Species Status Assessment
For The
Coterminous Distinct Population Segment
Of
BULL TROUT
(*Salvelinus confluentus*)



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Executive Summary

This species status assessment (SSA) documents the results of our comprehensive review of the life history, ecology, threats, and viability for the distinct population segment (DPS) of bull trout (*Salvelinus confluentus*) in the conterminous (lower-48) United States. The bull trout is listed as a threatened DPS under the Endangered Species Act (Act) in the lower-48 States (64 FR 58910; November 1, 1999), and this bull trout DPS is the subject of this SSA report. For this assessment, unless specified otherwise, we use the term "species" to refer to the bull trout DPS and the term "core area" to refer to population units of analysis that we used to assess viability. A core area consists of a combination of core habitat and core population. Core habitat contains, or if restored would contain, the essential physical elements for the long-term persistence of bull trout. Core population is a group of one or more local bull trout populations that exist within a core habitat. A total of 118 core areas, distributed across 5 states (Washington, Oregon, Montana, Idaho, and Nevada), were individually evaluated in this assessment. This SSA report provides the best available biological information to inform the U.S. Fish and Wildlife Service's (Service's) decisions for bull trout under the Act, including a 5-year status review and any additional actions, as needed. The SSA will be updated as needed and this version incorporates the most recent data available.

We used the three-part SSA framework (USFWS 2016, entire; Smith *et al.* 2018, entire) to guide this biological risk assessment for the species and to assess viability. We define viability as the ability of the bull trout to sustain populations in natural ecosystems over a biologically meaningful timeframe. The SSA characterizes viability for bull trout currently through approximately the latter half of the 21st century (2080). The SSA uses the conservation biology principles of resiliency, redundancy, and representation, collectively known as the "3Rs," as a lens to evaluate the current and future condition of the species (USFWS 2016, p. 6).

Species Overview

Initially described as *Salmo confluentus* in 1859, bull trout is a native North American char of the family Salmonidae (Cavender 1978, pp.146-147). Prior to 1978, bull trout and Dolly Varden (*Salvelinus malma)* were considered a single species. Subsequent work demonstrated species distinction as well as little to no interbreeding where the two species overlap (Cavender 1978, entire; Crane *et al.* 1994, pp. 182-183; Leary and Allendorf 1997, p. 715). In the coterminous U.S., Dolly Varden occurs only in western Washington, with some overlap with the current bull trout distribution.

Bull trout have both resident and migratory life history strategies (Rieman and McIntyre 1993, p. 2). The size and age of bull trout at maturity depends upon habitat capacity and subsequent life history strategy. Resident fish tend to be smaller than migratory fish at maturity and produce fewer eggs (Fraley and Shepard 1989, pp. 135-137; Al-Chokhachy and Budy 2008, pp. 1716-1717). Bull trout normally reach sexual maturity in 4 to 7 years (Johnston *et al.* 2007, pp. 14-16). They frequently live for 10 years and occasionally for 20 years or more (McPhail and Baxter 1996, pp. 14-15; Al-Chokhachy and Budy 2008, entire).

Of native salmonids in the Pacific Northwest of the United States, bull trout have the most specific habitat requirements (Rieman and McIntyre 1993, p. 4), which are often referred to as "the four Cs": cold, clean, complex, and connected habitat. Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, entire; Hoelscher and Bjornn 1989, entire; Sedell and Everest 1991, entire; Howell and Buchanan 1992, entire; Pratt 1992, entire; Rieman and McIntyre 1993 pp. 4-7, 1995 entire; Rich 1996, pp. 1-9; Watson and Hillman 1997, entire; Shellberg 2002, entire; Al-Chokhachy *et al.* 2010, entire). Juveniles remain in the substrate after hatching, such that the time from egg deposition to emergence of fry can exceed 200 days. During the relatively long incubation period in the gravel, bull trout eggs are especially vulnerable to fine sediments, streambed scour, and water quality degradation (Fraley and Shepard 1989, p. 141; Shellberg et al. 2010, p. 636-637, Bowerman et al. 2014, pp. 1065-1067).

Bull trout are distributed from Coastal Alaska and Western Canada, south to the Pacific Northwest, and portions of the middle and northern Rocky Mountains. Within the coterminous United States portion of the range, bull trout are currently known to occur in the Columbia and Snake River basins; the Puget Sound and Olympic Peninsula coastal basins; and the Saint Mary and Upper Klamath River basins. At the time of listing in 1999 bull trout in the coterminous United States, although still widely distributed in portions of Washington, Oregon, Idaho, Montana, and Nevada, were considered to be in widespread decline (Quigley and Arbelbide 1997, p. 1177). As recently as 1975, bull trout occurred in the Sacramento River basin in California, specifically the McCloud River (Behnke 2002, pp. 296–297).

Summary of Needs

The needs of a species are those ecological conditions that allow it to maintain itself over time. We applied a hierarchy that progressed from individuals, local population, core area, recovery/representative unit, and ultimately the coterminous level, to characterize what bull trout require to remain viable into the future. To assess viability into the future, understanding the species' needs across this hierarchy is critical.

An individual's basic resource needs include habitat for breeding, rearing, feeding, sheltering, and dispersal. We categorize habitat needed to fulfill the life cycle of bull trout into Spawning and Rearing (S&R), and Feeding, Migration, and Overwintering (FMO). Beyond the needs of the individual are the demographic needs of a population to persist despite stochastic events that disturb the species or its habitat. The habitat and demographic needs for bull trout were based on our understanding of life history and ecology (Figure ES 1).

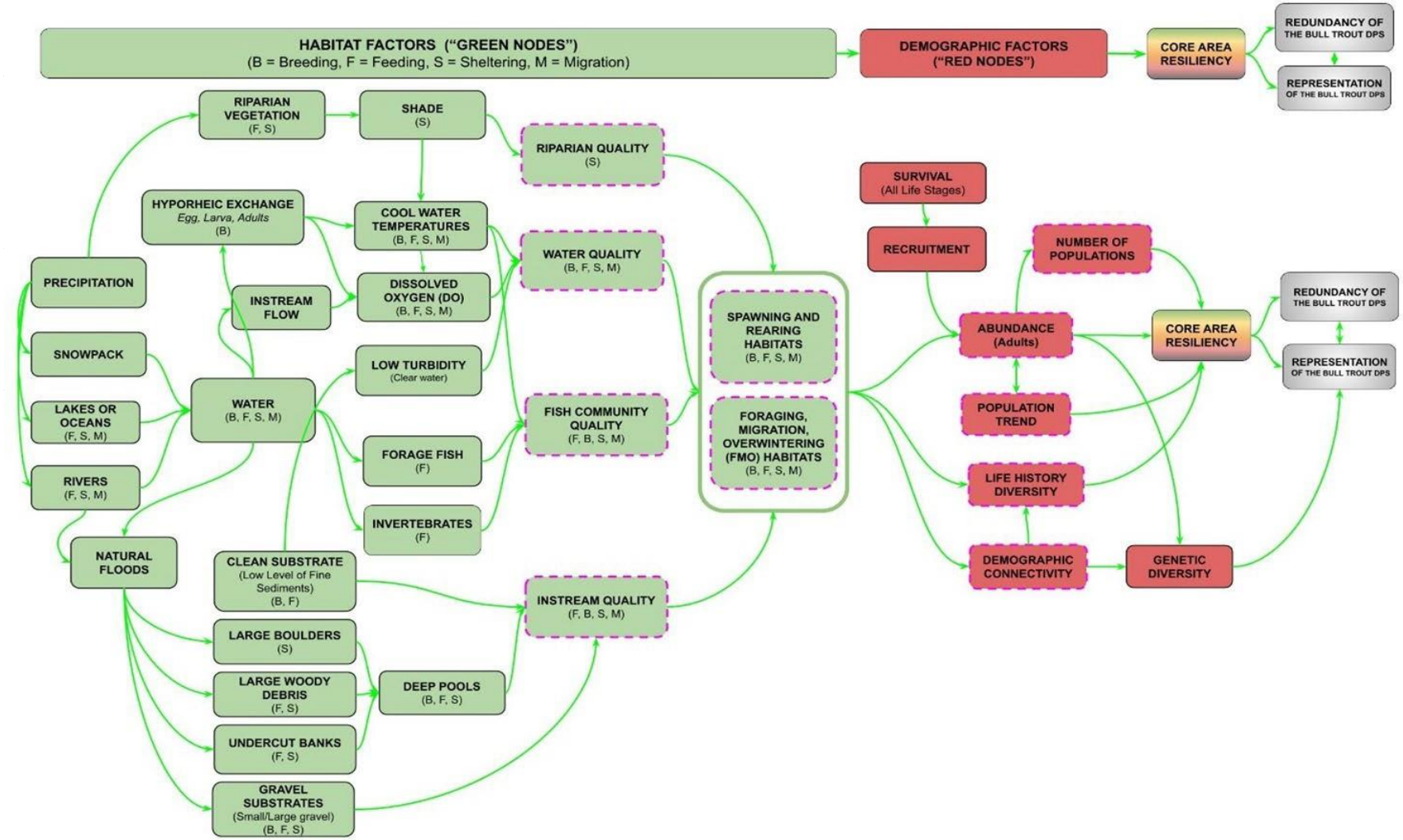


Figure ES 1. Conceptual model for the resiliency of bull trout DPS core areas, in terms of habitat factors (green boxes) needed by individuals to breed (B), feed (F), shelter (S), and migrate (M), and demographic factors (red boxes) that populations need to be resilient. Green arrows represent positive relationships between nodes. Not all relationships are shown. The core conceptual model is provided at the top of the figure for reference. The primary drivers for resiliency are highlighted with a red, dashed outline.

A bull trout individual's habitat needs are reflective of the needs of a population and encompass the resources and abilities to access those resources. We identified the following habitat factors needed by individual bull trout to successfully complete all stages of their life cycle, ultimately contributing to the resiliency of a core area (see also Figure ES 1).

- **Water Quality** – All life stages need enough clean and cold water to breed, feed, and shelter for each life stage to survive.
- **Feeding, Migration, and Overwintering (FMO) Habitat Access** – Connectivity between spawning and rearing habitats and feeding migrating and overwintering habitats which provided diverse resources.
- **Fish Community Quality** – habitat with limited interaction with deleterious nonnative species.
- **Instream Quality** – In-water habitat with complex substrates, stream morphology, and structure to meet the needs of each life stage.
- **Riparian Quality** – Intact habitat within the riparian corridor which provides shade, channel complexities, insect communities, and allochthonous inputs leading to higher quality instream habitat and water quality.
- **Spawning and Rearing (SR) Habitat Quantity** – having a sufficient amount and quality of habitat to allow for individual adults to spawn and juveniles to rear.

The demographic needs of bull trout are conditions that each core area needs to be resilient. We identify five primary demographic factors that are important to resiliency of a core area (see also Figure ES 1).

- **Growth rate/Population trend** – the trajectory of a population
- **Life history diversity** – what life history expressions are present in a core area (resident, migratory [fluvial, adfluvial, anadromous], or a combination).
- **Number of populations** – number of occupied local populations making up the core area
- **Demographic Connectivity** – the ability of individuals from one local population to be able to access other local populations within a core area to help maintain genetic diversity.
- **Abundance** – the number of breeding age adults making up the core area.

Summary of Causes and Effects

Our cause-and-effect analysis identified a comprehensive suite of sources and stressors that may have caused the species' current condition and that may affect its future condition. Along with these sources and stressors, we also consider activities (conservation efforts) that can positively affect bull trout at the individual, core area, or DPS levels, either currently or into the future. Together these factors influence the viability of the bull trout DPS.

The cause-and-effect analysis illustrates the causal relationships between stressors and a species' habitat and demographic needs and highlights the most probable hypotheses for how these stressors affected the current conditions. We examined the ways in which conservation efforts have lessened or interrupted the effects of these stressors, and then analyzed these efforts in more detail with respect to future conditions. Stressors alter optimal air and water temperatures, stream flows, runoff, and sedimentation rates; create physical barriers and impediments to spawning and rearing and FMO habitats; and reduce the availability of woody debris that provides the complex cover needed in bull trout habitats.

Some stressors may directly influence the demographics of a core area through mortality of individuals resulting from actions or activities such as hydropower turbine strikes. Other stressors such as land development, may first affect habitat factors that then indirectly affect demographic factors. Some stressors may directly affect individuals and habitat factors at the same time. We reviewed potential stressors to the bull trout DPS (see USFWS 2015, Recovery Plan and Recovery Unit Implementation Plans). The potential stressors we evaluated for bull trout were organized into four primary themes:

- Climate change
    - Seasonal water availability
    - Change in air and water temperature
    - Dynamic weather patterns
    - Wildland fire
- Forest and lands management
    - Forest management
    - Agricultural management
    - Residential and urban development
    - Roads and transportation networks
    - Mining
    - Recreation
    - Beaver management
- Water management
    - Dams (hydropower, flood control, and water supply)
    - Irrigation and water diversion
- Fisheries management
    - Angling
    - Hatchery introductions
    - Illegal activities
    - Nonnative species
    - Disease and pathogens

Through our cause-and-effect analysis, we identified the most significant stressors acting on the habitat and demographic needs of bull trout and the effect pathways through which these stressors exert an influence. Our conceptual model (ES 2) illustrates these effect pathways.

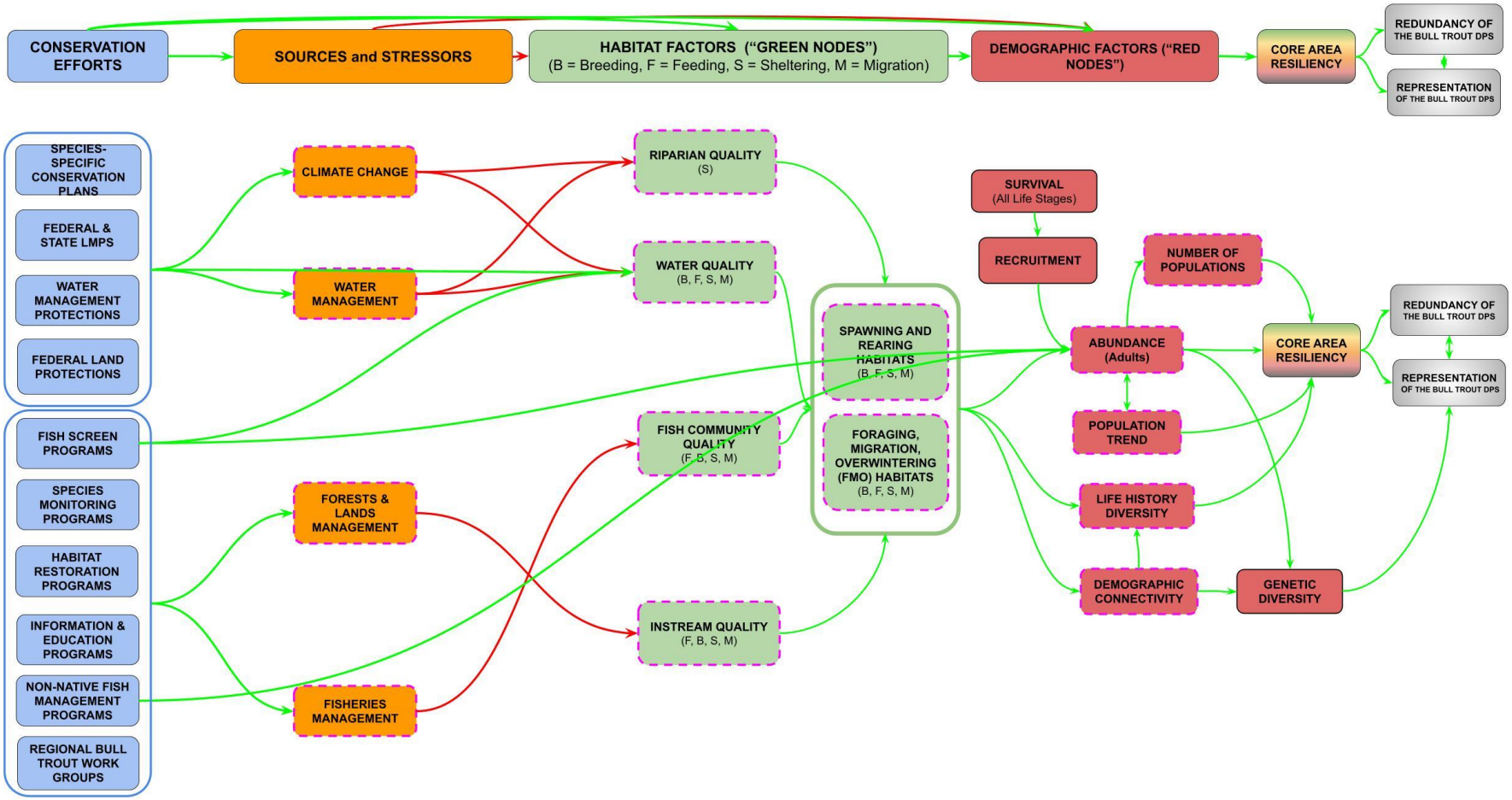


Figure ES 2. Simplified conceptual model for the primary causes (conservation efforts, sources, and stressors) and effects on individuals or core areas that may cumulatively influence the resiliency of core areas for the bull trout DPS. B = breeding, F = feeding, S = sheltering, and M =migration. Green arrows represent positive relationships between nodes and red arrows represent negative relationships between nodes. The five habitat factors and six demographic factors (with pink outlines) were used to score resiliency. Note: Not all relationships are shown.

Climate change affects the habitat needs of bull trout through impacts to seasonal water quality and quantity, riparian quality, and habitat quantity which in turn affect the essential spawning and rearing and FMO habitats. All the demographic needs of bull trout are intricately connected to and can be affected by these habitat impacts. Specific climate-related effects on the current condition of bull trout include declines in snowpack and snowmelt water which affect stream flow and timing, as well as water quality (e.g., temperature), to which bull trout are particularly vulnerable. Increases in air and water temperatures may drive cold-dependent species like bull trout to higher elevations with more limited access and connectivity. Size and frequency of fire-related disturbance can result in habitat loss and fragmentation of aquatic resources in response to climate change and past land management.

Forest and land management activities affect the habitat needs of bull trout through impacts to riparian quality and water quality, which in turn affect the essential spawning and rearing and FMO habitats. As with climate change, these types of habitat disruption have an impact on all the demographic needs of bull trout. Specific effects of forest and land management on the current condition of bull trout result from general development, timber extraction and road construction. These activities can reduce necessary woody debris in stream channels which provide complexity and protective cover to stream habitats occupied by bull trout. Timber extraction also increases erosion and sedimentation rates that promote excessive substrate movement resulting in increases in egg and juvenile mortality, and reduction of habitat.

Water management activities affect the habitat needs of bull trout through impacts to riparian and water quality and quantity, which in turn affect the essential spawning and rearing and FMO habitats. Demographic needs including connectivity and abundance may be directly affected by water management activities, such as dams, irrigation diversions, and road crossings, which often form impassable barriers to fish movement and cause entrainment and mortality. Water management activities present physical barriers, change stream temperature and flows, and increase sedimentation, all of which have had effects on the current condition of bull trout presenting impediments to optimal migration, foraging, and reproduction.

Fisheries management practices associated with past and ongoing introductions of nonnative and hatchery-reared native fish species, may affect the habitat needs of bull trout through degradation of fish community quality which in turn can affect access to essential habitats and competition with nonnative fish species within these habitats. The current condition of bull trout has been affected by the introduction and presence of deleterious nonnative fish species that compete with bull trout for resources including food and space. Increased interactions between bull trout and nonnatives could lead to increased predation on, displacement of, and hybridization with bull trout with declines in abundance and extirpation in some areas.

The SSA analysis is focused on stressors which result in population level effects to the species, though individual level effects can be important when considering cumulative stressors. The stressors and associated effects determined to be most significant at the population level were included in the SSA current and future condition analyses and considered when assigning resiliency scores for habitat and demographic factors. Stressors with the potential for population

level impacts that were limited in geographic scope were evaluated as part of the core area threats assessment process.

Summary of Current Condition

The current condition of each core area was systematically evaluated using a condition category table (CCT). The CCT is a model which defines categories of health and functionality for each of the five demographic and six habitat factors representing the habitat and demographic needs of bull trout. These categories were used to assess the current condition of each factor and, when combined, to evaluate the resiliency of each core area. Our evaluation of resiliency is calibrated to the standardized categories in the condition category table, insuring to the extent possible, a consistent and methodical approach across the core areas and bull trout DPS. Those core areas with higher levels of resiliency are more likely to persist than those with lower levels of resiliency, as calibrated by the CCT. We summarized our evaluation of current condition for the bull trout DPS in terms of the 3Rs: resiliency, redundancy, and representation.

All bull trout core areas were assigned a total resiliency score which was the weighted sum of the individual scores for all eleven current condition factors, including six habitat factors and five demographic factors (Figure ES 2). Scores were assigned consistently to all 110 core areas, both simple and complex, recognized as extant at listing to characterize the current viability of bull trout. Simple core areas have only one local population and inherently have reduced resiliency when compared to complex (more than one local population) core areas. Total resiliency scores fell within one of the following 5 equal interval score categories: Very High (3.97–4.62), High (3.30–3.96), Medium (2.64–3.29), Low (1.97–2.63) and Very Low (1.31–1.96). The categories represent relative levels of stochastic risk for each factor, with very high being the most resilient, and functionally extirpated (a sixth category) being without resiliency, based on the condition of the factor as described in the table's rows. There are seven historical core areas and one Resource Needs Area (RNA), all extirpated at the time of listing with no current resiliency, which were included in Future Resiliency ranking for a total of 118 core areas in that evaluation.

Across the DPS, one core area in the Columbia Headwaters RU has become extirpated since listing, no core areas ranked very low resiliency, 20 core areas ranked low resiliency, 45 core areas ranked medium, 26 core areas ranked high, and 18 core areas ranked very high (Table ES 1 and Figure ES 3). We summarized individual core area scores and present their overall relative resiliency in Table 5.

Table ES 1. Summary of Current Condition resiliency categories for all 118 bull trout core areas across the coterminous range in the United States. Included are the seven historical core areas, one RNA, and three core areas extirpated since listing.

Core Area Resiliency

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated	Total
Coastal	2	8	7	3	0	5	25
Columbia Headwaters	2	5	20	9	0	1	37
Klamath	0	0	1	2	0	0	3
Mid-Columbia	4	7	9	4	0	3	27
Saint Mary	0	0	4	0	0	0	4
Upper Snake	10	6	4	2	0	0	22
Bull Trout DPS	18	26	45	20	0	9*	118

** Includes eight core areas that currently do not have resiliency; seven core areas that were extirpated historically and one RNA.*

The current condition of bull trout is varied across the range. Thirty-seven percent (n = 44) of the listed range have high or very high resiliency. In general, core areas with high or very high resiliency occupy large, interconnected habitats with thermal refuge in the form of stream hydrographs driven by snow melt and/or access to FMO habitat in lake and large river systems. Typically, these core areas have high demographic scores and few habitat threats. Medium resiliency is documented in 38 percent (n = 45) of core areas across the listed range. In some cases, medium resiliency core areas have reduced demographic scores but high habitat factor scores. Other medium resiliency core areas have high demographic scores but low habitat scores. Some medium resiliency core areas are spatially limited, simple core areas which limits the maximum scores achievable. Others are larger complex core areas where demographic and/or habitat threats were identified. Core areas with low resiliency comprise 17 percent (n = 20) of core areas. These core areas have low demographic and habitat scores. Of the 20 core areas with low resiliency (none have very low resiliency), 55 percent are simple core areas. One core area has become extirpated since listing. Lake Pend Oreille C was occupied with low abundance at listing but has since become extirpated.

Redundancy is the ability of a species to withstand catastrophic events and is best achieved by having multiple resilient populations (core areas) widely distributed across the species' range. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species, and the greater redundancy a species has, the more viable it will be. We characterize redundancy by describing the number and distribution of bull trout core areas relative to the scale of anticipated catastrophic events. The more widespread the core areas are, the better able the DPS can withstand a catastrophic event as it is unlikely to impact all core areas across the range. The Bull Trout DPS has a high level of redundancy across the range. Currently there are 109 extant core areas across the same major watersheds and spatial area occupied at listing. Extant core areas are resilient in five States within numerous large river and lake systems across the range. All six Representation Units currently contain multiple extant core areas.

Representation describes the ability of a species to adapt to changing environmental conditions and is measured by the genetic, ecological, and life history diversity of bull trout across the 109

currently extant core areas and the six representative units. Bull trout exhibit ecological plasticity across the range occupying a variety of ecological regions and utilizing a suite of habitat types depending on life stage and life history expression. Currently, a diverse set of genetic, ecological, and life history components are evident within the species range.

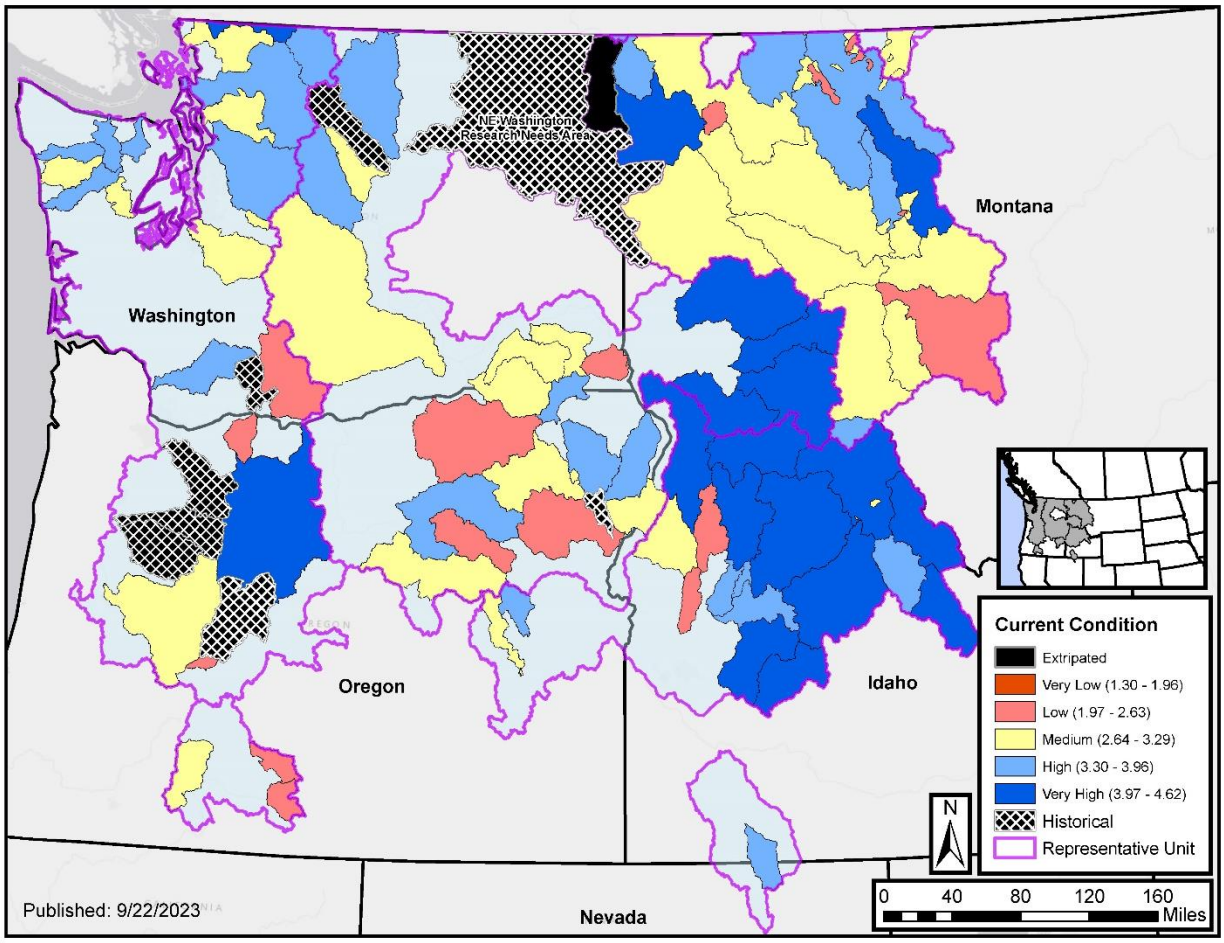


Figure ES 3. Map of current resiliency ratings of the 118 Bull Trout core areas. The seven historical core areas and the RNA are shown in black hatch and currently have no resiliency.

Summary of Future Condition

To assess future conditions, we conducted a future scenario analysis. In that analysis we developed five scenarios to represent different plausible futures in terms of climate conditions and associated environmental variability and the level of implementation of 10 conservation efforts. The scenarios range from "substantially improved conservation in a warmer climate" (scenario 1), to "substantially decreased conservation in a hotter and drier climate" (scenario 5). Each scenario represents a plausible, yet simplified representation of the climatic stressors and conservation efforts likely to influence species viability either directly or indirectly. The actual future condition could include a combination of factors from any of these scenarios. Scenarios are qualitative in nature, include a high level of uncertainty, and are intended to frame the extent

of potential future impacts of climate change, associated environmental variability, and the implementation of conservation actions. Although there may be different probabilities associated with our future scenarios, all five of our scenarios are assumed equally plausible for the purposes of this analysis.

For each future scenario we projected core area resiliency 60 years into the future using the same methodology and condition category model we used to evaluate current condition. In the absence of quantitative, predictive models, we relied on best professional judgment to evaluate conditions under the five plausible future scenarios. The same weighted average used for current condition was applied to calculate overall resiliency for each core area and redundancy and representation of the DPS were evaluated for each future scenario.

Future Resiliency

The resiliency of all 118 core areas is projected under conditions outlined in future scenario 1, substantially improved conservation in a warmer climate, using the condition category model. No core areas are rated very low, 1 (1 percent) rated low, 38 (32 percent) rated medium, 27 (23 percent) rated high, and 49 (42 percent) rated very high resiliency. Three (3 percent) core areas are projected to remain extirpated in 60 years, of which all are historical core areas. No currently extant core areas are projected to become extirpated under this scenario. Four historical core areas and the RNA are rated as medium resiliency based on the assumption that under this scenario reintroduction or recolonization of bull trout is plausible. Scenario 1 core area resiliency ratings are displayed in Table ES 2 and Figure ES 4.

Table ES 2. Summary of future scenario 1 (substantially improved conservation in a warmer climate) resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated
Coastal	11	6	6	0	0	2
Columbia Headwaters	12	6	19	0	0	0
Klamath	0	1	2	0	0	0
Mid-Columbia	11	7	7	1	0	1
Saint Mary	1	1	2	0	0	0
Upper Snake	14	6	2	0	0	0
DPS	49	27	38	1	0	3

The resiliency of all 118 core areas is projected under conditions outlined in future scenario 2, increased conservation in a warmer climate. No core areas are rated very low, 8 (7 percent) rated low, 41 (35 percent) rated medium, 36 (31 percent) rated high, and 26 (22 percent) rated very high resiliency (Table 8). Seven (6 percent) core areas are projected to be extirpated in 60 years; these include 6 of the 7 historical core areas, and the RNA. No currently extant core areas are projected to become extirpated under this scenario. Scenario 2 resiliency ratings are displayed in Table ES 3 and Figure ES 4.

Table ES 3. Summary of future scenario 2 (increased conservation in a warmer climate) resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very low	Extirpated
Coastal	4	11	4	2	0	4
Columbia Headwaters	4	9	22	2	0	0
Klamath	0	0	3	0	0	0
Mid-Columbia	5	8	7	4	0	3
Saint Mary	0	2	2	0	0	0
Upper Snake	13	6	3	0	0	0
DPS	26	36	41	8	0	7

The resiliency of all 118 core areas is projected under conditions outlined in future scenario 3 which assumes the implementation of conservation efforts continues at the current rate, magnitude, and effectiveness. In addition, climate conditions are projected to be hotter and wetter in this scenario. Overall resiliency is lower under this scenario than in scenario one, two and current condition. Throughout the bull trout DPS no core area is rated as very low, 17(14 percent) as low, 42 (36 percent) as medium, 25 (20 percent) as high, and 12 (10 percent) as very high resiliency. In addition, 22 (19 percent) core areas are projected to be extirpated in 60 years. Of those 22 core areas, 7 are historical core areas and the RNA that were not expected to recover, one has been extirpated since listing and 13 are currently extant core areas that are projected to become extirpated. Scenario 3 resiliency ratings are displayed in Table ES 4 and Figure ES 4.

Table ES 4. Summary of future scenario 3 (current conservation efforts in a hotter and wetter climate) resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated
Coastal	2	6	8	3	0	6
Columbia Headwaters	2	2	16	7	0	10
Klamath	0	0	1	2	0	0
Mid-Columbia	2	6	10	3	0	6
Saint Mary	0	0	4	0	0	0
Upper Snake	6	11	3	2	0	0
DPS	12	25	42	17	0	22

The resiliency of all 118 core areas is projected under conditions outlined in future scenario 4, decreased conservation in a hotter and drier climate. Overall resiliency is lower under this scenario than in previous scenarios and current condition. Throughout the bull trout DPS 14 (12 percent) core areas are rated as very low, 27 (23 percent) as low, 30 (25 percent) as medium, 14 (12 percent) as high and none were rated as very high resiliency. In addition, 33 (28 percent) core areas are projected to be extirpated under this scenario in 60 years. Of those 33 extirpated core areas, 24 are currently extant. The remaining eight extirpated core areas are historical core areas and the RNA which do not currently support self- sustaining bull trout populations. Scenario 4 resiliency ratings are displayed in Table ES 5 and Figure ES 4.

Table ES 5. Summary of future Scenario 4 (decreased conservation in a hotter and drier climate) resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated
Coastal	0	2	6	5	4	8
Columbia Headwaters	0	2	5	8	5	17
Klamath	0	0	0	1	2	0
Mid-Columbia	0	4	6	8	2	7
Saint Mary	0	0	2	2	0	0
Upper Snake	0	6	11	3	1	1
DPS	0	14	30	27	14	33

The resiliency of all 118 core areas is projected under conditions outlined in future scenario 5, substantially decreased conservation in a hotter and drier climate. Overall resiliency is lowest under this scenario compared to previous scenarios and current condition. Throughout the bull trout DPS 15 (13 percent) core areas are rated as very low, 29 (25 percent) as low, 23 (19 percent) as medium, 1 (1 percent) as high and none are rated as very high resiliency. Fifty (4 percent) core areas are projected to be extirpated within 60 years, including 41 currently extant core areas. Scenario 5 resiliency ratings are displayed in Table ES 6 and Figure ES 4.

Table ES 6. Summary of future Scenario 5 (substantially decreased conservation in a hotter and drier climate) resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated
Coastal	0	0	3	7	5	10
Columbia Headwaters	0	0	2	5	4	26
Klamath	0	0	0	0	1	2
Mid-Columbia	0	0	6	8	4	9
Saint Mary	0	0	0	3	1	0
Upper Snake	0	1	12	6	0	3
DPS	0	1	23	29	15	50

Future Redundancy

The number and distribution of resilient core areas across the DPS describes redundancy and the species' ability to withstand large scale catastrophes including, but not limited to, drought, wildland fire and flooding (see Figure ES 4). In scenario 1, 115 extant core areas are distributed throughout all six representative units in the DPS (Table ES 2 and Figure ES 4). In scenario 2, 111 extant core areas are distributed throughout all six representative units in the DPS (Table ES 3 and Figure ES 4). In scenario 3, 96 extant core areas are distributed throughout all six representative units in the DPS (Table ES 4 and Figure ES 4). In scenario 4, 85 extant core areas are distributed throughout all six representative units in the DPS (Table ES 5 and Figure ES 4). In scenario 5, 68 extant core areas are distributed throughout all six representative units in the

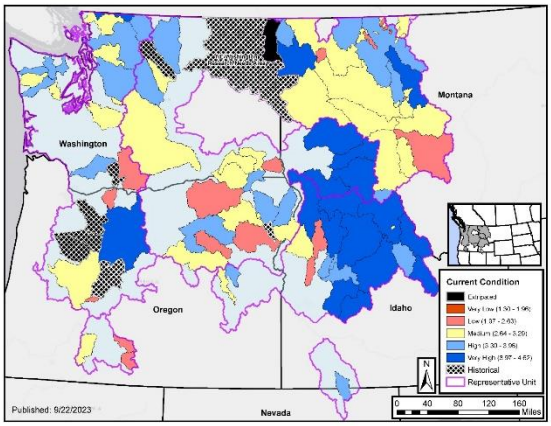
DPS (Table ES 6 and Figure ES 4). The reduction in core areas and thus future redundancy seen in scenarios 3,4, and 5 is associated with worsening climate conditions and declines in conservation efforts (scenarios 4 and 5) examined in the future scenarios.

Future Representation

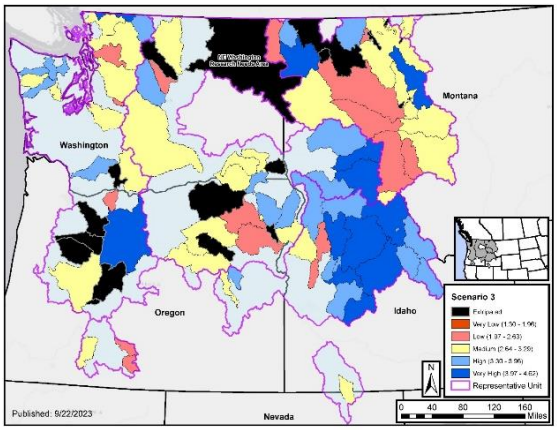
Representation is the ability of a species to adapt to changing environmental conditions over time, as indicated by genetic and environmental diversity within and among populations. This diversity for bull trout is captured by the six representative units that comprise the DPS. The greater number of resilient core areas within each representative unit, the greater the representation and therefore the more likely bull trout will be able to adapt to changing environmental conditions on both a long-term and short-term time scale.

Bull trout currently occupy a wide breadth of ecological settings from the high desert of the Klamath and Upper Snake Representative Units to the temperate coastline of the Coastal Representative Unit. Within this wide and varied distribution, population level genetic structuring, inter-population connectivity, and the ability to express a full range of life history types provide bull trout the opportunity to adapt to new and changing environments. Conditions set forth under scenario 1 not only retain the current degree of representation but build on it by improving core area resiliency throughout the DPS. Implemented conservation efforts are anticipated to result in the removal of barriers, to suppress nonnative species, to improve and protect habitats, and generally to manage for the protection of bull trout, ultimately increasing effective population size, improving gene flow and expanding occupied habitats (see Figure ES 4).

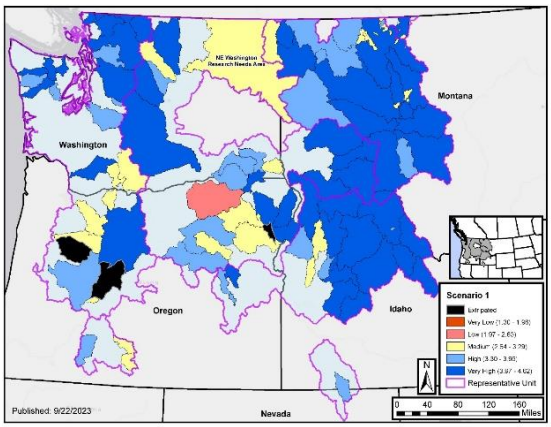
Conditions set forth under scenario 2 retain the current degree of representation but build on it slightly by improving resiliency in some core areas throughout the DPS. Implemented conservation efforts are anticipated to result in providing passage past barriers, managing non-native species, restoring key riparian and upland habitats, and generally managing for the protection of native species, ultimately maintaining, and in some cases, improving effective population size, improving gene flow, and preserving occupied habitats (see Figure ES 4).



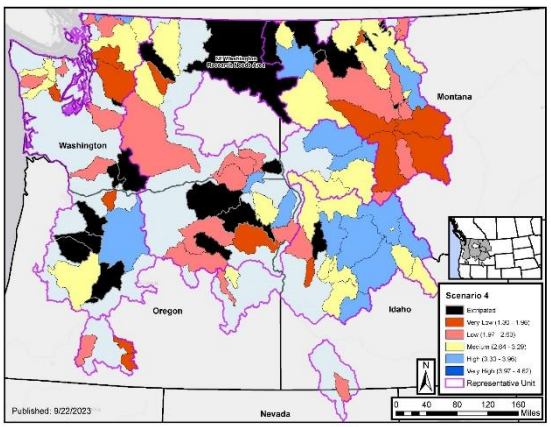
Map of current resiliency ratings for the 118 core areas.



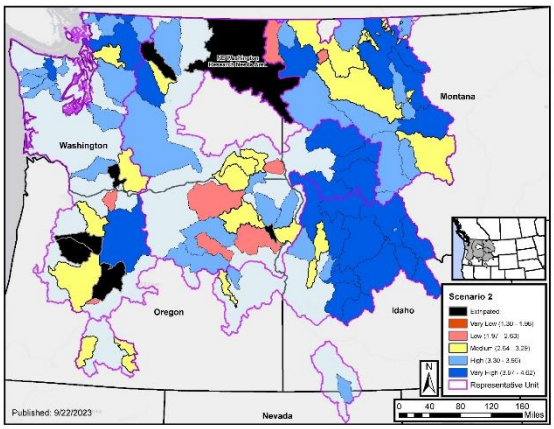
Future Scenario 3 resiliency ratings for the 118 core areas.



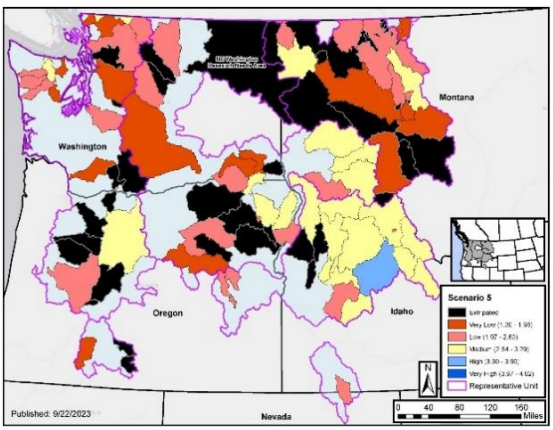
Future scenario 1 resiliency ratings for the 118 core areas.



Future scenario 4 resiliency ratings for the 118 core areas.



Future scenario 2 resiliency ratings for the 118 core areas.



Future scenario 5 resiliency ratings for the 118 core areas.

Figure ES 4. Maps of core area resiliency ratings for the 118 bull trout core areas under current and future conditions.

Representation decreases under conditions outlined in Scenario 3 compared to previous scenarios and current condition. The current rate of implementation and degree of effectiveness of conservation, as well as a hotter and dry climate, is projected to result in multiple core area extirpations throughout the DPS. Twenty-two core areas are anticipated to be extirpated, 13 of those are the loss of currently extant core areas. The Coastal, Columbia Headwaters and Mid-Columbia Representative Units lose 1 (5 percent), 9 (25 percent), and 3 (13 percent) of their currently extant core areas respectively. These extirpated core areas represent an overall decrease in effective population size, potentially less genetic diversity, and likely less population connectivity and therefore reducing their capacity to adapt to new and changing environments (see Figure ES 4).

Decreased conservation and a hotter and drier climate are projected to result in multiple core area extirpations throughout the DPS under scenario 4. Thirty-three core areas are anticipated to be extirpated, 24 of those are the loss of currently extant core areas. The Coastal, Columbia Headwaters, Mid-Columbia and Upper Snake Representative Units lose 3 (15 percent), 16 (44 percent), 4 (17 percent) and 1(5 percent) of their currently extant core areas respectively. These extirpated core areas represent an overall decrease in effective population size, potentially less genetic diversity, and likely less population connectivity and therefore reducing their capacity to adapt to new and changing environments (see Figure ES 4).

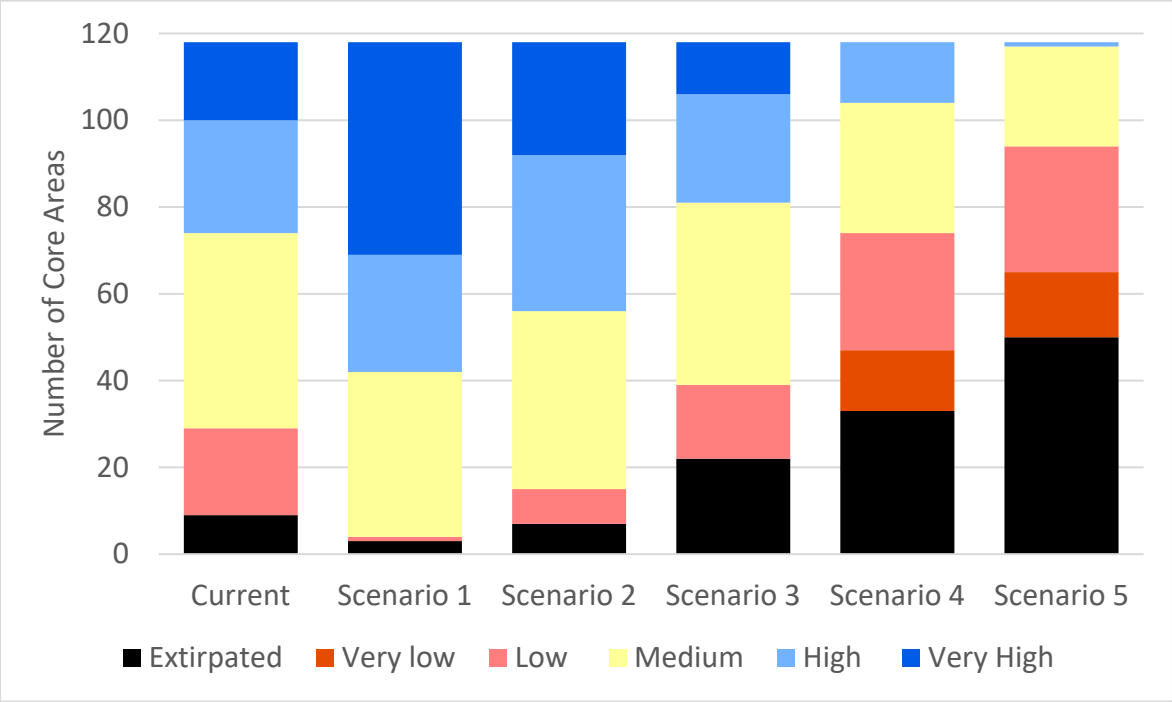


Figure ES 5. Summary of core area resiliency by scenario across the coterminous DPS.

