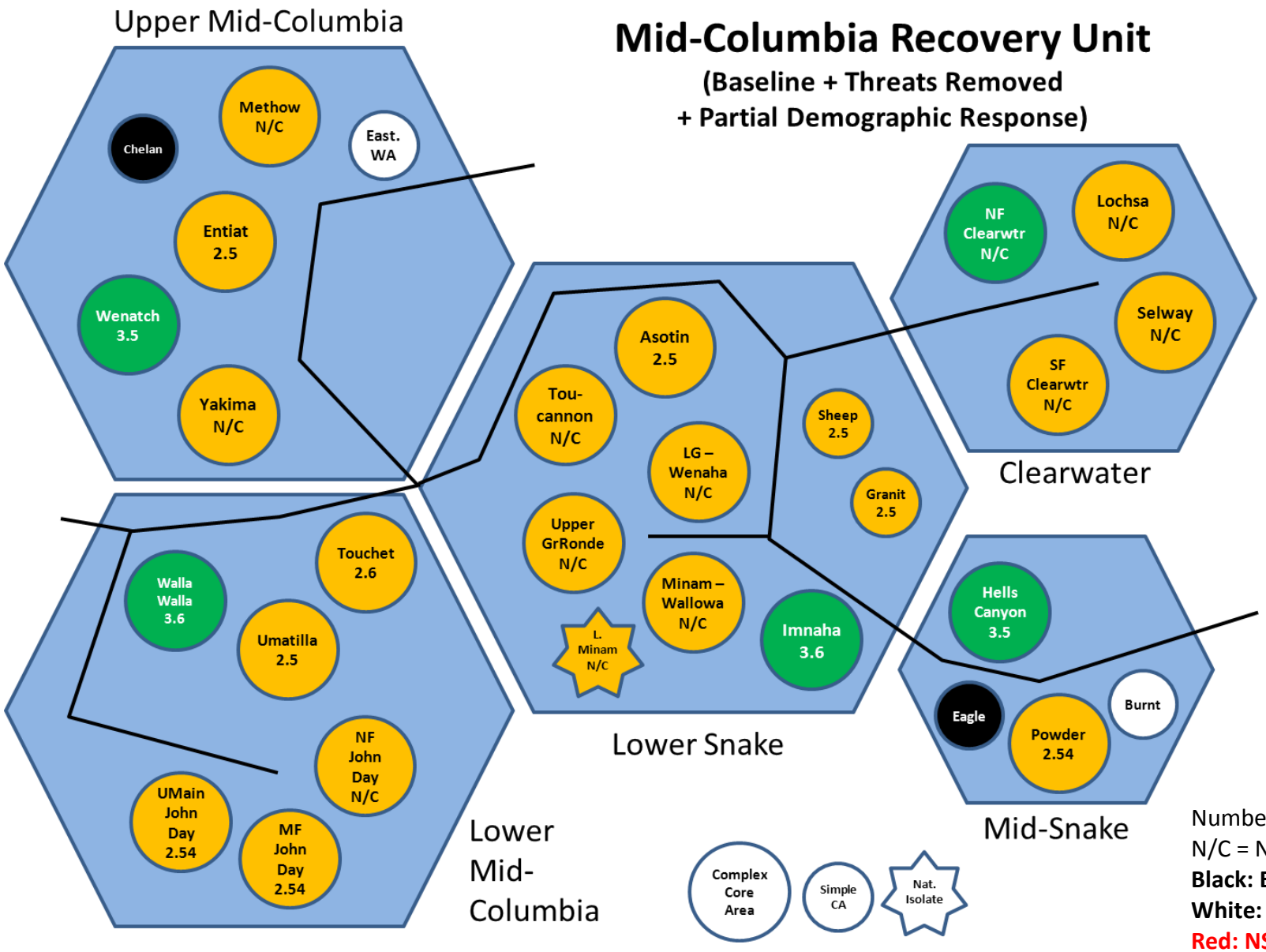
Appendix D: Hypothetical Application of Viability Rule Set to the MCRU as an <u>Example</u> of Recovery



Number: NatureServe Score
N/C = No change needed
Black: Extirpated
White: Research Needs Area
Red: NS < 2.5
Yellow: 2.5 ≤ NS < 3.5
Green: NS ≥ 3.5


Mid-Columbia Recovery Unit
(Baseline + Threats Removed)
Upper Mid-Columbia
Methow 2.7
Chelan
East. WA
Entiat 2.0
Wenatch 3.1
Yakima 2.7
Asotin 1.8
Tou-cannon 2.9
LG – Wenaha 2.7
Sheep 1.6
Granit 1.6
Upper GrRonde 2.7
Minam – Wallowa 2.7
Imnaha 3.4
L. Minam N/C
NF Clearwtr N/C
Lochsa N/C
Selway N/C
SF Clearwtr 2.6
Clearwater
Touchet 2.2
Walla Walla 2.8
Umatilla 1.9
NF John Day 2.5
UMain John Day 2.3
MF John Day 2.45
Lower Mid-Columbia
Lower Snake
Hells Canyon 2.8
Eagle
Burnt
Powder 2.45
Mid-Snake
Complex Core Area
Simple CA
Nat. Isolate
Number: NatureServe Score
N/C = No change needed
Black: Extirpated
White: Research Needs Area
Red: NS < 2.5
Yellow: 2.5 ≤ NS < 3.5
Green: NS ≥ 3.5



Number: NatureServe Score
N/C = No change needed
Black: Extirpated
White: Research Needs Area
Red: NS < 2.5
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Green: NS ≥ 3.5

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