Substantially decreased conservation and a hotter and drier climate is projected to result in multiple core area extirpations throughout the DPS under scenario 5. Fifty core areas are anticipated to be extirpated, 43 of those are the loss of currently extant core areas. The Coastal, Columbia Headwaters, Klamath, Mid-Columbia, and Upper Snake Representative Units lose 5 (25 percent), 25 (69 percent), 2 (67 percent), 6 (25 percent) and 3 (14 percent) of their currently

extant core areas respectively. These extirpated core areas represent an overall decrease in effective population size, potentially less genetic diversity, and less population connectivity and therefore reducing their capacity to adapt to new and changing environments (see Figure ES 4).

Summary of Viability

Bull trout viability depends upon the species' ability to sustain core areas in the face of normal environmental stochasticity, catastrophes, and novel changes in its environment. The species' ability to do so is influenced by the condition and distribution of its core areas. Demographically and physically robust populations are better able to withstand and recover from environmental variability and disturbances and are more likely to withstand and recover from events that would otherwise be catastrophic. Populations spread across heterogeneous conditions are unlikely to be exposed at the same time to poor environmental conditions, thereby guarding against synchronous population losses. Lastly, in addition to conserving cold water habitats and migratory corridors, populations spread across the breadth of genetic and phenotypic diversity help to preserve this wide-ranging species' adaptive capacity, which are essential for adapting to ongoing climate change impacts and associated changes to their environment. Without such variation, species are less responsive to change and more prone to extinction.

Historically, bull trout within the coterminous U.S. were widely distributed, occupying portions of six states. Currently bull trout remain widespread within 109 extant core areas within five states (Figure ES 4). The analysis of current resiliency indicates two of the six representation units (Klamath and St. Mary) lack core areas with high to very high resiliency. Despite being widespread across a diversity of habitats, seven historical core areas no longer support bull trout (excluding historical population(s) in California). One core area has become extirpated since listing under the ESA and known losses in distribution (including extirpations of some local populations) have occurred within extant core areas. These extirpations and losses in distribution are primarily due to (1) loss and degradation of habitat, (2) impacts from nonnative fish, and (3) effects of climate change.

Despite a warmer climate our projections suggest resiliency can be improved for most core areas across all six representation units with increased or substantially increased conservation effort. With the current level of conservation and even less favorable climate conditions, our projections suggest resiliency of most vulnerable core areas will decline into the future with an increased likelihood of additional extirpations of some core areas. With the least favorable climate change projection and decreased (scenario 4) or substantially decreased (scenario 5) conservation efforts resiliency across all core areas will decline substantially. In these future scenarios, only 85 and 68 core areas will persist across the conterminous range, respectively. Under the worst-case climate and conservation scenario, only one remaining core area is projected to have at least high resiliency (Figure ES 6).

As core area resiliency fluctuates, so does redundancy and representation of the DPS (Table ES 7). Retaining resilient core areas spread across representative units allows for the species to adapt to changing environmental conditions over time, indicated by genetic and environmental diversity within and among populations. Retaining widespread distribution of resilient core areas

across the DPS allows the species to withstand large scale catastrophes including, but not limited to, drought, wildfire, and flooding. Figures ES 4 and ES 5 show the plausible range of resiliency, redundancy, and representation for bull trout in the current and future (2080) timeframe.

Table ES 7. Summary of viability for the bull trout DPS in terms of resiliency across core areas, and redundancy and representation across the DPS, currently and 60 years into the future under 5 plausible future scenarios.

3 Rs	Current Condition	Future Scenario 1	Future Scenario 2	Future Scenario 3	Future Scenario 4	Future Scenario 5
Resiliency	18 - Very High 26 - High 45 - Medium 20- Low 0 - Very Low 1 – Extirpated*	49 - Very High 27 - High 38 - Medium 1 - Low 0 - Very Low 3 - Extirpated	26 - Very High 36 - High 41 - Medium 8 - Low 0 - Very Low 7 - Extirpated	12 - Very High 25 - High 42 - Medium 17 - Low 0 - Very Low 22 - Extirpated	0 - Very High 14 - High 30 - Medium 27 - Low 14 - Very Low 33 - Extirpated	0 - Very High 1 - High 23 - Medium 29 - Low 15 - Very Low 50 - Extirpated
Redundancy	109 Core Areas, widely distributed	115 Core Areas, widely distributed	111 Core Areas, widely distributed	96 Core Areas, widely distributed	85 Core Areas, widely distributed	68 Core Areas, widely distributed
Representation	Diversity across 109 core areas & 6 Rep Units	Diversity across 115 core areas & 6 Rep Units	Diversity across 111 core areas & 6 Rep Units	Diversity across 96 core areas & 6 Rep Units	Diversity across 85 core areas & 6 Rep Units	Diversity across 68 core areas & 6 Rep Units

** Does not include the 7 historical core areas and 1 RNA.*

Realizing climate change is likely to impact all core areas negatively across the DPS, an increase in focused conservation across the DPS is the path to stabilizing viability of bull trout into the future.

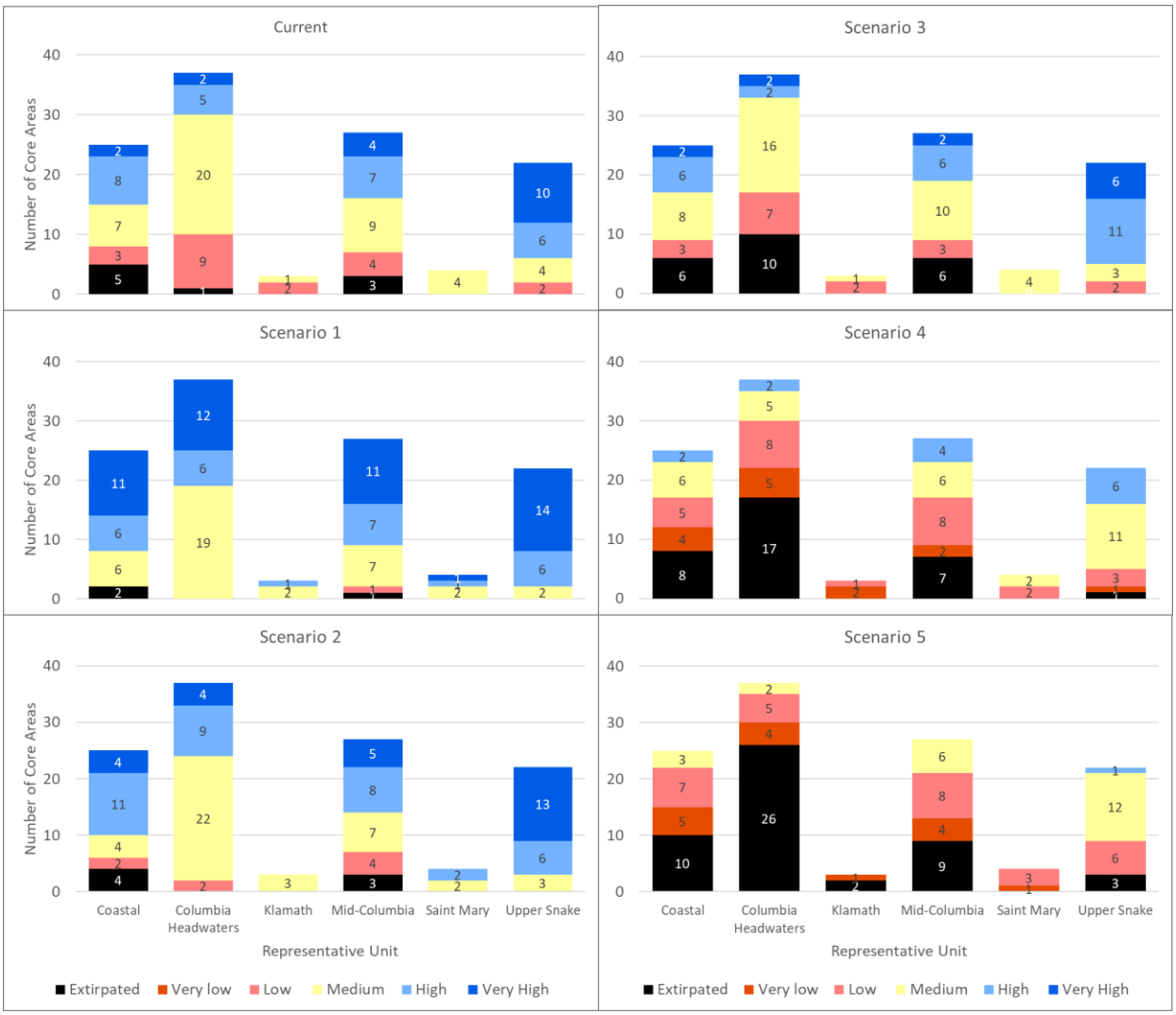


Figure ES 6. Summary of Representation and Core Area Resiliency by Representative Units

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Chapter 1 - Introduction and Analytical Framework

1.1 Regulatory Background

On November 1, 1999, the Service listed all populations of bull trout (*Salvelinus confluentus*) within the coterminous (lower 48 states) United States as a threatened species pursuant to the Endangered Species Act of 1973, as amended (Act) (64 FR 58910). Incorporating what had been considered three separate distinct population segments (DPS) previously, the 1999 listing designated one DPS of bull trout within the coterminous United States by including bull trout in the Coastal- Puget Sound populations (Olympic Peninsula and Puget Sound regions) and Saint Mary-Belly River populations (east of the Continental divide in Montana) with previous listings of three separate DPSs of bull trout in the Columbia River, Klamath River, and Jarbidge River basins (63 FR 31647, June 10, 1998; 64 FR 17110, April 8, 1999). This coterminous listed entity is the subject of this Species Status Assessment (SSA) report.

On November 17, 2010, the Service designated critical habitat for bull trout across the DPS (75 FR 63898; October 18, 2010). The critical habitat designation includes approximately 19,795 miles (31,857 kilometers) of streams and 488,252 acres (197,589 hectares) of lakes and reservoirs in Idaho, Oregon, Washington, Montana, and Nevada. In Washington, 754 miles (1,213 kilometers) of marine shoreline were also designated.

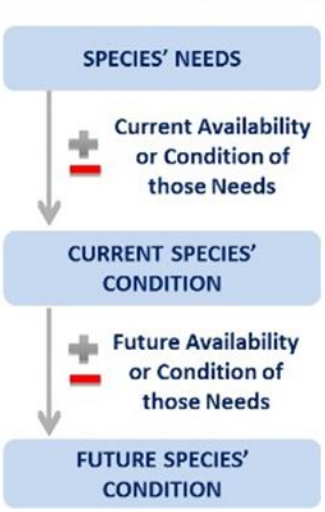
We completed the first 5-year status review for the bull trout DPS on April 25, 2008, in which we concluded that the species remain classified as threatened under the Act. On November 13, 2015, in our next 5-year status review we also concluded that the species remained classified as threatened under the Act. In our 2015 5-year status review, incorporated into the final Recovery Plan, we reported that bull trout were generally “stable” range-wide, with some core areas decreasing, some stable, and some increasing. In general, all but one core areas present at the time of listing in 1999 are present today. Additionally, since listing, conservation measures have been, and continue to be, implemented across the overall range of the bull trout DPS. A wide variety of local and regional partnerships have undertaken these measures, including State fish and game agencies, State and Federal land management and water resource agencies, Tribal governments, power companies, watershed and core area working groups, NGOs, water users, and ranchers.

1.2 Analytic Framework

This SSA report summarizes the biology, life history, ecology, and stressors (threats) for the distinct population segment of bull trout (*Salvelinus confluentus*) in the coterminous United States (hereafter, bull trout or bull trout DPS). A large portion of the extant range of the species exists outside of the DPS in Canada, however, analysis of that portion of the range is outside the scope of the SSA report. This report summarizes the results of a biological risk assessment for the bull trout DPS, using the SSA framework (USFWS 2016, entire; Smith et al. 2018, entire). The SSA framework is an analytical approach that systematically compiles the foundational science on a species to help inform the Service’s decisions under the Act (USFWS 2016, p. 4).

This SSA report is intended to provide a clear, in-depth characterization of the species' biology and ecology; the influence of environmental stressors and conservation management actions on the species' viability; its current biological status, also called its "current condition;" and its projected, plausible future biological status, also called its "future condition," under a range of future scenarios. Viability describes the ability of a species to sustain populations in the wild over time (USFWS 2016, p. 9). This SSA report for bull trout is not meant to describe all accumulated information regarding the species but provides foundational scientific information to help inform recovery planning and the Service's responsibilities under the Act, including a 5-year status review and other actions, as needed. This SSA report is a living document and can be updated as new scientific information becomes available to support all functions of our Endangered Species program.

Figure 1. Species status assessment (SSA) Framework (USFWS 2016, p.6.)



Importantly, this SSA report does not make any decisions by the Service, such as whether a species' status under the Act should be changed. It is not a decision document constituting a final agency action. Instead, this SSA report provides a review of the best available scientific and commercial information regarding the biological status, or condition, of the bull trout. Thus, this SSA report is a stand-alone, science-based document produced independently from the Service's application of policy or regulation, and it provides a review of the available information strictly related to the life-history, ecology, stressors, and current and future viability of bull trout. Any decisions under the Act, such as a 5-year status review recommendation, will be made by the Service after reviewing this document and all relevant laws, regulations, and policies, and the results of any decisions to change status will be announced in the Federal Register, with opportunities for public input, if appropriate.

The SSA framework has three iterative assessment phases, as summarized below and illustrated above in Figure 1.

Phase 1: Species' Needs –Describes the ecological needs of the species at the individual, population, and species levels based on how environmental factors act on the species and its habitat.

Phase 2: Current Species' Condition –Describes the current condition of the species' habitat and demographic needs, the probable explanations for past and ongoing changes in the abundance of populations, and the distribution and diversity of the species.

Phase 3: Future Species' Condition –Projects the species' response to probable future scenarios of environmental conditions and conservation efforts.

As a result, the SSA characterizes the species' viability, or its ability to sustain populations in the wild over time, based on the best scientific understanding of its current and future abundance

(resiliency), distribution (redundancy), and diversity (representation) (USFWS 2016, p. 6). Throughout this report, we describe the needs and viability of bull trout in terms of the conservation biology principles of resiliency, redundancy, and representation, collectively known as the 3Rs (Shaffer and Stein 2000, pp. 307–310; Wolf et al. 2015, entire; USFWS 2016, pp. 12–13, 21; Smith et al. 2018, entire).

The 3Rs are defined as follows:

Resiliency is the ability for populations to persist in the face of stochastic events, or for populations to recover from years with low reproduction or reduced survival. Resiliency is positively associated with demographic factors such as population size (abundance), growth rate, survival, connectivity between populations, and the quality and quantity of habitats, which are directly influenced by other resources needed by the species. Populations need an abundance of individuals within habitat patches of adequate quantity and quality to survive and reproduce despite disturbance (USFWS 2016, p. 12). We evaluated resiliency at the scale of core areas as our standard analysis unit, which are recognized population units for bull trout comprised of a core population and core habitat. A core area may be complex (viewed as a metapopulation containing more than one local population and adjacent habitat) or simple (containing only one isolated local population and typically limited habitat).

Redundancy is the ability for the species to withstand catastrophic events, such as a rare destructive natural event or episode involving many populations. Redundancy is associated with the number and distribution of populations. Catastrophes are stochastic events that lead to population collapse regardless of population health and for which adaptation is unlikely (Mangal and Tier 1993, p. 1083). Redundancy is about spreading risk among multiple populations to minimize potential loss of the species from catastrophic events and is characterized by having multiple, resilient populations distributed within the species' ecological settings and across the species' range. Redundancy can be measured by the number of populations, their spatial extent, and degree of connectivity and assessing the cumulative risk of catastrophes occurring over time. We characterize redundancy as the number and distribution of resilient core areas across the overall range of the DPS.

Representation is the ability of a species to adapt to changes in the environment over time and is associated with its diversity, whether ecological, genetic, behavioral, or morphological. It is characterized by the breadth of genetic and environmental diversity within and among populations. Measures of representation may include the number of varied occupied niches, genetic diversity, or other geographic, genetic, or life history variation of the species. Representation constitutes the persistence of resilient core areas within each of the representation units.

In general, extinction risk will decrease, or at least does not increase, with increases in representation, resiliency, and redundancy. In other words, the more redundant and representative the species is, and the more resilient its populations, the more likely the species is to sustain populations over time, even under changing environmental conditions. A species with a high degree of resiliency, representation, and redundancy (the 3Rs) is better able to adapt to novel changes and tolerate environmental stochasticity and catastrophes. As a result, species

viability will increase with increases in resiliency, redundancy, and representation (Smith et al. 2018, p. 306).

Throughout this report, we use the 3Rs together to characterize the current and projected future viability for the bull trout DPS. The SSA does not assess status of the species related to its historical condition. For this assessment, we define viability as the ability of the bull trout DPS to sustain multiple populations across diverse representative units in natural ecosystems over a biologically meaningful timeframe, in this case, by approximately 2080, or approximately 60 years into the future. While the SSA characterizes viability, it does not determine the future state of the species or whether it is viable. Viability is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations over time (USFWS 2016, p. 9). Our assessment of viability explores and describes the foundational relationships of what influences the 3Rs and the potential changes from the species' current condition to its projected future conditions, given the species' unique life history. (USFWS 2016, p. 13). The term viability denotes a trajectory opposite to extinction and a focus on species conservation (USFWS 2016, p. 9). The 2080, 60-year, timeframe for this assessment is a period that accounts for approximately 8 generations of bull trout and allows adequate time for populations and core areas to respond to stressors (threats) and conservation efforts. It is also the time-period to which we can reasonably project climate conditions based on the best available climate models across the range of the DPS. The 60-year time frame is bounded between 2070 to 2090 to match stream temperature projections used in the analysis (Isaak et al. 2017, entire).

The Service's decisions under the Act are based on an assessment of a species' risk of extinction. The objectives of the SSA report are to inform those decisions through a characterization of species viability, outlined below:

- Summarize bull trout biology, including its taxonomy, distribution, habitat, life history, and life cycle (Chapter 2).
- Describe the ecological needs at the individual, population (core area), and species (coterminous DPS) levels in terms of resiliency, redundancy, and representation (Chapter 3).
- Identify known stressors (threats) that negatively influence viability and the conservation actions that positively influence viability (Chapter 4).
- Describe the current condition in terms of the resiliency of populations (core areas), and the redundancy and representation for the bull trout DPS (Chapter 5).
- Project the response of bull trout to plausible future scenarios of environmental conditions and conservation efforts (Chapter 6).
- Summarize current condition and projected future conditions (Chapter 7).
- Describe the uncertainties inherent in the analysis related to data limitations, species-related factors, and modeling assumptions (Chapter 8).

1.3 Core Conceptual Model for Assessment of Viability

For our assessment of viability, we relied on the SSA framework's core conceptual model to describe the current and future conditions of the bull trout DPS, in terms of the 3Rs (USFWS 2016, p. 10; Smith et al. 2018, entire) (Figure 2). The conceptual model illustrates the

relationship between habitat factors that are important to individuals, demographic factors that are important to populations, the resiliency of these populations, and the redundancy and representation at the species-level (Figure 2). For this SSA, we refer to populations of the bull trout DPS as core areas, which are recognized units that include a core population and core habitat. Habitat factors are those resources needed by individual bull trout to breed (including all stages of reproduction), feed, shelter, and survive from one stage in its life cycle to the next and allow successful dispersal of some individuals. Demographic factors, related to distribution and abundance, capture what a population needs to be resilient to stochastic events. The SSA framework includes both habitat and demographic factors in the core conceptual model, illustrating the importance of considering both the needs of individuals and populations in our assessment of the 3Rs. In general, a species needs a certain number and distribution of resilient populations to withstand catastrophes (redundancy) and diversity to adapt to novel, environmental change (representation).

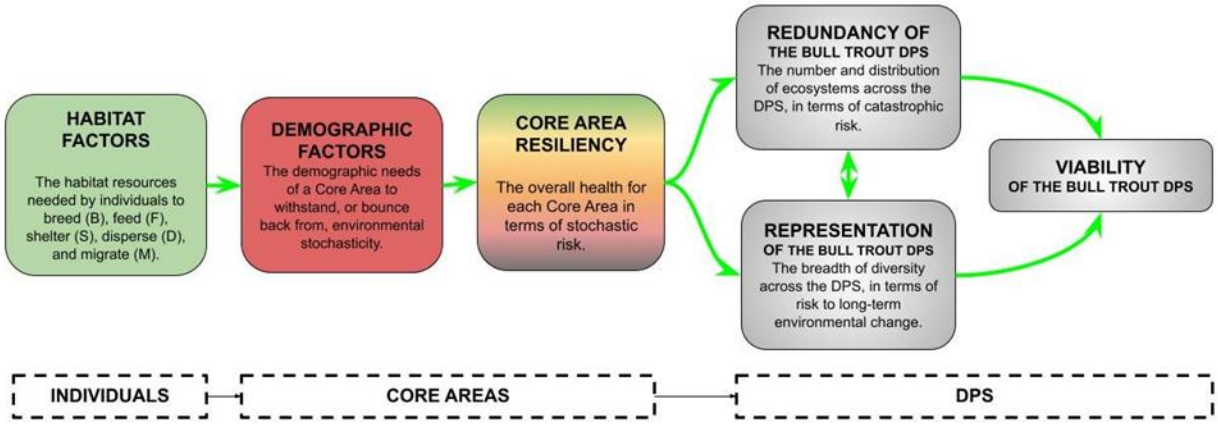


Figure 2. Simple core conceptual model used for our assessment of viability for the bull trout DPS, in terms of the 3Rs of conservation biology: resiliency, redundancy, and representation. Throughout this report, habitat factors are illustrated in green and demographic factors in red. Model based on the core conceptual model for the species status assessment (SSA) framework (USFWS 2016, p. 10). Throughout our assessment, core areas are synonymous with populations and are the scale at which we evaluated the 3Rs.

1.4 Core Areas Used to Evaluate the 3Rs

For this SSA, we assess populations of the bull trout DPS at the core area scale. Core areas are recognized units that include a core population and core habitat. Consistent with the SSA framework, we describe the resources, circumstances, and demographics that most influence the resiliency of a population at the core population level.

Because species viability corresponds to the resiliency of its populations, it is necessary to first define populations for the subject entity of the SSA analysis. For some species, including bull trout, identifying population structures or other delineations is helpful and necessary to evaluate resiliency (USFWS 2016, p. 12). A grouping of individuals acting as a panmictic (randomly interbreeding) population constitutes a bull trout local population. Groups of interacting local populations are here termed a core area population and most closely represent a metapopulation. Core area habitat provides the essential physical elements for the long-term security of bull trout

within the core area, which corresponds to the definition of resiliency. The combination of core habitat (habitat that could supply all elements for the long-term resiliency of a bull trout core population) and a core population is termed a core area and constitutes the basic unit on which to gauge current and future conditions. A bull trout core area may be complex (a metapopulation containing more than one local population and associated habitat) or simple (containing only one local population and typically limited habitat).

For this SSA, we evaluated 118 core areas, distributed across five states (Washington, Oregon, Montana, Idaho, and Nevada). These core areas are distributed across six representative units (Coastal, Mid-Columbia, Columbia Headwaters, Upper Snake, Klamath, and St. Mary), which capture ecological and genetic diversity across the bull trout DPS (Figure 3). We evaluated the Lake Pend Oreille core area as three separate units of analysis based on segregated spawning habitats: Lake Pend Oreille A above Cabinet Gorge Dam, Lake Pend Oreille B which includes Lake Pend Oreille proper and its tributaries, and Lake Pend Oreille C below Albeni Falls Dam. Four of the representative units (Coastal, Mid-Columbia, Columbia Headwaters, and Saint Mary) contain transboundary populations of bull trout with Canada. Although the Canadian portions of these transboundary populations are not encompassed by the representative units, we acknowledge they are functionally part of their respective core areas within these representative units and have incorporated those portions into the SSA analysis to the extent possible. The remaining portion of the extant range of the species in Canada was not analyzed in this analysis.

The SSA also identifies seven historical core areas and one Research Needs Area (RNA) which we included in our current and future condition analyses. Historical core areas were once occupied by a population of bull trout but are either currently extirpated, occupied by a reintroduced experimental population, or intermittently occupied by individual bull trout (functionally extirpated). An RNA is a geographic location (e.g., watershed) where bull trout were known to occur historically, but the current status and historical use of the area are uncertain. These areas may have been historically occupied or had a few contemporary or historical observations to suggest at least some current or potential level of use (USFWS 2015, p. 74).

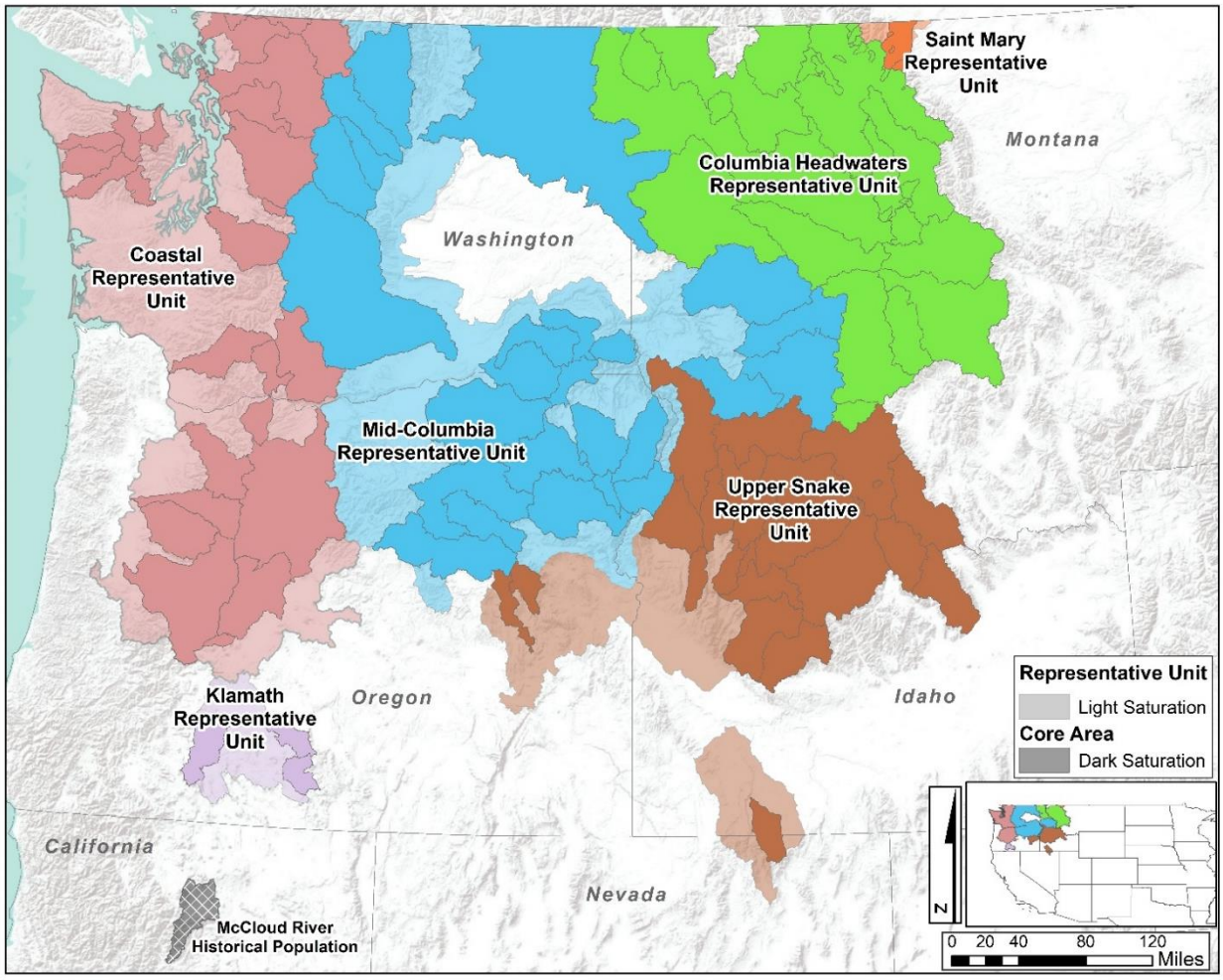


Figure 3. Distribution of core areas within the 6 representative units of the coterminous United States DPS including the McCloud historical population.

1.4.1 Representative units

For our analysis, representative units are synonymous with previously described recovery units. Post listing, new data and reanalysis suggested that the coterminous United States DPS would be more appropriately divided into 6 recovery units, rather than the 5 DPSs identified in previous listing rules, or the 27 recovery units identified in the 2002 and 2004 draft recovery plans. The Service worked with state, federal, and tribal partners in 2008 and 2009 to evaluate alternatives for organizing core areas into possible recovery units. Ten alternatives were evaluated that explored from 2 to 69 potential recovery units based on mitochondrial and microsatellite DNA analysis and on biogeographical considerations, including geological establishment of major watersheds, isolation of portions of watersheds above major waterfalls, co-occurrence with other fish species, and occurrence in different ecological zones (Ardren et al. 2011, entire). The following six recovery units, which we examine in this SSA, were first described in the 2010 proposed critical habitat rule (USFWS 2010a, pp. 2275–2276) and again in the 2015 final Recovery Plan (USFWS 2015, entire) (Figure 4): Coastal Recovery Unit (Figure 5); Klamath Recovery Unit (Figure 6); Mid-Columbia Recovery Unit (Figure 7); Upper Snake Recovery Unit (Figure 8); Columbia Headwaters Recovery Unit (Figure 9); and Saint Mary Recovery Unit (Figure 10). To summarize, although alternate configurations of core areas other than these six

representative units (both in groupings of core areas and number) could be identified, the current six recovery units reference the best available science in terms of groupings of core areas with similar ecological and genetic diversity for our analysis of representation in this SSA.

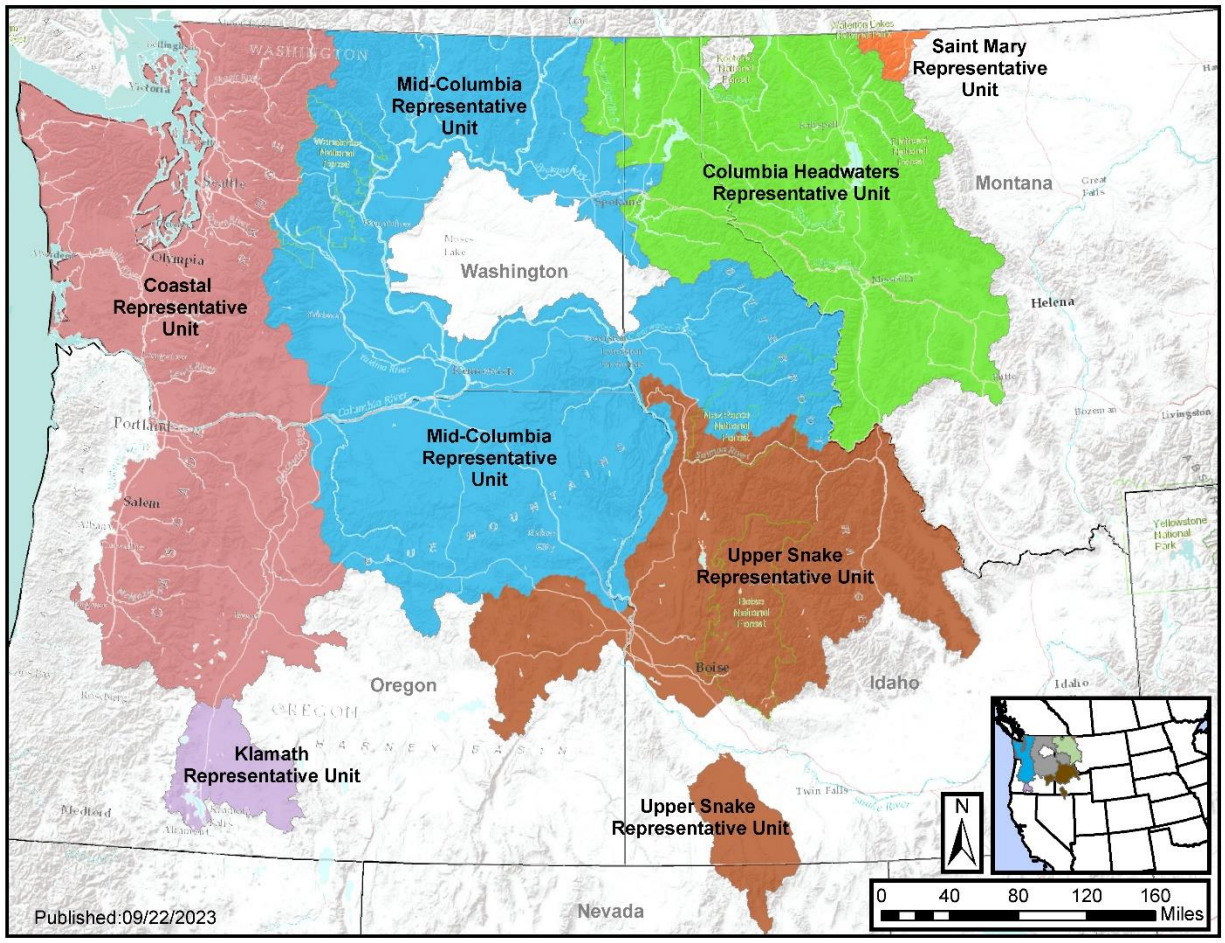


Figure 4. Representative units for the bull trout DPS, which are assemblages of core areas that share similar ecological and genetic diversity. They are based on the recovery units from the 2015 final recovery plan for the bull trout DPS.

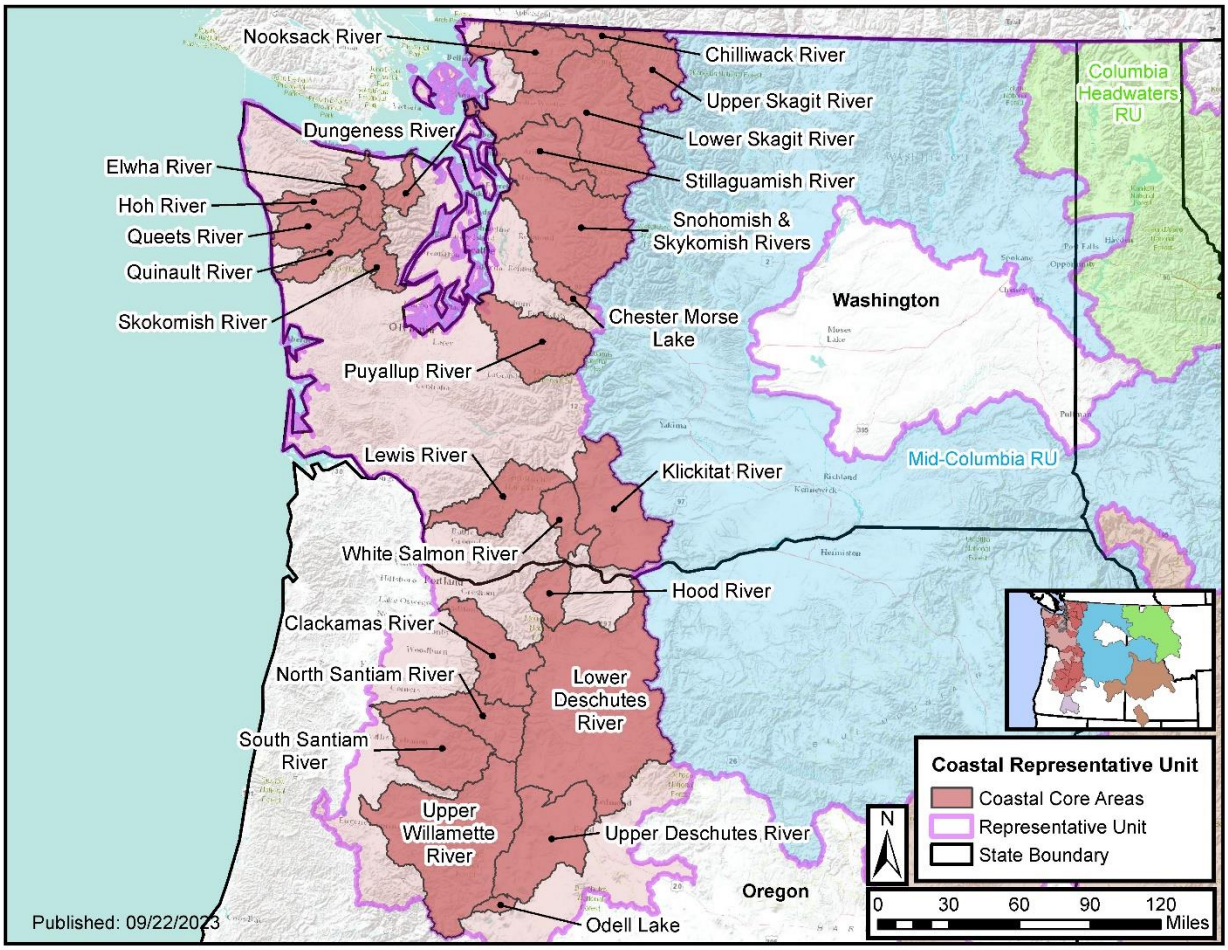


Figure 5. Coastal Representative Unit with 25 core areas.

The Coastal representative unit contains the only amphidromous/anadromous core areas within the bull trout DPS. The ecology is unique within portions of the representative unit associated with Puget Sound/Salish Sea and Olympic Peninsula/Pacific Coast where anadromy is the primary life history. Interior portions of the Coastal representative unit contained within the lower Columbia River drainage share similarities with core areas upstream within the Mid-Columbia representative unit containing both resident, fluvial, and adfluvial life history.

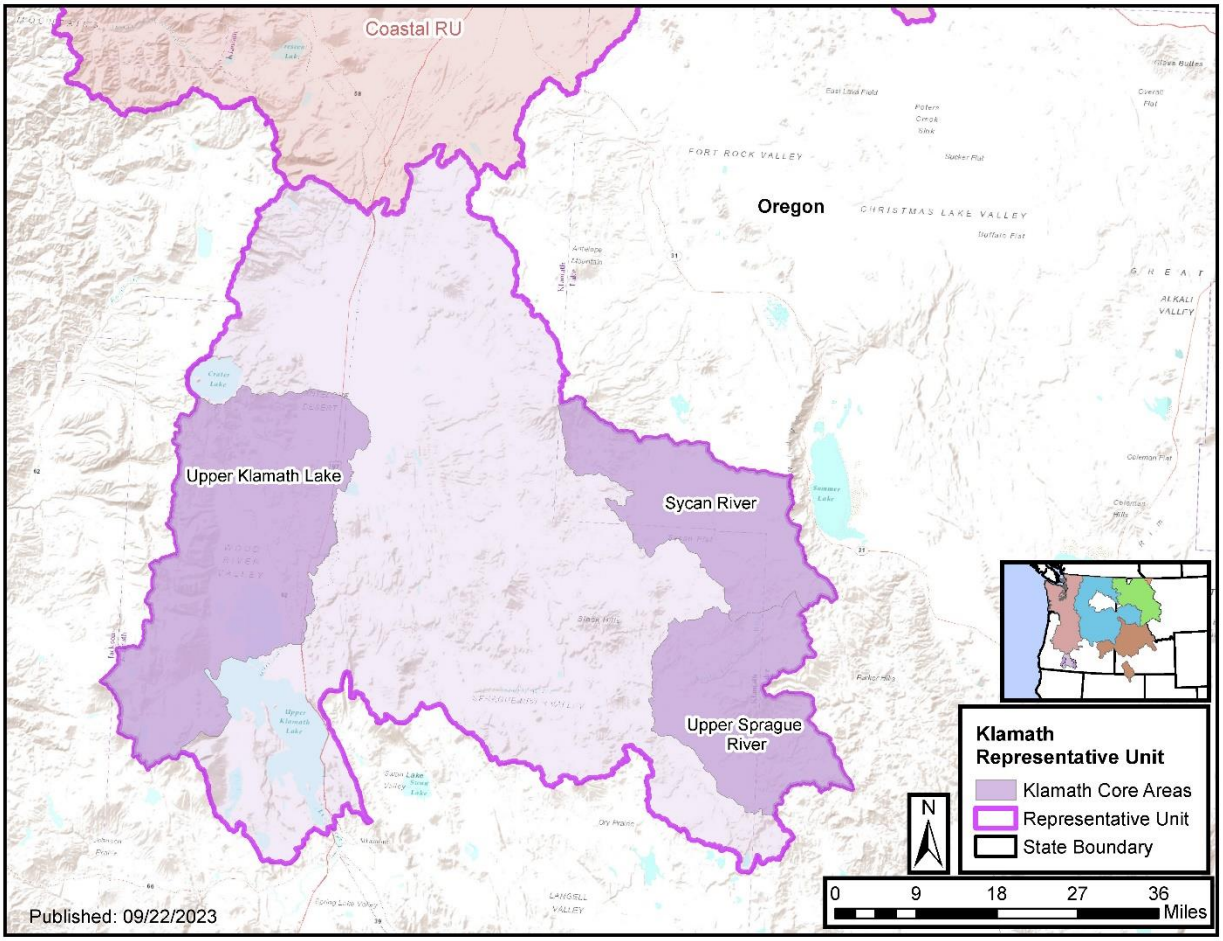


Figure 6. Klamath Representative Unit with three core areas.

The Klamath representative unit contains a mix of resident and fluvial life histories though migratory individuals are currently only present in the Upper Klamath Lake River core area. A variety of anthropogenic alterations to core areas in the representative unit have affected and reduced the presence of migratory life histories. Ecological settings present within the Klamath representative unit share similarities with Mid-Columbia and portions of the Coastal representative units; however, no natural connection exists between the Klamath and these neighboring representative units.

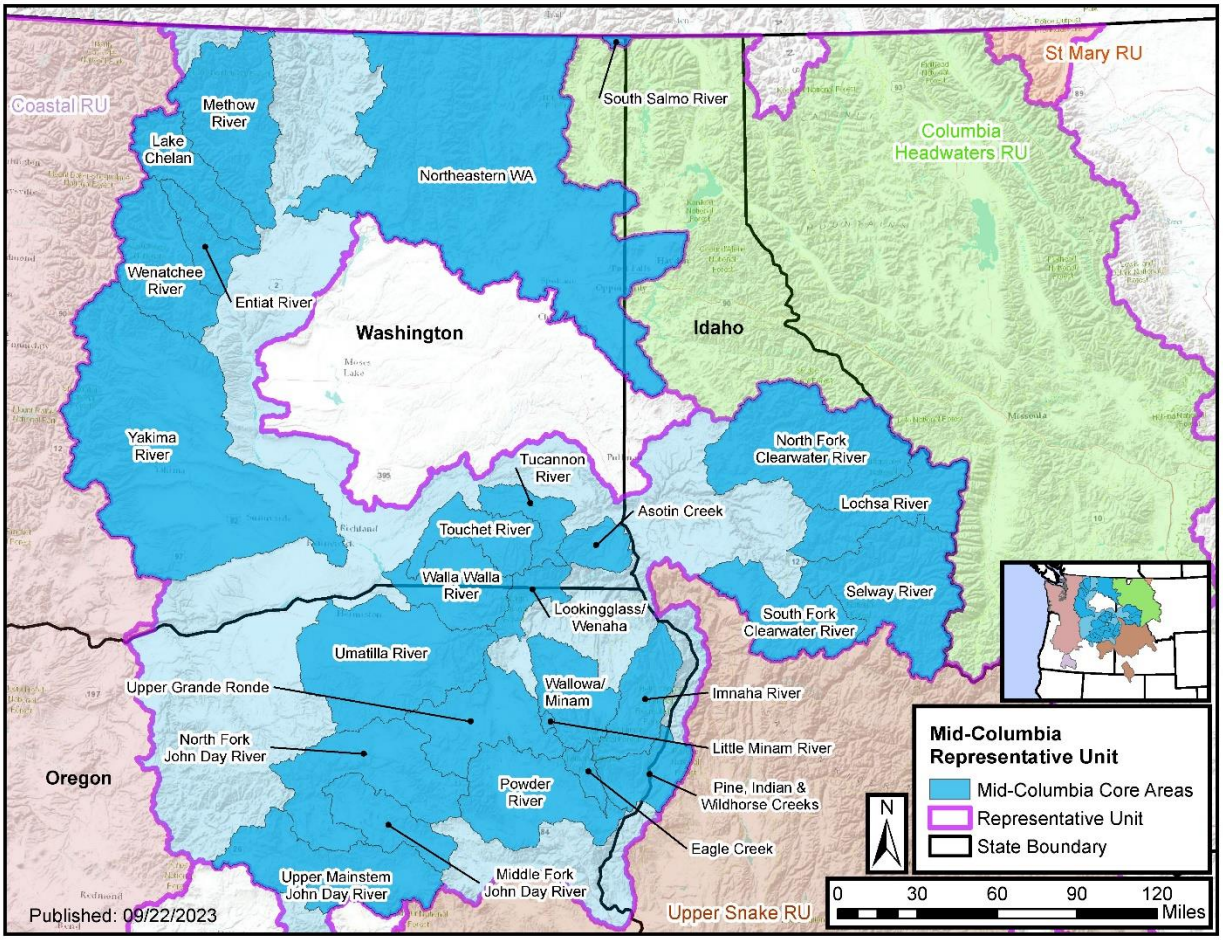


Figure 7. Mid-Columbia Representative Unit with 27 core areas.

The Mid-Columbia representative unit contains a mix of resident, fluvial, and adfluvial life histories. In the North Fork Clearwater River, Yakima, and Wenatchee core areas bull trout have adapted to use reservoirs contemporarily, where fluvial fish would have been present historically. Recent data from Clearwater River core areas have documented mixing of core area populations in mainstem FMO habitat within the Clearwater and Snake rivers. Core area mixing also occurs within the Columbia River proper (Nelson and Johnsen 2007, entire; Kelly Ringel et al. 2014, pp. 61-65). Ecological settings present within the Mid-Columbia representative unit share similarities with neighboring representative units, specifically the Upper Snake and Klamath.

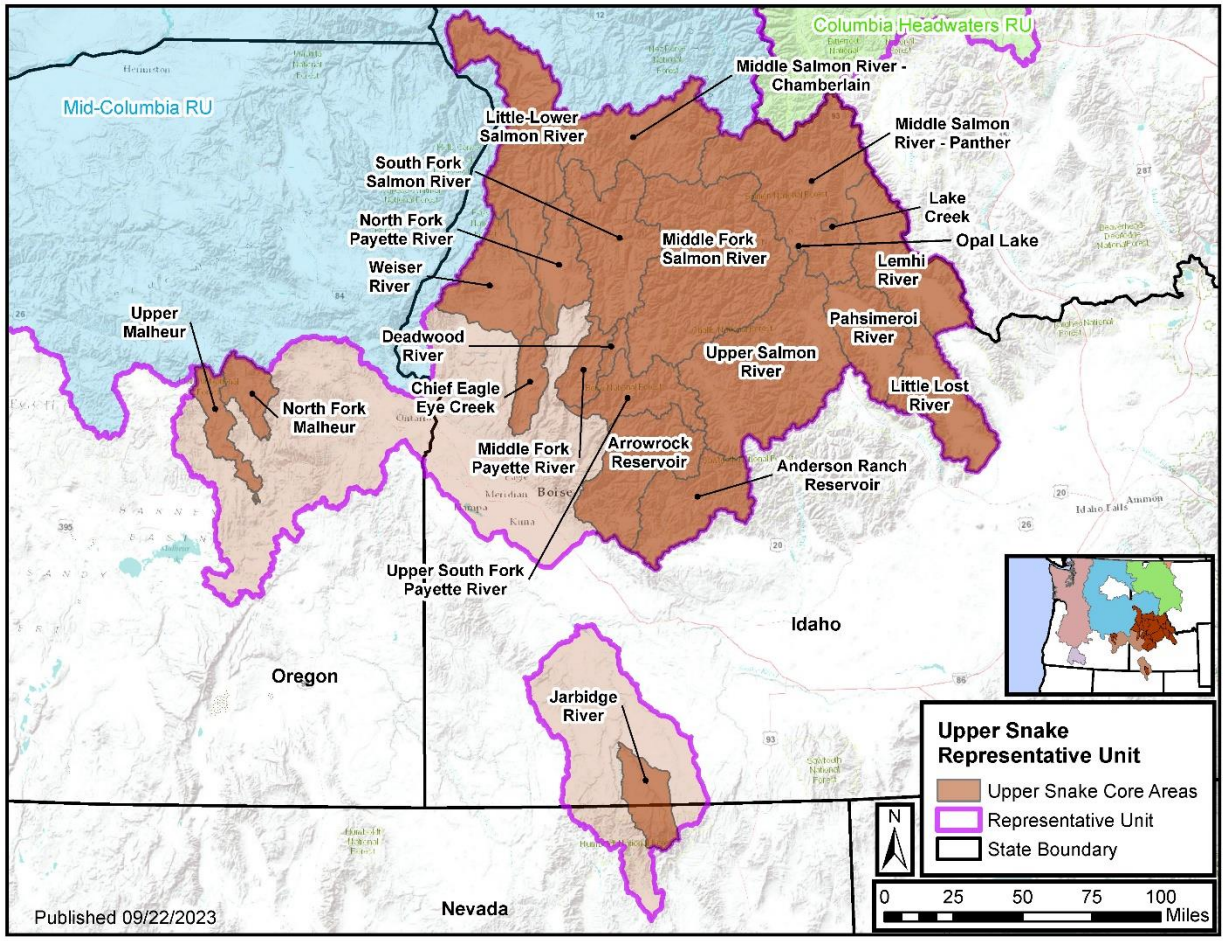


Figure 8. Upper Snake Representative Unit with 22 core areas.

The Upper Snake representative unit contains a mix of resident, adfluvial, and fluvial life histories. Numerous core areas contained within the Salmon River drainage are connected by mainstem river habitat. There has been documentation of mixing between adult fish using FMO habitat in the Snake River between the Upper Snake and Mid-Columbia representative units. The southern portion of the representative unit contains core areas which are isolated by natural processes and anthropogenic alterations such as mainstem dams. Ecological settings present within the Upper Snake Representative Unit share similarities with neighboring representative units, specifically the Mid-Columbia.

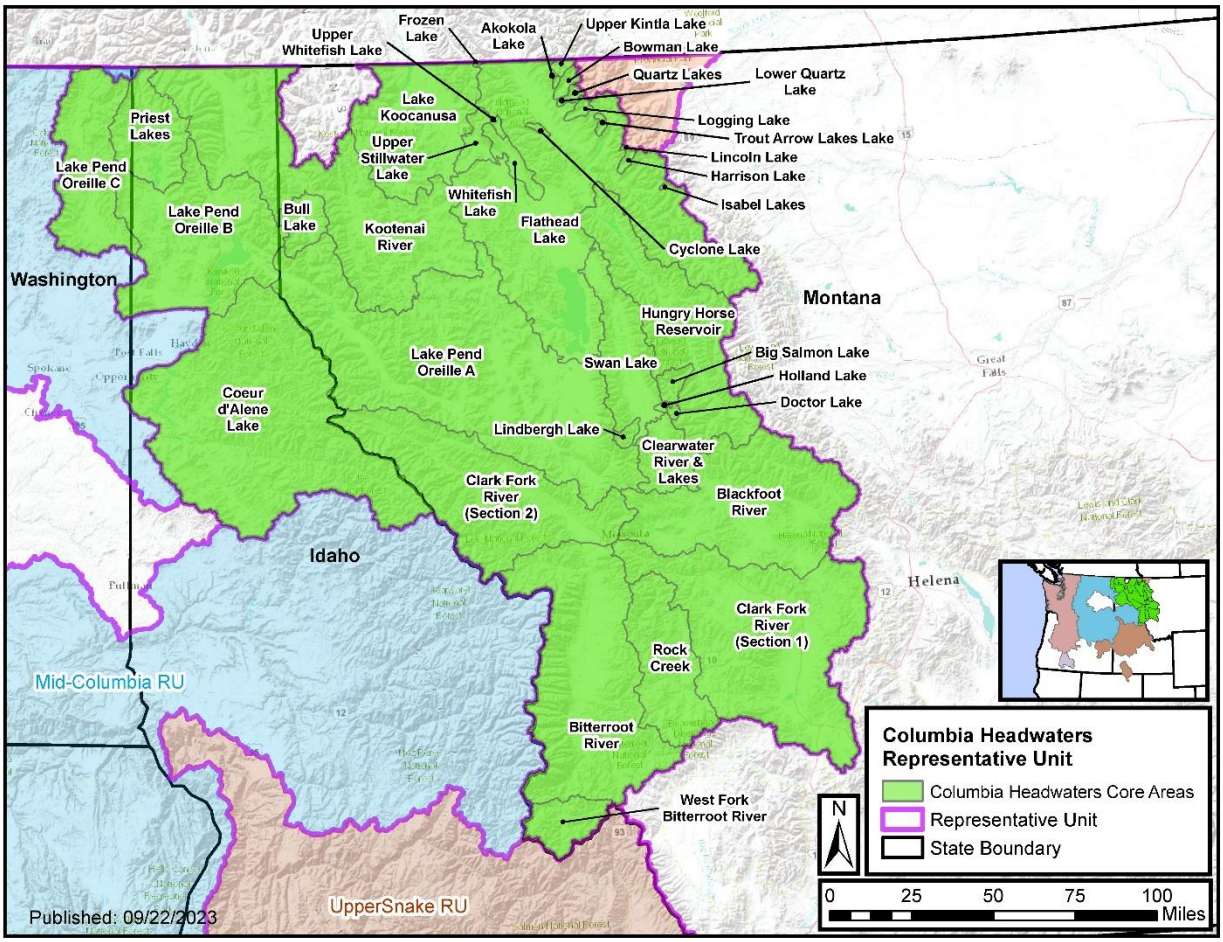


Figure 9. Columbia Headwaters Representative Unit with 32 core areas.

The Columbia Headwaters representative unit contains a mix of adfluvial, fluvial, and resident life history forms. The representative unit includes core areas, connected to large natural lakes, where bull trout appear to express an adfluvial obligate life history. Ecological settings in the Columbia Headwaters have some similarity with neighboring representative units though some core areas in Montana on the east side of the Bitterroot Mountains are more influenced by rain shadow. The Columbia Headwaters is a large representative unit; however, numerous core areas are isolated either through natural or anthropogenic processes. The representative unit contains the largest number of simple core areas, in the form of isolated mountain lake systems, of any representative unit.

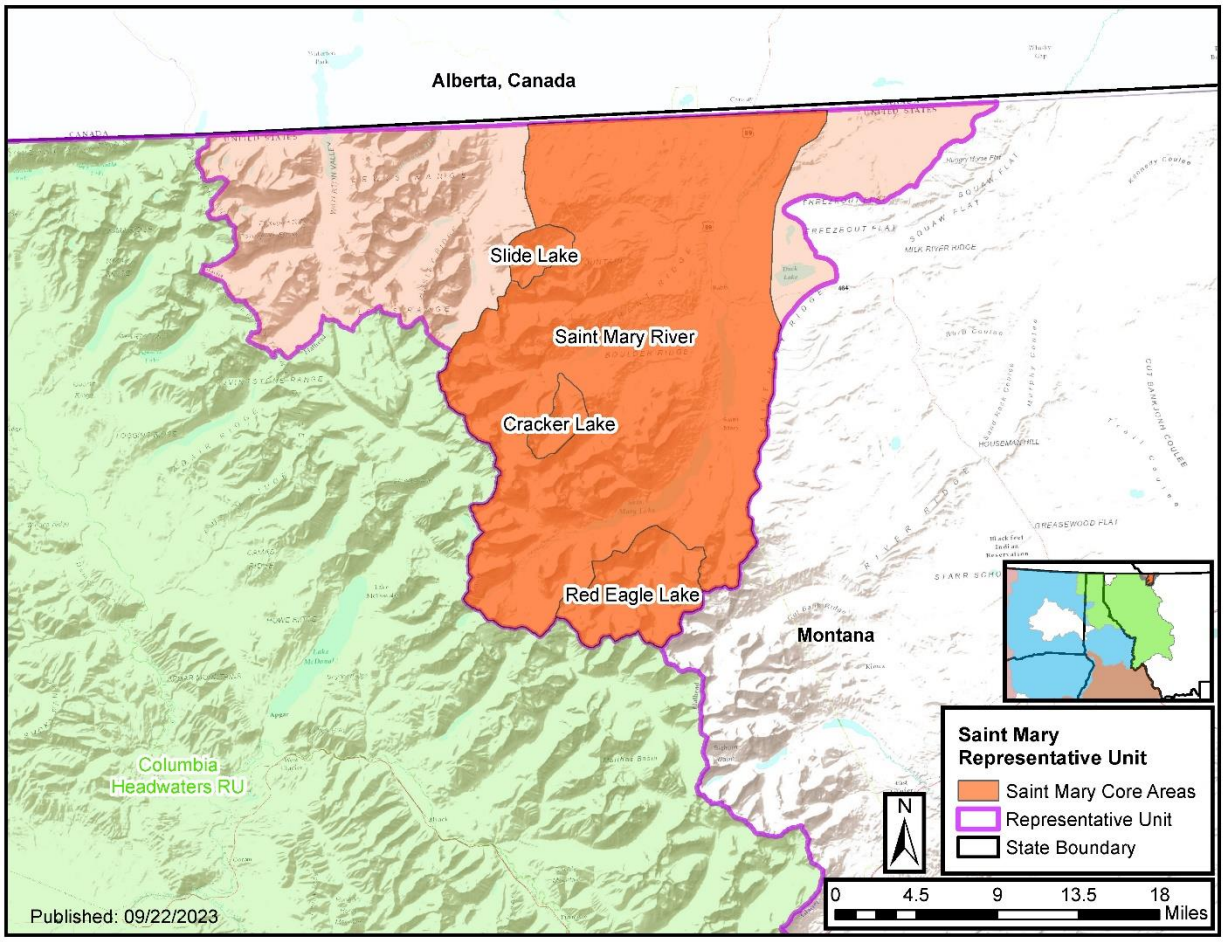


Figure 10. Saint Mary Representative Unit with four core areas

The Saint Mary representative unit is located east of the Continental Divide and includes the U.S. portions of the Saint Mary River basin, from its headwaters to the international boundary with Canada. Bull trout populations within this unit are linked to downstream aquatic resources in southern Alberta, Canada; the U.S. portion consists of four core areas (one complex and three simple). Canada identified the population status within the Saint Mary representative unit as "very low" ("very high risk of extirpation") (Fisheries and Oceans Canada 2020, Figure 3a).

Core areas within the Saint Mary representative unit support both migratory and resident populations of bull trout. Roughly half of the linear extent of available FMO habitat in the mainstem Saint Mary system (between Saint Mary Falls at the upstream end and the downstream Canadian border) is comprised of Saint Mary and Lower Saint Mary Lakes, with the remainder in the Saint Mary River. The other three core areas (Slide Lakes, Cracker Lake, and Red Eagle Lake) are simple core areas. Slide Lakes and Cracker Lake occur upstream of seasonal or permanent barriers and are comprised of isolated bull trout populations entirely within Glacier National Park, Montana. The St. Mary representative unit is unique in its location and isolation from other units.

1.5 Assumptions and Uncertainties

Any scientific analysis, even one with a well-established framework like the SSA, requires assumptions to apply the framework to a unique species with a unique set of traits that exists within multiple ecosystem types across an area consisting of portions of five states. Through each phase of this assessment, we predicated every assumption on the best available scientific information. Our goal throughout this report is to provide clear explanations for our assumptions and to explain the uncertainties inherent in the assessment along with the implications of those uncertainties on our assessment of the 3Rs and viability.

The scope of our assessment, the coterminous DPS, is the listed entity which defined the extent of the bull trout study area. One key assumption is that recovery units within that study area represent the best scales of analysis and core areas represent the best units of analysis for assessing population resiliency. This analysis hierarchy is not intended to place value judgments on individual representative units, core areas, local populations within core areas, or individual life history forms. It is intended to provide a reasonable framework by which we can measure and evaluate the condition of the species given the variation across its coterminous range.

Our model for assessing current and future conditions was built on the best available scientific information for the demographic and habitat needs of bull trout and the factors that influence resiliency. The model required a set of assumptions about how those factors should be evaluated and scored and how to consistently evaluate the resiliency of 118 core areas with varying degrees of data and data reliability. Both habitat and demographic factors were used to assess current and future conditions. The Bull Trout Recovery Plan and previous 5-year Status Reviews relied on both demographic and habitat threats to the species to direct recovery efforts and assess their status. A similar approach was used in this SSA analysis. Figure 11 shows the complete conceptual model including the three phases of the SSA's framework, ultimately characterizing viability in terms of the 3Rs.

Assumptions regarding the nature and extent of core area threats to bull trout and their impact on demographic and habitat factors were key to assessing resiliency. In the last phase of the assessment, where we develop five plausible future scenarios based on climate conditions and conservation efforts, assumptions and uncertainties are inevitable given that the future is inherently uncertain.

Throughout this report we document the assumptions made and uncertainties encountered. The following chapters provide additional context for and description of the assumptions that facilitated our analyses of species needs (Chapter 3), causes and effects (Chapter 4), current conditions (Chapter 5) and future conditions (Chapter 6). A thorough summary of uncertainties and the implications for our estimates of resiliency and viability is presented in Chapter 8.

1.6 Summary- Analytical Framework used for the Bull Trout Species Status Assessment

We followed the three-phase SSA framework for our biological risk assessment of the bull trout DPS (USFWS 2016, p. 6). The SSA-framework begins with an assessment of the species needs,

followed by an assessment of the current condition of those needs, considering positive and negative factors that influence resiliency, and ending with an evaluation of the projected future condition of those same needs (USFWS 2016, p. 6; Smith et al. 2018, entire). Throughout our various analyses for this SSA, the core areas are recognized units with metapopulations (complex core area) or a single local population (simple core area).

Figure 11 shows the complete conceptual model broken into the three phases of the SSA's framework, ultimately characterizing viability in terms of the 3Rs.

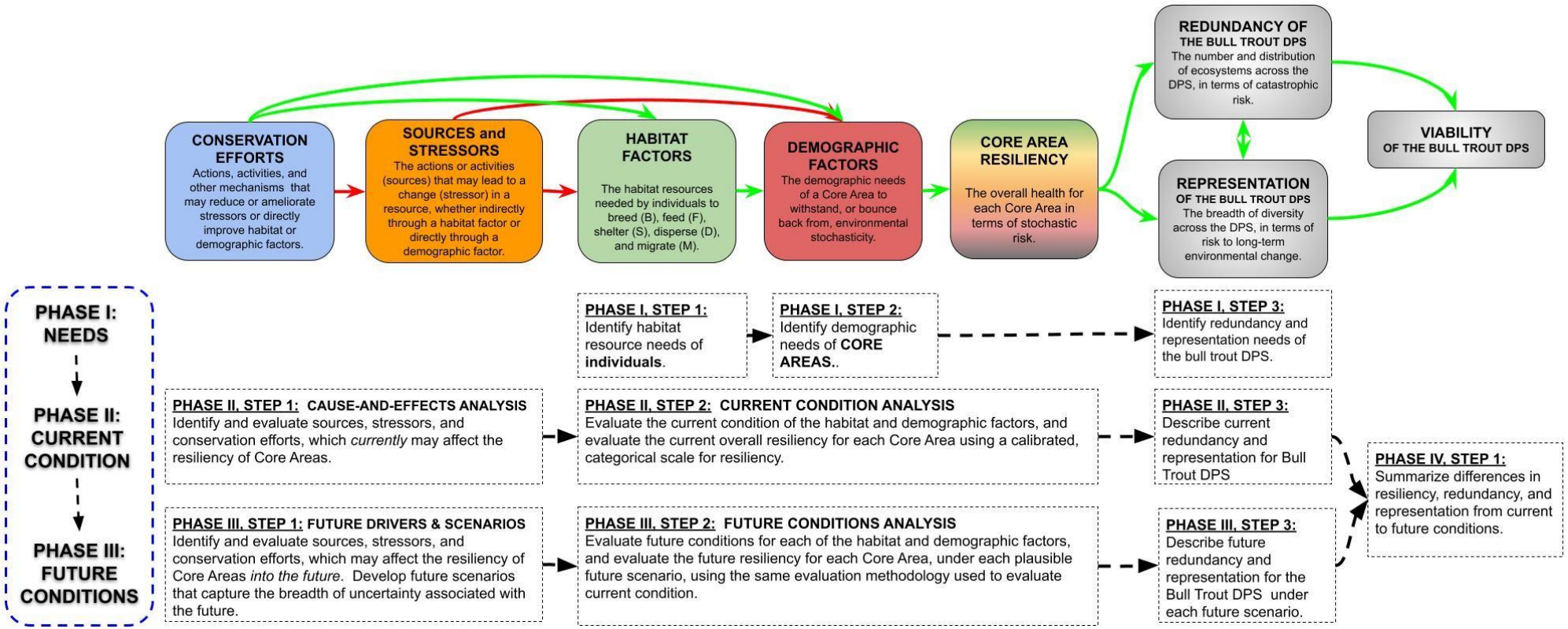


Figure 11. A conceptual model of our analytical framework for the SSA used to evaluate current and future condition for the bull trout DPS. The three-phase SSA framework (species needs, current condition, and future condition) and the core conceptual model for viability guided our analysis (USFWS 2016, p. 6; Smith et al. 2018, entire). Green arrows represent positive relationships between nodes and red arrows represent negative relationships between nodes. Dashed boxes and arrows represent the steps of our analysis. Throughout our SSA, core areas are synonymous with populations. We note that the core conceptual model's inclusion of habitat factors, which indirectly influence resiliency, and demographic factors, which directly influence resiliency, facilitates a broad, inclusive, and cumulative evaluation of core area resiliency starting with individuals, populations, and considers the conservation efforts, sources, and stressors that may directly and indirectly influence them.

Chapter 2 - Description, Distribution, and Ecology of the Bull Trout DPS

This chapter describes the bull trout DPS and the taxonomy, historical and current distribution, and life history of bull trout. The purpose of this overview is to provide scientific background on bull trout life history and ecology in advance of our identification of ecological needs at the individual, core area, and DPS levels in Chapter 3.

2.1 Species Description

Bull trout are members of the char subgroup of the family Salmonidae and are native to waters of western North America. Bull trout have unusually large heads and mouths for salmonids, and their body colors can vary tremendously depending on their environment. Bull trout are often brownish green with lighter colored spots ranging from pale yellow to crimson running along their dorsa and flanks and no spots on the dorsal fin (Figure 12). Their underbellies are light colored to white. They have white leading edges on their fins, as do other species of char (Cavender 1978, entire). Bull trout have been measured as large as 103 centimeters (cm) (41 inches [in]) in length, with weights as high as 14.5 kilograms (32 pounds).



Figure 12. Illustration of bull trout in spawning coloration by Joel Sartore with Wade Fredenberg. Although body color may vary, bull trout are often brownish green with lighter colored spots ranging from pale yellow to crimson running along their dorsa and flanks and no spots on the dorsal fin.

The largest portion of the current range of bull trout are found in the Canadian provinces of British Columbia, Alberta, Northwest and Yukon territories (Rieman et al. 1997, p. 1114). Bull trout distribution remains widespread in British Columbia but distribution in Alberta has become more restricted over the last century (COSEWIC 2012, p. vi).

Within the coterminous United States, bull trout currently occur in six basins: the Columbia River and Snake River basins in Washington, Oregon, Montana, Idaho, and Nevada; Puget Sound and Olympic Peninsula watersheds in Washington; the Saint Mary basin in Montana; and the Klamath River basin of south-central Oregon. As recently as 1975, bull trout occurred in the Sacramento River basin in California, specifically the McCloud River. In general, the current distribution of bull trout is fragmented and localized within the boundaries of its historical range (Cavender 1978, p. 165–168; Howell and Buchanan 1992, entire; Behnke 2002, pp. 296–297). At the time of listing in 1999 bull trout in the coterminous United States, although still widely distributed, were in widespread decline (Quigley and Arbelbide 1997, p. 1177)(Figure 13).

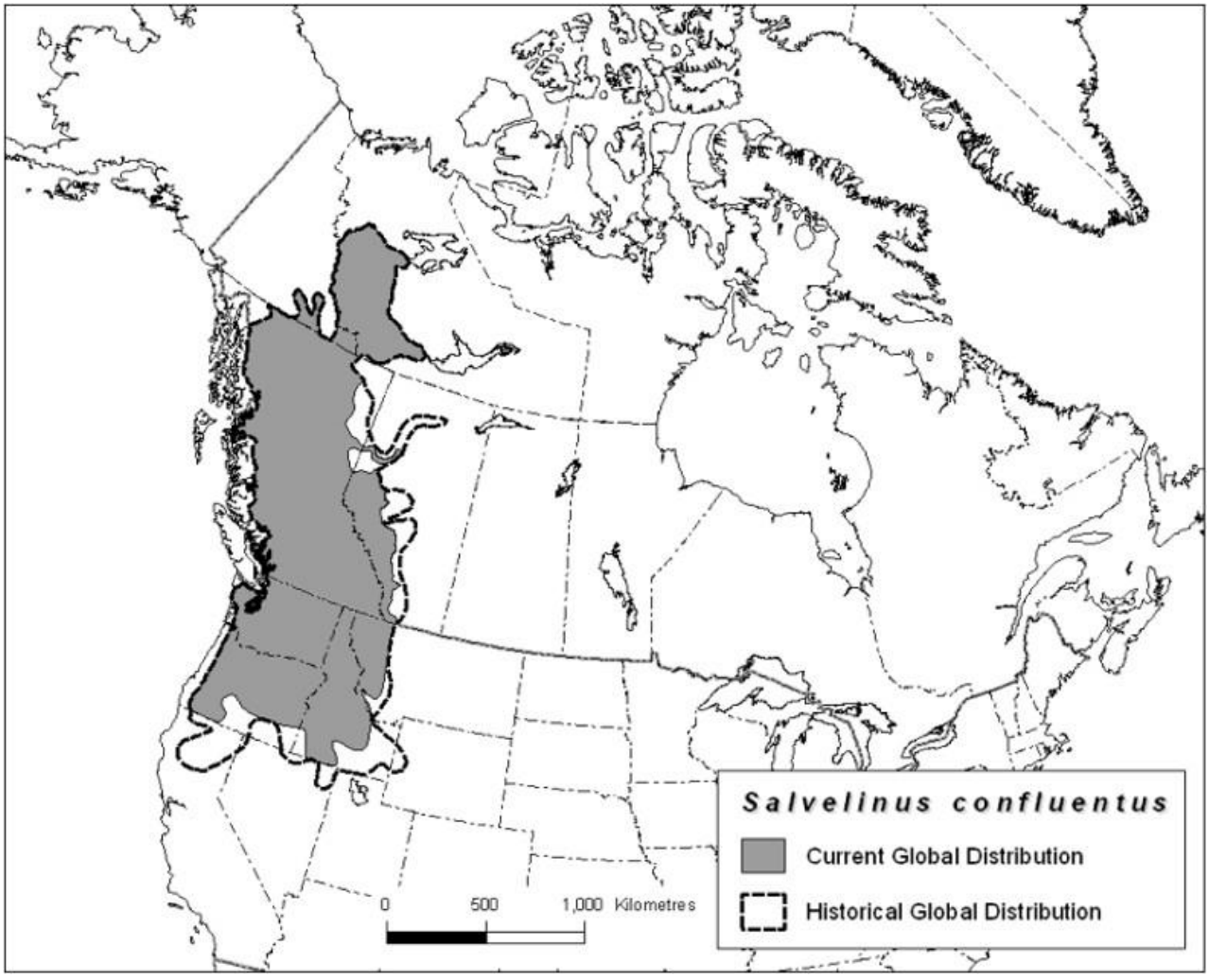


Figure 13. Bull trout approximate current and historical range (COSEWIC 2012 p. 20).

2.2 Taxonomy & Genetics

The bull trout, initially identified as *Salmo confluentus* in 1859, is a native North American char of the family Salmonidae (Cavender 1978, pp.146–147). Char differ from trout and salmon in that they possess light-colored spots on a dark brownish green background (as opposed to dark spots on a light background) and they generally lack spots or have only a few light-colored spots on the dorsal fin (typical of bull trout). Another distinguishing characteristic common to all char is that the leading edge of the anal fin is white. The bull trout's species name (confluentus) translates roughly from Latin to mean "flowing together," presumably referring to the larger rivers and streams which they inhabit (Moyle 2002, p. 297). Prior to taxonomic work published in 1978 and accepted by the American Fisheries Society in 1980, bull trout and Dolly Varden (*Salvelinus malma*) were considered a single species (Cavender 1978, entire). At that time, morphometric, meristic, and osteological characteristics of the two forms were described with evidence of specific distinctions between the two. Several genetic studies have subsequently confirmed the species distinction of bull trout and Dolly Varden (Crane et al. 1994, pp. 182–183). Both species occur together in western Washington, for example, and it is suggested that there is little or no interbreeding across populations (Leary and Allendorf 1997, p. 715). Despite an overlap in the geographic range of bull trout and Dolly Varden in the Puget Sound area and along the British Columbia coast, introgression between the species is thought to be limited (Haas and McPhail 1991, p. 2191). The two species have both contemporary and likely some level of historical introgression in some areas within this part of their range, but still maintain distinct genomes (Taylor et al. 2001, pp. 416-417; Redenbach and Taylor 2002, entire).

2.3 Life History

Bull trout exhibit a suite of complex life history strategies. These strategies can be split into migratory and non-migratory (resident) forms. Resident bull trout complete their entire life cycle in the tributary or nearby streams in which they spawn and rear. Within the migratory form there is recognition of a riverine or fluvial expression, a lacustrine/allacustrine or adfluvial expression, and a rarer marine or amphidromous/anadromous expression (Figure 14). Across the range, bull trout may exhibit any one or more of these expressions, and due to their plasticity, some individual bull trout may express variable life histories within their lifetime and either form may give rise to offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, pp. 2–3; Brenkman et al. 2007, entire; DuPont et al. 2007, entire; Homel et al. 2008, entire; Brenkman et al. 2019, entire; Austin et al. 2019, entire).

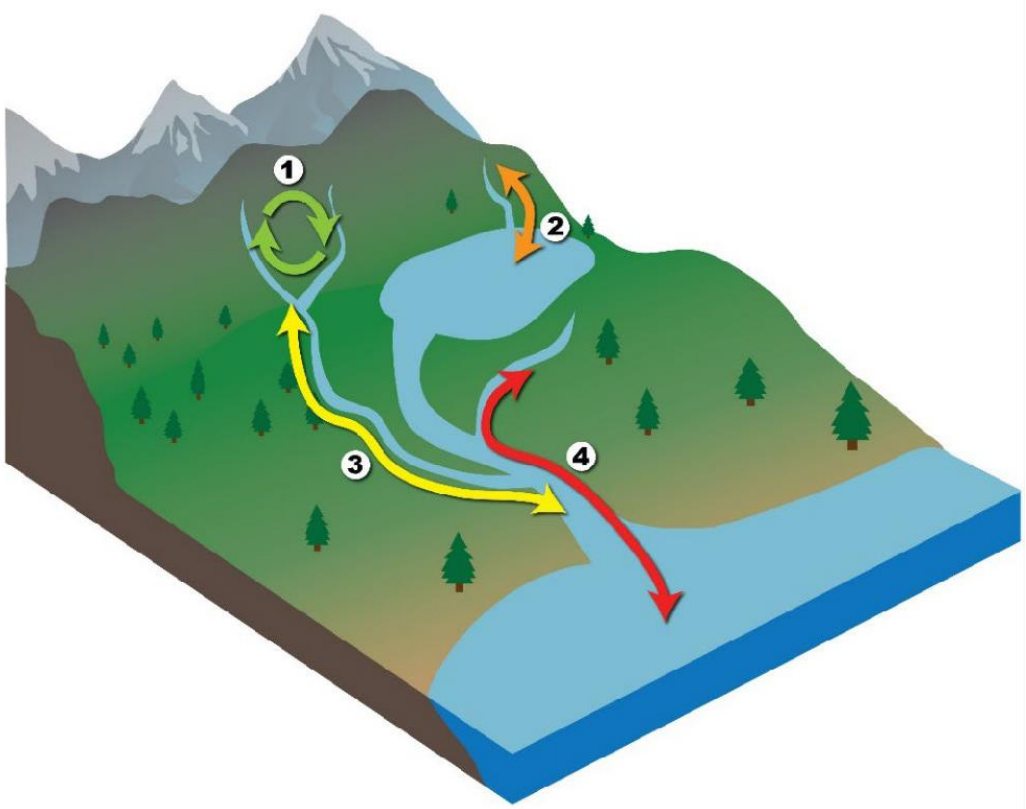


Figure 14. Bull trout life history diversity. Illustration of typical habitat use by (1) the resident life history form and the three migratory life history forms of bull trout: (2) lacustrine or adfluvial, (3) riverine or fluvial, and (4) marine or amphidromous/anadromous.

The migratory forms of bull trout are typically larger and more fecund, have access to more productive foraging habitats (Dunham et al. 2008, p.540; Goetz et al. 2004, p. 125) and occupy a greater range of spawning habitats (Guzevich and Thurow 2017, p. 209). Migratory bull trout may be more resistant to brook trout (*Salvelinus fontinalis*) invasion (Warnock 2012, p. 100), may have a decreased probability of hybridization with introduced brook trout (Rieman and McIntyre 1993, p. 4) and typically have decreased risk of local extinction compared to resident forms (Dunham and Rieman 1999, p. 646). Migratory forms that are not limited by barriers can reestablish in habitats that become temporarily unsuitable as a result of disturbance from events such as landslides, fire, or flood (Rieman and McIntyre 1993, pp. 2, 18). Migratory movements by fluvial and adfluvial bull trout are among the longest reported for inland salmonids, with movements over 200 kilometers (km) reported (Fraley and Shepard 1989, p. 135; McPhail and Baxter 1996, p. 16). Movements of around 150 km through marine waters have been reported for the anadromous form of bull trout (McPhail and Baxter 1996, p. 14; Brenkman and Corbett 2005, p. 1075).

Bull trout typically mature between four to seven years of age (Johnston et al., 2007 pp. 117-120). Reproduction may occur annually or every other year. Variation in spawn timing may occur across the range due to climate and geography. Spawning typically takes place between August and November (Johnston et al. 2007 p. 114), but in some places as late as December

(Brenkman et al. 2001, p. 985). Eggs are laid in redds dug in clean gravel, with the number averaging 5,000, dependent on the size of the female (COSEWIC 2012, p. 31).

2.3.1 Life Cycle and Life Stages

The bull trout life cycle is well described and can be divided into five phases — egg/embryo, alevin/fry, the juvenile (pre-reproductive) phase, the subadult phase (for migratory bull trout), and the adult phase. Each new life cycle begins with fertilization of eggs (Figure 15).

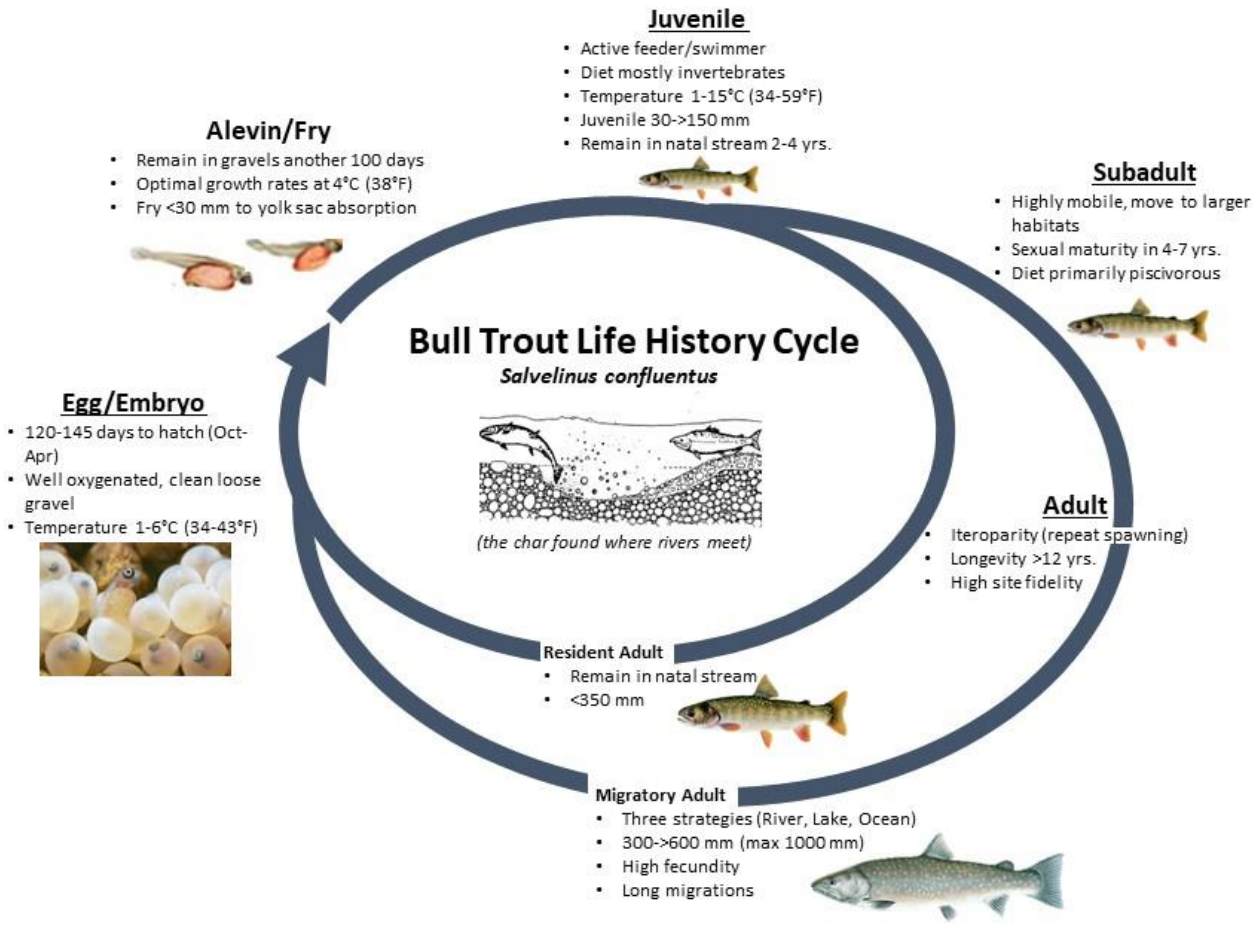


Figure 15. Bull trout life cycle diagram.

The fertilized eggs of bull trout hatch into alevin after 120–145 days of development (generally October through April). Eggs require well oxygenated, loose, clean gravel with an optimal water temperature of 1–6 °C (34–43 °F) (Poole et al. 2001, p. 5). After hatching, alevin, or fry, remain in stream gravels for another 100 days before emerging (generally April through May). Optimal growth of alevin is achieved at around 4 °C (38 °F) (Fraley and Shepard 1989, p. 138; McPhail and Baxter 1996, p. 10). Once alevin absorb the nutrients provided by their attached egg sack,

they begin feeding on small aquatic invertebrates. The alevin life stage ends with total absorption of the attached egg sack resulting in a mobile 30–40 millimeter (mm) juvenile (Horner 1978, entire; Shepard et al. 1984, pp. 3–5; Pratt 1992, pp. 1–2).

The juvenile life stage for bull trout exists for approximately 2–4 years as the bull trout matures from approximately 40 to 150 mm in its natal stream. Juvenile bull trout are active swimmers and feeders of aquatic invertebrates during this period. Water temperature between 1 and 15 °C (34 -59 °F) has been documented for this life stage (Fraley and Shepard 1989, p. 138; McPhail and Baxter 1996, pp. 11–12; Downs et al. 2006, pp. 194–195).

Juvenile bull trout may transition into adult resident fish that generally remain in their natal stream or transition into migratory subadults. Resident adult bull trout have been documented up to 350 mm, moving minimally from natal streams where they forage on insects and small fishes. Resident fish tend to be smaller than migratory fish at maturity and produce fewer eggs (Fraley and Shepard 1989, p. 138; McPhail and Baxter 1996, pp. 11–12; Al-Chokhachy and Budy 2008, pp. 1717–1719).

Subadult bull trout generally move to larger water bodies such as high order rivers, lakes, reservoirs, or in some regions, the Pacific Ocean and Puget Sound/Salish Sea depending on habitat availability (Rieman and McIntyre 1993, p. 2; Beamer et al. 2004, pp. 5–6; Brenkman et al. 2007, p. 9; Hayes et al. 2012, entire). This life stage is thought to express mostly piscivorous behavior resulting in larger growth potential. Sexual maturity is reached in 4–7 years (Johnston et al. 2007, pp. 114–115; Howell et al. 2016, pp. 179–181; Nelson and Nelle 2008, pp. 13–21).

Once subadult fish become sexually mature, migratory adults typically maintain a piscivorous diet and reach lengths upwards of 600 mm but may range from 400 mm to over 800 mm in some populations. These migratory adults may travel long distances between spawning habitat and their foraging and overwintering habitat in large rivers, lakes or the ocean. Migratory adults are more fecund than resident adults (Al-Chokhachy and Budy 2008 p. 1719; Howell et al. 2016 pp. 179–181; Nelson and Nelle 2008 pp. 13-21).

Both resident and migratory adults may or may not spawn in the same headwater stream reach regardless of selecting different overwintering locations (Howell et al. 2016, pp. 175–181). Where the two life history expressions co-exist, there is a distinguishing difference in redd size based on the size of spawning females with migratory redds being much larger. Both resident and migratory bull trout may spawn every year once sexual maturity is met, however skip year spawning has also been documented (Hanson et al. 2014, p. 29). Spawning typically occurs between August and November and adults have been documented frequently living up to 10 years and “under exceptional circumstances” for 20 years or more (McPhail and Baxter 1996, pp. 12–15; Al-Chokhachy and Budy 2008, p. 1720).

2.3.2 Seasonal Variability

Seasonal variability was captured in a temporal life cycle Gantt chart (Table 1). In the table,

shading indicates when most of each activity, behavior, or function occurs for each life stage (Zymonas et al. 2021; Howell et al. 2016, p. 182; Starcevich et al. 2010, entire; Buchanan et al. 1997, pp. 3–6; Barnett et al. 2013, entire). While this is a range-wide depiction of temporal differences, the specific timeframe and duration of these activities varies between local populations and core areas across the range. Each bull trout life stage also exhibits specific habitat requirements.

Table 1. Gantt chart of seasonal behaviors for each bull trout life stage. Lighter shades capture variation across the range.

Life stage	Behavior (Habitat Function)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	DCH
Egg/ Embryo 120-145 days	Incubating (S)	x	x	x	x				x	x	x	x	x	S&R
Alevin/Fry ~100 days	Yolk sac absorbed, begin feeding (S)	x	x	x	x	x	x						x	S&R
Juvenile 2-4 years	Feeding (F) & Sheltering (S)	x	x	x	x	x	x	x	x	x	x	x	x	S&R
Subadult 4-7 years	Feeding (F) & Sheltering (S)	x	x	x	x	x	x	x	x	x	x	x	x	S&R and FMO
	Migrating (M)	x	x	x	x	x	x	x	x	x	x	x	x	FMO
Migratory Adult 4-12 years	Spawning (B)	x						x	x	x	x	x	x	S&R
	Feeding (F) & Sheltering (S)	x	x	x	x	x	x	x	x	x	x	x	x	S&R and FMO
	Migration (M)	x	x	x	x	x	x	x	x	x	x	x	x	FMO
	Staging (M)						x	x	x	x	x			FMO
Resident Adult 3-12 years	Spawning (B)								x	x	x	x		S&R
	Feeding (F) Sheltering (S)	x	x	x	x	x	x	x	x	x	x	x	x	S&R

Notes: B: breeding; F: feeding; S: sheltering; M: migrating; S&R: spawning and rearing; FMO: foraging, migrating, and overwintering; DCH: designated critical habitat.

2.4 Habitat

Of all the native salmonids in the Pacific Northwest of the United States, bull trout are generally recognized as having the most thermally restrictive habitat requirements (Rieman and McIntryre 1993, p.4). Characteristics of optimal bull trout habitat are often referred to as "the four Cs": Cold, Clean, Complex, and Connected habitat. This includes cold water temperatures (often less than 12 °C [54 °F] for egg and juvenile life stages); excellent water quality with high dissolved-oxygen concentrations and minimal contamination from chemicals and sediment; complex stream habitat including deep pools, overhanging banks and large woody debris; and connectivity across populations and between spawning and rearing (SR) areas and downstream foraging, migration, and overwintering (FMO) habitats for migratory forms (Fraley and Shepard 1989, p. 138; Goetz 1989, p. 19; Watson and Hillman 1997, p. 247).

2.4.1 Spawning and rearing (SR) habitat

Spawning and rearing habitat generally supports multiple year classes of juveniles of resident or migratory fish and may also support subadults and adults from local populations of resident bull trout. In general, watersheds must have specific physical characteristics to provide the necessary habitat requirements for bull trout spawning and rearing, though the characteristics need not be ubiquitous throughout the watershed (Watson and Hillman 1997, p. 248). The preferred spawning habitat of bull trout consists of stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 133). Bull trout typically spawn from August to November during periods of decreasing water temperatures (Swanberg 1997, p. 735; Schoby and Curet 2007, p.16). However, migratory forms are known to begin spawning migrations as early as April and to move upstream as much as 250 km (155 mi) to spawning areas (Fraley and Shepard 1989 p. 138; Swanberg 1997, p. 735).

The initiation of spawning by bull trout in the Flathead River system appeared to be related largely to water temperature, with spawning initiated when water temperatures dropped below 10°C (50 °F) (Fraley and Shepard 1989, p. 137). Increased spawning has been reported closer to 5 to 6 °C (41–43 °F) (Goetz 1989, p. 16). Such areas often are associated with cold-water springs or groundwater upwelling (Rieman et al. 1997, p. 1121; Baxter et al. 1999, p. 137). Groundwater influence and proximity to cover are important factors influencing spawning site selection and the combination of relatively specific requirements may result in a restricted spawning distribution in relation to available stream habitat (Fraley and Shepard 1989, p. 137).

Depending on water temperature, egg incubation is normally 100 to 145 days (Pratt 1992, p. 5). Water temperatures of 1.2 to 5.4 °C (34.2 to 41.7 °F) have been reported for incubation, with an optimum (best embryo survivorship) temperature reported to be from 2 to 4 °C (36 to 39 °F) (Fraley and Shepard 1989, p. 138; McPhail and Baxter 1996, p. 10). Individuals remain in the substrate after hatching, such that the time from egg deposition to emergence of fry can exceed 200 days. During the relatively long incubation period in the gravel, bull trout eggs are especially vulnerable to fine sediments and water quality degradation (Fraley and Shepard 1989, p. 141). Increases in fine sediment appear to reduce egg survival and emergence (Pratt 1992, p. 6). Juveniles are likely also affected by fine sediment. High juvenile densities have been reported in areas characterized by a diverse cobble substrate and a low percentage of fine sediments (Shepard et al. 1984, p. 6). Habitats with cold water temperature, appropriately sized stream substrate with a low level of fine material (less than 12 percent fine substrate that is less than

0.85 mm) [0.03 in.] in diameter) are necessary factors for egg incubation and juvenile rearing that supports individual and population growth (WFPB 1997, pp. 98, F-25).

2.4.2 Foraging, migration, and overwintering (FMO) habitat

Information on the complex migratory movements of fluvial, adfluvial, and anadromous life history forms (e.g., see USFWS 2002b; 2004; USFWS 2005b, 2005c) has now increased our understanding of the extensive habitat use and connectivity requirements of the migratory life history form of bull trout. This information has affirmed that the use of migratory corridors is critical to the survival of migratory bull trout (e.g., see Bahr and Shrimpton 2004, entire; Brenkman and Corbett 2005, entire; Mogen and Kaeding 2005 entire; 2007 pp. 1-2; Nelson et al. 2002, entire; Neraas and Spruell 2001, entire; Brenkman et al. 2007, entire; Homel and Budy 2008, entire; Monnot et al. 2008 entire).

These migratory corridors are more broadly referred to as foraging, migration, and overwintering (FMO) habitat. FMO habitats for migratory life forms consist of relatively large streams and mainstem rivers, including lakes or reservoirs, estuaries, and marine nearshore environments, where subadult and adult migratory bull trout forage, migrate, mature, or overwinter. This habitat is typically downstream from spawning and rearing habitat and contains all the physical elements to meet critical overwintering, migration, and developmental needs of subadult and adult bull trout. Although each core area contains FMO habitat, there are FMO habitats outside of and shared by multiple core areas such as the mainstem Columbia and Snake rivers, Pacific Ocean, Puget Sound, and non-natal watersheds. Shared FMO is essential to the persistence of long-distance fluvial and anadromous life history forms (Muhlfeld and Marotz 2005, p. 805; Brenkman et al. 2007, entire; Barrows et al. 2016, entire).

While bull trout expressing the resident life history will remain localized to watersheds with spawning and rearing habitat, they may also use localized FMO habitat, migrating short distances to take advantage of prey base or habit needs that change seasonally. However, migratory life history strategies (fluvial, adfluvial, or anadromous) are dependent on the presence of appropriate FMO habitat, suitable flow levels, and lack of barriers (physical or thermal) to promote connectivity. Metapopulation structure, genetic exchange, and recolonization of extirpated local populations are dependent on unrestricted movement of migratory individuals through FMO habitat (USFWS 2015, p. 25). While smaller bull trout such as juveniles and adult residents feed on a diverse array of zooplankton, aquatic insects, and small fish, larger migratory subadults and adults need access to a variety of larger forage fish within these FMO habitats (Fraley and Shepard 1989, p. 135; Brown 1994, pp. 20–21; Donald and Alger 1993, pp. 242–243; WDFW et al. 1997, pp. 20, 23; Goetz et al. 2004 pp. 101–114, appendix D; Guy et al. 2011, pp. 185–186).

Adult bull trout prefer complex forms of habitat, including large woody debris, undercut banks, boulders, and pools for foraging, migrating, and overwintering in large river systems (Fraley and Shepard 1989, pp. 137–138; Watson and Hillman 1997, p. 249). Bull trout have been observed overwintering in deep beaver (*Castor canadensis*) ponds or pools containing large woody debris in larger rivers (Jakober 1995, p. 90). Adult bull trout migrating to spawning areas have been recorded as staying 2 to 4 weeks at the mouths of spawning tributaries in deeper holes or near logs utilizing cover for shelter and ambush feeding (Fraley and Shepard 1989, p. 137). Bull trout

may also use mainstem rivers and saltwater environments seasonally as feeding and wintering habitat. The following habitat elements provide cover and shelter to support individual and population growth and allow for normal bull trout behavior: riparian vegetation; large wood; variable stream channel morphology including deep pools, side-channels, undercut banks and large substrates; and access to downstream environments.

Large lakes and reservoirs are also utilized as FMO habitat by adult bull trout. Many lentic environments utilized by bull trout for overwinter habitat provide shelter, optimal thermal refuge, and increased forage base. Bull trout with historical access to natural lakes have evolved to incorporate lentic habitat in their life history, while other populations have adapted to lentic habitat created in reservoirs.

In the October 18, 2010, final rule to designate critical habitat for the bull trout DPS (75 FR 63938) we identified marine or mainstem riverine habitat areas outside of bull trout core areas, but within recovery units, that provide primary constituent elements of critical habitat. These areas do not include spawning and rearing habitat but provide FMO habitat that is typically shared by bull trout originating from multiple core areas within a Recovery Unit. These shared FMO critical habitats support the viability of bull trout populations by contributing to successful overwintering survival and dispersal among core areas, and the persistence of certain migratory life history expressions (e.g., anadromy).

2.5 Population Structure and Size

Across the historical range of bull trout both natural and anthropogenic habitat features have shaped the presence and absence of individuals and populations. A population of bull trout must consist of individuals with the opportunity to be geographically connected for the completion of a life cycle.

The “local population” is the smallest scale of bull trout population dynamics and theoretically represents a panmictic group of individuals with genetic mixing who are not reproductively isolated from each other. Individuals of a local population share connected and suitable habitat, similar breeding habits (space and time), and have an extinction risk on a similar time frame that is independent from other groups (Whitesel et al. 2004, pp.11–14).

Bull trout core areas can have multiple local populations or a single local population with the former considered complex core areas and the latter simple core areas. Complex core areas, made up of a set of local populations within a larger geographic area where there exists a potential for typical migration from one local population to another, are synonymous with a metapopulation (Hanski and Simberloff 1997, pp. 5–26). A core area aggregation of bull trout local populations is unlikely to be a panmictic group, further supporting the idea that a bull trout core area with multiple local populations functions as a metapopulation (Dunham and Rieman 1999 pp. 642–644). Core area designation has also been applied to naturally isolated bull trout local populations. Though referred to as core areas, they do not meet the definition of a metapopulation and thus are referred to as “simple core areas”.

The coterminous range includes seven historical core areas. These core areas were occupied by

one or more populations of bull trout, but are either currently extirpated, intermittently occupied by individual bull trout (functionally extirpated), or in one case (Clackamas River), had a recent reintroduction effort. There is also one geographic area within the coterminous range identified as an RNA (NE Washington), given the uncertainty of this area's role or contribution to conserving the species. Not included in this SSA analysis is the extirpated population of bull trout from the McCloud River portion of the Sacramento River Basin in California. As recently as 1975, bull trout were captured in the McCloud River and prior to the construction of Shasta Dam in the 1950s the population supported a small fishery. Due to a lack of data specific to the habitat or bull trout that once occupied this portion of the range, similarly to its treatment in the final recovery plan we have not included the McCloud River historical population in the SSA analysis at this time.

In the recovery plan for the bull trout DPS, groupings of similar bull trout core areas are called recovery units. For the purposes of this analysis, recovery units are synonymous with representative units, as they capture core area assemblages of similar ecological and genetic diversity. We discuss these representative units in more detail below.

2.6 Current and Historical Abundance, Range and Distribution

Bull trout are native to western North America where they occupy the headwaters of most major river systems draining the Rocky Mountains and coastal rivers draining into the Pacific Ocean (Figure 13). In Canada, bull trout are found in the headwaters of the Mackenzie and Yukon Rivers in British Columbia, Yukon, and Northwest Territories, coastal rivers in British Columbia, the Columbia River basin in British Columbia, as well as the Saskatchewan River drainages of Alberta. Bull trout also occur in coastal rivers of southeast Alaska (Sigler and Zaroban 2018, p. 438; Behnke 2002, pp. 296–297).

Within the coterminous United States, bull trout currently occur in the Columbia River and Snake River basins in Washington, Oregon, Montana, Idaho, and Nevada; Puget Sound/Salish Sea and Olympic Peninsula watersheds in Washington; the Saint Mary basin in Montana; and the Klamath River basin of south-central Oregon (Sigler and Zaroban 2018, p. 438; Behnke 2002, pp. 296–297). At the time of listing in 1999 bull trout in the coterminous United States, although still widely distributed in portions of Washington, Oregon, Idaho, Montana and Nevada, were considered to be in widespread decline (Quigley and Arbelbide 1997, p. 1177). As recently as 1975, bull trout occurred in the Sacramento River basin in California, specifically the McCloud River (Behnke 2002, pp. 296–297).

The specific historical range of bull trout across North America is unclear due to frequent confusion with Dolly Varden. In addition to where bull trout are found today, they also existed in the McCloud River, in California, until the 1970s. Bull trout may have been present within the Bonneville Basin of Idaho, Wyoming, and Utah based on fossil fragments and writings from the 1830s referencing "char" in the Bear River (Sigler and Zaroban 2018, p. 438, Behnke 2002, pp. 296-297). Haas and McPhail (1991, entire) suggest bull trout were broadly distributed across their existing range since the Wisconsin Glaciation over 10,000 years ago. Nearly all anthropogenic perturbations to the landscape and changes to aquatic species composition that have affected bull trout distribution and abundance have occurred over the past 200 years, most in the past 100 years. Thus, from an evolutionary and geologic perspective, many significant

alterations in bull trout distribution, abundance, and habitat have occurred very recently and are ongoing. Separating the effects of naturally occurring processes, such as fire and flood, from the effects of climate change and other processes that are caused by human activity represents a significant challenge in the evaluation of population structure (Whitesel et al., 2004, p. 5).

2.6.1 Survey Data and Methodology

Our understanding of current bull trout distribution and abundance is dependent on ongoing monitoring efforts. Bull trout monitoring is conducted by federal, state, and tribal entities as well as NGOs across much of the DPS; however, not all core areas or local populations within core areas have been or are currently being monitored. In areas where monitoring exists, bull trout populations are surveyed using a variety of protocols and sampling techniques including redd counts (systematic counting of clean depressions in gravel associated with spawning activities), targeted or incidental observations during snorkel surveys, smolt trapping, creel surveys, environmental DNA, and electrofishing or counts from dams or weirs.

2.6.2 Land Ownership

Across the DPS, most of the land ownership is through federal agencies (49.7 percent) with private (38.3 percent), tribal (6.0 percent) and state (5.4 percent) representing smaller percentages. Less than one percent is owned by local governments (0.4 percent) and non-governmental agencies (0.2 percent). Figure 16 shows a coarse representation of land ownership by core area.

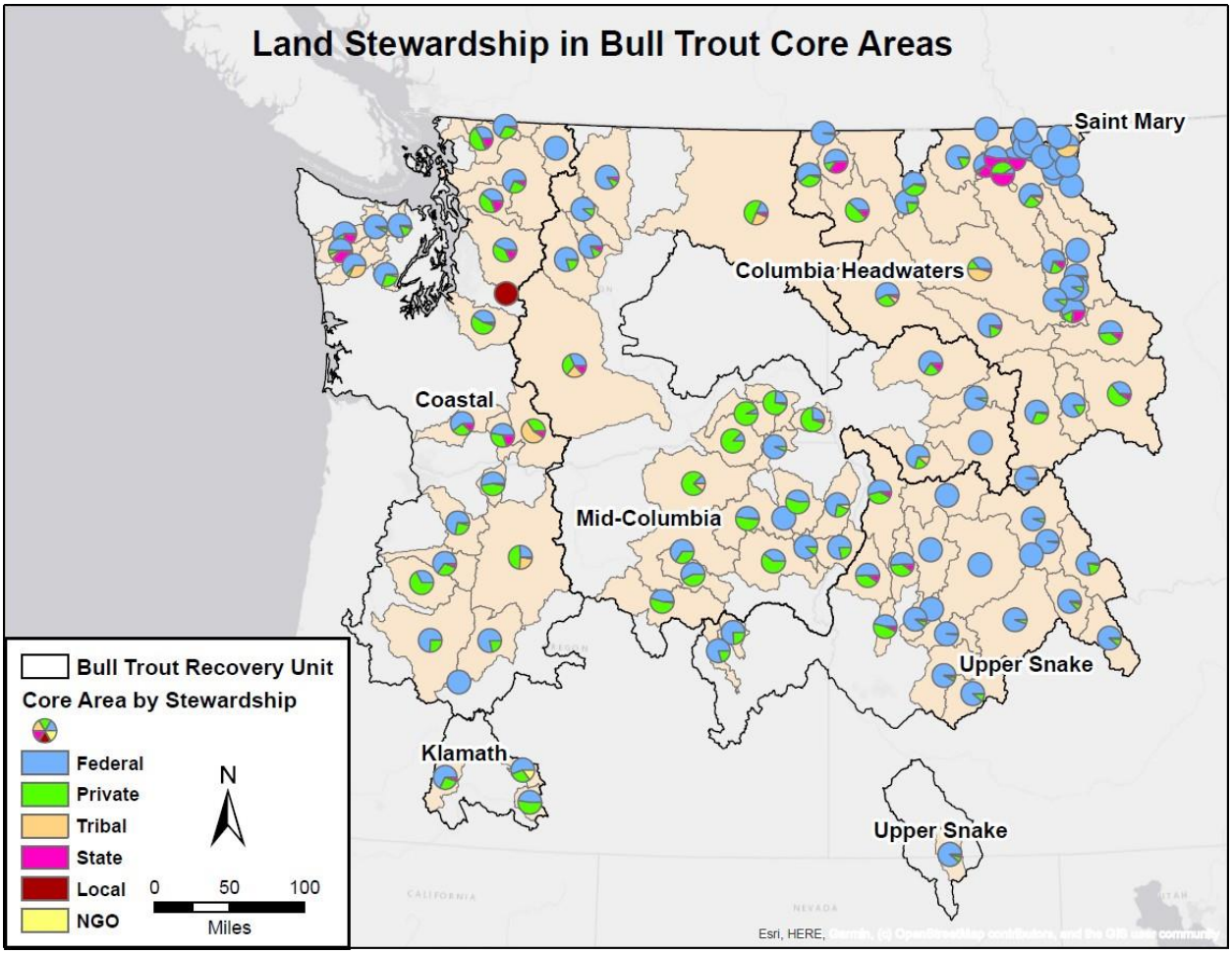


Figure 16. Bull trout land stewardship across core areas.

Chapter 3 - Needs of the Bull Trout DPS

This chapter describes the habitat and demographic needs of bull trout. The needs of a species are evaluated hierarchically, starting at the lowest level with an individual's basic resource needs for breeding (including all stages of reproduction), feeding, sheltering, and dispersal. In the SSA, these needs are described as the habitat factors necessary to support bull trout at the individual level. At the population level, core areas need sufficient population trend, life history expression, numbers of individuals, connectivity of local populations, and adult abundance to be resilient and be able to withstand stochastic events. In the SSA, these needs are described as demographic factors. Needs of the species at the DPS level include redundancy to withstand catastrophic events, and representation to adapt to environmental change. An understanding of the species' needs at both the individual and population levels help inform our viability assessment. In this chapter we summarize the habitat and demographic needs of bull trout individuals, populations at the core area scale, and species at the level of the coterminous DPS. Our understanding of needs for individuals, core area populations, and the bull trout DPS were derived from our discussion of life history and ecology in Chapter 2. The hierarchal relationship between these scales allows for a broad and inclusive understanding of the needs of the bull trout DPS in terms of resiliency, redundancy, and representation.

3.1 Individual Needs

For individual bull trout, habitat needs are collectively referred to as the 4Cs; cold, clean, complex, and connected habitats. A bull trout's habitat needs reflect the demographic needs of a core area and encompass the resources and abilities to access those resources. We identified resource needs for all life stages of bull trout (see Appendix A). The following habitat factors are needed by individual bull trout in the DPS to successfully complete all stages of their life cycle, ultimately contributing to the resiliency of a core area (see also Figure 17).

- Water quality – All life stages need sufficient clean and cold water to breed, feed, and shelter for each life stage to survive.
- Feeding, migration, and overwintering (FMO) Habitat Access – Connectivity between spawning and rearing habitats and feeding migrating and overwintering habitats which provided diverse resources.
- Fish community quality – Habitat with limited interaction with deleterious nonnative species.
- Instream quality – In-water habitat with complex substrates, stream morphology, and structure to meet the needs of each life stage.
- Riparian quality – Intact habitat within the riparian corridor which provides shade, channel complexities, insect communities, and allochthonous inputs leading to higher quality instream habitat and water quality.
- Spawning and rearing (SR) habitat quantity – having a sufficient amount and quality of habitat to allow for individual adults to spawn and juveniles to rear.

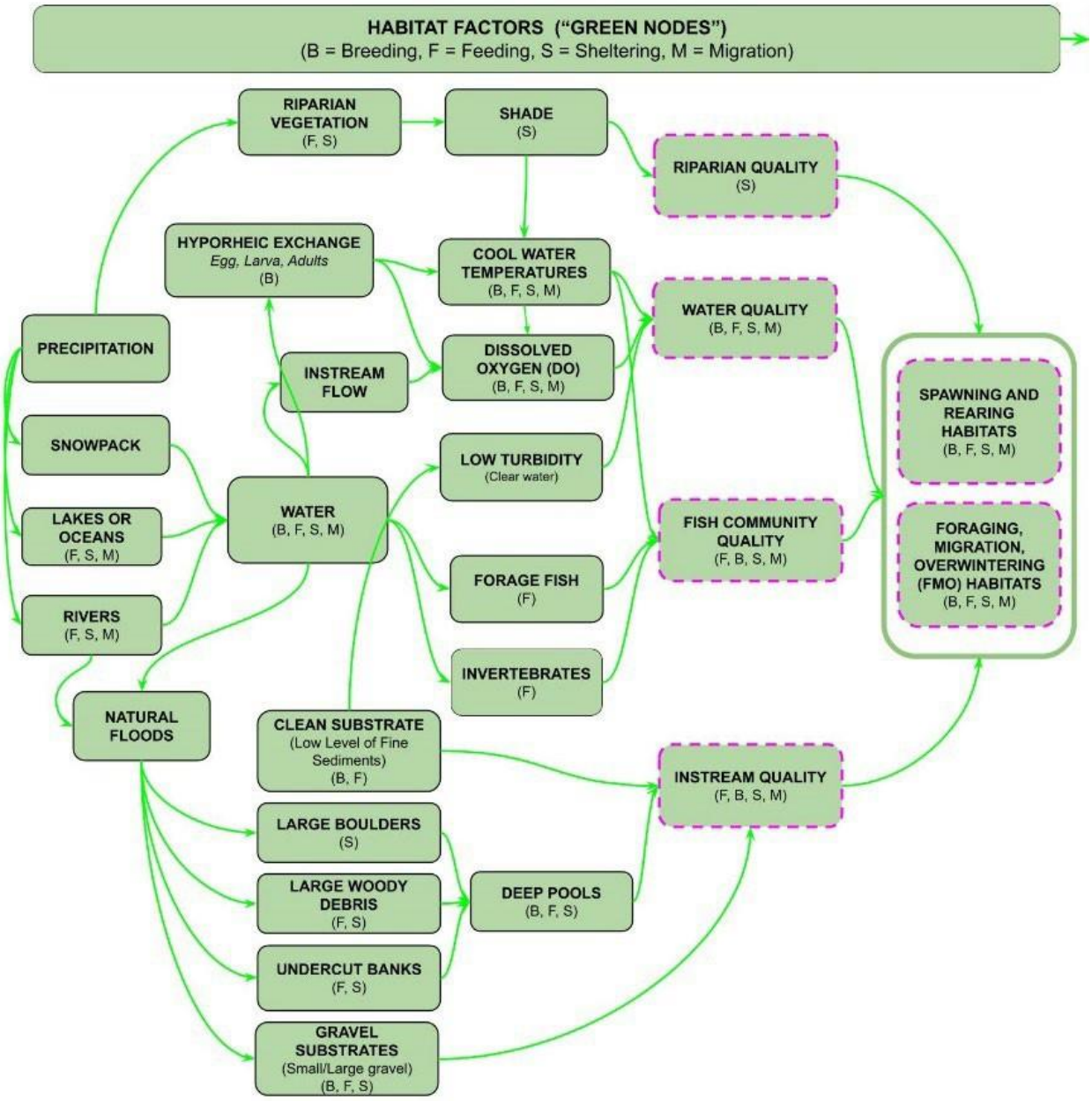


Figure 17. Habitat factors influencing resiliency-bull trout conceptual model: green nodes represent habitat needs considered in this analysis. Nodes with red dotted borders represent bins of needs that are carried through for evaluating resiliency in the current and future condition.

We discuss these habitat needs below.

3.1.1 Water Quality

Water quality includes water composition, water temperature, and water quantity sufficient for the successful completion of all bull trout life stages. Bull trout need clean water over extended timeframes during development of early life stages. When fine sediments enter streams, it can accumulate within spawning gravels and reduce survival of eggs and embryos by impairing their access to oxygenated water, as well as negatively affecting juveniles and adults by interfering

with foraging, clogging gills, physically abrading tissues, and disrupting orientation and movement patterns (Pratt 1992, pp. 5–6). Accumulation of sediment can degrade stream structure by filling in pools and changing substrate composition rendering it useless for life stages.

Bull trout have low tolerance for warm water temperatures, especially in spawning and rearing habitat. Thermal tolerances are narrowest during egg incubation, when warm water reduces egg survival rates and size at hatching. Optimum water temperatures for juvenile rearing are about 7 to 8 °C (44 to 46 °F) and optimum water temperatures for egg incubation are 2 to 4°C (35 to 39 °F) (Goetz 1989, pp. 22–32).

Bull trout need stable and persistent flows throughout the development of the egg and alevin life stages ("not too much, not too little"). Stream flow amounts and timing are influenced by geomorphic complexity of the streambed, surface water/groundwater interaction, hydrograph dynamics, watershed condition, and road densities. Spawning areas are often associated with cold-water springs, glacial and snow melt, or groundwater upwelling (Rieman et al. 1997, p.1121; Baxter et al. 1999, p. 137).

3.1.2 Access to Feeding, Migratory, and Overwintering Habitat

Bull trout need access to diverse feeding, migratory, and overwintering habitats (FMO) that are not synonymous with where they spawn and rear. In some areas bull trout have evolved to take advantage of FMO habitat and any loss may reduce the ability of individuals to fulfill their life cycle. Information on the complex migratory movements of fluvial, adfluvial, and anadromous life history forms (e.g., see 64 FR 58921, November 1; 1999; Jakober 1995, entire; Swanberg 1997, entire; Bahr and Shrimpton 2004, entire; Chandler et al. 2001, entire) has increased our understanding of the extensive habitat use and connectivity requirements of the migratory life history form. This information has affirmed that the use of migratory corridors is critical to the survival of bull trout (Bahr and Shrimpton 2004, pp. 301–303, Brenkman and Corbett 2005 entire; Nelson et al. 2002 entire; Neraas and Spruell 2001, entire; Homel and Budy 2008, entire; Monnot et al. 2008, entire). Maintaining access to downstream habitat for subadult and adult life histories provides population stability, access to alternative prey-base, and increases population resiliency. Connectivity can help maintain population stability despite stochastic events (Muhlfeld and Marotz 2005, p. 805).

Bull trout require large, connected habitats. Connectivity between spawning and rearing habitat and downstream FMO habitat sufficient for bull trout to move freely and with minimal risk is necessary for the expression of migratory life history patterns. In core areas where multiple local populations exist, interaction among local populations through movement of migratory individuals is critical to maintaining genetic diversity. When connectivity with FMO habitat is impaired or blocked, bull trout populations tend to become restricted to isolated local populations of small resident fish, which may have low genetic diversity, are vulnerable to extirpation, and cannot be readily recolonized. Barriers to connectivity include natural physical features such as waterfalls; river reaches that create mortality risks or prevent movement of adult fish because of

entrainment; excessively warm water, or poor water quality; and human-made instream structures such as culverts, weirs, or dams. The severity of passage barriers can be affected by the volume of streamflow, which can vary with seasonal precipitation, droughts, and dam operations, so that passage is available only at certain times of year.

3.1.3 Fish Community Quality

Bull trout need sufficient habitat with limited amounts of competition, predation, and hybridization. Because bull trout depend on the availability of invertebrates and smaller fish as prey, they can be vulnerable to the introduction of other species with overlapping diets (lake trout [*Salvelinus namaycush*], northern pike [*Esox lucius*], brown trout [*Salmo trutta*], brook trout [*Salvelinus fontinalis*], and bass [*Micropterus spp.*]) that can compete effectively for these resources and reduce the prey base. Insufficient availability of food or behavioral exclusion from preferred prey items or foraging habitat due to competition can result in decreased growth and survival of bull trout when competing with either lake trout (Donald and Alger 1993, p. 246; Stewart et al. 2007, p. 6) or brook trout (Gunckel et al. 2002, p. 1128). Nonnative fishes can exploit changes in habitat so that other species that are better adapted to warmer water temperatures might competitively exclude bull trout as water temperatures increase with a warming climate. For example, the competitive advantage of brook trout over bull trout may be more pronounced in warmer waters (McMahon et al. 2007, entire; Rodtka and Volpe 2007, entire). Brown trout and brook trout may also compete directly for spawning and rearing areas, damaging bull trout redds and reducing incubation success. Moreover, brook trout have been well-documented to hybridize with bull trout and negatively affect bull trout recruitment and species integrity/population health (Kanda et al. 2002, entire; Rieman et al. 2006, entire). Finally, larger predatory species (particularly lake trout, northern pike, smallmouth bass, and brown trout) can prey directly on smaller bull trout. Once established, nonnative fish populations can colonize connected watersheds and are difficult to eradicate.

Introductions of nonnative species by a variety of public and private parties across the range of bull trout have resulted in declines in abundance, local extirpations, and hybridization of bull trout (Bond 1992, p. 3; Howell and Buchanan 1992, p. viii; Donald and Alger 1993, p. 245; Leary et al. 1983, entire; Pratt and Huston 1993, p. 75; MBTSG 1995b, p. 10; MBTSG 1995d, p. 21; Platts et al. 1995, p. 9; MBTSG 1996b, p. 7; Palmisano and Kaczynski, in litt.1997, p. 29). Nonnative species may exacerbate other stressors on bull trout from habitat degradation, fragmentation, isolation, and species interactions (Rieman and McIntyre 1993, p. 3). These activities can, over time, reduce the species' resiliency through competition, predation, and hybridizations.

3.1.4 Instream Quality (Clean, Complex, and Cool Habitat)

Bull trout need complex habitats including deep pools, overhanging banks and large woody debris. Bull trout have the following specific requirements for spawning and rearing habitat:

- Appropriate spawning substrate (loose, clean gravel with minimal fine sediment).

- Cold water (influenced by flow levels, groundwater infiltration, cold springs, riparian shading, solar radiation, valley geomorphology, air temperature, temperature of upstream tributaries, and other factors).
- Low-gradient stream segments with stable channel structure.
- Presence of complex cover (woody debris, undercut banks, boulders, and pools).

While bull trout expressing the resident life history will remain localized to watersheds with spawning and rearing habitat, the expression of migratory life history strategies (fluvial, adfluvial, or anadromous) is also dependent on the presence of appropriate FMO habitat, suitable flow levels, and lack of barriers (physical or thermal) to connectivity. Metapopulation structure, genetic exchange, and recolonization of extirpated local populations are dependent on unrestricted movement of migratory individuals to and from FMO habitat.

Appropriate timing and seasonality of streamflow is important for successful spawning (avoiding redd mortality from drying or flood scouring events), adult survival (preventing stranding in side-channels), and to provide adequate flow for migratory movement past barriers. Instream quality supports a suitable prey base and is necessary for successful survival and reproduction. Smaller bull trout such as juveniles and adult residents feed on a diverse array of zooplankton, aquatic insects, and small fish (and are themselves vulnerable to predation by larger predatory fish), while larger migratory adults feed on a variety of smaller fish.

3.1.5 Riparian Quality

For all life stages, bull trout need sufficient levels of intact riparian conditions that provide sources of allochthonous inputs, shade, cover, temperature control, invertebrates, and large woody debris to the streams for breeding, feeding, sheltering, and migration. High quality riparian habitat promoting shade (Dambacher and Jones 1997, p. 355) provides needed solar protections for habitat used by all life stages. Removal or alteration of riparian structure (intact vegetation of all sizes, grounded large woody debris) may negatively affect bull trout populations by contributing to bank destabilization, stream channelization and detachment from flood plain, as well as contributing excessive sediment into the stream. Riparian zones act as the interface between terrestrial and aquatic ecosystems, moderating the effects of upslope processes (Spence et al. 1996, p. 56). Upland habitats influence hydrology, sediment transport, and nutrient dynamics to streams. In addition to moderating peak flows, mature upland habitats can reduce impacts to riparian areas and instream habitat by lowering the risk of mass wasting events that may initiate upslope and outside of riparian areas. However, when episodic mass wasting events do occur in mature forests, they can be an important source of large woody debris recruitment to streams.

3.1.6 Spawning and Rearing Quantity

Bull trout need sufficient space for spawning and rearing. The habitats bull trout use to spawn and rear are dynamic and may change enough between seasons to no longer function for a life stage. Having more habitat able to function as spawning and rearing habitat allows for stochastic variation in its ability to meet the needs of bull trout life stages. While watersheds must have

specific physical characteristics to provide the habitat requirements for bull trout to successfully spawn and rear, these characteristics are not necessarily ubiquitous throughout these watersheds, resulting in patchy distributions even in pristine habitats (Watson and Hillman 1997, p. 248). For example, the Middle Clark Fork River core area contains 302 kms of designated spawning and rearing habitat across ten local populations, however, the total length of documented spawning occurs in less than 16 kms.

Designating spawning and rearing habitat under ESA is intended to protect the most sensitive life stages of bull trout as well as allowing the species to complete critical parts of its life cycle.

3.2 Core Area Population Needs

We evaluate the demographic factors that each core area needs to be resilient. We identified five primary demographic factors that are important to resiliency of a core area (Figure 18). As discussed previously, resiliency is the ability to sustain core areas through the natural range of favorable and unfavorable conditions. Resiliency is based upon the ability of a core population to withstand and recover from environmental or demographic stochastic events such as drought, decreases in abundance, or impacts of forest fires.

- Growth rate: Population trend – The population trajectory of a core area
- Life history diversity – What life history expressions are present in a core area (resident, migratory [fluvial, adfluvial, anadromous], or a combination).
- Number of populations – The number of occupied local populations making up the core area.
- Demographic connectivity – The ability of individuals from one local population to be able to access other local populations within a core area to help maintain genetic diversity.
- Abundance– The number of breeding adults within the core area.

3.2.1 Growth rate: Population trend

The trend in population growth rate considers whether bull trout populations in a core area are increasing, stable, or decreasing. Bull trout core areas need a stable or increasing population trend to be resilient over time. Growth rate and trend are important factors in determining a core area's risk of extirpation (Lande 1993, pp. 911- 912; Fagan 2002, entire). A core area with less resiliency, or at a higher risk of extirpation, would be characterized by a consistently low population growth rate and low abundance whereas a core area with more resiliency, or low or moderate risk of extirpation, may have a stable or increasing trend with greater abundance and support multiple connected local populations with sufficient genetic diversity.

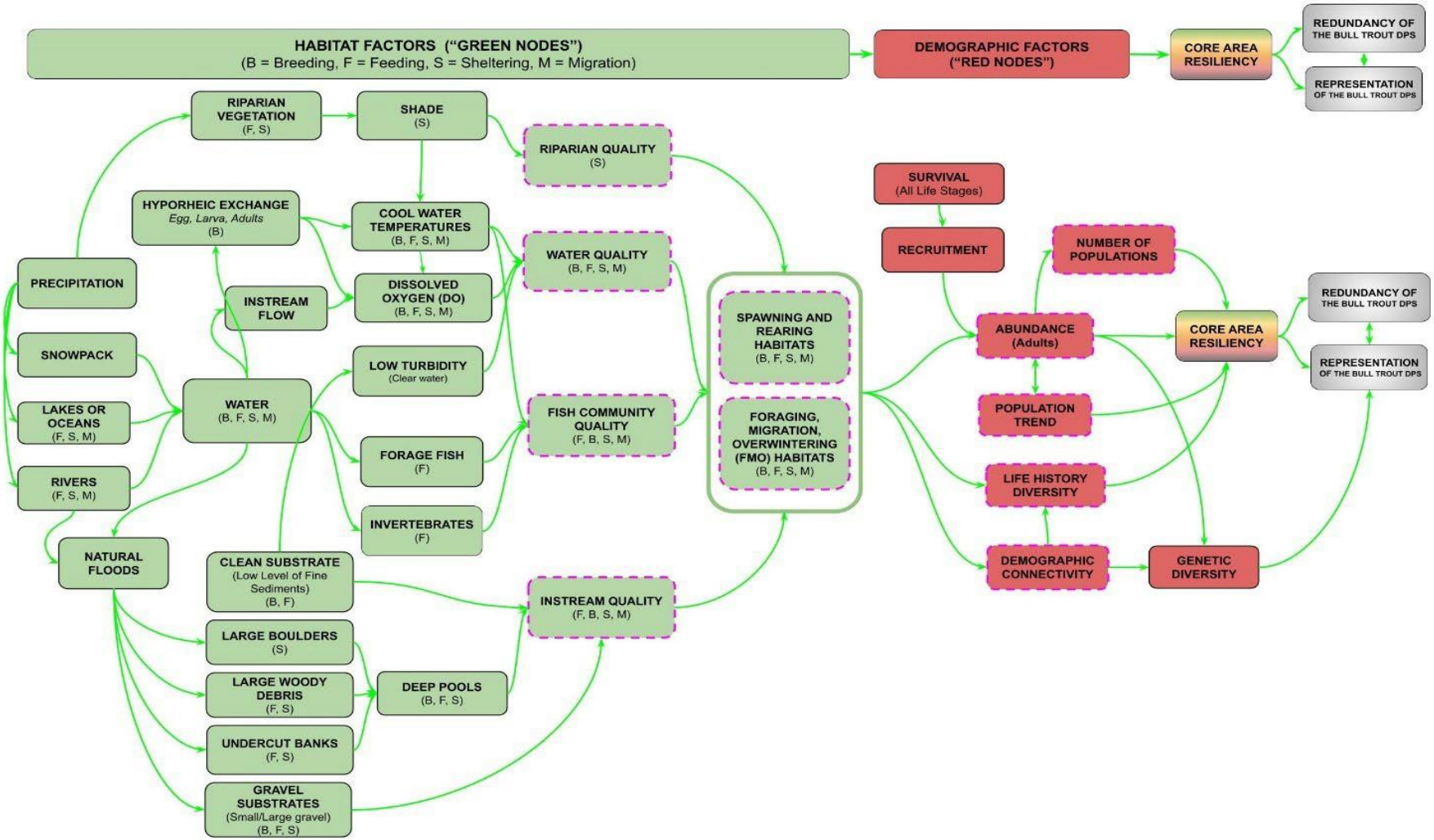


Figure 18. Conceptual model for the resiliency of bull trout DPS core areas, in terms of habitat factors (green boxes) needed by individuals to breed (B), feed (F), shelter (S), and migrate (M), and demographic factors (red boxes) that populations need to be resilient. Green arrows represent positive relationships between nodes. The core conceptual model as shown in Figure 2. is provided at the top of the figure for reference. The primary drivers for resiliency are highlighted with a red, dashed outline.

3.2.2 Life History Diversity

Multiple life history expressions provide opportunity to adapt to natural stochastic and anthropogenic changes within the core habitat. Additionally, having multiple local populations and the opportunity for individuals to move between them allows for genetic diversity and recolonization after stochastic events. Life history diversity considers whether both migratory (including fluvial, adfluvial and anadromous) and resident forms of bull trout are present in a core area. The presence of multiple life history forms of bull trout increases overall resiliency within a core area by distributing risk across multiple spatial and temporal scales. One life history may be advantageous over another depending on environmental conditions and stochastic events in certain habitats.

3.2.3 Number of Populations

The number of local populations in a core area can range from one isolated population (simple core area) to many connected populations (complex core area) that may function as a metapopulation. Simple core areas are naturally at higher risk of extirpation and have lower resiliency. In general, small, isolated populations can have an inherently higher risk of extirpation than multiple, well-connected populations (Hanski and Gilpin 1991 pp. 5–14). Alternatively, the risk of extirpation for a complex core area is inversely associated with the number of local populations (Fagan 2002 pp. 3243–3249).

Maintaining as many local populations as possible would provide for the highest probability for maintaining a viable population of bull trout. The basis for this concept is that the closer to the historical distribution and abundance (or number of resilient core areas) the greater confidence we have for maintaining a viable population (see McElhany et al. 2000, entire). A key measure of representation could be the resiliency of complex core areas, since their larger geographic size and multiple local populations make them inherently more likely to persist than smaller complex and simple core areas (Rieman and McIntyre 1993, pp. 9-23; Rieman and McIntyre 1995, entire), and accordingly have greater influence on overall viability of the DPS.

Simple core areas, often characterized by less resiliency, may contribute less to viability. However, their importance should not be overlooked. Simple core areas may contain important genetic resources (Haak et al. 2010, entire). Simple core areas are subject to genetic drift and tend to have low genetic variability (Meeuwig et al. 2010, entire). Because of this, they also represent a significant, perhaps even disproportionate amount of genetic variability between core areas (Haak et al. 2010, entire). Phenotypic variability is apparent in some of these populations as well and there may be adaptive traits yet to be determined or described. Peripheral populations at the edge of a species' range can carry unique genetic structure and provide new evolutionary material when compared to populations at the core of a species' range, and therefore the evolutionary future of a species could ultimately rely on its peripheral populations (Nielson et al. 2001, entire). Regarding bull trout conservation, Epifanio et al. (2003, entire) asserts the highest priority, as well as the greatest investment, should be directed to depleted, unique, and isolated populations as the most irreplaceable elements of biological diversity. However, Isaak et al. (2022, p. 1359) asserts management effort in large, well-connected habitats with high

probabilities of occupancy and resiliency of local population enclaves will maximize the long-term persistence of bull trout in the face of an uncertain climate. These findings support the idea that both complex and simple core areas may contribute to redundancy and representation of the bull trout DPS.

3.2.4 Demographic Connectivity

Core areas that contain multiple interacting bull trout local populations are considered demographically connected, inherently more resilient, and can provide more redundancy within and across large areas. Maintaining as many core areas as possible would provide for the highest probability for maintaining the viability of the DPS. The basis for this concept is that the closer to the historical number of resilient core areas, the greater confidence we have for maintaining greater viability in the species (see McElhany et al. 2000, entire). Resiliency of connected complex core areas, given their larger geographic size and multiple local populations make them inherently more likely to persist than smaller fragmented complex and simple core areas (Rieman and McIntyre 1993, pp. 9-23; Rieman and McIntyre 1995, entire), and accordingly have greater influence on the persistence of representative units and overall viability of the DPS.

3.2.5 Abundance

Bull trout need a sufficient number of individuals at the local population level and core area scale. Core areas with larger populations produce more offspring and increase the chances that the species will refound adjacent habitats or expand its geographic range and ensure continuous source of individuals. Adult abundance should be viewed as a best estimate given limited systematic site-specific population monitoring across core areas. Stable and increasing population trends accompanied by high numbers of breeding adults result in resilient core areas.

When abundance data exist and are believed to represent the entire population, the size of the population may be the factor most correlated with risk of extinction (Mace et al. 2008, p. 1428). A study using newly developed and more variable genetic markers than previous studies examined genetic variation among 75 representative bull trout populations sampled throughout the coterminous United States. Seventy-six percent of the populations were estimated to have an effective population (N_e) size of less than 50, indicating high divergence among populations caused by genetic drift and a high degree of natal fidelity (Ardren et al. 2011, p. 507, 518). Estimates of N_e are influenced by factors such as variance in family size, adult sex ratios, and fluctuations in populations size and should not be considered direct comparisons to number of breeding adults (N_b) estimates. Research suggests each population would require a minimum of approximately 100 spawners (N_b) to avoid significant demographic and genetic risk (Koski and Whitesel 2015, p. 1363; Schultz and Lynch 1997, p.1363; Rieman and Allendorf 2001, p. 762; Allendorf and Ryman 2002, p. 149; and Whitesel et al. 2004, p. 38).

3.3 Species Needs for the DPS

In this section, we evaluate the needs of the bull trout DPS in terms of redundancy and representation.

3.3.1 Redundancy

Redundancy describes a species' ability to withstand catastrophic events. Redundancy gauges the likelihood that bull trout can withstand catastrophic events such as rare destructive natural events or episodes involving multiple populations or large portions of the species range. Catastrophes may be very large stochastic events from which adaptation is unlikely and that may lead to core area collapse regardless of population health and for which adaptation is unlikely (Mangal and Tier 1993, p. 1083). In general, well-distributed species like bull trout are more redundant than species confined to a more-narrow geographic distribution (Carroll et al. 2021, pp. 5–6; Redford et al. 2011, p. 40; Smith et al. 2018, pp. 306–307). Bull trout need multiple resilient core areas distributed across a large geographic area to reduce the risk of catastrophic events. While the DPS ranges widely across the Pacific Northwest, including five states, the current distribution of bull trout is fragmented within the boundaries of its historical range. A sufficiently wide distribution of multiple resilient core areas ensures that all core areas are not exposed to the same catastrophic event at the same time, thereby reducing the risk to the DPS.

3.3.2 Representation

Representation describes the ability of a species to adapt to changing environmental conditions. The breadth of genetic, ecological, behavioral, morphological, and physiological diversity within and among populations can be a measure of representation (Smith et al. 2018, pp. 306–307). Genetic diversity provides for morphological and behavioral plasticity that allows a species to respond to habitat variation. Representation gauges the probability that the bull trout can use some variation of habitat and life strategy in response to a change in its environment. The more representation or diversity a species has (genetic, morphological, and/or behavioral), the more capable it is of adapting to changes (natural or anthropogenic) in its environment. In this SSA, we considered genetic and ecological diversity of bull trout across the DPS. The bull trout DPS needs sufficient genetic and ecological diversity, including the retention of multiple life history expressions, to adapt to changing environmental conditions, especially climate forced changes in hydrology and temperature.

3.4 Summary of Needs for the Bull Trout DPS

The bull trout DPS needs resilient core areas comprised of functioning core habitat to allow individual bull trout to complete each life stage. The specific quality and quantity of these habitats influences the ability of individual bull trout to breed, feed, and shelter. Core areas need sufficient population trend, life history expression, numbers and connectivity of local populations, and adult abundance. Core areas need a sufficient quality and quantity of the habitat and demographic factors to withstand stochasticity and be resilient. The bull trout DPS needs resilient core areas to be redundant to withstand catastrophic events. Additionally, the bull trout DPS needs genetic and ecological diversity to preserve variation and allow for long-term adaptation to changing conditions. The interaction between spatial and temporal habitat heterogeneity and life history diversity is central to the concept of spreading risk in conservation biology, where naturally diverse populations may have more stable dynamics in the face of environmental changes (Rieman and Dunham 2000, pp 55– 57). In general, resiliency across

core areas preserves the opportunity and options to attain strongholds within representative units, allows for neighboring core areas to benefit from potential source populations in the event of local extinctions, conserves a broad array of options among all core areas to contribute to species persistence under uncertain stochastic change, and prevents the viability of the larger units (representative units and the DPS) from being susceptible to a single catastrophic event. Risk to the DPS decreases with more, resilient core areas distributed across the range.

Chapter 4 – Causes and Effects

This chapter summarizes and interprets the available information on the probable explanations for past and ongoing changes in abundance and distribution of bull trout in the DPS. In order to inform our evaluations of current and future conditions in Chapters 5 and 6, we first conducted a comprehensive review of the literature to identify the most significant environmental sources and stressors, including past and present, natural and anthropogenic, that may have shaped the species' current condition and that may influence its future condition. Many of these sources and stressors have been identified as primary threats in the Recovery Unit Implementation Plans (RUIP). RUIPs are recovery unit specific documents tiered to the 2015 Bull Trout Recovery Plan. They identify the primary threats to bull trout and the site-specific management actions necessary for recovery of the species within the recovery unit, including estimate of time required and cost. Here we integrate the evidence to form the most current understanding of the sources and stressors and the causal relationships and pathways by which these sources and stressors can affect current conditions. Along with these sources and stressors, we also consider activities (conservation efforts) that can positively affect bull trout at the individual, core area, or DPS levels, either currently or into the future. Together these factors influence the viability of the bull trout DPS. We identify the likely drivers and major contributors to changes in abundance and distribution at the population and species level from historical to current conditions within important geographic and genetic areas. Together with the species' ecological needs, this chapter provides an evidence-based explanation of the species' current condition (Chapter 5) and the potential impacts associated with the various future scenarios (Chapter 6).

A stressor has an effect on a habitat or demographic resource, such as an increase in water temperature or decrease in abundance. Some stressors may directly influence the demographics of a core area through mortality of individuals resulting from actions or activities, such as hydropower turbine strikes. Other stressors, such as land development, may first affect habitat factors that then indirectly affect demographic factors. Some stressors may directly affect individuals and habitat factors at the same time. We reviewed potential stressors to the bull trout DPS (see USFWS 2015, Recovery Plan and Recovery Unit Implementation Plans). The stressors we evaluated for bull trout were organized into four primary themes:

- Climate change
    - Seasonal water availability
    - Change in air and water temperature
    - Dynamic weather patterns
    - Wildland fire
- Forest and lands management
    - Forest management
    - Agricultural management
    - Residential and urban development
    - Roads and transportation networks
    - Mining
    - Recreation

    - Beaver management
- Water management
    - Dams (hydropower, flood control, and water supply)
    - Irrigation and water diversion
- Fisheries management
    - Angling
    - Hatchery Introductions
    - Illegal activities
    - Nonnative species
    - Disease and pathogens

These sources and stressors may influence the habitat and demographic factors that we identified as needs. Many of these sources and stressors will have varying levels of negative effects, and potentially positive effects, depending on how well or poorly the management addresses the needs of bull trout. For example, suitable forest management can protect or restore riparian function and reduce catastrophic fire risk within a core area, while incompatible forest management practices can degrade riparian areas and lead to catastrophic fire risk, creating increased stream sedimentation. We broadly account for this variation in management by examining different management scenarios in our future scenarios assessment, with each future scenario resulting in resiliency scores for each core area. As shown in Figure 19 and 20 (see Appendix C for the model version detailing all sources and stressors affecting habitat and/or demographic factors) the bull trout conceptual model illustrates the relationships between conservation efforts, source/stressors, and habitat and demographic factors, all of which affect resiliency, redundancy, and representation. Consistent with the SSA framework, this model explains our hypotheses and current knowledge about the ecology of the bull trout DPS and its environment (USFWS 2016, p. 9). Only stressors found to currently exert negative effects at the population level (core area), or species level would result in negative changes to species viability. Stressors with either no clear effect to bull trout or an effect that did not rise to a core area level effect, were not carried forward to assess species viability in the subsequent parts of this SSA.

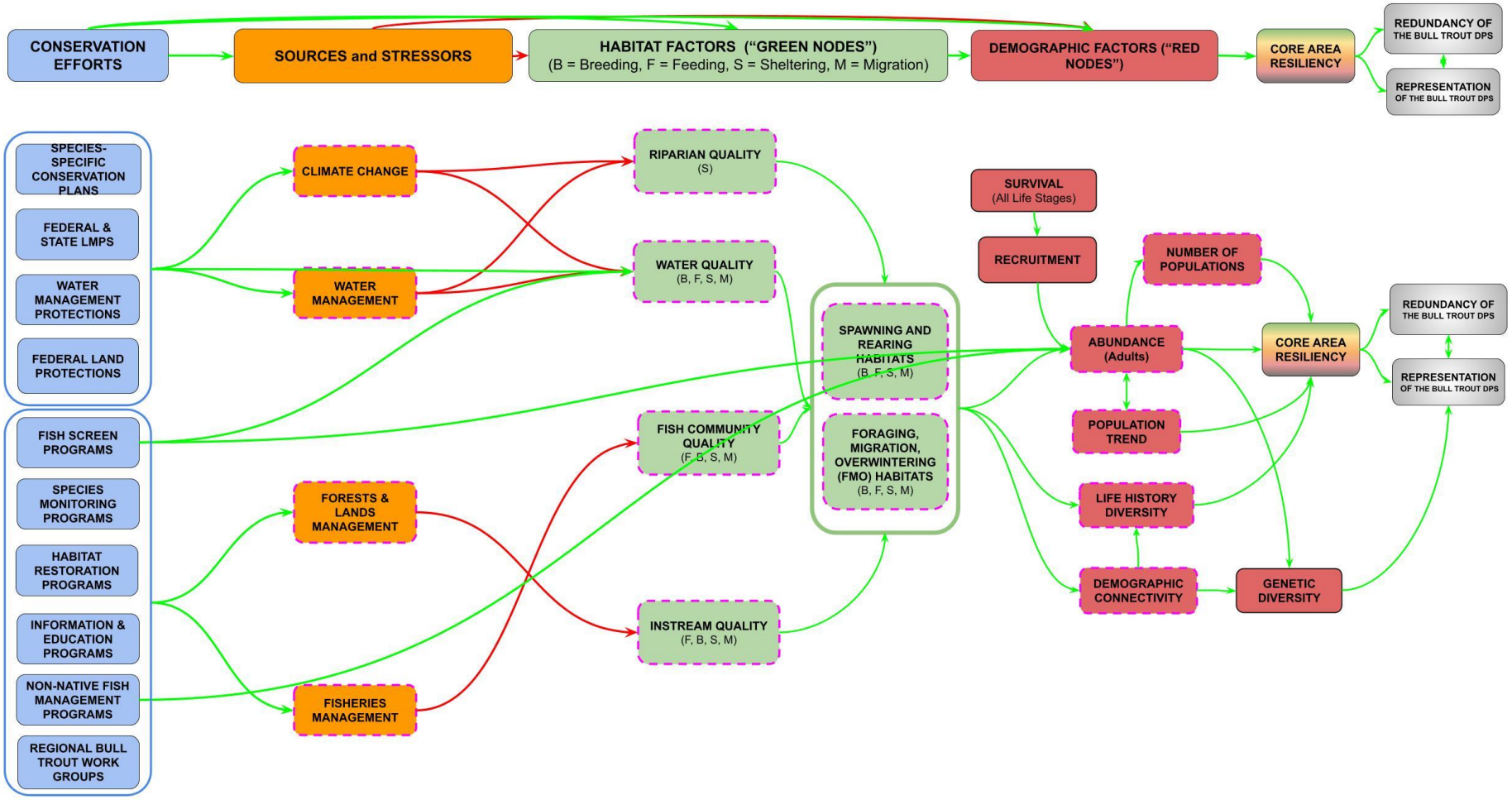


Figure 19. Simplified conceptual model for the primary causes (conservation efforts, sources, and stressors) and effects on individuals or core areas that may cumulatively influence the resiliency of core areas for the bull trout DPS. B = breeding, F = feeding, S = sheltering, and M =migration. Green arrows represent positive relationships between nodes and red arrows represent negative relationships between nodes. Note: Not all relationships are shown.

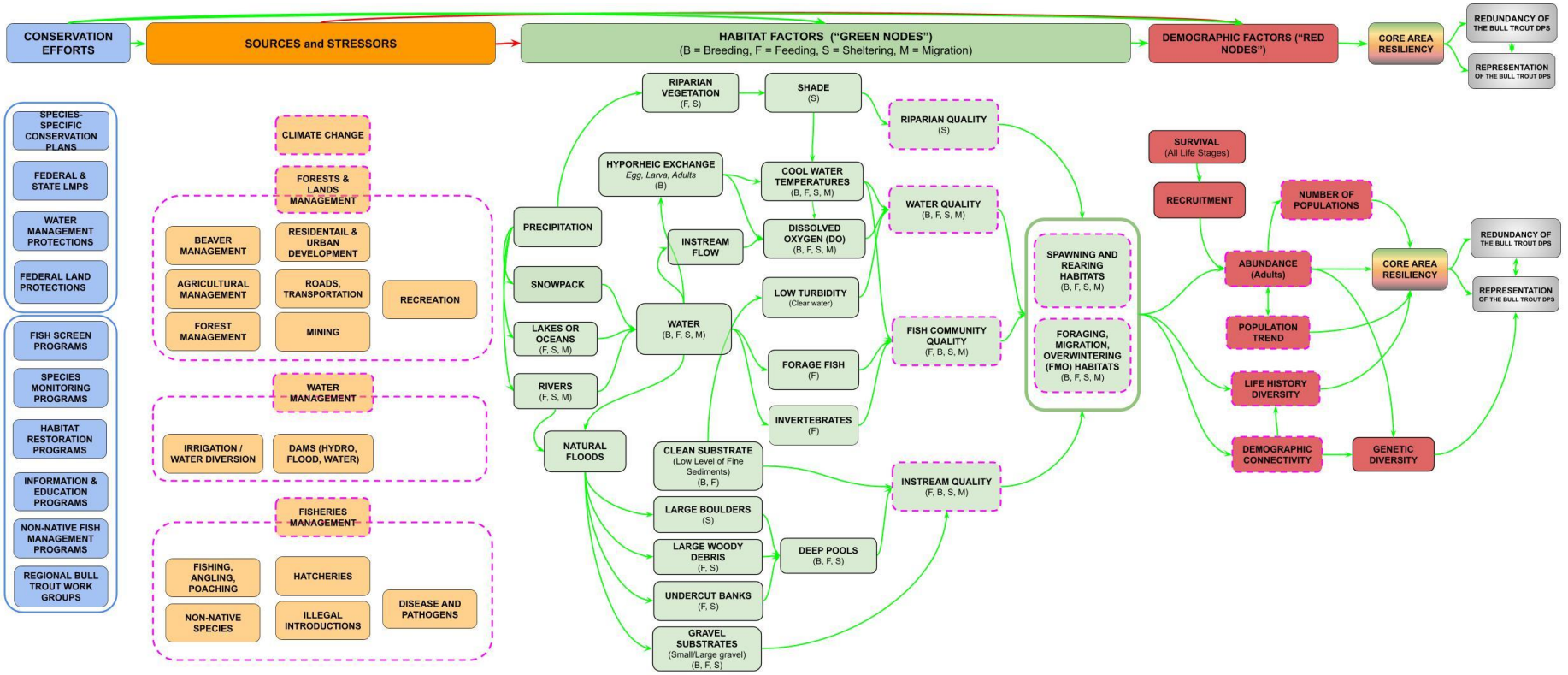


Figure 20. Expanded conceptual model for the primary causes (conservation efforts, sources and stressors) and effects on individuals or core areas that may cumulatively influence the resiliency of core areas for the bull trout DPS. B = breeding, F = feeding, S = sheltering, and M =migration. Green arrows represent positive relationships between nodes and red arrows represent negative relationships between nodes. Arrows removed for conservation efforts and sources and stressors for ease of readability. Note: Not all relationships are shown.

4.1 Sources and Stressors

This section discusses the effects each of these sources and stressors can have on current and future conditions.

4.1.1 Climate Change

Climate change is defined by The Intergovernmental Panel on Climate Change (IPCC) as a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC 2018, p. 544). Climate change is already occurring, and is projected to continue (IPCC 2018, entire). Human activities, particularly carbon dioxide emissions from use of fossil fuels, have already contributed to an increase of approximately 1°C (1.8°F) in global warming from pre-industrial levels, which is likely to reach 1.5°C (2.7°F) in the next 30 years if warming continues to increase at the current rate (IPCC 2018, p. 4). Across the Pacific Northwest, water temperatures in free-flowing streams have increased by about 0.2 °C [0.36 °F] per decade since 1980, due to air temperature increases and flow reduction (Isaak et al. 2011, pp. 499–524).

Climate change affects the habitat needs of bull trout through impacts to seasonal water quality, riparian quality, and habitat quantity which in turn affect the essential spawning and rearing and FMO habitats. All the demographic needs of bull trout are intricately connected to and can be affected by these habitat impacts. Specific climate-related effects on the current condition of bull trout include declines in snowpack and snow water equivalent which affect stream flow and timing, as well as quality (e.g., temperature) to which bull trout are particularly vulnerable. Increases in air and water temperatures may drive cold-dependent species like bull trout to higher elevations with more limited access and connectivity. Fires can result in habitat loss and fragmentation of aquatic resources through post-fire landslides and debris flows, and changes in channel form and stream temperatures (Falke et al. 2015, pp. 314-315).

In many mountain watersheds, the water stored within the snowpack accounts for a significant portion of the seasonal runoff that contributes to streamflow (Hamlet et al. 2007, pp. 1469–1472). In mountain watersheds, signs of climate change are already evident. From 1950 to 1997, snowpack in mountain watersheds declined by more than half in some regions due to changing precipitation patterns and increased temperature (Ryan et al. 2014, p. 236; Hamlet et al. 2005, p. 4559-4560; Mote et al. 2005, pp. 39–42). Across the western United States, snow water equivalent is projected to decline by 25 percent by 2050. Models indicate that snow disappearance (low-to-no snow) could occur within 35 to 60 years if greenhouse gas emissions continue, with potentially catastrophic impacts on the water system (Siirila-Woodburn et al. 2021, p. 800). Effects on seasonal runoff from a decline in snowpack are difficult to tease apart from other factors such as high evapotranspiration, altered vegetation, and changes in wildfire behavior (Siirila-Woodburn et al. 2021, p. 800). A low-to-no snow climate impacts the spatiotemporal partitioning of water, including precipitation stores (e.g., surface water, soil

moisture, and groundwater) and fluxes (e.g., evapotranspiration, runoff, and streamflow) (Siirila-Woodburn et al. 2021, p. 808). Other modeling efforts indicate loss of snowfall and snowpack will be variable across the landscape with some high elevation areas predicted to have below average projected warming rates and climate change having a weaker impact on snowpack particularly in some high elevation areas closer to the inter-mountain west (Ikeda et al. 2021, entire; Isaak and Luce 2023, entire).

Future climate models for the Pacific Northwest project warmer air temperatures, with increases in winter precipitation, decreases in summer precipitation, and precipitation more likely to fall as rain rather than snow (ISAB 2007, pp. 15–17). A reduction in seasonal snowpack is expected to shift the volume and timing of stream flows, leading to increased peak river flows in some areas. Water temperatures are likely to increase because of higher air temperatures (ISAB 2007, pp. 15-17). Additionally, in these areas, snowmelt is shifting toward earlier runoff each year.

As water temperatures within rivers rise, many coldwater-dependent species, including bull trout, may move or migrate to aquatic ecosystems at higher elevations (Hari et al. 2006, entire; Isaak and Young 2023, entire). Climate change can accelerate shifts in species' population distributions (Eby et al. 2014, entire; LeMoine et al. 2020, entire). Bull trout connectivity in mountain watersheds and access to upstream habitat are often limited by natural and artificial barriers (Hari et al. 2006, entire). Changes in water temperature at different elevations can also result in a reduction of range and population abundance (Hari et al. 2006, entire), given bull trout require cold water temperatures, especially in spawning and rearing habitat.

Many fish species have a preferred temperature range in which they carry out their various life stages. Bull trout spawning, for example, is typically triggered when water temperatures drop below 9°C in the fall (McPhail and Baxter 1996, p. 6; WDFW et al. 1997, p. 18; Tennant et al. 2015, p. 1). For coldwater fish, fall spawning permits the young maximum use of the spring growing season (Shuter and Meisner 1992, p. 11). Higher overall water temperatures, especially in the summer, may reduce habitat available below the thermocline in lakes and in headwater areas of rivers. For example, a study of changing stream temperatures over a 13-year period in the Boise River basin estimated an 11 to 20 percent loss of suitable coldwater bull trout spawning and early juvenile rearing habitats (Isaak et al. 2010, pp. 1350–1371). Elevated water temperatures can negatively affect bull trout egg survival. Cool water temperatures during early life history results in higher egg survival and faster fry growth rates (Pratt 1992, pp. 5–7). Warming, expected within some lake environments, will increase during the summer and it may lead to reduced spring and fall periods of favorable temperature ranges (Shuter and Meisner, 1992. p. 12). If coldwater-dependent fish must remain in suboptimal habitats for longer durations, growth rates could be negatively affected (Burns 1971, pp. 44–57) due to competition for both space and prey resources. Bull trout will likely experience this effect, as fluvial, adfluvial, and anadromous (migratory) bull trout rely upon seasonal access to prey resources in large rivers, lakes and marine waters, respectively (Shuter and Meisner 1992, p. 11). The projected reductions in coldwater refugia for bull trout will likely result in decreases in overall population abundance (Shuter and Meisner, 1992. p. 12). While the effects of climate change are generally predicted to be negative, some locations will likely be more resilient than others. Bull

trout range in northern latitudes is predicted to expand as habitat suitability increases in areas currently unsuitable due to cold temperature limitations (Mochnacz et al. 2022, p. 14). Also, large lakes within the range of bull trout will provide continued thermal refugia and ideal growth conditions under moderate climate change.

Climate change will also likely increase the magnitude and frequency of wildland fires, especially in drier areas such as those found east of the Cascade Mountains (Bisson et al. 2003, pp. 216–217). In several studies on the influence of habitat characteristics and their linkages to fire, terrestrial landscapes, and climate (Falke et al. 2015, pp. 313–316; Hessburg and Agee, pp. 30–32), bull trout appeared to have adapted to previous fire disturbances by inhabiting a large area and adapting to changes in their environment. However, the projected increase in scope and intensity of fires in the future may have a substantial impact on bull trout through continued habitat loss, fragmentation of aquatic systems, and the introduction and expansion of exotic and invasive species (Bisson et al. 2003, pp. 218–219). As noted in the previous paragraph, the effects of climate change may restrict bull trout to smaller areas of coldwater refugia. This confinement to suitable coldwater areas, projected to diminish in size and abundance, will likely put bull trout populations at greater risk from forest fires and other natural disturbances that could further isolate populations and limit their abundance and distribution (Shuter and Meisner 1992, p. 12).

Uncertainties are associated with predictions of the timing, location, and magnitude of future climate change. The intensity of effects will vary based on the region (ISAB 2007, p 7). Several studies indicate that climate change has the potential to affect ecosystems in nearly all streams throughout the range of bull trout (ISAB 2007, p. 13; Battin et al. 2007, p. 6722; Rieman et al. 2007, pp. 1558–1561). Bull trout may not be able to adapt to or avoid the warming of streams and rivers resulting from climate change. Due to the differences in landform and geographic location across the range of bull trout, some populations face higher risks than others. Bull trout in the southern edge of its range, at lower elevation, and/or areas with currently degraded water temperatures are at higher risk of adverse effects from current and future climate change (Dunham et al. 2003, entire) and populations in the northern areas of the species range may expand due to reduced cold-limiting conditions which currently exist (Mochnacz et al. 2022, p. 14).

A patch occupancy model, used to examine spatial and temporal dynamics of populations, indicated that in the Rocky Mountain region, “regional improvements in bull trout status were difficult to achieve in realistic restoration strategies due to the pervasive nature of climate change and the limited extent of restoration actions given their high costs” (Isaak et al. 2022, p. 1). Climate change will likely limit the distribution and core population size of bull trout in the future, increasing the risk of isolating and reducing genetic diversity between core areas. Therefore, losses in connectivity may accelerate the rate of extirpation of local bull trout populations beyond that resulting from changes in stream temperature alone (Rieman et al. 2007, pp. 1559–1560). The effects of global climate change have and are expected to continue to influence the resiliency of core areas and the viability of the DPS. For these reasons, climate

change is carried forward as a driver of current and future conditions in the subsequent parts of the SSA.

4.1.2 Forest and Lands Management

Various forms of forest and land management are known to impact bull trout and their habitat across the species range (USFWS 2015, p. 58768). The most common forms of management with effects to bull trout and their habitat include forest practices, agriculture practices (including livestock grazing), residential and urban development, mining, and associated transportation network development and maintenance. Recreation infrastructure and activities can also have many of the same or similar impacts to bull trout habitat but can also have some unique impacts to bull trout and their habitats, so we have included recreation as its own subsection. We have also included the management of beaver under this section given this species' significant ecological influence on aquatic systems and the growing adoption of beaver reintroduction or their man-made surrogates (beaver dam analogs) in habitat restoration efforts. Because the suite of forest and land management stressors will likely have varying levels of effects on individuals and populations of bull trout depending on land use in each core area, this theme is carried forward as a driver of current and future condition in the subsequent parts of the SSA.

Forest and land management activities affect the habitat needs of bull trout by reducing instream quality, which in turn affect the two essential types of habitats, spawning and rearing and FMO. As with climate change, these types of habitat disruption impact all the demographic needs of bull trout. Specific effects of forest and land management on the current condition of bull trout result from timber extraction and road construction that can reduce necessary woody debris in stream channels that provide complexity and protective cover to stream habitats occupied by bull trout. Timber extraction can increase erosion and sedimentation rates that promote excessive substrate movement with resulting increases in egg and juvenile mortality, and reduction of habitat.

Many core areas have "legacy effects" of past land use practices that continue to degrade bull trout habitats, or where habitat restoration or improved land management has not yet occurred or has not yet been demonstrated to be effective to address these legacy effects. Because legacy effects may persist for decades it may also take many years (bull trout generations) for bull trout populations to respond to new management actions and for researchers to evaluate the effectiveness of future conservation actions (USFWS 2015, p. 11; see also RUIPs).

Forest Management

Forest management activities, including timber extraction and road construction, can affect bull trout stream habitats by altering recruitment of large woody debris, erosion and sedimentation rates, runoff patterns, the magnitude of peak and low flows, water temperature, and annual water yield (Cacek 1989, entire; Furniss et al. 1991, entire; Wissmar et al. 1994, entire; Spence et al. 1996, pp. 5–6; Spencer and Schelske 1998, entire; Swanson et al. 1998, entire). Activities that promote excessive substrate movement reduce bull trout production by increasing egg and juvenile mortality, and reducing or eliminating habitat (e.g., pools filled with substrate)

important to later life-history stages (Fraley and Shepard 1989, p. 141; Brown 1992, p. 24; Bowerman et al. 2014, p. 1069–1070). The length and timing of bull trout egg incubation and juvenile development (typically more than 200 days during winter and spring) and the strong association of juvenile life stages with stream substrate make bull trout vulnerable to changes in peak flows and timing that affect stream channels and substrate (Goetz 1989, pp. 22–24; Pratt 1992, pp. 5–6; McPhail and Baxter 1996, pp. 9–12; MBTSG 1998, pp. 7–10).

Although bull trout occur in watersheds where timber has been harvested, bull trout strongholds primarily occur in watersheds with little or no past timber harvest, such as the wilderness areas of central Idaho and the South Fork Flathead River drainage in Montana (Henjum et al. 1994, pp. 58, 62, 83, 155; MBTSG 1995e, entire; USDA and USDI 1996, pp. 130–136; Rieman et al. 1997, entire). An exception, the Swan River basin in Montana has had extensive timber harvest and road construction and remained a bull trout stronghold into the early 2000s (Watson and Hillman 1997). However, the overall effects of forestry practices on bull trout in parts of this basin are difficult to assess because of the complex geomorphology and geology of the drainage (MBTSG 1996a, pp. 24–25).

Agricultural Management

Agricultural activities, including cultivation and harvest of crops, irrigation diversions (also see Water Management section 4.1.3), pesticide and fertilizer/nutrient application, and raising and grazing livestock contribute to nonpoint source pollution in some areas within the range of bull trout (MDHES 1998, entire; WDOE 2000, pp. vi, appx A 1–111; IDEQ 2022, pp. 3, 11, appx A 38). These practices can release sediment, nutrients, insecticides, and herbicides into bull trout streams or their tributaries; increase water temperature; reduce riparian vegetation; alter stream banks through increased erosion and armoring; and alter hydrologic regimes, typically by reducing flows in spring and summer (Spence et al. 1996, pp. 119–130; MBTSG 1998, pp. 27–33; Hughes and Vadas 2021, entire). Other effects include water quality degradation resulting from irrigation return flows and runoff from fields; entrainment of bull trout into canals and fields (MBTSG 1998, pp. 30–32); stream channelization, loss of habitat complexity, and large woody debris removal (Spence et al. 1996, p. 129).

Runoff from nearby agricultural lands can be a major stressor for individual bull trout and bull trout populations. Streams and rivers adjacent to agricultural lands can be exposed to fertilizer and pesticide runoff, especially following storm events. The exposure of bull trout to agricultural chemicals may result in direct mortality or sublethal impacts. These sublethal impacts include chronic effects to migratory behavior, swimming ability, reproductive success, and overall survival rates (USFWS 2015, p. 26). For instance, a common fertilizer in the form of nitrogen breaks down into materials that are toxic to fish such as ammonia and nitrates. In general, the smaller concentrations of these products in the water could lead to sublethal physiological and histopathological impacts rather than direct mortality (Frank and Brewer 2010 p. 4).

Improperly managed livestock grazing degrades bull trout habitat by removing or degrading riparian vegetation, destabilizing streambanks, widening stream channels, promoting incised

channels, lowering water tables, reducing pool frequency, increasing soil erosion, and altering water quality (Howell and Buchanan 1992, p. viii; Mullan et al. 1992, pp. 123, 126; Platts et al. 1993, p. 82; Henjum et al. 1994, pp. 5-6, 8–10, ; MBTSG 1995a,b,c; USDA and USDI 1996, pp. 51, 78, 116, 126; 1997, pp. 104–112). These effects reduce overhead cover, increase summer water temperatures, and promote formation of anchor ice (ice attached to the bottom of an otherwise unfrozen stream, often covering stones, etc.) in winter (MBTSG 1998, p. 27-28; Brown et al. 2011, entire), and increase sediment in spawning and rearing habitats. Negative effects of livestock grazing on bull trout habitat may be minimized if grazing is managed appropriately for conditions at a specific site. Practices generally compatible with the preservation and restoration of bull trout habitat include fences to exclude livestock from riparian areas, rotation schemes, relocation of water and salting facilities away from riparian areas, and use of herders.

Rural-Residential and Urban Development

Residential development continues to increase within portions of the range of bull trout. Residential development alters stream and riparian habitats through contaminant inputs, stormwater runoff, changes in flow regimes, streambank modification and destabilization, increased nutrient loads, and increased water temperatures from the removal of streamside vegetation (MBTSG 1998, pp. 23–25). Indirectly, urbanization within floodplains alters groundwater recharge by rapidly routing water into streams through drains rather than through more gradual subsurface flow (Booth 1991, pp. 97–99, 109). Urbanization negatively affects the lower reaches of many of the large rivers and their associated side channels, wetlands, estuaries, and near-shore areas of Puget Sound, Washington.

Activities such as dredging; removing large woody debris (e.g., snags, log jams, driftwood); installing revetments, bulkheads, and dikes; and filling side channels, estuarine marshes, and mudflats have led to the reduction, simplification, and degradation of habitats used by bull trout, other salmonids, and forage fish used as prey (Thom et al. 1994, pp. 6.1–6.17, 8.1; Spence et al. 1996, p. 133; PSWQAT 2000, pp. 22–23). Pollutants associated with urban environments such as heavy metals, pesticides, fertilizers, bacteria, and organics (oil grease) have contributed to the degradation of water quality in streams, lakes, and estuaries (NRC 1996, pp. 197–198; Spence et al. 1996, p. 133, PSAT 2007, p. 228) and continue to do so (French et al. 2022, entire).

Rural-residential development is not only the fastest growing land use type in the United States (Lohse et al. 2008, p. 468), but it has also been modeled as a significant predictor of elevated levels of in-stream fine sediment and related decreases in the proportion of high-quality spawning sites for salmonids within a watershed (Lohse et al. 2008, p. 476). Expansion of residential and urban development in the Pacific Northwest also leads to increasing demands for surface and/or ground water (Houston et al. 2003, entire), with potential to impact base flows in some bull trout streams especially when combined with projected impacts of climate change (Mote et al. 2003, pp. 54–62).

Roads and Transportation Networks

Roads may have hydrologic, geomorphic, chemical, and ultimately ecological impacts to stream corridors (Sholtes et al. 2017, p. 31). Roads degrade bull trout habitats by creating flow constraints and channel modifications in ephemeral, intermittent, and perennial stream reaches. Roads also reduce riparian vegetation (Furniss et al. 1991, entire; Ketcheson and Megahan 1996, entire; Trombulak and Frissell 2000, pp. 21–25; Sholtes et al. 2017, pp. 31–33). In the Clearwater River basin of Idaho, for example, Highway 12 is adjacent to much of the Lochsa and Clearwater rivers and crosses the river at eight different bridge sites. The highway has constrained the river in some areas and highway maintenance may negatively affect bull trout and their habitats (CBBTTAT 1998, p. 36). Moreover, the proximity of highways to bull trout habitat increases the likelihood of hazardous materials from automobile use or fuel spills entering the river.

Roads may affect aquatic habitats considerable distances away. For example, roads can increase perennial channels, erosion, and sedimentation; create passage barriers; channelize sediments, and alter debris flows and peak flows, all of which affect streams longitudinally. Through these effects, the area occupied by a road can be small compared to the entire downstream area subjected to its effects (Jones et al. 2000, entire; Trombulak and Frissell 2000, pp. 25-26). Upstream from road crossings, large areas of suitable habitats may become inaccessible to bull trout due to fish passage barriers (e.g., culverts).

Roads constructed for forest management are a prevalent feature on managed forested and rangeland landscapes. Roads have the potential to adversely affect several habitat features, including water temperature, substrate composition and stability, sediment delivery, habitat complexity, and connectivity (Baxter et al. 1999, entire; Trombulak and Frissell 2000, pp. 21–23). Many forest road networks include culvert crossings, which installed improperly can create connectivity issues. Roads may also isolate streams from riparian areas, causing a loss in floodplain connectivity and riparian function. The aquatic assessment portion of the Interior Columbia Basin Ecosystem Management Project provided a detailed analysis of the relationship between road densities and bull trout status and distribution (Quigley and Arbelbide 1997, pp. 63-93). The assessment found that bull trout are less likely to use streams in highly roaded areas for spawning and rearing, and do not typically occur where average road densities exceed 1.1 km per square km (1.7 miles per square mile) Quigley and Arbelbide 1997, pp. 1258–1262). Isaak and others (2022, entire) found a similar negative association with road density and bull trout patch occupancy.

Road networks also affect bull trout habitats in protected areas such as National Parks. Roads have been constructed to provide access to the Hoh River and Quinault River basins, including areas within Olympic National Park. These roads were typically built following river valleys and often constrain the floodplains. As a result, these roads have been subjected to high flow events and shifts in river channels, forcing extensive streambank armoring to maintain them (Chad 1997, entire; NPS 2000, entire; NPS 2007, entire). Bank armoring impairs bull trout habitats through reduced habitat complexity, stream channelization, reduced riparian vegetation, and

bank erosion downstream. Within Olympic National Park, about 1,770 meters (5,476 feet) of riprap were documented along the Hoh River in 1997 (Chadd 1997, pp. 32, 45), and additional bank stabilization projects have occurred since then. In more recent years, more fish-friendly bank stabilization alternatives (e.g., engineered log jams) are being selected (USDOT 2017, entire).

Maintenance of many roads, and their associated infrastructure such as bridges and culverts, require frequent channel and floodplain modifications that affect bull trout habitat, such as channelization; removal of riparian trees and beaver dams; and placement of rock, sediment, and concrete (Furness et al. 1991, p. 312; McNeill et al. 1997, pp. 4-6–4-7, 5-1; Jensen et al. 1999, pp. 8-11; Schmetterling et al. 2001, entire).

Railways may also impact aquatic systems within the range of bull trout. For example, in Washington the Washington State Department of Ecology (2013, p. 18) found more than 150 miles of active railroads are located near protected salmonid habitat. Railroads constructed parallel to stream channels can result in lateral hydrological (floodplain) disconnections that can significantly impact function of riparian areas by negatively affecting floodplain evolution, riparian ecosystem processes, and side-channel habitats (Pennington et al. 2010, p. 190) in addition to their potential to hinder passage at stream crossings and increasing spill risks to aquatic habitats similarly to roads. There is also the potential for exposure to creosote-treated wood leachate from treated railroad ties and railroad crossings within aquatic habitats (WDOE 2013, p. 9).

Roads and transportation networks disproportionally impact the migratory life form as these networks typically have their highest density in areas lower in a watershed or core area such as FMO habitats that migratory bull trout require as part of their life history. Unlike the resident life form, migratory forms may rely on degraded FMO habitats (often the result of some impacts from road networks) for their persistence (Schaller et al. 2014, p. 7, 54).

Mining

Mining may degrade aquatic habitats used by bull trout by altering water chemistry (e.g., pH); altering stream morphology and flow; and causing sediment, fuel, and heavy metals to enter streams (Martin and Platts 1981, entire; Spence et al. 1996, pp. 134-143, 172). The types of mining that occur within the range of bull trout include extraction of hard rock minerals, coal, gas, oil, and sand and gravel. Past and present mining activities (both commercial and recreational) have adversely affected bull trout and bull trout habitats in Idaho, Oregon, Montana, Nevada, and Washington (Johnson and Schmidt 1988, pp. 1.4-1.6, 3.56; Moore et al. 1991, entire; Mongillo 1993, p. 15; Platts et al. 1993, p. 83; MBTSG 1995a, pp. 22-24; 1995c, p. 23-24; 1996b, pp. 17-18; 1996c, pp. 20–21; Shoshone-Paiute Tribes et al. 2004, pp. 48-49, 87-88; Kiser et al, 2010, entire; US News & World Report, 2022) as well as in other parts of their range (Palace et al. 2004, entire). For example, it is thought that bull trout were widely distributed in the Coeur d'Alene River drainage, Idaho (Maclay 1940, p. 14) and upper Clark Fork River, in Montana. However, extensive mining and associated operations have modified

stream channels and floodplains, created barriers to fish movement, and released toxic substances, especially in the South Fork Coeur d'Alene River (PBTTAT 1998, p. 8). Portions of the system were essentially devoid of aquatic life during surveys conducted in the 1940s. Bull trout have been functionally extirpated in the Coeur d'Alene River basin since 1992 (USFWS 1999a). New mining proposals have the potential to impact other bull trout populations (Crosscut, 2020; Clark Fork Valley Press/Mineral Independent, 2021; S&P Global Market Intelligence, 2021).

Recreation

Indirect recreational impacts to salmonid habitats stem from boating, log removal, off-highway vehicle (OHV) use, parks and campground development and their use. These activities, especially in concentrated or high use areas, can lead to degradation of stream and lake banks, riparian vegetation, impaired water quality, and disturbance of spawning areas and/or redds (Spence et al. 1996, p. 152). Recreationists can substantially alter salmonid habitats by removing wood and snags for safety reasons (Spence et al. 1996, p. 152) or for firewood (Opperman et al. 2006, p. 8, 10) and by constructing rock dams to create or enhance pools for recreation (Reiss et al. 2012, p. 39; BTWG and YBFWRB 2017, pp. 73, 83, 89, 121, 150, 192; Native Fish Society, 2018). These activities may degrade stream habitat complexity and function and/or block or delay fish migration.

Beaver Management

A long history of beaver management, including trapping and removal of individuals, which has greatly reduced the beaver population across North America, as well as beaver dam removal, has caused substantial changes to stream hydrology and geomorphology, impacting quantity and sometimes quality of habitat available for fish (Pollack et al. 2003, pp. 1– 4, 17; Wohl 2021, pp. 2–4). Beavers play an important role in instream habitat formation by impounding water to create large pools and ponds. In return, these features trap sediment, create wetland habitats, improve water quality, facilitate groundwater recharge, help to increase summer low flows (Pollack et al. 2003, pp. 3, 6–8), and create spatially complex stream corridors with multiple channels (Wohl 2021, pp. 1–2). Beaver ponds may be important habitat for overwintering bull trout in some populations (Jakober 1995, pp. 90–92). There are ongoing efforts to reintroduce beaver populations in some watersheds to reestablish these ecosystem engineers or install beaver dam analogs to act as surrogate habitat forming features in watersheds where reintroduction may be difficult. However, as beaver populations continue to rebound and as beaver dam analogs increase in habitat restoration efforts, there may not always be the desired results in some streams (Mailson et al. 2016, entire; Larsen et al. 2021, 28–30; Wohl 2021, pp. 4–6; Stevenson et al. 2022, entire) that would support bull trout. In addition, some beaver dams have the potential to create barriers to fish migration but are likely to be temporary or seasonal and species-specific (Pollack et al. 2003, pp. 16–17; Lokteff et al. 2013, entire).

Forest and Land Management Interactions with Climate Change

Climate change interacts with and can exacerbate forest and land management stressors (also see Climate Change section 4.1.1). For example, fire suppression, timber harvest, and overgrazing have altered regional fire regimes and have created conditions which, in combination with climate change impacts (e.g., drought), exacerbate the severity and magnitude of wildfires (Falke et al. 2015, p. 305). Transportation networks can further increase the impacts to and vulnerability of bull trout from wildfire through the impairment of stream and population connectivity from road crossings (Falke et al. 2015, p. 311; Isaak et al. 2022, p. 6). Within Puget Sound, shoreline armoring is increasing and likely to be a common response to sea level rise in developed areas (Mauger and Vogel 2020, p. 34; Shirk et al. 2021, p. 13). Armoring negatively impacts shoreline dynamics and nearshore fish habitat important to the anadromous form of bull trout. Climate change is expected to further exacerbate the growing water demand especially in summer months for both agricultural and development purposes across the Pacific Northwest, but particularly within the Columbia River Basin, placing further strain on available instream flows for fish (Mote et al. 2003, pp. 54–62; Bumbaco et al. 2022, entire).

4.1.3 Water Management

Water management structures and activities occur across the coterminous United States range of bull trout (USFWS 2015, pp. 12-13). Examples include dams, levees and other shoreline infrastructure, flood risk management, water storage, and water withdrawals for irrigation and water supply. Each of these structures and activities impact bull trout populations in different ways. Water management activities affect the habitat needs of bull trout through riparian and water quality and quantity, which in turn affect the two types of essential habitats, spawning and rearing and FMO. Demographic needs, including connectivity and abundance, can be directly affected by water management activities. Dams, irrigation diversions, and road crossings often form impassable barriers to fish movement; cause entrainment and mortality; change suitable water temperature and stream flows, increase sedimentation, and result in habitat fragmentation (USFWS 2015, pp. 12–13). These effects isolate bull trout local populations and negatively affect the availability of suitable FMO habitat. Because the suite of water management stressors will likely have varying levels of effect on individuals and populations of bull trout depending on water use in each core area, this theme is carried forward as a driver of current and future condition in the subsequent parts of the SSA.

Dams (Hydropower, Flood Control, and Water Supply)

Fish passage for fluvial, adfluvial, and anadromous bull trout through dams can be limited or blocked completely without the inclusion of fish passage facilities. When fish passage capability is inadequate, reduced movement of bull trout can impair or block connectivity (USFWS 2015, p.28). Dams and associated operational facilities can entrain fish into turbine intakes, modify flows and water temperature regimes downstream, dewater shallow areas during peaking operations, and create sporadic water level fluctuations (Spence et al. 1996, pp. 7–8, 141–142; McPhail and Baxter 1996, p. 18; Muhlfeld et al. 2012, entire). The process of fish passing through a dam can result in direct mortality, as seen in the Rimrock Lake dam, Washington. Fish

enter the intake tower above the dam and are expelled below the dam via a jet valve. Pressures exerted on bull trout can reach approximately five atmospheres (Underwood and Cramer 2007, pp.198–199). Modelled mortality rates of entrained bull trout using this type of passage were calculated to be near 60 percent (Underwood and Cramer 2007, pp.198–199).

Dams can also hinder or limit fish movement by causing seasonal dewatering of downstream reaches. Seasonal flow regimes resulting from dam operations often fluctuate to meet various needs, such as agricultural supply needs. These seasonal dam operations differ substantially from the required flow patterns needed for bull trout migration (USFWS 2015, p. 28) and can also result in reservoir elevations that may impact either spawning or subsequent incubation (Barnett et al. 2013, entire; BOR and WDOE 2016, pp. 2–3). Bull trout access to move and migrate through various habitat types is crucial for the expression of all life history strategies. Resident and migratory life history strategies may buffer a population against local extinction. Therefore, a loss of a life history strategy due to lack of access to certain habitats may further increase the chance of extirpation of the species (Neraas and Spruell 2001, p. 1153).

Population declines associated with dams are primarily due to the change from a riverine to a lacustrine environment and the isolation of migratory fishes from their spawning and feeding grounds (Barthem et al. 1991, entire; Wei et al. 1997, entire; Ruban 1997, entire; Neeras and Spruell 2001, entire). These disruptions can lead to localized extinctions if critical habitats are lost or no longer accessible (Neeras and Spruell 2001, p. 1153). Migratory bull trout may spend several years in lakes or larger rivers before returning to spawn in tributaries (Bjornn 1957 p. 87; Shepard et al. 1984b pp. 10–11, Rieman and McIntyre, 1993 p. 2). An example of this type of loss of habitat access due to the existence of hydroelectric dams has been observed between Lake Pend Oreille, Idaho and its main upstream tributary, the Clark Fork River, Montana. This area was historically known for having one of the largest bull trout populations in the U.S. (Neraas and Spruell 2001, p. 1154). The bull trout population within Lake Pend Oreille has remained robust, however, construction of three hydroelectric dams in the lower Clark Fork River disrupted connection to key spawning habitat in the Blackfoot River to the lake. Bull trout within this area were radio-tagged and studied, and data from these studies indicate that 8 percent of radio-tagged individuals in the Blackfoot River swam downstream over the Milltown Dam with no natural way to move back up over the dam (Swanberg 1997, pp. 735–746). Likewise, 18 percent of the bull trout tagged in the Boise River went over the Arrowrock Dam (Flatter 1998, pp. 11–12), another dam without volitional fish passage return over the dam. Surveys conducted throughout the bull trout's range have indicated that significant percentages of local populations near hydroelectric dams become separated over time because of fish travelling over these dams with no ability to return (Neraas and Spruell 2001, entire; Swanberg 1997, pp. 735–746; Flatter 1998, pp. 11–12). These data indicated that hydroelectric impoundments could cause geographical and genetic isolation of migratory fish from their native tributaries. Over time, this continued separation of individuals from the overall population above the dam could lead to a loss of that local population. Actions taken to aid bull trout movement above hydroelectric dams may begin to reverse the decline of those fragmented populations (Neraas and Spruell 2001, p.

1160). Dams affect bull trout on the individual and population levels and are considered a driver of current and future conditions in some core areas.

Irrigation and Water Diversions

While hydroelectric dams present a physical barrier between bull trout and their native spawning grounds and local populations, water diversion can substantially affect water quality and quantity and limit bull trout populations as well by affecting stream flow, water temperature, and sediment delivery.

Irrigation diversions have been documented to entrain fish and water out of stream systems (USFS and USFWS, 2013 p. 526; Kaeding and Mogen, 2020 p. 1369). Bull trout in all three of the core areas within the Klamath River Recovery Unit, for example, are currently impacted by unscreened irrigation diversions (USFWS 2015, p. 13). Bull trout individuals that come within proximity of these unscreened diversions often become entrained and, thus, become stranded or isolated from the local population. LeMoine and others (2020, entire) also described how irrigation diversions and other barriers appear to play a role in restricting the distribution shifts of bull trout and other species to climate change and related disturbances in the Bitterroot Valley, highlighting passage improvement and connectivity as an important climate adaptation tactic for conserving bull trout on fluvial landscapes.

Low stream flows can limit a bull trout's ability to move up or downstream, limit the availability of prey resources, and make individuals more susceptible to predation. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel during winter through spring (Fraley and Shepard 1989, pp. 133–143; Pratt 1992, pp. 5–7; Pratt and Huston 1993, pp. 6–7; USFS and USFWS, 2013, pp. 9–10). Water temperatures of streams are affected substantially due to irrigation withdrawals (USFS and USFWS, 2013 p. 75). Increases in water temperature can be further exacerbated in streams where the riparian zone has lost much of its stream shading capacity, or the stream width becomes overly wide due to livestock grazing (USFS and USFWS, 2013 p. 87).

Increased erosion and delivery of fine sediment within streams from diverted water have detrimental effects on bull trout habitat. When fine sediments enter streams at levels beyond natural background conditions, they can accumulate within spawning gravels and reduce survival of bull trout eggs and embryos by impairing their access to oxygenated water (Pratt 1992, pp. 5–7). Elevated levels of fine sediment may negatively affect adult and juvenile bull trout by clogging their gills, abrading tissue, and disrupting their orientation within aquatic environments and movement patterns. Bull trout may experience limited foraging success and require more energy for proper orientation and movement/migrations through their habitat (USFWS 2015, p. 26). Accumulation of sediment can also degrade stream structure by filling in pools and changing the composition of the substrate. (USFWS 2015, pp. 26). These habitat and temperature changes become less suitable for bull trout to occupy over time. Properly managing runoff water and maintaining high water quality standards will benefit bull trout and reduce

potential exposure to contaminants. Irrigation and water diversions affect bull trout on the individual and population levels and are considered drivers of current and future conditions in some core areas.

4.1.4 Fisheries Management and Other Activities

Fisheries management activities, both contemporary and historical, have impacted bull trout. Widespread stocking of nonnative fishes across portions of the bull trout range have increased likelihood of intraspecies competition and potential for hybridization. Angling and poaching can have direct and indirect effects on bull trout. Because the suite of fisheries management stressors will likely have varying levels of effect on individuals and populations of bull trout depending on fisheries management practices in each core area, this theme is carried forward as a driver of current and future condition in the subsequent parts of the SSA.

We discuss the following activities below:

- Angling
- Hatchery Introductions
- Illegal Activities
- Nonnative species
- Disease and pathogens

Angling

Current and historical fisheries management practices have contributed to the decline in bull trout populations. Historical bounties targeting bull trout existed throughout the 1900s (ending in the 1990s) and poisoning campaigns that took place in the 1950s and 1960s resulted in direct mortality. While these actions no longer occur within the coterminous range, recreational fisheries continue to result in incidental angling injury, mortality, and mistaken harvest of bull trout (Ratliff and Howell 1992, pp. 15–16). Incidental catch from non-target or targeted fisheries that include bull trout also contributes to mortality from stress and injury (Ratliff and Howell 1992, pp. 15–16; Brenkman and Corbett 2005, pp. 1079–1080). Catch and release angling can result in mortality of individuals, however the potential population level impact is varied in the literature (Joubert et al. 2020, p. 3, Roth et al. 2019, pp. 195–198). The levels of handling associated with recreational angling vary (Chiaramonte et al. 2018, pp. 1116–1117; Lamansky and Meyer 2016, p.1021; Joubert et al. 2020, p. 3). Most studies do not identify substantively increased mortality or sublethal effects from catch and release on target fisheries (Roth et al. 2018, pp. 41–42; Chiaramonte et al. 2018, pp. 1116–1117; Lamansky and Meyer 2016, p.1021; Roth et al. 2019, pp. 195–198;), while Joubert et al. (2020, p. 3) document incidental mortality that may result in a population level concern.

Hatchery Introductions

The current and historical stocking of native and nonnative fishes by federal and state agencies across the range of bull trout contributes to declines in abundance and local extirpation. Nonnative fish species result in predation on bull trout, competition for food and space,

disruption of food webs, diseases and pathogens, hybridization with bull trout, and bycatch from nonnative fish suppression. In some areas, nonnative fish are preferred to bull trout by the public resulting in a lack of support for their control. We also recognize that the hatchery introduction of some species may provide important forage base for bull trout though these benefits vary by core area.

Illegal Activities

Illegal activities such as poaching and illegal stocking of fish species can have negative effects on bull trout populations. Management agencies monitor and regulate angling across the range of bull trout. Regulations are implemented to provide angling opportunity in bull trout occupied habitat with consideration for potential impacts to population resilience. However, illegal angling (poaching) outside of these regulations has been documented. Enforcement action and angler education have reduced the occurrence of poaching, though it does still occur. Illegal fish stocking is not authorized by management agencies and can have negative effects on bull trout populations similar to issues outlined in the Hatchery Introduction section above. These illegal introductions occur without consideration of impacts and without use of contemporary hatchery tools (e.g. triploid, M_{yy}) to mitigate impacts. Illegal introduction is subject to enforcement action, though these actions still occur.

Nonnative Species, Disease, and Pathogens

Historically, stocking of nonnative fishes occurred extensively. Many high mountain lakes were stocked with brook trout. For example, 11 of 22 core areas in Oregon have brook trout in headwater streams. While current stocking is limited to triploid (sterile) trout which aims to address hybridization, these trout continue to compete for food and space and many historically stocked (non-sterile) nonnative populations are self-sustaining and illegal introductions still occur. Nonnative fish species distribution now overlaps with bull trout due to these historical stocking practices and illegal introductions. Notably, stocked hatchery salmon and trout benefit large adult bull trout in FMO habitats by providing supplemental forage (Faler 1991, p. 2; Pratt 1992, pp.6–7).

Increased interactions between bull trout and nonnatives could lead to increased predation on, displacement of, and hybridization with bull trout. Nonnative species including lake trout, brown trout, northern pike, and other warmwater species (e.g., smallmouth bass) are known to consume bull trout resulting in direct mortality (Ratliff and Howell 1992, p. 16; Pratt and Huston 1993, pp. 75–91). In the Klamath River basin for example, brown trout have been observed preying on bull trout (Light et al. 1996, p. 56). Brook trout, brown trout, and lake trout also compete for resources including food and space resulting in indirect mortality. A study of 34 lakes in Montana, Alberta, and British Columbia, Canada, found that lake trout likely limit foraging opportunities and reduce the distribution and abundance of migratory bull trout in mountain lakes (Donald and Alger 1993, p. 245). Brown trout have been found to compete for spawning and rearing areas and superimpose redds on bull trout redds (Pratt and Huston 1993, p. 76; Light et al. 1996, pp. 56–57). Competition for food and space as well as predation occur seasonally

(winter and spring) when in sympatry or year-round if the bull trout population exhibits alternate year spawning migrations.

In addition to competing for resources, brook trout and lake trout are congeneric species and brook trout are known to hybridize with bull trout reducing abundance and recruitment of genetically pure mates (Markle 1992, pp. 58–67; Ratliff and Howell 1992, p. 16; Leary et al. 1993, p. 860). Core areas with adfluvial bull trout are more likely to be influenced by lake trout and core areas with fluvial and/or resident bull trout populations are more likely to be influenced by widespread distribution and abundance of brook trout. Management actions have been documented to reduce lake trout threats in some lake systems (Dux et al. 2019, p. 7; Hansen et al. 2019, pp. 11–12); however, brook trout have been shown to be more tolerant of degraded habitats than bull trout (Clancy 1993; Rich 1996, pp. 40–41), occur in streams with higher water temperatures (McMahon et al. 2007, p. 1321), and have been found to be dominate over bull trout in controlled in-stream experiments (Gunckel et al. 2002, p. 6) possibly contributing to the displacement and/or replacement of bull trout. Furthermore, the presence of nonnatives has been linked to disruption of food webs resulting in indirect mortality (Wainright et al. 2021, p. 4).

Nonnatives have also been linked to the introduction of diseases and pathogens. Nelson (2012, pp. 16–22) reported that a mass mortality of bull trout in Lake Chelan was presumed to be the result of a fungus associated with plantings of nonnative fish, although the pathogen allegedly responsible was never identified. Bull trout have been found to be relatively resistant to bacterial kidney disease (BKD) compared to other trout, char, and salmon species (Jones et al. 2007, pp. 699–700); however, lethal doses were affected by water temperature suggesting increased water temperature associated with climate change may increase the impacts of BKD on bull trout mortality. Bull trout have also been shown to be susceptible to *Myxobolus cerebralis* (the causative agent of Whirling Disease) (Hedrick et al 1999, p. 336); however, infection rates were low (5 percent) after a single high dose in yearling bull trout (Bartholomew et al. 2003, p. 251).

Distribution of nonnatives, such as brown trout, brook trout, and others, are predicted to expand and occupy higher elevations as environmental conditions change due to climate change (Rieman et al. 2007, p. 1555; Wenger et al. 2011a, p. 14176; Wenger et al. 2011b, p. 1001; Isaak et al. 2010, p. 1360; Bell et al. 2021, p. 2). However, not all nonnative trout populations may respond in this manner. In Montana, Bell et al. (2021, p. 2) project a decline in brook trout under climate change scenarios and other studies suggest that brook trout do not dramatically alter the distribution and relative position likely to be occupied by bull trout, particularly for large individuals with migratory life histories in larger or steeper streams (Peterson et al. 2013, p. 119).

Nonnative fish affect the habitat needs of bull trout through degradation of fish community quality and instream quality which in turn affect access to essential habitats and competition with nonnative fish species within these habitats. The current condition of bull trout has been affected by the introduction and presence of deleterious nonnative fish species that compete with bull trout for resources, present a hybridization risk with nonnative brook trout and could lead to

declines in abundance and extirpation in some areas. Fisheries Management, specifically the introduction of nonnative fish species, is a driver of current and future conditions of bull trout.

4.2 Conservation Efforts

Recovery actions (conservation, protection, and restoration) have occurred at the core area scale to promote recovery of bull trout since listing. The level of action is core area-specific, with some receiving extensive and others limited recovery actions. An array of state, federal, tribal, and non-governmental partners have undertaken such efforts. These activities can be either voluntary or regulatory in nature and range from specific land and water management protections and broadscale conservation plans/strategies to bull trout monitoring efforts and proposed habitat restoration. Appendix B includes a non-exhaustive list of conservation measures and types of actions, organized by Representative Unit and core areas, that were reflected in the SSA analysis. While the goal(s), scope, support, and efficacy of these conservation measures differ among core areas, through bull trout recovery efforts and bull trout critical habitat preservation, all are expected to positively influence the current resiliency of a core area. The following 10 general conservation effort categories assert a positive influence on either reducing or eliminating stressors within individual core areas, and thereby influence both habitat and demographic factors within our conceptual model.

4.2.1 Species-Specific Conservation Plans

These include bull trout-specific conservation plans but could also be plans for salmon or other cold water fish species. Plans may be implemented by state, tribal and federal agencies and include a variety of management actions to ameliorate the impacts of climate change, habitat degradation, and other stressors that affect the survival of bull trout.

4.2.2 Federal and State Land Management Plans

Federal (USFS, BLM and NPS) and state land management plans set direction for land management actions at a broad scale generally balancing resource use and extraction with protection of sensitive habitats such as aquatic resources and riparian areas. These plans are generally updated every 15–30 years and address habitat-related threats to bull trout such as recreation, forest roads, grazing, and climate change. Review of a variety of stream habitat characteristics have documented positive trends in habitat quality on federally managed lands since the 1990's (Roper et al. 2019, entire). State forest practice rules have been revised and updated in Washington, Oregon, and Idaho partly in response to concern for the conservation of sensitive, threatened, and endangered species, including bull trout (USFWS 2015, p. 16).

Trends for riparian habitats have been generally improving during the past 25 years on federally managed timber lands, due in part to recent improvements in management practices, selective timber harvest, and reduction of road building on Federal lands (USFS and USFWS 2013, pp. 300, 449, 476, 546; USFWS 2018, pp. 74-80, 99). Updated National Forest plans provide a mechanism to maintain or improve riparian habitat protections.

4.2.3 Water Management Protections

Water management protections and improvements include plans and actions that affect the quantity, quality and timing of instream flows as well as ensure fish passage around barriers created by hydroelectric and water delivery systems. These efforts address the need for flood control, hydroelectric generation, agriculture, and effects of climate change while providing additional management actions to conserve bull trout.

Efforts to reduce the effects hydroelectric facilities have on bull trout population connectivity have reduced this threat in some areas. The Clark Fork River, Montana, has seen fish passage modifications, dam removal, and bull trout trap and haul efforts to maintain connectivity within the Clark Fork River itself and between Lake Pend Oreille, Idaho (Schmetterling 2003, p. 1; DeHaan and Bernall 2013, entire). These efforts have improved connectivity of adfluvial fish to upstream reaches with documented adfluvial bull trout migration from rearing in Lake Pend Oreille to upstream spawning tributaries (DeHaan and Bernall 2013, entire). Activities to begin to mitigate the effects of storage reservoirs and hydroelectric facilities on bull trout movement and migration have also been undertaken in drainages such as the Yakima River, Washington and Boise River, Idaho (YBIP 2021, pp. 3, 17). Water management incentive programs have been implemented to improve efficiency of irrigation practices, increase instream flow and fish passage in some core areas. Extensive work is being conducted in the Lemhi River, Idaho, to partner with local landowners to improve instream flows in bull trout spawning and rearing habitat which has been historically impacted by water management. Tributary reconnects and improved upstream and downstream passage has resulted in better connectivity for fluvial and resident bull trout populations in the drainage (Uthe et al. 2017, pp. 26, 28).

4.2.4 Federal Land Protections

Federally designated Wilderness Areas are managed for preservation in their natural condition. These protected areas also include proposed Wilderness areas, designated and proposed Wild and Scenic Rivers and Inventoried Roadless Areas. Protections ensure bull trout habitats remain in good condition and provide the greatest buffer against climate change. Federal land protections such as those within National Parks (Glacier National Park, North Cascades National Park, Mount Rainier National Park, Olympic National Park, Crater Lake National Park) and designated Wilderness Areas continue to be key in supporting some bull trout populations and strongholds across the range (USFWS 2015, p. 58768). More recent designations, such as Wild Sky Wilderness in Washington (P. Murray, in litt 2008), continue to add protection to bull trout core areas. Provincial Parks and other protective designations (e.g., ecological reserves) also continue to protect portions of transboundary core areas within Canada.

4.2.5 Fish Screen Programs

Fish screens prevent fish from entering irrigation diversions or municipal or industrial water intakes. The fish screen programs provide cost share incentives and technical assistance to encourage water users to voluntarily install fish-friendly screens at water diversions. These programs decrease threats associated with water management (irrigation activities) and directly increase bull trout survival by preventing entrainment.

Fish screen programs are implemented variably across the bull trout range based on the level of agricultural irrigation occurring and funding available within a core area. When warranted, fish screens have been demonstrated to positively affect native fish abundance and survival out of spawning tributaries and mainstem rearing habitat. Screens have been documented to curtail significant amounts of adult and age-0 Westslope Cutthroat trout (*Oncorhynchus clarkii lewisi*) entrainment in Skallkaho Creek, Montana, greatly improving survival (Gale et al. 2008, pp. 1546–1549). In heavily irrigated watersheds such as the Lemhi River, Idaho, it was estimated that out-migrating Chinook salmon smolt loss would be 71.1 percent in the absence of screening and 1.9 percent when all diversions were screened (Walters et al. 2012, p. 1185). Similarly, downstream migrating fluvial adult bull trout entrainment ranged from 71 to 100 percent annually in 4th of July Creek, Idaho (Gilles-Rector et al. 2024, entire). However, because of the successful implementation of the screen program in these drainages and others, mortality of downstream migrating salmonids including bull trout is greatly reduced.

4.2.6 Species Monitoring Programs

Established bull trout-specific monitoring programs to track population status and trends are available in some core areas and absent in others. These programs assess the efficacy of implemented conservation and management actions as well as monitor impacts to changing climatic conditions. In addition, many core areas have monitoring programs focused on anadromous salmonids or resident trout species such as cutthroat trout which also collect bull trout data. Maintenance of existing and increased implementation of bull trout monitoring programs will remain a high priority for conservation of the species. Tools that have been developed since listing have provided a framework to evaluate bull trout status in a number of areas, however, some areas continue to be monitoring deficient.

Regional monitoring programs to track bull trout population status, distribution and threats have been developed through cooperation among numerous agency partners. The range-wide bull trout eDNA Project has greatly expanded the knowledge of bull trout distribution and habitat use (Young et al. 2017, entire). Broad-scale monitoring of the current and predicted effects of climate change on bull trout have been generated by crowd-sourcing temperature data across the Pacific Northwest within the NorWest Stream Temperature framework (Isaak et al. 2017, entire) and the Bull Trout Vulnerability Assessment (Dunham 2015, entire). These projects provide regional managers with tools for prioritizing management actions for bull trout conservation into the future.

The diversity of bull trout as a species, specifically life history diversity, results in a variety of monitoring approaches across the range. Studies of bull trout population demographic characteristics have been completed for some populations (Al-Chokhachy and Budy 2008, entire; McCubbins et al. 2016, entire; Mucciarone et al. 2022, entire). These studies have direct implications for management of study populations and potential application to others, though demographic rates are expected to differ by life history strategies and environmental conditions across the range.

Monitoring data have been compiled to evaluate bull trout population trend and future persistence at a variety of scales. In Idaho, bull trout were relatively abundant and apparently stable with a population estimate of greater than one million fish greater than 70mm (High et al. 2008, p. 1687). Additional work found similar results with overall stable trends and low foreseeable extirpation risk (Meyer et al. 2014, p. 202). An analysis of trend and abundance in the upper Columbia River basin documented 85 percent stable and 13 percent declining trends with overall low abundance in study populations (Kovach et al. 2018, p. 1960). The assessment focused on the most robust migratory populations and many local populations were omitted from the study (Kovach et al. 2018, p. 2018) highlighting the need for a comprehensive assessment. Nevertheless, these studies have provided valuable long-term trend and persistence data on bull trout to inform contemporary management decisions as well as document changes in the future to aid in conservation of the species.

4.2.7 Habitat Restoration and Fish Passage Programs

These programs are established to promote aquatic habitat restoration and fish passage within the distribution or potential distribution of bull trout. Projects within these programs range from the small addition of large wood into streams to large scale basin restoration or dam passage projects. These programs aim to ameliorate threats associated with legacy land management, mining, agriculture, flood control, and hydroelectric development and could reduce the effects of climate change. Numerous restoration actions have been implemented or planned in many National and State Forests and nearby private timber lands across the species range. In several watersheds the most egregious road and sediment problems have been addressed (USFWS 2015, p. 11). Programs administered by the Service such as Recovery Challenge Grants and National Fish Passage Program have funded and implemented bull trout conservation actions across the DPS.

Habitat restoration efforts beyond bull trout-specific programs are also producing meaningful conservation for the species. Large scale partnership programs such as the Western Native Trout Initiative have been developed to broaden restoration strategies beyond local levels for native trout including bull trout (Western Native Trout Initiative 2016, entire). Regional habitat restoration programs focused on salmon and steelhead restoration have also provided significant benefit to bull trout. Bull trout are not the focal species; however, these programs have funded thousands of miles of in-stream restoration and barrier removals in bull trout drainages (NOAA Fisheries 2021, entire). In addition, extensive restoration action has occurred in partnership with private landowners. Habitat restoration actions have a diverse funding nexus with some programs focused directly on bull trout and others focused on other cold-water species (salmon, steelhead, cutthroat) which also benefit bull trout populations.

4.2.8 Information and Education Programs

Public and private sector information and education programs have been designed to generate public interest and involvement in bull trout conservation issues at local and regional scales. Recreational use and conservation-focused outreach programs raise the profile of bull trout and

encourage participation in conservation of bull trout within the angling community. These programs can ameliorate stressors associated with angling, illegal introductions, and recreation.

A range of active information and education efforts are being implemented in various parts of the coterminous range to assist in the conservation of bull trout. For example, within the Yakima River core area the Bull Trout Task Force has directly engaged close to 8,000 anglers and recreationists about bull trout and their habitat, removed nearly 800 recreational dams, and posted hundreds of signs related to these efforts in addition to developing and posting bull trout educational videos on their organization's website (Mid-Columbia Fisheries Enhancement Group 2022). Efforts to improve bull trout and brook trout identification in angler and biologist groups continue to reduce the threat of misidentification in fisheries and scientific surveys. Public outreach programs such as Know Your Bull, You're in Bull Trout Waters, and increased outreach on bull trout angling opportunities through Western Native Trout Initiative have all increased angler awareness regarding conservation of the species. In addition, development of a reference guide for brook trout/bull trout hybrids has improved hybrid identification accuracy during monitoring activities.

4.2.9 Nonnative Fish Management Programs

Management actions that reduce the effects of nonnative fish and other species on bull trout have been implemented in numerous core areas. These actions address the threat posed by certain nonnative fish species to the survival and abundance of bull trout. These efforts include suppression and eradication projects as well as implementation of fishing regulations. Several past and ongoing suppression or eradication efforts have been successful across the range to control nonnative fish that are known to directly or indirectly impact bull trout populations (Buktenica et al. 2013, entire; Fredenberg et al. 2017, entire; Dux 2019, entire; Dux et al. 2019, entire; Banish et al. 2019, entire; Kovach et al. 2017, entire, Camacho et al. 2018, p. 43–50). There has been an increase in interest to eradicate or suppress nonnatives in habitats supporting bull trout populations or in connected waters (March et al. 2017, p. 52; MRBTTAC 2017, p. 14).

Stocking programs have been modified to reduce the threat of nonnative game fish to bull trout populations. In some instances, stocking of species such as brook trout has been discontinued in any waters containing bull trout (IDFG 2019, p. 20). In addition, the development of sterile triploid stocking programs has been used to reduce long-term competition risks for bull trout populations (IDFG 2019, pp. 4, 20). Lastly, a consortium of Western states is working together to develop a Trojan Y Chromosome method to eradicate undesirable populations of nonnative species, including brook trout and lake trout (Kennedy et al. 2018, entire; Schill et al. 2017, entire).

Presence of certain nonnative fishes remains a significant threat to bull trout populations in several areas, however, it is important to note that nonnative stockings of sport fish such as kokanee have likely benefitted bull trout populations in a number of lake and reservoir systems. Kokanee provides the main prey item for bull trout in several systems which contain adfluvial populations of bull trout (Guy et al. 2011, p. 184; Clarke et al. 2005, p. 267).

4.2.10 Regional Bull Trout Working Groups

Multi-agency working groups of local bull trout experts, managers, and interested parties were integral to the completion of the bull trout SSA. These experts provided core area scale data on demographic and habitat factors, and in the absence of explicit empirical data, we relied on bull trout working groups to score various demographic factors included in the current condition categorical model. However, the conservation value of these groups extends well past the SSA. Bull Trout working groups which operate at a core area scale provide valuable insight on on-the-ground activities such as monitoring, restoration prioritization, and identification of habitat- or demographic-limiting factors. Continued collaboration of partners through the local work group framework is considered a significant value to future bull trout conservation.

4.3 Summary of Causes and Effects

The cause-and-effect analysis summarizes and interprets the available information on the probable explanations for the species' current condition and the causal relationships between stressors, conservation efforts and the habitat and demographic needs of bull trout. The cause-and-effect analysis identified the most significant stressors acting on the habitat and demographic needs of bull trout and the mechanisms by which these stressors exert an influence. Stressors alter optimal air and water temperatures (water quality, habitat quantity, and fish community quality), stream flows (instream quality, access to FMO, and habitat quantity), runoff, and sedimentation rates (instream quality); create physical barriers and impediments to spawning and rearing and FMO habitats (access to FMO); reduce the availability of woody debris or streamside vegetation that provides the complex cover and level of bank stability needed in bull trout habitats (riparian quality); and indirectly or directly influence the impact of nonnative fish to bull trout (fish community quality).

While most stressors initially act on the habitat needs of individual bull trout, those of sufficient magnitude, intensity, and geographic scope may influence the resiliency of core areas. This influence on habitat inevitably leads to a resulting effect on demographic conditions. Some stressors may affect the demographic needs of bull trout directly or in combination with other stressors. The cause-and-effect analysis evaluated the full complement of potential sources and stressors and associated effects to bull trout habitat and demographics that may cumulatively influence the resiliency of core areas for the bull trout DPS. The SSA analysis is focused on stressors which result in population level effects to the species, not individual level effects. Stressors with the potential for core area level impacts that were limited in geographic scope were evaluated as part of the core area threats assessment process described in Chapter 5.

In this chapter, we summarized stressors which may affect bull trout core areas at the individual and population scales, and we also highlighted ongoing conservation measures that may reduce or ameliorate them. Bull trout have been listed under the Act since 1999 and numerous conservation actions have been implemented since then to reduce or eliminate the stressors acting on the habitat and demographic needs of bull trout in core areas and thus viability of the DPS. Like many stressors, conservation and techniques to reduce stressors are often core area

specific. Because of this diversity, the impact of conservation measures to ameliorate stressors varies across the range of bull trout.

While Chapter 4 examines causes and effects with respect to the needs of bull trout, Chapter 5 applies this information to consider the current condition of each core area.

Chapter 5 - Current Condition

This chapter describes the current condition of the bull trout DPS in terms of its resiliency, redundancy, and representation (3Rs). We do this by evaluating the current condition of the habitat and demographic factors that we identified as needs in Chapter 3. In Chapter 4, we presented a conceptual model to illustrate the most probable causes (stressors) and effects of current conditions. Chapter 5 evaluates the current condition of each core area with consideration of the causes and effects identified in Chapter 4. We begin our evaluation of current condition with a description of the methodology used to evaluate resiliency consistently across the core areas of the bull trout DPS. We developed a current condition categorical model, also called a condition category table (CCT), which defines and standardizes categories of health and functionality for each of the five demographic and six habitat factors. These categories were used to score the current condition of each factor and, when combined, to evaluate resiliency of each core area. Our evaluation of resiliency is calibrated to the standardized categories in the condition category table, insuring to the extent possible, a consistent and methodical approach across the core areas and bull trout DPS. Those core areas with higher levels of resiliency are more likely to persist than those with lower levels of resiliency.

5.1 Methodology to Evaluate Current and Future Conditions

Chapter 3 identified the habitat (individual or species level), and demographic (population level) needs of bull trout. For our analysis of current and future condition, these needs also represent the five demographic and six habitat factors that are most influential to core area resiliency while being consistently measured across all core areas. The five demographic factors and six habitat factors that we used to evaluate resiliency were:

Demographic factors:

- Growth rate: Population trend
- Life history diversity
- Number of local populations within a core area
- Demographic connectivity
- Abundance

Habitat factors:

- Water quality
- Access to foraging, migration, and overwintering (FMO)
- Fish community quality
- Instream quality
- Riparian quality
- Habitat quantity

We then developed a current condition category table (the categorical model) to systematically evaluate the current condition of each demographic and habitat factor in each core area and score (categorize) the functional level of the factor from very high to very low (Table 2).

As we considered the condition, we used a variety of data sources, including compiled information from peer-reviewed literature, a threats assessment process, surveys and reports, and input from scientific experts. When available, we used scientific reports (published white and gray literature) and analyses to quantify and describe these conditions for the core areas. In the absence of published data, we relied on bull trout working groups to assess the current condition of the factors, which included scientific experts from a variety of backgrounds. Bull trout work group meetings were conducted across multiple phases of the SSA process. Initial meetings familiarized working groups with the SSA structure and solicited core area scale data on demographic and habitat factors. Subsequent meetings facilitated work group participation in the threats assessment process, described below, and scoring of various demographic factors included in the current condition categorical model.

In the current condition assessment, we considered past and present bull trout habitat, demographics, and distribution (Smith et al. 2018, p. 306). We evaluated current condition for extant core areas at listing (excluding Historical and RNA areas) for a total of 110. Additionally, the Lake Pend Oreille core area was evaluated as three separate units of analysis for the SSA, Lake Pend Oreille A above Cabinet Gorge Dam, Lake Pend Oreille B includes Lake Pend Oreille proper and its tributaries, and Lake Pend Oreille C below Albeni Falls Dam. Historical and RNA core areas do not currently contribute to viability; however, future scenario analysis (Chapter 6) includes all 118 core areas including potential for re-establishment of bull trout into Historical and RNA areas.

To calculate a resiliency score, demographic factors (five in total) were collectively weighted at 50 percent of the score as were the habitat factors (six in total), resulting in individual demographic factors being weighted slightly higher than habitat factors. In addition, factors were weighted slightly based on whether the factor had a 5-point maximum score (number of occupied local populations within a core area; connectivity, abundance, and habitat quantity); 4.5-point maximum score (all habitat factors except habitat quantity) or 4-point maximum score (growth rate: population trend and life history diversity). While the weighting differences were not large, we have documented these fine-scale differences in the categorical model's scoring process. For a discussion of the use of demographic and habitat factors, and the weighting selected, see section 8.1.2. For all factors, a higher score indicated a more favorable condition in terms of species needs, and a lower score indicated a less favorable condition (Table 2).

Scores were assigned consistently to all 110 currently extant core areas to characterize the current viability of bull trout. All bull trout core areas were assigned a total resiliency score which was the sum of the individual scores for all eleven current condition factors. Total resiliency scores fell within one of the following 5 interval score categories: Very High (3.97–4.62), High (3.30–3.96), Medium (2.64–3.29), Low (1.97–2.63) and Very Low (1.31–1.96). The categories represent relative levels of stochastic risk for each factor, with very high being the

most resilient, and very low being the least resilient, based on the condition of the factor as described in the table's rows. No resiliency remains within the extirpated category. We summarized individual core area scores and presented their overall relative resiliency (Table 5). With resiliency characterized for each core area, we could then characterize current redundancy and representation for the bull trout DPS.

Table 2. Condition category table (categorical model) used to evaluate the resiliency of core areas based on the current and future projected conditions of five demographic factors and six habitat factors. If any demographic factor is in extirpated condition, the core area has no resiliency, regardless of the condition of the habitat factors.

	DEMOGRAPHIC FACTORS					HABITAT FACTORS						RESILIENCY
	Growth Rate: Population Trend	**Life History Diversity**	**Number of occupied local populations**	**Connectivity**	**Abundance**	**Water Quality**	**Access to FMO**	**Fish Community Quality**	**Instream Quality**	**Riparian Quality**	**Habitat Quantity**	
Factor Description	Short-term trend (2008-2020)	Presence of migratory and/or resident fish.	Measure of internal local population redundancy within a core area	Ability for local populations to mix within the core area	Number of breeding adults (all life history types)	Water temperature and quality (chemical and physical characteristics influenced by runoff, sedimentation, etc.) sufficient for spawning, incubation and rearing.	Access to habitat which provides full expression of resident and migratory life histories.	Fish assemblage which limits predation, hybridization and competition with non-native fishes negatively impacting bull trout.	Flow conditions which maintain quantity and timing of water for bull trout to breed, feed, shelter and migrate.	Adequate shading, bank stabilization, vegetation, and buffers around stream sufficient to maintain complex habitat.	Stream distance in each core area sufficient for spawning and rearing. The amount of breeding habitat available	Point scores for each demographic and habitat factor are multiplied by 10% and 8.3%, respectively. Sum of % weighted point scores = the total resiliency score.
Very High Condition	Significantly increasing 4 points	Both migratory and resident fish = 2 life history types 4 points (High)	More than 10 local populations 5 points	76 to 100% of local populations are connected 5 points	> 1000 5 points	No threat or low Threat Assessment Score 4.5 points (High)	Full access to and from FMO and no identified barriers 4.5 points (High)	No deleterious non-natives in the core area 4.5 points (High)	No threat or low Threat Assessment Score 4.5 points (High)	No threat or low Threat Assessment Score 4.5 points (High)	= >1000 rkm of essential habitat 5 points	**Very High** 3.97-4.62
High Condition	Non-significant, stable 3 points		5 - 10 local populations 4 points	51 to 75% of local populations are connected 4 points	501-1000 4 points						201-1000 rkm of essential habitat 4 points	**High** 3.30-3.96
Medium Condition	No data or data limited 2 points	1 life history type 2 points (Medium)	2 - 4 local populations 3 points	26 to 50% of local populations are connected 3 points	101-500 3 points	Moderate Threat Assessment Score 3.0 points	Limited or seasonal access to FMO habitats 3 points	Deleterious nonnatives are present or moderate Threats Assessment Score 3 points	Moderate Threat Assessment Score 3.0 points	Moderate Threat Assessment Score 3.0 points	41 – 200 rkm of essential habitat 3 points	**Medium** 2.64-3.29
Low Condition	Significantly decreasing 1 point (Low)		1 local population (includes Simple core areas) 2 points (Low)	0 to 25% of local populations are connected 2 points	51-100 2 points	High Threat Assessment Score 1.5 points (Low)	Access to and from FMO is completely impeded 1.5 points (Low)	High Threat Assessment Score 1.5 points (Low)	High Threat Assessment Score 1.5 points (Low)	High Threat Assessment Score 1.5 points (Low)	5-40 rkm of essential habitat 2 points	**Low** 1.97-2.63
Very Low Condition				Only one local population present (includes Simple core areas) 1 point	<50 1 point						0-4 rkm of essential habitat 1 point	**Very low** 1.31-1.96
Extirpated Condition	X	X	No longer a spawning population in the core area.	X	No breeding adults present, or unlikely spawning population in the core area.	X	X	X	X	X	X	**No Resiliency**

In the next section we describe the habitat and demographic factors, and underlying metrics, used to evaluate resiliency in more detail.

5.1.1 Demographic Factors and Metrics

Demographic factors used in the categorical model of the SSA were developed to evaluate the resiliency of bull trout at a core area scale based on demographic needs. Each factor was assigned a scoring metric used to categorize the current condition of each factor for each individual core area. In general, core areas with the highest demographic resiliency have stable/non-significant or increasing trends, occupy large spatial scales of connected habitat, and contain moderate to high levels of bull trout abundance. A detailed explanation of each factor including definitions and scoring are presented below.

Growth Rate: Population Trend

Definition – Population growth rate considers the trend of bull trout populations in a core area as to whether population abundance is increasing, stable, or decreasing. Trend was evaluated for core areas using data which met the requirements of the range-wide trend analysis. Detailed descriptions of data outputs and data used, as well as the methodology for the state-based model, can be found in Appendix D. Bull trout core areas were the unit of analysis for the model. Data series had to meet the following minimum requirement for inclusion in the model: (1) contain a minimum of 10 years of data between 2008 and 2020, and (2) be collected using consistent methods and site selection. A total of 73 of 108 extant core areas had data series in the analysis. Adult and juvenile data series were included and summarized by core area in Appendix D. The analysis was conducted by Mark Scheuerell, USGS Cooperative Unit at the University of Washington.

Scoring Metric – The growth rate score has four categories: (1) significantly increasing, (2) stable or non-significant trend, (3) insufficient data, or (4) significantly decreasing. Core areas that received the insufficient data designation lacked data meeting the requirements outlined above. Bull trout population trend was estimated from 2008-2020 to evaluate current condition. Long-term trend (1991 – 2020) was also generated and estimates are contained in Appendix D though not scored as part of the growth rate factor given the focus on current condition in core area growth rate. When core area data did not include data from all local populations, we assumed data could be extrapolated across the core area. Although we acknowledge local populations without data within a core area could have differing trends, we relied on the best available data set(s) to score a core area. Core areas which had both adult and juvenile data series but with divergent trend results (substantially increasing, stable or non-significant, or substantially decreasing trend) were evaluated by the team on a core area by core area basis and the dataset most representative of the core area was incorporated into the scoring.

Life History Diversity

Definition – Life history diversity considers whether both migratory (including fluvial, adfluvial and anadromous) and resident forms of bull trout are present in a core area. The presence of

multiple life history forms of bull trout increases overall resilience within a core area by distributing risk across multiple spatial and temporal scales. One life history may be advantageous over another depending on environmental conditions and stochastic events in certain habitats; therefore, one life history type was not weighted over another.

Scoring Metric – The life history diversity score has two categories: (1) having both resident and migratory life histories, or (2) only one life history strategy present within a core area (resident or migratory). This factor was assessed using existing data or expert opinions from local bull trout working groups. The source of the information used for scoring is documented in Appendix H.

Number of Occupied Local Populations

Definition – The number of occupied local populations is one way to describe the spatial extent of a core area. The spatial scale of core areas varies across the range. The number of local populations within a core area characterizes redundancy at that scale. This factor captures the spatial extent and designates simple and complex core areas.

Scoring Metric – The number of occupied local populations score has four categories: (1) more than 10 local populations, (2) 5-10 local populations, (3) 2-4 local populations, and (4) 1 local population, based on local populations identified within RUIPs in 2015. The higher the number of local populations within a core area the higher the score. We assumed that RUIP designations were the best information available in defining the number of local populations. This was verified using input from bull trout working groups. If the number of occupied local populations was changed from the RUIP based on more recent data, the new data source was cited in Appendix H.

Connectivity

Definition – Connectivity assesses the level of intra-core activity between local populations and/or the presence of impediments to such activity. Connectivity between local populations within a core area allows for increased effective population size, genetic diversity, and ability to recolonize areas in the event of stochastic and catastrophic events within a core area.

Scoring Metric – The connectivity score has five categories based on the percentage of local populations within a core area documented, observed, or judged to be connected to one another; the higher the percentage of local population connection, the higher the score. This factor was assessed using existing data, qualitative and quantitative analyses, and expert information including observations of local bull trout working groups across the range. Simple core areas automatically were assigned a very low score given they only contain a single local population.

Abundance

Definition – Abundance represents the current number of annual breeding adults in a core area. Breeders were defined as fish of reproductive age and size and included both migratory and resident life history forms in core areas with multiple life histories present.

Scoring Metric – The abundance score has five categories with the highest estimated abundance category receiving the highest score. We assessed this factor using existing data and expert information from local bull trout working groups across the range. Core areas with current abundance estimates relied on those data for scoring. In core areas without current abundance estimates, working groups were asked to categorize abundance using the following assumptions: (1) abundance of breeding adults includes all life history forms; (2) the abundance estimate should reflect an average abundance for the core area; and (3) the abundance estimate does not include skip-spawning adults in core areas where that life history expression is present. Using these assumptions, working groups were asked if abundance was in one of three categories (1) High (>1,000 breeding adults), (2) medium (100-999 breeding adults) and (3) low (< 100 breeding adults). When initial abundance was estimated in the medium category the group was next asked if abundance was in the upper 50 percent (501-1000 breeding adults) or lower 50 percent (101-500 breeding adults) of that category to arrive at the score for the abundance factor. Likewise, when initial abundance was estimated in the low category, the group estimated whether abundance was upper 50 percent (50-100 breeding adults) or lower 50 percent (<50 breeding adults) to arrive at the abundance score.

5.1.2 Habitat Factors and Metrics

The habitat factors that we identified as species needs and that we could use to evaluate resiliency at a core area scale were used in the current condition categorical model of the SSA. Core areas with the highest resiliency had habitat of highest quality meeting the needs of bull trout and often included either land protections (e.g., wilderness designation) or active restoration programs which were improving or maintaining habitat conditions.

Below, we briefly describe the Threats Assessment process used to evaluate five habitat factors (Water Quality, Access to FMO Habitat, Fish Community Quality, Riparian Quality, and Instream Quality) as well as detailed explanation of all six habitat factors used in the categorical model for resiliency.

Threats Assessment

Except for habitat quantity, the habitat factors included in the current condition categorical model were evaluated and scored using a Threats Assessment process (see Appendix I). Threats Assessments were conducted as part of the SSA by bull trout working groups across the range of the species in all extant core areas. The Threats Assessment process was conducted on all primary threats identified for each core area in the 2015 RUIPs. In addition, work group members were asked to identify if additional potential threats had arisen in core areas since 2015 or had been missed in the 2015 analysis. Potential threats were scored in the Threats Assessment

Matrix framework. Stressors not recorded as primary threats in the 2015 RUIPs, and not identified as potential threats at present, were not scored in those core areas.

A Threats Assessment enables (1) monitoring of threat severity in the future to track positive and negative change; (2) identification of data gaps on a core area scale; and (3) better coordination of funding to address highest priority recovery actions. The basic framework of the process was outlined in the 2015 Bull Trout Recovery Plan Appendix E (USFWS 2015, Appendix E). Integration of the Threats Assessment into the SSA process provided a standardized approach to assess some habitat factors contained within the current condition categorical model.

The Threats Assessment process utilized a Threats Assessment Matrix which ranks threat severity and management effectiveness of each threat (Table 3). Threat severity was ranked from minor to severe. A minor score means no bull trout local populations in a core area would be extirpated due to this threat on a 50-year timeline. A severe score means all bull trout local populations in a core area would be extirpated due to a threat on a 50-year timeline. Management effectiveness was scored from effective to none or ineffective. Effective indicated the threat was ameliorated by management action and none or ineffective indicated the threat was not ameliorated by management action.

Table 3. Threats Assessment Matrix and associated scoring used by bull trout working groups to score threats identified in core areas across the range.

			Threat Severity			
			Minor	Moderate	High	Severe
			1	2	3	4
Management Effectiveness	None or Ineffective	0.8	0.8	1.6	2.4	3.2
	Partially Effective	0.6	0.6	1.2	1.8	2.4
	Mostly Effective	0.4	0.4	0.8	1.2	1.6
	Effective	0.2	0.2	0.4	0.6	0.8

Threat severity and management effectiveness were combined on the Threats Assessment Matrix to produce an overall threat score for the core area. Threats Assessment scores evenly split across the range of scores into three categories (low 0.2-1.2, medium 1.21 - 2.2 and high 2.21-3.2). Higher threats assessment scores represented a more significant threat in the core area and therefore received a lower resiliency score in the current condition categorical model assessment. For instance, a core area with a water quality threats assessment score of 2.8, received a score of 1.5 in the current condition model; a core area with a water quality threats assessment score of 0.8 received a score of 4.5 in the current condition model. Detailed methods and core area

scoring are provided in Appendix I. The final current condition scores associated with this Threats Assessment process are presented in Table 5.

The next five habitat factors (water quality, instream quality, riparian quality, fish community quality and access to foraging, migration, and overwintering habitat) use or are informed by the Threats Assessment.

Water Quality

Definition - A high standard of water quality is considered one of the primary habitat requirements of bull trout (Section 3.2.2). Bull trout have some of the most stringent water quality habitat requirements of all North American salmonids (Rieman and McIntryre 1993, p.4). Deterioration of water quality in bull trout spawning and rearing habitat can result in displacement, reduced productivity, or direct mortality. The water quality factor of the current condition model specifically addresses water quality parameters such as temperature and suspended sediment (organic and inorganic contaminants).

Scoring Metric –The water quality score was based on Threats Assessment scoring and has three categories: high (4.5 pts), medium (3.0 pts) and low (1.5 pts). Individual bull trout work group member threats assessment scores were averaged to generate a group score for each threat. This threat score fell into one of three bins (high, medium, or low) that were based on breakpoints which are outlined in Appendix I. If the work group identified multiple threats to water quality in a core area, the highest Threats Assessment score was used for scoring the factor.

Instream Quality

Definition – Instream quality considers flow conditions necessary to maintain spawning and rearing habitat and instream complexity to maximize bull trout production. Deterioration of instream quality parameters in bull trout spawning and rearing habitat can result in displacement, reduced productivity, or direct mortality.

Scoring Metric – The instream quality score was based on Threats Assessment scoring and has three categories: high (4.5 pts), medium (3.0 pts) and low (1.5 pts). Individual bull trout work group member scores were averaged to generate a group score for the threat. If multiple instream quality issues were identified in a core area, the highest Threats Assessment score was used for scoring the factor.

Riparian Quality

Definition – The riparian quality factor relates to the function and stability of riparian habitats and associated upland interface with respect to bull trout habitat health in spawning and rearing habitat. Intact and mature riparian habitats promote a variety of key components of bull trout spawning and rearing habitat including shade which promotes stream cooling in warmer months as well as insulates stream habitats during cold months resulting in more favorable thermal

conditions across all bull trout life stages. In addition, mature riparian and upland habitats promote instream habitat and recruitment of large woody debris into the stream channel resulting in added complexity and protective cover to stream habitats occupied by bull trout.

Scoring Metric –The riparian quality score was based on Threats Assessment scoring and has three categories: high (4.5 pts), medium (3.0 pts) and low (1.5 pts). Individual bull trout work group member scores were averaged to generate a group score for the threat. If multiple riparian quality issues were identified in a core area, the highest Threats Assessment score was used for scoring the factor.

Fish Community Quality

Definition – A variety of biological components comprise fish community quality (e.g., species assemblage and forage base), however the primary driver related to bull trout resiliency is the presence or absence of deleterious nonnatives. This factor considers the presence of nonnative fish, identified as a significant threat in the original listing of bull trout (USFWS 1998a, p. 31668; 1999a, p. 58924). Nonnative species of most concern included brook trout, lake trout, brown trout, and northern pike. Impacts of nonnatives can include competition, hybridization, and predation. The degree of impact from deleterious nonnative fish species in less studied portions of the range, rates of expansion of nonnatives, and environmental factors that exacerbate or reduce nonnative impacts are data gaps regarding the severity of the threat.

Scoring Metric –Fish community quality was assessed by the working groups through a combination of the Threats Assessment process and work group member observations. Scores of medium (3 pts) and low (1.5 pts) were based on group Threats Assessment scoring covering deleterious nonnatives and concerns over the loss of anadromous species as prey base. A high (4.5 pts) score was not based on the Threats Assessment process but rather on monitoring data from within the core area that did not detect deleterious nonnative species within the core area and no threats associated with prey base. In all cases where threats associated with prey base were identified within a core area, nonnative species were also identified as present and causing a greater impact (the primary driver).

Access to Foraging, migration and overwintering habitat (FMO)

Definition – FMO habitat is needed for both migratory and resident forms of bull trout to complete their life history. Migratory and resident life history forms of bull trout require the ability to move from spawning and rearing habitat to overwintering and feeding habitat. For this factor, FMO is defined for each core area based on the bull trout life history(ies) present and associated habitat need, not a formal FMO habitat designation. FMO habitat as defined in the current condition model can range from hundreds of miles to hundreds of yards from spawning and rearing habitat and be contained within or outside of the core area.

Scoring Metric –The FMO score has three categories; high (4.5 pts) contained full access to and from FMO habitat, medium (3 pts) contained limited or seasonal access to FMO habitat, and low

(1.5 pts) contained completely impeded access to FMO habitat. Access to FMO habitat was assessed through the Threats Assessment process using local bull trout working groups, existing barrier assessments, and monitoring efforts across the range. Access to FMO was scored based on existing barrier assessments or evaluation of a Connectivity Threat through the Threats Assessment process. In the absence of sufficient data, core area working groups determined the level of access to FMO based on expert opinion.

Habitat Quantity

Definition – Habitat quantity refers to the amount (occupied km) of spawning and rearing habitat in each core area. The factor was assessed using the 2010 Critical Habitat designations, assumed to be the best measure of this factor for each core area. If deviations from Critical Habitat designation occurred (e.g., transboundary core areas), the data source indicating increased or decreased spawning and rearing habitat availability was documented within the core area supplemental information (Appendix H).

Scoring Metric – Habitat quantity was scored based on linear river kilometer of occupied spawning and rearing habitat designated in a core area. Critical Habitat in unoccupied local populations was not included in the total.

5.2 Evaluation of Current Condition

5.2.1 Current Core Area Resiliency

We evaluated current resiliency for each core area using the model presented on the condition category table (CCT) (Table 2). Simple and complex core areas were scored across a range of resiliency categories. No core areas ranked very low, 20 core areas ranked low, 45 core areas ranked medium, 26 core areas ranked high, and 18 core areas ranked very high (Table 4). Individual factor scores for all 118 core areas are displayed in Table 5. One core area extirpation has occurred since listing based on the Extirpation Triggers (see also Figure 21).

Table 4. Summary of current condition resiliency categories for all 118 bull trout core areas across the coterminous range in the United States. Included are the seven historical core areas, one RNA, and three core areas extirpated since listing.

	Core Area Resiliency						
Representation Unit	**Very High**	**High**	**Medium**	**Low**	**Very Low**	**Extirpated**	**Total**
Coastal	2	8	7	3	0	5	25
Columbia Headwaters	2	5	20	9	0	1	37
Klamath	0	0	1	2	0	0	3
Mid-Columbia	4	7	9	4	0	3	27
Saint Mary	0	0	4	0	0	0	4
Upper Snake	10	6	4	2	0	0	22
Bull Trout DPS	18	26	45	20	0	9*	118

** Includes eight core areas that currently do not have resiliency; seven core areas that were extirpated historically and one RNA.*

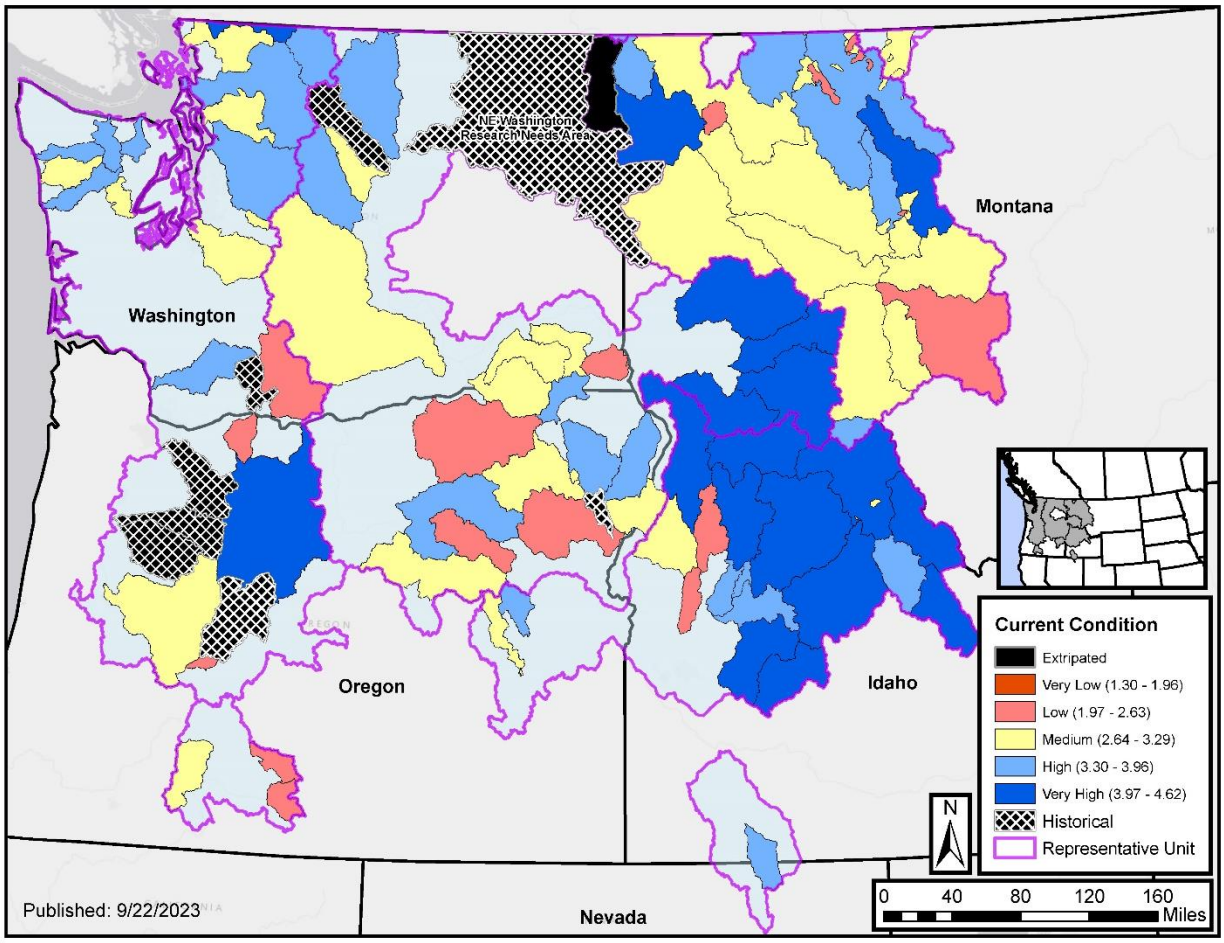


Figure 21. Map of current resiliency ratings of the 118 Bull Trout core areas. The seven historical core areas and the RNA are shown in black hatch and currently have no resiliency.

Table 5. Current condition for all 118 core areas for the bull trout DPS, evaluated using the condition category table for resiliency. Resiliency was a weighted average of all factors. An 0 in a demographic factor results in no resiliency, regardless of the other factors. In general, core areas with higher resiliency are more likely to persist based on their ability to withstand stochastic events, than core areas with lower resiliency.

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Coastal Representative Unit														
Chester Morse Lake	3	2	3	4	3	3.00	4.5	4.5	3	3.0	4.5	2.0	3.57	3.28
Chilliwack River	2	4	4	5	5	4.00	4.5	4.5	3	4.5	4.5	5.0	4.32	4.16
Clackamas River (historical)	2	0	X	0	0	X	4.5	4.5	3	4.5	4.5	2.0	3.82	X
Dungeness River	3	4	3	5	3	3.60	3	4.5	3	3.0	4.5	3.0	3.49	3.54
Elwha River	2	4	3	5	3	3.40	3	4.5	1.5	4.5	4.5	3.0	3.49	3.44
Hoh River	2	4	3	5	3	3.40	4.5	4.5	4.5	4.5	3.0	3.0	3.98	3.69
Hood River	3	2	2	1	2	2.00	3	1.5	4.5	3.0	3.0	2.0	2.82	2.41
Klickitat River	2	2	2	1	2	1.80	4.5	3	1.5	4.5	4.5	2.0	3.32	2.56
Lewis River	3	4	3	4	3	3.40	3	3	3	4.5	4.5	2.0	3.32	3.36
Lower Deschutes River	3	4	4	5	5	4.20	4.5	4.5	3	4.5	4.5	3.0	3.98	4.09
Lower Skagit River	1	4	5	5	5	4.00	1.5	3	3	3.0	3.0	4.0	2.91	3.45
Nooksack River	2	4	4	4	4	3.60	1.5	3	3	3.0	3.0	4.0	2.91	3.25
North Santiam River (historical)	0	0	X	0	0	X	NA	NA	NA	NA	NA	NA	0.00	X
Odell Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	1.5	3.0	4.5	2.0	3.32	2.56
Puyallup River	3	4	3	3	3	3.20	3	3	1.5	3.0	3.0	4.0	2.91	3.05
Queets River (simple)	2	4	2	1	2	2.20	4.5	4.5	4.5	4.5	3.0	3.0	3.98	3.09
Quinault River	2	4	3	5	3	3.40	4.5	4.5	4.5	4.5	1.5	3.0	3.74	3.57
Skokomish River	3	4	3	2	3	3.00	4.5	3	3	3.0	3.0	2.0	3.07	3.04
Snohomish/Skykomish River	1	4	3	3	4	3.00	4.5	3	3	4.5	4.5	3.0	3.74	3.37
South Santiam River (historical)	0	0	X	0	0	X	NA	NA	NA	NA	NA	NA	0.00	X
Stillaguamish River	1	4	3	3	2	2.60	1.5	3	3	4.5	4.5	3.0	3.24	2.92
Upper Deschutes River (historical)	0	0	X	0	0	X	NA	NA	NA	NA	NA	NA	0.00	X
Upper Skagit River	2	4	5	3	5	3.80	3	1.5	3	3.0	3.0	4.0	2.91	3.35
Upper Willamette River	3	2	3	3	3	2.80	4.5	3	1.5	3.0	4.5	2.0	3.07	2.94
White Salmon River (historical)	0	0	X	0	0	X	UK	3	3	UK	UK	2.0	1.33	X

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Columbia Headwaters Representative Unit														
Akokala Lake (simple)	2	2	2	1	1	1.60	4.5	4.5	4.5	4.5	4.5	2.0	4.07	2.83
Big Salmon Lake (simple)	2	2	2	1	3	2.00	4.5	4.5	4.5	4.5	4.5	2.0	4.07	3.03
Bitterroot River	1	4	5	2	4	3.20	1.5	1.5	1.5	3.0	3.0	4.0	2.41	2.80
Blackfoot River	1	4	4	4	3	3.20	4.5	3	1.5	3.0	3.0	4.0	3.15	3.18
Bowman Lake (simple)	2	2	2	1	1	1.60	4.5	4.5	1.5	4.5	4.5	2.0	3.57	2.58
Bull Lake (simple)	1	2	2	1	2	1.60	4.5	4.5	1.5	3.0	3.0	2.0	3.07	2.34
Clark Fork River (Section 1)	3	4	3	1	3	2.80	1.5	1.5	1.5	1.5	4.5	4.0	2.41	2.60
Clark Fork River (Section 2)	1	4	3	4	3	3.00	1.5	1.5	1.5	3.0	3.0	4.0	2.41	2.70
Clearwater River and Lakes	3	2	3	5	3	3.20	3	4.5	1.5	4.5	1.5	3.0	2.99	3.09
Cyclone Lake	3	2	2	1	1	1.80	4.5	4.5	4.5	4.5	4.5	2.0	4.07	2.93
Doctor Lake (simple)	2	2	2	1	1	1.60	4.5	4.5	4.5	4.5	4.5	2.0	4.07	2.83
Flathead Lake	3	2	5	5	5	4.00	3	4.5	1.5	4.5	3.0	4.0	3.40	3.70
Frozen Lake (simple)	2	2	2	1	2	1.80	4.5	4.5	4.5	4.5	4.5	1.0	3.90	2.85
Harrison Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	1.5	4.5	4.5	2.0	3.57	2.68
Holland Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	1.5	4.5	4.5	1.0	3.40	2.60
Hungry Horse Reservoir	3	2	4	5	5	3.80	4.5	4.5	4.5	4.5	4.5	4.0	4.40	4.10
Isabel Lake (simple)	2	2	2	1	1	1.60	4.5	4.5	4.5	4.5	4.5	1.0	3.90	2.75
Kootenai River	1	2	4	4	3	2.80	3	1.5	1.5	1.5	4.5	3.0	2.49	2.65
Lake Coeur d'Alene	1	2	3	5	2	2.60	3	4.5	1.5	4.5	4.5	3.0	3.49	3.04
Lake Koocanusa	1	2	4	5	5	3.40	3	4.5	3	4.5	4.5	5.0	4.07	3.73
Lake Pend Oreille A	3	4	5	2	3	3.40	1.5	1.5	1.5	3.0	3.0	3.0	2.24	2.82
Lake Pend Oreille B	3	2	5	5	5	4.00	4.5	4.5	3	4.5	4.5	3.0	3.98	3.99
Lake Pend Oreille C	X	0	X	0	0	X	1.5	1.5	1.5	3.0	3.0	3.0	2.24	X
Lincoln Lake (simple)	2	2	2	1	1	1.60	4.5	4.5	1.5	4.5	4.5	1.0	3.40	2.50
Lindbergh Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	1.5	4.5	4.5	2.0	3.57	2.78
Logging Lake	1	2	2	1	1	1.40	4.5	4.5	1.5	4.5	4.5	1.0	3.40	2.40
Lower Quartz Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	1.5	4.5	4.5	1.0	3.40	2.60

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Priest Lakes	3	2	3	5	3	3.20	4.5	4.5	1.5	4.5	4.5	3.0	3.74	3.47
Quartz Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	1.5	4.5	4.5	2.0	3.57	2.68
Rock Creek	1	4	4	5	3	3.40	3	3	1.5	3.0	4.5	4.0	3.15	3.28
Swan Lake	1	2	4	5	4	3.20	4.5	4.5	1.5	4.5	4.5	3.0	3.74	3.47
Trout/Arrow Lakes (simple)	2	2	2	1	1	1.60	4.5	4.5	1.5	4.5	4.5	2.0	3.57	2.58
Upper Kintla Lake (simple)	2	2	2	1	2	1.80	4.5	4.5	4.5	4.5	4.5	1.0	3.90	2.85
Upper Stillwater Lake	3	2	2	1	1	1.80	4.5	4.5	1.5	4.5	4.5	3.0	3.74	2.77
Upper Whitefish Lake	2	2	2	1	1	1.60	4.5	4.5	4.5	4.5	4.5	2.0	4.07	2.83
West Fork Bitterroot River	3	2	4	5	4	3.60	4.5	3	1.5	4.5	4.5	3.0	3.49	3.54
Whitefish Lake	2	2	2	1	1	1.60	4.5	4.5	1.5	4.5	4.5	2.0	3.57	2.58
Klamath Representative Unit														
Sycan River (simple)	2	2	2	1	3	2.00	4.5	3	1.5	4.5	3.0	3.0	3.24	2.62
Upper Klamath Lake	2	4	3	1	5	3.00	4.5	1.5	1.5	3.0	3.0	3.0	2.74	2.87
Upper Sprague River	2	2	3	1	2	2.00	4.5	4.5	1.5	1.5	1.5	3.0	2.74	2.37
Mid-Columbia Representative Unit														
Asotin Creek (simple)	1	2	2	1	1	1.40	4.5	3	3	4.5	4.5	2.0	3.57	2.48
Eagle Creek (historical)	0	0	X	0	0	X	NA	NA	NA	NA	NA	NA	0.00	X
Entiat River	1	4	3	5	2	3.00	1.5	3	1.5	3.0	4.5	3.0	2.74	2.87
Imnaha River	3	4	4	3	5	3.80	4.5	3	4.5	3.0	4.5	3.0	3.74	3.77
Lake Chelan (historical)	0	0	X	0	0	X	UK	1.5	1.5	UK	UK	1.0	0.66	X
Little Minam River (simple)	2	2	2	1	4	2.20	4.5	4.5	4.5	4.5	4.5	2.0	4.07	3.13
Lochsa River	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	4.0	4.15	4.28
Lookingglass / Wenaha	3	4	3	4	5	3.80	4.5	4.5	3	4.5	4.5	3.0	3.98	3.89
Methow River	3	4	4	5	3	3.80	3	3	1.5	3.0	3.0	4.0	2.91	3.35
Middle Fork John Day River	2	2	3	4	1	2.40	1.5	3	3	3.0	3.0	3.0	2.74	2.57
North Fork Clearwater River	1	4	5	5	5	4.00	4.5	4.5	3	4.5	4.5	4.0	4.15	4.08
North Fork John Day River	2	4	4	4	3	3.40	4.5	4.5	1.5	3.0	3.0	3.0	3.24	3.32

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Northeast Washington RNA	0	0	X	0	0	X	3	3	3	3.0	3.0	1.0	2.66	X
Pine Indian & Wildhorse Creeks	1	2	4	4	5	3.20	4.5	1.5	1.5	3.0	3.0	3.0	2.74	2.97
Powder River	2	2	4	1	4	2.60	1.5	1.5	1.5	3.0	3.0	3.0	2.24	2.42
Selway River	3	4	4	5	5	4.20	4.5	4.5	3	4.5	4.5	4.0	4.15	4.18
South Fork Clearwater River	4	4	4	5	4	4.20	4.5	4.5	3	4.5	4.5	4.0	4.15	4.18
South Salmo River	2	4	3	4	3	3.20	4.5	3	3	4.5	3.0	3.0	3.49	3.34
Touchet River	3	4	3	5	3	3.60	3	3	1.5	3.0	3.0	3.0	2.74	3.17
Tucannon River	3	4	4	4	3	3.60	3	1.5	1.5	3.0	3.0	3.0	2.49	3.05
Umatilla River (simple)	3	2	2	1	1	1.80	1.5	3	3	3.0	3.0	2.0	2.57	2.19
Upper Grande Ronde River	2	4	4	4	4	3.60	3	3	3	3.0	3.0	3.0	2.99	3.29
Upper Mainstem John Day River	2	4	3	5	2	3.20	3	4.5	1.5	4.5	3.0	3.0	3.24	3.22
Walla Walla River	3	4	3	5	3	3.60	3	3	3	3.0	3.0	3.0	2.99	3.29
Wallowa / Minam Rivers	3	4	4	4	5	4.00	3	3	1.5	4.5	4.5	3.0	3.24	3.62
Wenatchee River	3	4	4	5	5	4.20	1.5	3	1.5	4.5	4.5	4.0	3.15	3.68
Yakima River	3	4	5	3	4	3.80	1.5	3	1.5	3.0	3.0	4.0	2.66	3.23
Saint Mary Representative Unit														
Cracker Lake	3	4	2	2	3	2.80	4.5	3	4.5	4.5	4.5	1.0	3.65	3.23
Red Eagle Lake (simple)	2	2	2	1	2	1.80	4.5	4.5	4.5	4.5	4.5	2.0	4.07	2.93
Slide Lake	3	2	2	1	3	2.20	4.5	4.5	4.5	4.5	4.5	1.0	3.90	3.05
St Mary (complex)	1	4	4	4	3	3.20	3	3	1.5	4.5	3.0	3.0	2.99	3.09
Upper Snake Representative Unit														
Anderson Ranch Reservoir	3	4	5	4	4	4.00	4.5	4.5	3	4.5	4.5	4.0	4.15	4.08
Arrowrock Reservoir	2	4	5	5	4	4.00	4.5	4.5	3	4.5	4.5	4.0	4.15	4.08
Chief Eagle Eye Creek	2	2	3	2	1	2.00	4.5	1.5	1.5	4.5	3.0	3.0	2.99	2.49
Deadwood River	2	4	4	5	3	3.60	4.5	4.5	4.5	4.5	4.5	3.0	4.23	3.92
Jarbidge River	2	4	4	3	2	3.00	4.5	4.5	4.5	4.5	4.5	3.0	4.23	3.62
Lake Creek (simple)	2	4	2	1	3	2.40	4.5	4.5	4.5	4.5	4.5	2.0	4.07	3.23

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Lemhi River	3	4	4	3	5	3.80	4.5	4.5	3	4.5	4.5	4.0	4.15	3.98
Little Lost River	4	4	4	4	5	4.20	4.5	4.5	3	4.5	4.5	3.0	3.98	4.09
Little-Lower Salmon River	3	4	4	5	4	4.00	4.5	4.5	3	4.5	4.5	4.0	4.15	4.08
Middle Fork Payette River	2	4	3	5	3	3.40	4.5	4.5	1.5	4.5	4.5	3.0	3.74	3.57
Middle Fork Salmon River	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	5.0	4.32	4.36
Middle Salmon - Chamberlain	2	4	4	5	4	3.80	4.5	4.5	3	4.5	4.5	4.0	4.15	3.98
Middle Salmon - Panther	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	4.0	4.15	4.28
North Fork Malheur River	2	4	4	5	3	3.60	3	4.5	3	4.5	3.0	3.0	3.49	3.54
North Fork Payette River	2	2	2	1	1	1.60	4.5	1.5	1.5	4.5	4.5	2.0	3.07	2.34
Opal Lake (simple)	2	4	2	1	4	2.60	4.5	4.5	4.5	4.5	4.5	1.0	3.90	3.25
Pahsimeroi River	3	4	4	2	5	3.60	4.5	3	3	4.5	4.5	4.0	3.90	3.75
South Fork Salmon River	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4.0	4.15	4.38
Upper Malheur River	2	2	3	5	1	2.60	3	4.5	1.5	4.5	3.0	3.0	3.24	2.92
Upper Salmon River	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	4.0	4.15	4.28
Upper South Fork Payette River	2	4	5	5	4	4.00	4.5	4.5	1.5	4.5	4.5	4.0	3.90	3.95
Weiser River	3	2	4	4	3	3.20	4.5	1.5	1.5	4.5	4.5	3.0	3.24	3.22

5.2.2 Current Redundancy

Redundancy is the ability of a species to withstand catastrophic events and is best achieved by having multiple resilient populations widely distributed across the species' range. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species, and the greater redundancy a species has, the more viable it will be. We characterize redundancy by describing the number and distribution of bull trout core areas relative to the scale of anticipated catastrophic events. The more widespread the core areas are, the better able the DPS can withstand a catastrophic event as it is unlikely to impact all core areas across the range. Currently there are 109 extant core areas across the same major watersheds and spatial area occupied at listing. Extant core areas are resilient in five states within numerous large river and lake systems across the range. All six Representation Units currently contain multiple extant core areas (Figure 21, above). This current redundancy helps reduce the risk to bull trout from catastrophes within the DPS.

5.2.3 Current Representation

Representation describes the ability of a species to adapt to changing environmental conditions and is measured by the genetic, ecological, and life history diversity of bull trout across the 109 currently extant core areas and the 6 representative units. Bull trout exhibit ecological plasticity across the range occupying a variety of ecological regions and utilizing a suite of habitat types depending on life stage and life history expression. Currently, a diverse set of genetic, ecological, and life history components are evident within the species range.

Genetic Representation

Bull trout are comprised of two phylogenetic genetic lineages—coastal and interior (Figure 22) (Ardren et al. 2011, p. 514; Taylor et al. 1999, p. 1162). Mitochondrial DNA analyses indicate that these two reciprocally monophyletic lineages likely diverged during the Wisconsinan glacial period beginning approximately 70,000 years ago (Haas and McPhail 2001, entire; Ardren et al. 2011, p. 519). Currently, there is representation of these two lineages within extant bull trout core areas.

Within core areas and across the bull trout DPS, bull trout genetics is highly differentiated, even at local population scales. When analyzing bull trout genetic structure for finer scale partitioning, individual population collections (n=69) were found to be grouped independently, suggesting high levels of local population differentiation (Ardren et al. 2011, p. 517). Therefore, genetic groupings are difficult to generate without first assigning an a priori number of desired reporting groups. For this reason, consideration of representation of bull trout as a DPS in the SSA includes additional metrics beyond genetic representation.

A combination of genetic, biological, and ecological data was used to separate these genetic lineages into genetic assemblages resulting in the six current bull trout recovery units (Ardren et al. 2011, entire). There is current representation of these genetic groups within the representative

units analyzed as part of the SSA, with the level of resiliency and redundancy varying across representative units.

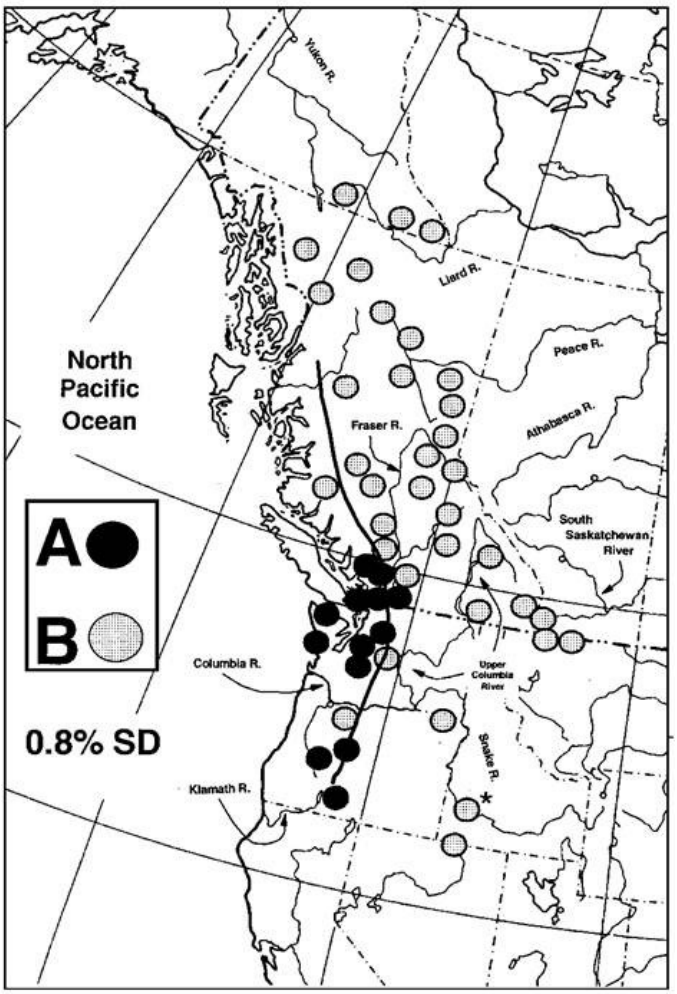


Figure 22. Distribution of two major bull trout mitochondrial DNA lineages identified by restriction fragment length polymorphism of 47 bull trout populations (n=348) (Taylor et al. 1999 p. 1162).

Ecological Representation

Extant core areas across the DPS exhibit ecological diversity within multiple ecosystem types across an area consisting of portions of five states in the northwestern United States. The adaptability of the species has allowed bull trout to occupy core areas in Puget Sound surrounded by temperate rainforest as well as inland portions of the Idaho batholith and as far south as the Nevada high desert. In the Upper Snake and Mid-Columbia representative units, large, complex, and connected river systems such as the Columbia, Snake, Clearwater, Salmon and Grande Ronde rivers maintain extensive connections between core areas. Adfluvial dominated core areas such as Pend Oreille and Flathead lakes maintain connection to natural lake FMO habitat. In other core areas, bull trout have adapted to the creation of man-made reservoirs for FMO habitat (e.g., Hungry Horse, Lower Deschutes, North Fork Clearwater and Arrowrock). Numerous other

core areas across the range are limited to small headwater streams or isolated high mountain lake systems. These small, isolated core areas have a range of resiliency scores and are comprised of both simple and complex core areas.

Life history Diversity

Extant core areas across the DPS exhibit the full suite of bull trout life histories. Multiple anadromous dominated core areas remain in the coastal representative unit. Adfluvial life history forms are present across multiple representative units, however, the most resilient core areas of adfluvial fish are present in the Columbia Headwaters representative unit. Fluvial and resident life histories are present at varying levels across the entire range. Highly resilient fluvial core areas are associated with large, interconnected river systems such as the Salmon, Clearwater, and Snake River drainages of Idaho and eastern Washington and Oregon.

5.3 Summary of Current Condition

The current condition of bull trout varies across the range. Thirty-seven percent (n = 44) of the core areas within the DPS have high or very high resiliency. In general, core areas with high or very high resiliency occupy large, interconnected habitats with thermal refugia in the form of snow melt driven stream hydrographs and/or access to FMO habitat in lake and large river systems. Typically, these core areas have high demographic scores and few habitat threats. Medium resiliency is evident in 38 percent (n = 45) of the core areas across the DPS. In some cases, medium resiliency core areas have reduced demographic scores but high habitat factor scores, other medium resiliency core areas have high demographic scores but low habitat scores. Some medium resiliency core areas are spatially limited simple core areas which limits the maximum scores achievable while others are larger complex core areas with demographic and/or habitat threats identified. Core areas with low or very low resiliency comprise 17 percent (n = 20) of core areas across the listed range. These core areas have low demographic and habitat scores. Of the 20 core areas with low or very low resiliency ranks, 55 percent are simple core areas. One core area has become extirpated since listing. Lake Pend Oreille C was occupied in low abundance at the time of listing but has since become extirpated.

Bull trout resiliency in an individual core area is related to a variety of factors which have been incorporated into the condition category table. The diversity of bull trout as a species and the habitats they occupy requires a complement of factors be used to evaluate resiliency across the range. Conservation measures implemented since listing have maintained or improved resiliency in some core areas. Added detail on factor scoring for each core area is available in Appendix H.

Currently bull trout remain widespread within 109 extant core areas within five states (Table 4). Though bull trout retain populations across all representation units, the analysis of current resiliency indicates two of the six representation units (Klamath and St. Mary) lack core areas with high to very high resiliency. Despite being widespread across a diversity of habitats (redundancy and representation), seven historical core areas no longer support bull trout, and one core area has become extirpated since listing under the ESA.

Chapter 6 - Future Conditions

This chapter considers how species viability could change from current condition into the future. To assess future conditions, we conducted a future scenario analysis. In that analysis we developed five scenarios to represent different plausible futures in terms of climate conditions and associated environmental variability and the level of implementation of the 10 conservation efforts (described in chapter 4). Each scenario represents a plausible, yet simplified representation of the climatic stressors and conservation efforts likely to influence species viability either directly or indirectly. To capture the full range of uncertainty, the scenarios span from the best to the worst plausible future outcomes. The actual future condition could include a combination of factors from any of these scenarios, however, those combinations are still captured somewhere between best and worst plausible future outcomes.

We projected future condition out 60 years, to approximately year 2080. The 60-year time-period accounts for approximately eight bull trout generations, adequate time for populations to respond positively or negatively to the changes in stressors or conservation efforts. It is also the time-period to which we can reasonably project climate conditions based on current climate models. The time frame is bounded between 2070–2090 to match stream temperature projections used in the analysis (Isaak et al. 2017, entire).

6.1 Future Scenarios

We developed five future scenarios based on projected climate conditions and conservation efforts. Scenarios are qualitative in nature, include a high level of uncertainty, and are intended to frame the extent of potential future impacts of climate change, associated environmental variability and the implementation of different levels of conservation action. All five of our scenarios examined in the future scenario analysis were assumed plausible. The scenarios include 3 climate factors and 10 conservation efforts as described below.

6.1.1 Climate Conditions

Our scenarios consider three plausible climate futures, (1) Warmer, (2) Hotter and Wetter, and (3) Hotter and Drier as defined by three climate factors: air temperature, precipitation, and environmental variability (stochasticity). Future climate scenarios were postulated based on data provided by the Climate Toolbox/Future Climate Scatter Tool (https://climatetoolbox.org/tool/future-climate-scatter; Hegewisch and Abatzoglou 2022, entire). The range of plausible outcomes specific to the geographic bounds of the bull trout DPS is based on projections of 20 Global Climate Models for moderate (4.5 RCP) and high (8.5 RCP) greenhouse gas scenarios (Figure 23). The Bull trout core team summarized the models into three climate futures that are used in the analysis to capture the spread of model variation.

The warmer climate projection is associated with increased mean summer air temperatures of 2-7°F, and average summer precipitation that could increase or decrease by 0.1-0.4 inches per year. The frequency, magnitude, and intensity of environmental stochastic events, such as extreme

wildfire, precipitation events and drought, are similar to current levels. This projection is used in future scenarios 1 and 2.

The hotter and wetter climate projection is associated with increased mean summer air temperatures of 8–14 °F and average precipitation increases of 0.2–0.8 inches per year. Environmental stochastic events will have a moderate increase in magnitude, frequency, and intensity compared to current levels. This projection is used in future scenario 3.

The hotter and drier climate projection is associated with increased summer air temperatures of 8–14 °F and the summer months may see little to no precipitation. The magnitude, frequency, and duration of environmentally stochasticity will increase substantially. This projection is used in scenarios 4 and 5.

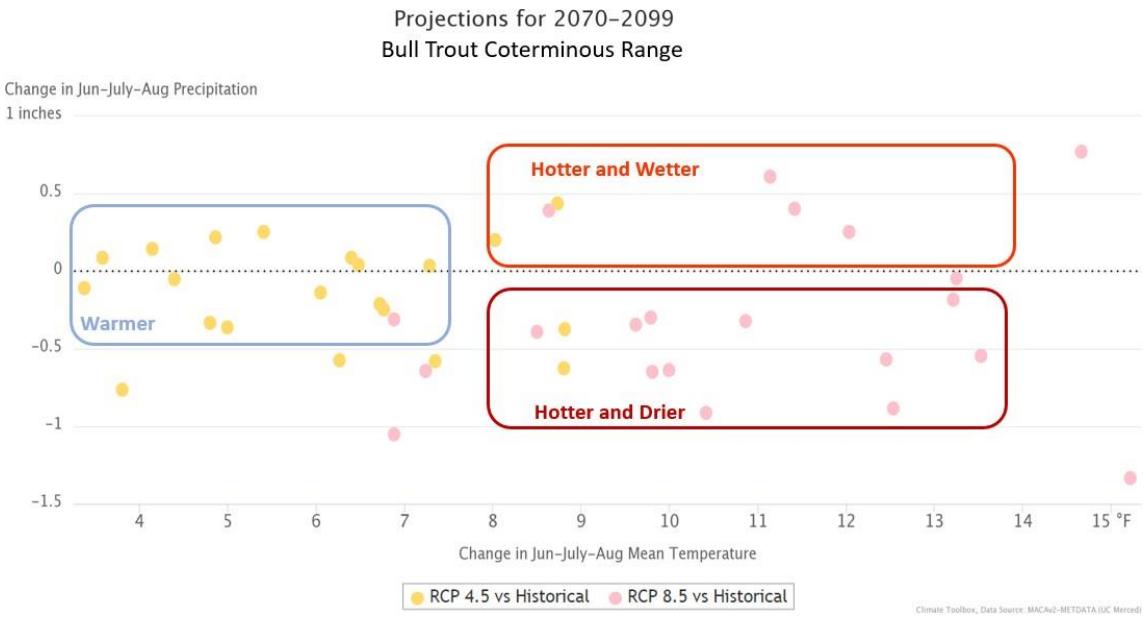


Figure 23. Future Climate Scenarios. Scatter plot of mean changes in summer (June-August) air temperature in °F (horizontal axis) vs. changes in summer precipitation (vertical axis) between historical (1971-2010) and late century (2070-2099) periods for the coterminous range of bull trout. Scatter points are the outcome of 20 Global Climate Models (GCMs) under 4.5 and 8.5 Representative Concentration Projections (RCP) (i.e., moderate (4.5) and high (8.5) greenhouse gas emission scenarios). Boxes labeled Warmer, Hotter and Wetter, and Hotter and Drier were added based on ocular evaluations by the Bull Trout core team and represent three plausible climate futures for this geography.

Air Temperature

Based on projected mean summer (June-August) air temperature increases in the coterminous bull trout range between 1971–2010 (historical) and 2070–2099 (late century) as estimated by 20 Global Climate Models (GCMs) (Figure 21 horizontal axis). Note that no GCMs project a decrease in mean summer temperatures for this region in late century (lowest projected increase is approximately 3 ºF; Figure 21).

Precipitation

Based on projected mean summer (June-August) precipitation changes in the coterminous bull trout range between 1971-2010 (historical) and 2070-2099 (late century) as estimated by 20 GCMs (Figure 21 vertical axis). Summer precipitation projections vary more widely than air temperature among GCMs indicating late century summer conditions may be 'wetter' or 'drier'.

Environmental Variability: Stochasticity

Environmental stochasticity is the random and unpredictable year-to-year variation in environmental conditions such as temperature and rainfall. Extreme stochastic events are projected to increase in frequency, intensity and duration by late century as mean summer air temperatures increase.

6.1.2 Conservation Efforts

Scenarios varied according to the level of implementation of 10 conservation effort categories affecting stressors. Those effort categories and their benefits are described under section 4.2 (Voluntary and Regulatory Conservation Measures).

Each of the five scenarios is generally summarized here and detailed in Table 6.

Future Scenario 1: Significant increase in conservation – warmer climate

Under this scenario, land, water, and species management plans identify and implement conservation actions with a specific focus on addressing threats to and protections for bull trout. Bull Trout working groups remain highly functional and collaborate to implement focused habitat restoration projects, nonnative fish management actions and long-term monitoring programs to benefit the entire core area. Climate projections trend toward warmer conditions and the frequency, duration, and magnitude of environmental stochastic events are similar to current levels.

Future Scenario 2: Increased conservation – warmer climate

Under this scenario, conservation is increased beyond current levels. Restoration and recovery actions reduce threat severity at the local population or core area scale. Actions emphasize benefits for cold water and/or anadromous species in general but may not be maximized for bull trout specifically. Climate projections are the same as in scenario 1, warmer temperatures and the degree of environmental stochasticity remains similar to current.

Future Scenario 3: Continuation of current levels of conservation – hotter and wetter climate

Under this scenario, implementation of conservation actions continues at the current rate, magnitude, and effectiveness. Climate conditions are projected to be hotter and wetter with a moderate increase in environmental stochasticity.

Future Scenario 4: Decreased conservation – hotter and drier climate

Under this scenario, implementation of conservation actions decreases from current levels. Implementation and effectiveness of habitat restoration and management plans are reduced, monitoring is ancillary to that for other species and interagency coordination is not prioritized for bull trout. Climate conditions are projected to be hotter and drier, and the frequency, duration and magnitude of severe stochastic events increase substantially.

Future Scenario 5: Significant decrease in conservation – hotter and drier climate

Under this scenario, implementation of conservation actions decreases substantially. Demand and use of natural resources increase significantly, and land and water protections are reduced. Conservation actions for bull trout and cold-water species are not prioritized and implemented only at a local population level. Climate conditions are the same as in scenario 4, hotter and drier conditions with a substantial increase in environmental stochasticity.

Table 6. Future scenarios used to evaluate future conditions.

FACTORS	PLAUSIBLE RANGE OF CONDITIONS FOR EACH FACTOR 60-YEARS INTO THE FUTURE				
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**
Climate	**Warmer**		**Hotter and Wetter**	**Hotter and Drier**	
Air Temperature	Mean summer air temperature increases 2 - 7 ºF		Mean summer air temperature increases 8-14 ºF	Mean summer air temperature increases 8-14 ºF	
Precipitation	Mean summer precipitation increases or decreases 0.1 - 0.4 in/yr About the same or a slight decrease in summer precipitation, with roughly no change in annual precipitation.		Mean summer precipitation increases 0.2 – 0.8 in/yr Slightly more precipitation annually, with most of the increase falling in the winter months (increased snowpack, potentially more water in the spring and summer for bull trout).	Mean summer precipitation decreases 0.2 - 1.0 in/yr Annual precipitation somewhat decreases; summer experiences little to no precipitation, with more drought.	

FACTORS	PLAUSIBLE RANGE OF CONDITIONS FOR EACH FACTOR 60-YEARS INTO THE FUTURE				
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**
Environmental Variability: Stochasticity	Same magnitude and frequency of environmental stochasticity (e.g., droughts, floods, fires) as current.		Medium increase in magnitude, frequency, and intensity of stochastic events.	Substantially more variability and increased magnitude, frequency, and duration of stochastic events.	
Conservation Efforts	**Significant Increase in Conservation**	**Increased Conservation**	**Continuation of Current Levels Conservation**	**Decreased Conservation**	**Significant Decrease in Conservation**
Species Specific Conservation Plans	Bull Trout specific plan implemented by multiple agencies within Core area. The plan includes quantitative or qualitative thresholds or management triggers. Bull Trout working groups are integrated and supported as part of these agreements. Management actions directed to addressing Bull Trout limiting factors.	Multi-species Conservation Plan implemented by multiple agencies within Core area. Multi-species working groups are integrated and supported as part of these agreements. Management strategies benefit Bull Trout but not maximized with focus on Bull Trout conservation.	Conservation Plans continue at the same level of implementation and effectiveness. Management programs remain in place and operational at current levels.	Plans or other mechanisms may exist but may no longer specifically address bull trout. Less effective implementation and adherence of plans. Management programs place reduced focus on Bull Trout conservation strategies and restoration.	Conservation Plans are not developed, and existing plans may be revoked or not funded or implemented. Management programs emphasize species or actions which are detrimental to Bull Trout.

FACTORS	PLAUSIBLE RANGE OF CONDITIONS FOR EACH FACTOR 60-YEARS INTO THE FUTURE				
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**
Federal and State Land Management Plans	Action and permitting agencies management plans fully consider viability and conservation of Bull Trout.	Plans consider Bull Trout but may only include standards to fully protect and prioritize riparian resources.	All current BLM, USFS and State land management plans continue at current implementation and effectiveness.	Moderate decrease of conservation standards in large scale land management plans.	Resource extraction or use programs (grazing, mining, timber extraction) increase substantially and conservation standards decrease substantially. This may include reductions of federal ownership at the Core area scale.
Water Management	Increase in the development and implementation of water conservation and management for the benefit of cold-water fisheries. Water management plans are developed by core area and include voluntary, incentivized and regulatory efforts to improve stream flows (timing and amount), improve fish passage, and improve water quality. These efforts may include drought management and changes in reservoir management/hydropower (e.g., timing of releases).	Management plans consider persistence and conservation of bull trout – water management facilities and operations provide sufficient flows and effective passage and eliminate or improve water quality issues (temperature and quality). Mitigation plans are effective and fully implemented (e.g., trap and transport programs).	Water Management continues as is, a loose amalgamation of regulations and incentives that do not provide a cohesive or synergistic benefit to cold water species including bull trout at the core area scale.	Management plans do not consider persistence and conservation of bull trout – water management facilities and operations provide ineffective passage or eliminate fish passage, water quality decreases (includes increased water temperatures and reduction of water quantity). Mitigation plans are ineffective	Decrease in the development and implementation of water conservation and management for the benefit of cold-water fisheries. Commercial (agriculture and hydropower) demands increase. More area is converted to cropland or non-producing ranches and new dams are constructed.
Federal Land Protections	Increase the number and extent of federally designated Wilderness Areas.	Increase in the number federal land designations with protections for aquatic habitat, but no increase in the number or extent of designated Wilderness.	No change in the number or extent of Federal Land protections. Current status of Federal land designation remains unchanged	Amount of designated Wilderness stays the same, but other land designations decrease.	Decrease of designated Wilderness Areas. Proposals are revoked.

FACTORS	PLAUSIBLE RANGE OF CONDITIONS FOR EACH FACTOR 60-YEARS INTO THE FUTURE				
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**
Fish Screen Programs	Significant Increase in the implementation and effectiveness of fish screen programs.	General improvement in the implementation and effectiveness of fish screen programs.	Fish screen programs continue as currently implemented with same effectiveness.	Decrease in the implementation and effectiveness of fish screen programs.	Fish screens are not effective. Little to no implementation or effectiveness of fish screen programs.
Species Monitoring Programs	Bull Trout specific long-term monitoring program of demographic factors (e.g. distribution, abundance, and genetics) in each core area.	Bull Trout specific long-term monitoring program of demographic factors (e.g., distribution, abundance, and genetics) in priority core areas. Priority areas identified based on current monitoring program (or lack thereof) and workgroups.	Bull Trout core area monitoring continues at current levels. Level of monitoring in an individual core area ranging from Bull Trout specific, ancillary to other target species, or completely absent.	Monitoring of Bull Trout demographic factors only ancillary to programs targeting other species, or monitoring programs sporadically implemented.	Monitoring of Bull Trout demographic factors occurs sporadically resulting in loss of long-term datasets which track demographic factors in all core areas.
Habitat Restoration and Fish Passage Programs	Habitat restoration programs and funding increase across the core area. Programs targeted specifically for Bull Trout.	Habitat restoration programs and funding increase across the core area. Some programs benefit Bull Trout but designed for other species.	Habitat restoration programs, funding, and target species priority remain at current levels.	Cold-water species habitat restoration programs and funding decrease across the core area.	Loss of habitat restoration programs and funding across the core area.
Information and Education Programs	Increase in coordination, implementation and effectiveness of I&E programs specifically targeting Bull Trout. Substantial improvement on coordination and collaboration between all partners and stakeholders (State, Tribal, and Federal) range-wide.	Increase in coordination, implementation and effectiveness of I&E programs targeting cold-water species. Improvement on coordination and collaboration between all partners and stakeholders (State, Tribal, and Federal) at core area scale.	I&E programs, funding, and target species priority remain at current levels. In general, maintain local level I&E with limited broader I&E strategy for Bull Trout.	Decrease in coordination, implementation and effectiveness of I&E programs targeting cold-water species. Reduced coordination and collaboration between all stakeholders (State, Tribal, and Federal) at core area scale.	Little to no coordination, implementation and effectiveness of I&E programs targeting cold-water species. No coordination and collaboration between all partners and stakeholders (State, Tribal, and Federal) at core area scale.

FACTORS	PLAUSIBLE RANGE OF CONDITIONS FOR EACH FACTOR 60-YEARS INTO THE FUTURE				
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**
NonNative Fish Management	Significant improvement in the implementation and effectiveness of conservation actions to manage nonnatives.	Increase in the implementation and effectiveness of conservation actions to manage nonnatives.	Nonnative fish management programs continue at the same level of implementation and effectiveness.	Decrease in the implementation and effectiveness of nonnative fish management.	Significant reduction in the implementation and effectiveness of nonnative fish management.
Regional Bull Trout Working groups	Working groups are highly functioning and supported to include state, tribal, and federal partners across regional scale. Provide within and across core area coordination of Bull Trout Conservation activities. Groups prioritize funding and conservation action priorities including draft and formalize species specific plans.	Working groups are highly functioning and supported to include state, tribal, and federal partners in priority core areas. Groups prioritize funding and conservation action priorities including draft and formalize species specific plans.	High functioning and supported working groups including state, tribal, and federal partners maintained in <25% of core areas.	Bull Trout funding and conservation actions are prioritized by single agencies and not coordinated across multiple partners and working groups.	Limited funding allocated to Bull Trout conservation actions. Bull Trout working groups not prioritized and minimal conservation actions occurring.

6.2 Evaluation of Future Conditions

For each future scenario we projected core area resiliency 60 years into the future using the same methodology and condition category model we used to evaluate current condition. In the absence of quantitative, predictive models, we relied on best professional judgment to evaluate conditions under the five plausible future scenarios. For all factors, scores for current condition were treated as the starting point and then adjusted up or down to derive the future scenario scores according to the environmental conditions and conservation efforts outlined in each scenario and the significant drivers for bull trout resiliency in the core area. For example, in core areas where nonnative fish are a threat to bull trout, the quality of fish community score may be adjusted lower under scenarios with hotter temperatures and less conservation (scenarios 4 and 5) if the nonnative species thrive in warmer water, whereas core areas where nonnative fish are absent the quality of fish community score may not change under the same conditions. The same weighted average used for current condition was applied to calculate overall resiliency for each core area, and redundancy and representation of the DPS were evaluated for each future scenario.

The current condition model was modified for the evaluation of future scenarios in two instances. First, the growth rate: population trend factor was scored with only three categories: increasing, stable, or decreasing trend. The fourth category, insufficient data, was not part of the analysis since the evaluation of future trend is qualitative and we assumed a trend based on best available information. Second, scoring of habitat quantity was the only factor in the future condition analysis to have a quantitative basis based on an analysis of habitat loss due to climate impacts. Under scenario 3 (continuation of current conservation in a hotter and wetter climate) the metric was scored using values of the total stream length of spawning and rearing critical habitat with projected August mean temperatures below 13.0°C for years 2071-90 (far term) as derived from the NorWeST database (Isaak et al. 2017, entire) (see Appendix E for values and Appendix G for scores). For scenarios 4 and 5, the metric was qualitatively scored assuming the percentage difference between current and far term values (scenario 3) was similar to that between scenario 3 and scenarios 4 and 5. Scores were then adjusted given the parameters of the scenario and core area-specific conditions and drivers. Scenarios 1 and 2 scores were qualitatively scored based on the far term score and adjusted according to the parameters of the scenario and core area-specific conditions and drivers.

For habitat factors based on the Threats Assessment Tool, the current threat score was used as a starting point, and we projected changes in threat severity and management effectiveness according to conditions outlined in each scenario. This future threat score then served as the basis to evaluate the habitat metric using the categories defined in the condition category table. Additional resources were used to qualitatively assist our evaluations and scoring of some habitat and demographic factors under future scenarios, particularly in terms of climate change. These included projected change in discharge within FMO habitats (Appendix F), and core area-specific changes to projected spawning and rearing habitat quantity (under scenario 3) (Appendix E).

For our analysis of future conditions, we included historical core areas to account for the potential re-establishment of bull trout populations either by natural recolonization or re-introduction efforts. We considered the re-establishment of bull trout in a historical core area or research needs area only under scenario 1 given that is the one scenario where specific, targeted bull trout conservation is anticipated, and most plausible where the feasibility of a re-introduction is currently being explored either formally or informally. The exception to this rule is the Clackamas core area which was also assessed under scenario 2 given a re-introduction effort is already well underway.

The results of the future condition analysis reflect the core team's collective opinion on the probable effectiveness of conservation efforts relative to the threats posed by the various climate scenarios in each of the 118 core areas. This approach provides a transparent means to consistently render professional opinion across the DPS and its constituent representative units and core areas. Therefore, the results, in terms of number of core areas at each level of resiliency for the five scenarios, are treated as plausible relative outcomes and not absolute projections of the future.

6.2.1 Future Scenario 1: Substantially increased conservation – warmer climate

Resiliency

Resiliency is the ability of a species to withstand environmental and genetic stochasticity and periodic disturbance within the normal range of variation. We projected the resiliency of all 118 core areas under conditions outlined in future scenario 1- substantially improved conservation in a warmer climate (Table 7). Our projected resiliency ratings indicate: no core areas are rated very low; 1 (1 percent) is rated low; 38 (32 percent) are rated medium; 27 (23 percent) are rated high; and 49 (42 percent) are rated very high resiliency. We projected three (3 percent) core areas to be extirpated in 60 years, of which all are historical core areas. No currently extant core areas were projected to become extirpated under this scenario. We rated four historical core areas and the RNA as medium resiliency based on the assumption that under this scenario reintroduction or recolonization of bull trout is plausible. Projected core area resiliency ratings for scenario 1 are displayed in Figure 24 and factor specific scores are provided in Appendix G.

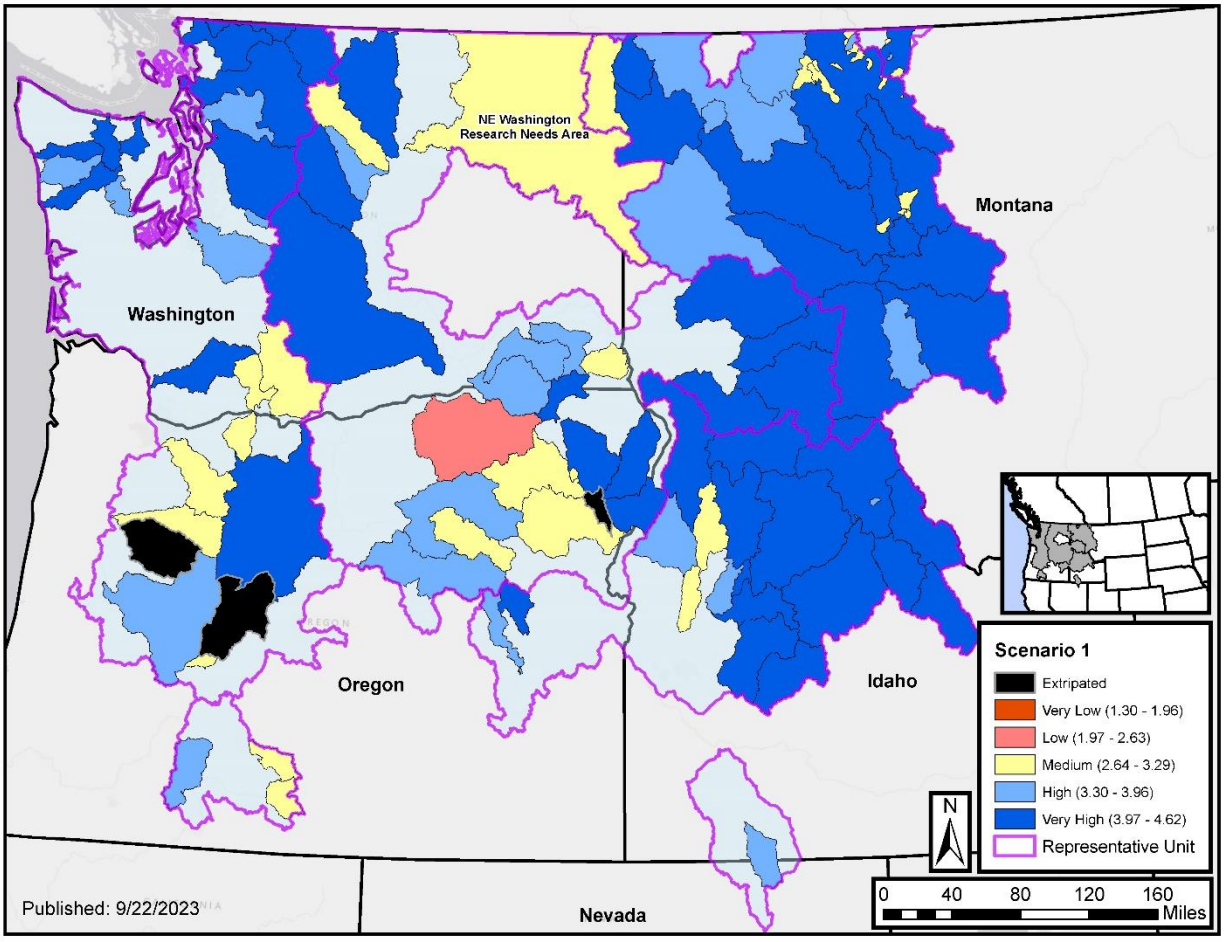


Figure 24. Map of core area resiliency ratings for the 118 bull trout core areas under conditions outlined in Scenario 1.

Table 7. Summary of future scenario 1 resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated
Coastal	11	6	6	0	0	2
Columbia Headwaters	12	6	19	0	0	0
Klamath	0	1	2	0	0	0
Mid-Columbia	11	7	7	1	0	1
Saint Mary	1	1	2	0	0	0
Upper Snake	14	6	2	0	0	0
DPS	49	27	38	1	0	3

Redundancy

The number and distribution of resilient core areas describes redundancy and the species' ability to withstand large scale catastrophes including, but not limited to, drought, wildfire and flooding. In scenario 1, 115 extant core areas are distributed throughout all six representative units in the DPS (Figure 24, and Table 7). The projected degree of redundancy reduces the risk to bull trout from catastrophes within the DPS.

Representation

Representation is the ability of a species to adapt to changing environmental conditions over time, as indicated by genetic and environmental diversity within and among populations. This diversity for bull trout is captured by the six representative units that comprise the DPS. The greater number of resilient core areas within each representative unit, the greater the representation and therefore the more likely bull trout will be able to adapt to changing environmental conditions on both a long-term and short-term time scale.

Bull trout currently occupy a wide breadth of ecological settings from the high desert of the Klamath and Upper Snake Representative Units to the temperate coastline of the Coastal Representative Unit. Within this wide and varied distribution, population level genetic structuring, inter-population connectivity, and the ability to express a full range of life history types provides bull trout the opportunity to adapt to new and changing environments. Conditions set forth under this scenario not only retain the current degree of representation but build on it by improving core area resiliency, including reestablishing bull trout in currently extirpated core areas. Implemented conservation efforts are anticipated to result in the removal of barriers, suppress nonnative species, improve and protect habitats, and generally manage for the protection of bull trout, ultimately increasing effective population size, improving gene flow and expanding occupied habitats.

6.2.2 Scenario 2: Increased conservation – warmer climate

Resiliency

We projected the resiliency of all 118 core areas under conditions outlined in future scenario 2 - increased conservation in a warmer climate (Table 8). Our projected resiliency ratings indicate: no core areas are rated very low; 8 (7 percent) are rated low; 41 (35 percent) are rated medium; 36 (31 percent) are rated high; and 26 (22 percent) are rated very high resiliency. We projected 7 (6 percent) core areas to be extirpated in 60 years including 6 of the 7 historical core areas and the RNA. The seventh historical core area, Clackamas River, was projected to be resilient given reintroduction efforts currently under way. Projected core area resiliency ratings for scenario 2 are displayed in Figure 25 and Appendix G.

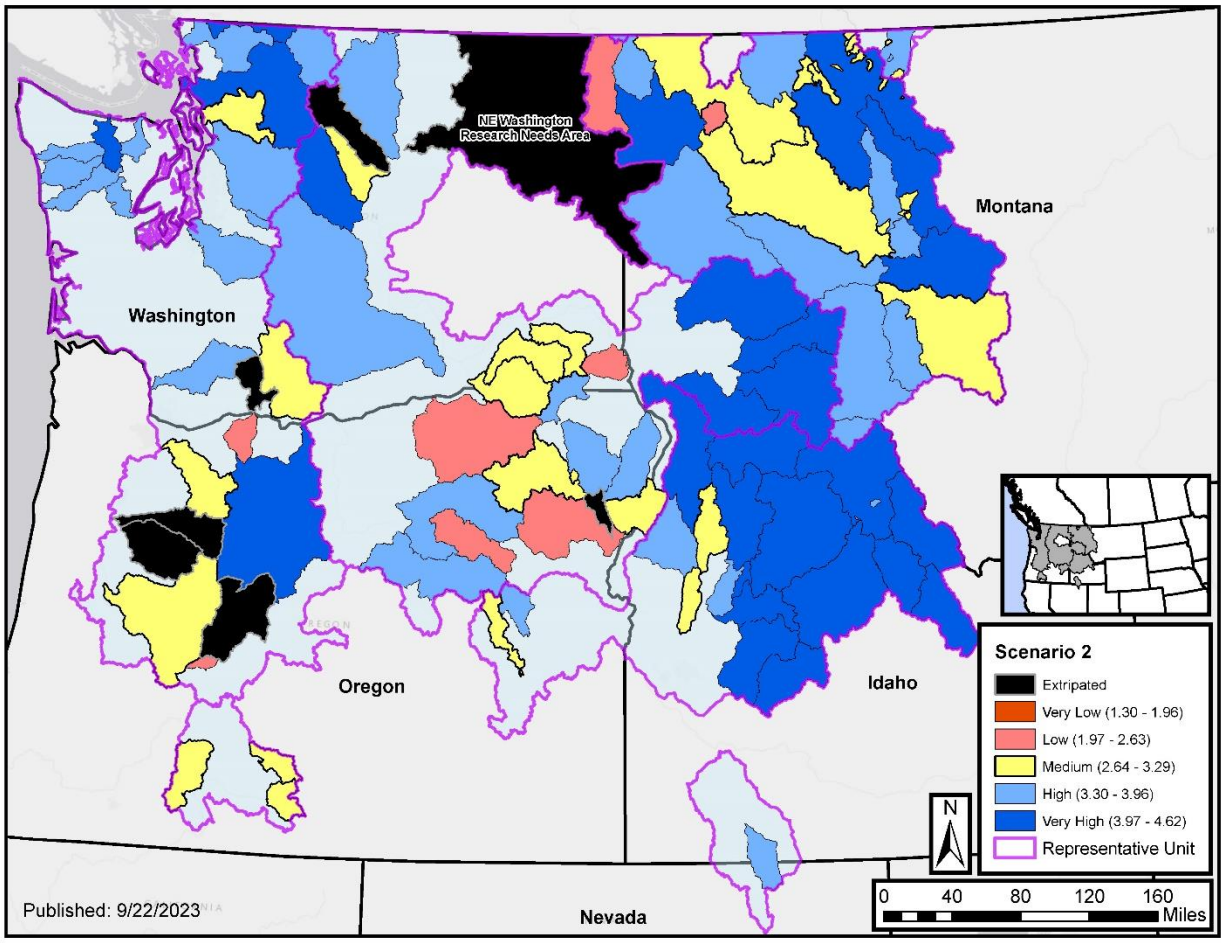


Figure 25. Map of core area resiliency ratings for the 118 bull trout core areas under conditions outlined in Scenario 2.

Table 8. Summary of future scenario 2 resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very low	Extirpated
Coastal	4	11	4	2	0	4
Columbia Headwaters	4	9	22	2	0	0
Klamath	0	0	3	0	0	0
Mid-Columbia	5	8	7	4	0	3
Saint Mary	0	2	2	0	0	0
Upper Snake	13	6	3	0	0	0
DPS	26	36	41	8	0	7

Redundancy

The number and distribution of resilient core areas describes species redundancy and the ability to withstand large scale catastrophes including, but not limited to, drought, wildfire and flooding. In scenario 2, 111 extant core areas are distributed throughout all six representative units in the DPS (Figures 25 and Table 8).

Representation

Conditions set forth under this scenario not only retain the current degree of representation but also build on it slightly by improving resiliency in some core areas throughout the DPS. Implemented conservation efforts are anticipated to result in providing passage past barriers, managing nonnative species, restoring key riparian and upland habitats, and generally manage for the protection of native species, ultimately maintaining, and in some cases, improving effective population size, improving gene flow, and preserving occupied habitats.

6.2.3 Scenario 3: Continuation of Current Conservation – Hotter and Wetter Climate

Resiliency

We projected the resiliency of all 118 core areas under conditions outlined in future scenario 3 - conservation efforts continue at the current rate, magnitude, and effectiveness with a hotter and wetter climate (Table 9). Overall, we project resiliency to be lower under this scenario than in scenarios one, two and current condition. Our projected resiliency ratings indicate: no core areas are rated as very low; 17 (14 percent) are rated as low; 42 (36 percent) are rated as medium; 25 (21 percent) are rated as high; and 12 (10 percent) are rated as very high resiliency. We projected 22 (19 percent) core areas to be extirpated in 60 years including 7 historical core areas, the RNA, and one currently extirpated core area that are not expected to recover, as well as 13 currently extant core areas that are projected to become extirpated. Projected core area resiliency ratings for scenario 3 are displayed in Figure 26 and Appendix G.

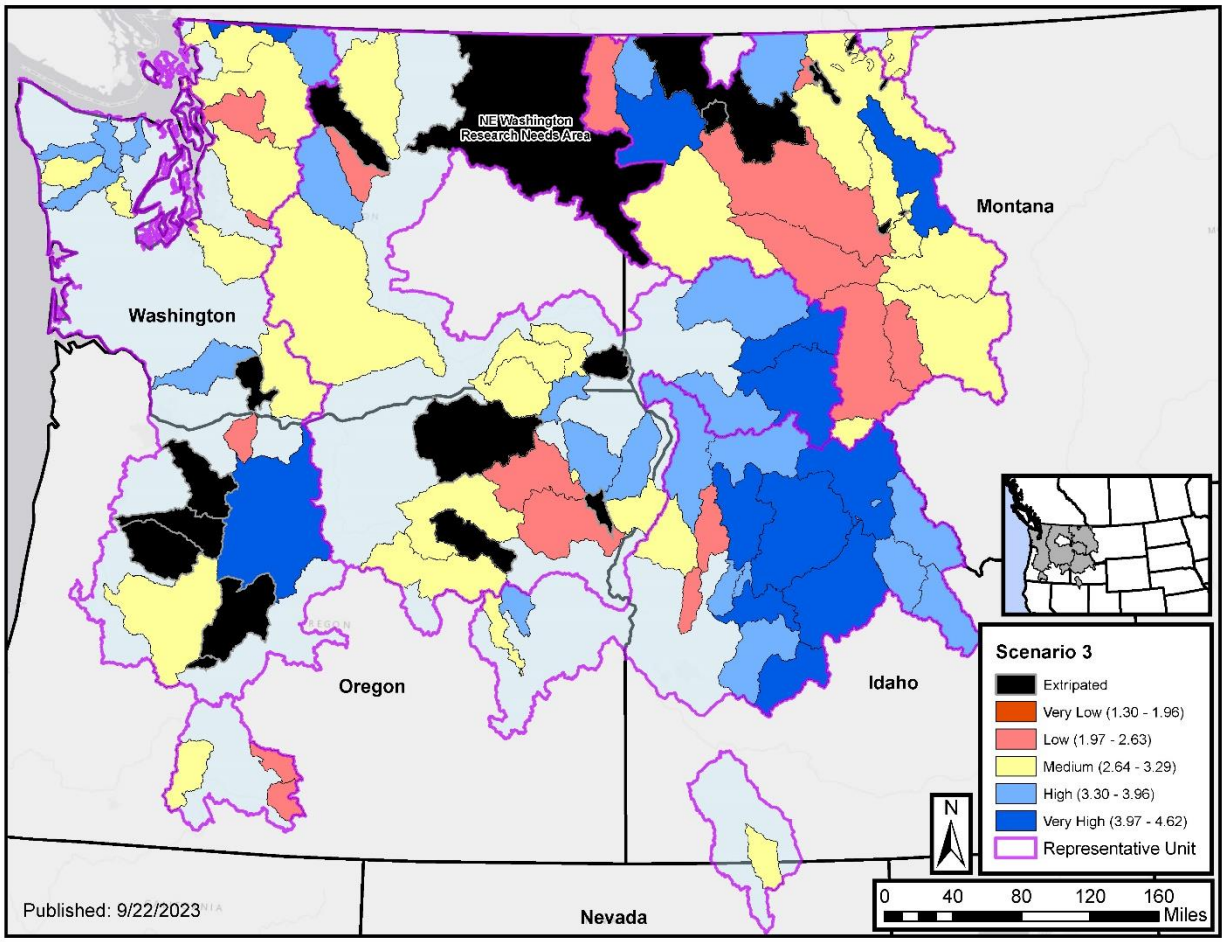


Figure 26. Map of core area resiliency ratings for the 118 bull trout core areas under conditions outlined in Scenario 3.

Table 9. Summary of future scenario 3 resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated
Coastal	2	6	8	3	0	6
Columbia Headwaters	2	2	16	7	0	10
Klamath	0	0	1	2	0	0
Mid-Columbia	2	6	10	3	0	6
Saint Mary	0	0	4	0	0	0
Upper Snake	6	11	3	2	0	0
DPS	12	25	42	17	0	22

Redundancy

The number and distribution of resilient core areas describes species redundancy and the ability to withstand large scale catastrophes including, but not limited to, drought, wildfire and flooding. In scenario 3, 96 extant core areas are distributed throughout all six representative units in the DPS (Figures 26 and Table 9). This degree of redundancy is less than that in previous scenarios and current condition, projecting higher risk to bull trout from catastrophic events.

Representation

Representation decreases under conditions outlined in Scenario 3 compared to previous scenarios and current condition. The current rate of implementation and degree of effectiveness of conservation, as well as a hotter and wetter climate, is projected to result in multiple core area extirpations throughout the DPS. Twenty-two core areas are anticipated to be extirpated, 13 of those are currently extant core areas. The Coastal, Columbia Headwaters and Mid- Columbia Representative Units lose 1 (5 percent), 9 (25 percent), and 3 (13 percent) of their currently extant core areas respectively (Table 9 and Figure 26). These extirpated core areas represent an overall decrease in effective population size, potentially less genetic diversity, and likely less population connectivity, therefore reducing capacity to adapt to new and changing environmental condition.

6.2.4 Scenario 4: Decreased Conservation –Hotter and Drier Climate

Resiliency

We projected the resiliency of all 118 core areas under conditions outlined in future scenario 4 - decreased conservation in a hotter and drier climate (Table 10). Overall, we project resiliency to be lower under this scenario than in previous scenarios and current condition. Our projected resiliency ratings indicate: 14 (12 percent) core areas are rated as very low; 27 (23 percent) are rated as low; 30 (25 percent) are rated as medium; 14 (12 percent) are rated as high; and none were rated as very high resiliency. We projected 33 (28 percent) core areas to be extirpated under this scenario in 60 years including 24 that are currently extant. The remaining nine extirpated core areas are historical core areas, the RNA and LPO-C that do not currently support self-sustaining bull trout populations. Projected core area resiliency ratings for scenario 4 are displayed in Figure 27 and Appendix G.

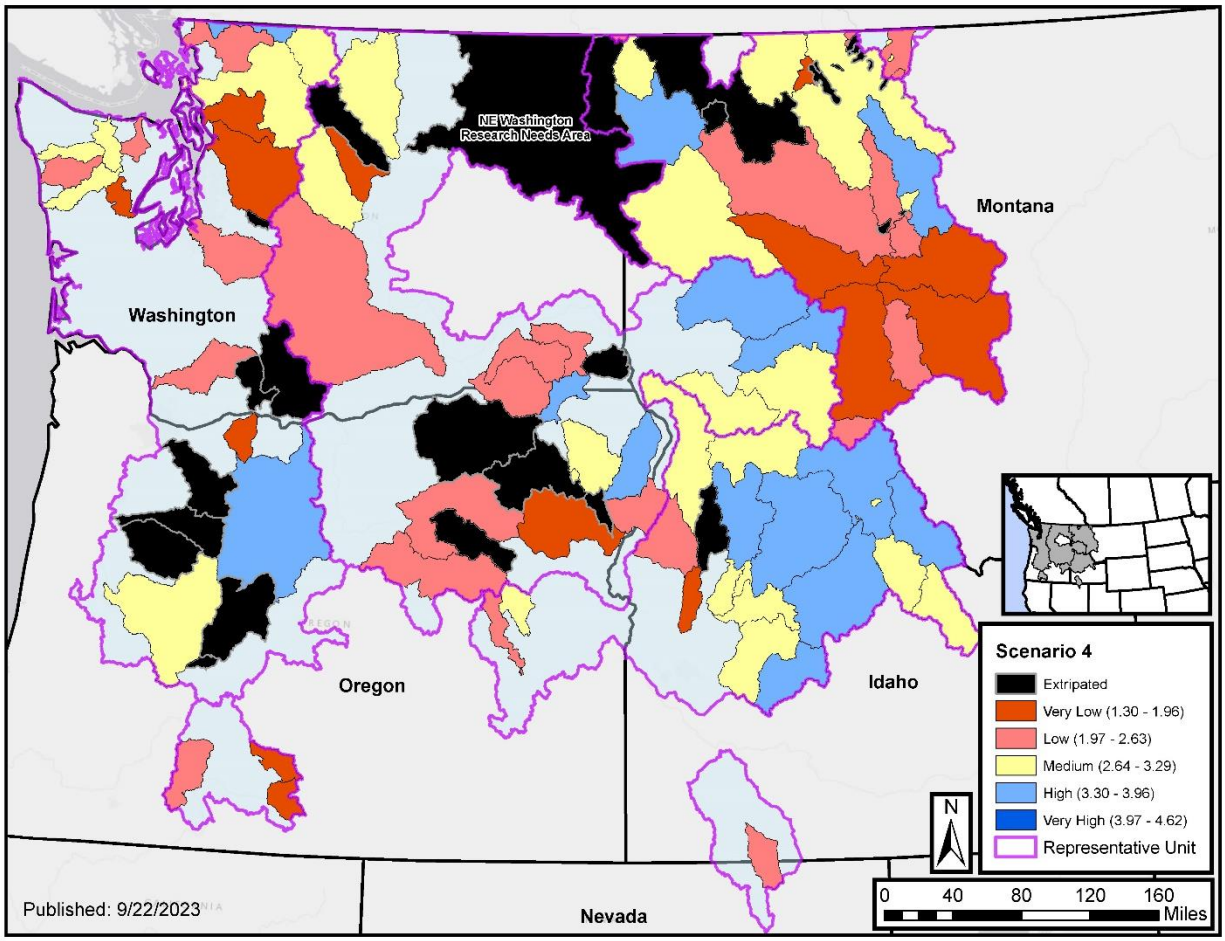


Figure 27. Map of core area resiliency ratings for the 118 bull trout core areas under conditions outlined in Scenario 4.

Table 10. Summary of future Scenario 4 resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated
Coastal	0	2	6	5	4	8
Columbia Headwaters	0	2	5	8	5	17
Klamath	0	0	0	1	2	0
Mid-Columbia	0	4	6	8	2	7
Saint Mary	0	0	2	2	0	0
Upper Snake	0	6	11	3	1	1
DPS	0	14	30	27	14	33

Redundancy

The number and distribution of resilient core areas describes species redundancy and the ability to withstand large scale catastrophes including, but not limited to, drought, wildfire and flooding. In scenario 4, 85 extant core areas are distributed throughout all six representative units in the DPS (Figure 27 and Table 10).

Representation

Representation decreases under conditions outlined in Scenario 4 compared to current condition and previous scenarios. Decreased conservation and a hotter and drier climate are projected to result in multiple core area extirpations throughout the DPS. Thirty-three core areas are anticipated to be extirpated, 24 of those are currently extant core areas. The Coastal, Columbia Headwaters, Mid-Columbia and Upper Snake Representative Units lose 3 (15 percent), 16 (44 percent), 4 (17 percent) and 1(5 percent) of their currently extant core areas respectively (Figure 27). These extirpated core areas represent an overall decrease in effective population size, potentially less genetic diversity, and likely less population connectivity, therefore reducing their capacity to adapt to new and changing environments.

6.2.5 Scenario 5: Substantially Decreased Conservation – Hotter and Drier Climate

Resiliency

We projected the resiliency of all 118 core areas under conditions outlined in future scenario 5 - substantially decreased conservation in a hotter and drier climate (Table 11). Overall, we project resiliency to be lowest under this scenario compared to previous scenarios and current condition. Our projected resiliency ratings indicate: 15 (13 percent) core areas are rated as very low; 29 (25 percent) as low; 23 (19 percent) are rated as medium; 1 (1 percent) are rated as high; and none are rated as very high resiliency. We projected 50 (42 percent) core areas to be extirpated within 60 years, including 41 currently extant core areas. Projected core area resiliency ratings for scenario 5 are displayed in Figure 28 and Appendix G.

Redundancy

The number and distribution of resilient core areas describes species redundancy and the ability to withstand large scale catastrophes including, but not limited to, drought, wildfire, and flooding. In scenario 5, 68 extant core areas are distributed throughout all six representative units in the DPS (Figure 28). This scenario projects the lowest degree of redundancy, resulting in the highest risk to bull trout from catastrophic events. In the Klamath and Columbia Headwaters representation units greater than 50 percent of core areas are projected to be extirpated.

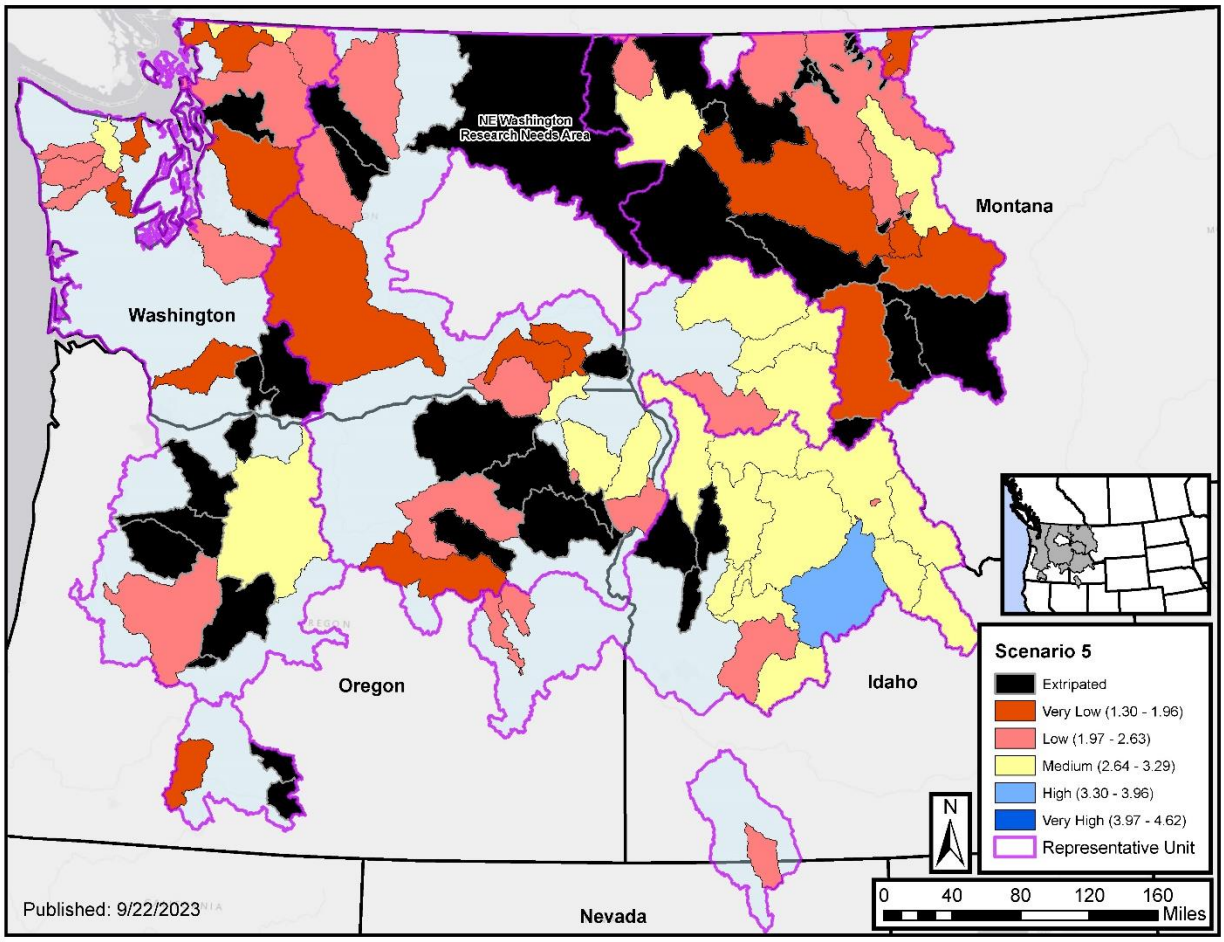


Figure 28. Map of core area resiliency ratings for the 118 bull trout core areas under conditions outlined in Scenario 5.

Table 11. Summary of future Scenario 5 resiliency ratings for all 118 bull trout core areas across the coterminous range in the United States.

Representation Unit	Very High	High	Medium	Low	Very Low	Extirpated
Coastal	0	0	3	7	5	10
Columbia Headwaters	0	0	2	5	4	26
Klamath	0	0	0	0	1	2
Mid-Columbia	0	0	6	8	4	9
Saint Mary	0	0	0	3	1	0
Upper Snake	0	1	12	6	0	3
DPS	0	1	23	29	15	50

Representation

Representation decreases under conditions outlined in Scenario 5. Substantially decreased conservation and a hotter and drier climate is projected to result in multiple core area extirpations throughout the DPS. Fifty core areas are anticipated to be extirpated, 43 of those are the loss of currently extant core areas. The Coastal, Columbia Headwaters, Klamath, Mid-Columbia, and Upper Snake Representative Units lose 5 (25 percent), 25 (69 percent), 2 (67 percent), 6 (25 percent) and 3 (14 percent) of their currently extant core areas respectively (Figure 28). These extirpated core areas represent an overall decrease in effective population size, potentially less genetic diversity, and less population connectivity, therefore reducing their capacity to adapt to new and changing environmental condition.

6.3 Summary of Future Condition

The suite of 5 future scenarios developed to assess future conditions provide the sideboards for the scope of uncertainty around resiliency, redundancy, and representation 60 years into the future. These scenarios vary according to the degree of implementation of conservation efforts and climatic conditions. Together they describe the range of plausible futures of what is reasonably possible to occur. Our analysis projected the responses of the habitat and demographic factors under each scenario in each analytic unit to describe 5 plausible futures across the DPS.

Scenarios 1 and 2 describe conditions where conservation actions are prioritized and implemented at rates higher than they are currently and climate conditions are consistent with projections for moderate greenhouse gas emissions (RCP 4.5). Under these two scenarios resiliency of core areas increases from current condition and, therefore, so do redundancy and representation across the DPS. In scenario 1 where conservation is implemented at the highest rate, the re-introduction or recolonization of currently extirpated core areas is thought to be plausible, further increasing redundancy and representation.

Scenario 3 represents a continuation of our current trajectory in which conservation actions are implemented at the same rate and degree as today and climate is projected to be hotter and wetter. These climate conditions are consistent with projections of climate models for high greenhouse gas emissions (RCP 8.5) that project higher annual precipitation. Compared to current condition, resiliency is highly variable across the DPS but proportionately is highest in the Upper Snake representation unit, where many core areas encompass large tracts of wilderness and intact hydrologic networks. Under this scenario 13 currently extant core areas are projected to be extirpated, primarily in the Columbia Headwaters but also the Coastal and Mid-Columbia representation units. This decrease in resiliency results in a concurrent decrease in redundancy and representation.

Scenarios 4 and 5 describe conditions where the degree of conservation efforts and resource protections decrease compared to today, and climate conditions are projected to be hotter and drier. These climatic conditions are consistent with projections of climate models for high

greenhouse gas scenarios (RCP 8.5) that project lower annual precipitation. Under these scenarios resiliency, redundancy and representation decrease. In scenario 5, only one core area has a high resiliency score and 50 core areas are extirpated. In the Klamath representation unit 2 core areas are projected to be extirpated and the remaining one is at very low resiliency. In the Columbia Headwaters representation unit, where the extirpation rate is the greatest, many of the isolated simple core areas are lost. Even though extant core areas remain in all of the 6 representative units the high rate of extirpation represents a significant loss of genetic and ecological diversity, especially given these core areas are either on the periphery of the DPS or are isolated populations where genetic structuring is most likely unique.

Chapter 7 – Viability - Synthesis of Current and Future Conditions

This chapter synthesizes the results of our current and future condition analyses and discusses the impact of the change in number, condition, and distribution of core areas over time on the viability of bull trout. We assessed bull trout viability by characterizing the species' ability to withstand (1) environmental stochasticity, through its resiliency; (2) catastrophes, through its redundancy; and (3) novel changes in its environment, through its representation.

The current condition of bull trout varies across the range. Thirty-seven percent (n = 44) of the core areas across the DPS have high or very high resiliency. Medium resiliency is evident in 38 percent (n = 45) of core areas across the DPS. Core areas with low or very low resiliency comprise 17 percent (n = 20) of core areas across the DPS. Of the 18 core areas with low or very low resiliency, 55 percent are simple core areas. One core area has become extirpated since listing.

For future conditions, up to 60 years into the future, resiliency may improve or decline, depending on a combination of conservation efforts, variability of climate conditions, and core area response. Improvements in resiliency occur under scenarios 1 and 2, assuming increased conservation efforts despite predictions of a warmer climate. With current levels of conservation and a hotter and wetter climate under scenario 3, resiliency declines, and the number of extirpated core areas increase from 1 to 22. If conservation efforts are reduced with a hotter and drier climate, as under scenarios 4 or 5, resiliency further declines across the range with the number of extirpated core areas increasing to 33 and 50, respectively (Table 12 and Figure 29).

Extirpation risk is widespread among all the representative units, though it is most concentrated in the Columbia Headwaters. It is notable that the Klamath representative unit is projected to lose two of its three core areas and the third is rated as very low resiliency under scenario 5. Much of this risk is driven by a combination of projected loss or degradation of spawning and rearing habitat, loss or degradation of habitat connectivity within core areas, and/or the increasing impact of nonnative fish anticipated under scenarios 3, 4, and 5 over the next 60 years. Many core areas face lower resiliency and increased extirpation risk in scenarios 3, 4, and 5 and although all representative units are projected to retain some core areas that could sustain viability to varying degrees under all five future scenarios, scenarios 4 and 5 have an extirpation rate of 22 and 38 percent, respectively.

Demographically and physically robust core areas are better able to withstand and recover from environmental variability and disturbances and, when widespread, are more likely to withstand and recover from events that would otherwise be catastrophic (redundancy). Core areas spread across heterogeneous conditions are unlikely to be exposed to poor environmental conditions simultaneously, thereby guarding against synchronous population losses. In addition to conserving cold water habitats and migratory corridors, core areas distributed across the breadth of genetic and phenotypic diversity help to preserve this wide-ranging species' adaptive capacity, which is essential for adapting to ongoing catastrophic climate change impacts and associated

changes to their environment (Wenger et al. 2011b, pp. 1000–1002; Jones et al. 2014, pp. 212–214; Isaak et al. 2016, pp. 4376–4377). Without such variation (representation), species are more vulnerable to change and extinction (Spielman et al. 2004, p. 15263; Kardos et al. 2021, pp. 7–8).

Historically, bull trout were widely distributed within the coterminous U.S., occupying portions of six states including California. Currently bull trout remain widespread (redundant) with 109 extant core areas across six representative units (see current condition; Table 12 and Figure 29). Future scenarios 4 and 5, involving reductions in conservation efforts, see significant decreases in resilient and highly resilient core areas with a concomitant increase in extirpated core areas. Although the remaining core areas under these scenarios may still be widely distributed, their resiliency is reduced. Thus, redundancy against catastrophes persists throughout the five scenarios, but is less in scenarios 4 and 5.

Current representation indicates all but two of the six representation units (Klamath and St. Mary) contain core areas with high to very high resiliency and the remaining core areas of varying levels of resiliency (Figure 29). For all future scenarios, genetic, ecological, and life history diversity remains distributed across the range, although future resiliency is dependent on conservation efforts and the extent of changing climate.

Table 12. Summary of viability for the bull trout DPS in terms of resiliency across core areas, and redundancy and representation across the DPS, currently and 60 years into the future under 5 plausible future scenarios.

3 Rs	Current Condition	Future Scenario 1	Future Scenario 2	Future Scenario 3	Future Scenario 4	Future Scenario 5
Resiliency	18 - Very High 26 - High 45 - Medium 20- Low 0 - Very Low 1 – Extirpated*	49 - Very High 27 - High 38 - Medium 1 - Low 0 - Very Low 3 - Extirpated	26 - Very High 36 - High 41 - Medium 8 - Low 0 - Very Low 7 - Extirpated	12 - Very High 25 - High 42 - Medium 17 - Low 0 - Very Low 22 - Extirpated	0 - Very High 14 - High 30 - Medium 27 - Low 14 - Very Low 33 - Extirpated	0 - Very High 1 - High 23 - Medium 29 - Low 15 - Very Low 50 - Extirpated
Redundancy	109 Core Areas, widely distributed	115 Core Areas, widely distributed	111 Core Areas, widely distributed	96 Core Areas, widely distributed	85 Core Areas, widely distributed	68 Core Areas, widely distributed
Representation	Diversity across 109 core areas & 6 Rep Units	Diversity across 115 core areas & 6 Rep Units	Diversity across 111 core areas & 6 Rep Units	Diversity across 96 core areas & 6 Rep Units	Diversity across 85 core areas & 6 Rep Units	Diversity across 68 core areas & 6 Rep Units

** Does not include the 7 historical core areas and 1 RNA.*

Despite core areas being widespread across a diversity of habitats, there are currently seven historical core areas that no longer support bull trout (excluding historical populations in California). One core area has become extirpated since listing under the Act in the Columbia Headwaters Representation Unit (LPO-C). In addition, known losses in distribution (including extirpations of some local populations) occurred within extant core areas. These extirpations and losses in distribution are primarily due to: (1) loss and degradation of habitat, (2) impacts from nonnative fish, and (3) effects of climate change.

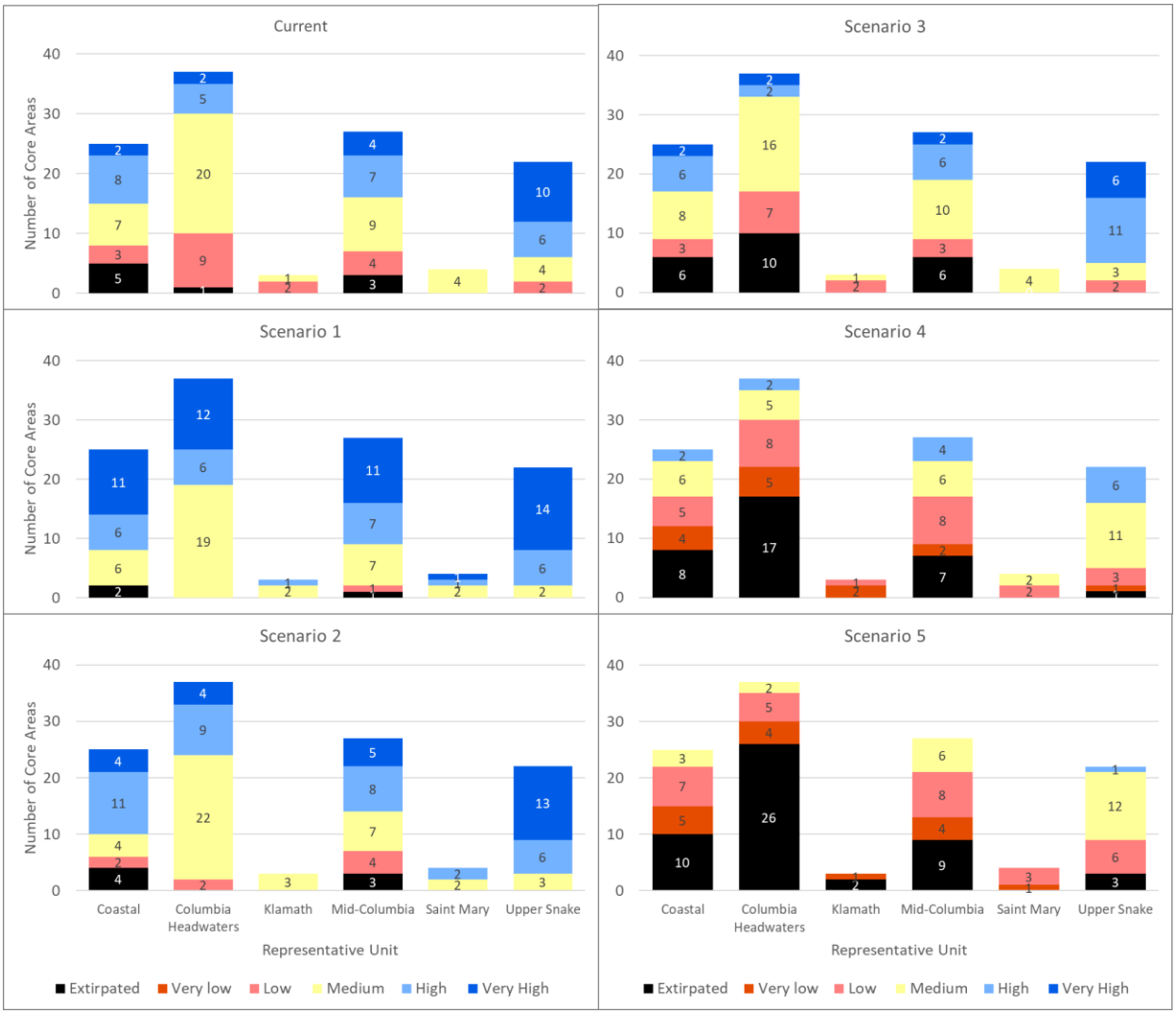


Figure 29. Summary of Representation and Core Area Resiliency by Representative Units, currently and 60 years into the future under 5 plausible future scenarios.

Despite a warmer climate our projections suggest resiliency can be improved for most core areas across all six representation units with increased or substantially increased conservation efforts. With the current level of conservation and even less favorable climate conditions, our projections suggest resiliency of most vulnerable core areas will decline into the future with an increased

likelihood of additional extirpations of some core areas. With the least favorable climate change projection and decreased or substantially decreased conservation efforts resiliency across all core areas will decline substantially. In these future scenarios, only 85 and 68 core areas will persist across the conterminous range, respectively. Under the worst-case climate and conservation scenario, only one remaining core area is projected to have high resiliency (Table 12 and Figure 29).

Realizing climate change is likely to impact all core areas negatively across the DPS, an increase in bull trout-specific conservation across the DPS is the path to stabilizing viability of bull trout into the future.

Chapter 8 Uncertainties, Limitations, and Implications for the SSA

Uncertainties are inherent in any scientific analysis involving empirical data, models, methods, and expert opinions. Numerous decisions and assumptions are required to apply these tools to the task of conducting an SSA. In addition, bull trout exhibit plasticity allowing the species to take advantage of the diversity of habitats. This adaptive capacity of bull trout is likely variable across the range from both biotic and abiotic factors. Furthermore, the speed at which bull trout exhibit adaptative capacity to changing biotic and abiotic factors remains uncertain. While some uncertainties stem from data limitations and inconsistencies in the collection of the data, uncertainties are inevitable when characterizing viability for a species that exists in multiple ecosystems, from temperate rain forests to high desert of the Pacific drainage, to the headwaters of Hudson Bay.

The analytical foundation of the SSA is the condition category model we developed to evaluate current and future resiliency. The model incorporates a set of widely recognized species' needs as habitat and demographic factors to score current and future resiliency. In the real-world environment, bull trout live in conditions where some of these needs are not met, and other factors compensate for that deficit. Certain factors may disproportionately provide the basis of support for core area population while other important factors are absent. One of the major areas of uncertainty in the SSA stems from applying the model to the diversity of conditions represented by the core areas. While it may be possible to assess the implications of our modeling assumptions on an individual core area, it is not possible to assess the implications at the level of the DPS. We believe a balanced approach whereby all the essential species' needs were incorporated in the model and given equal weight was the best approach to not overestimate or underestimate viability across the DPS.

8.1 Data Limitations

8.1.1 Number of Local Populations

Confirming the specific number of local populations for some core areas has been an ongoing challenge due to the lack of specific baseline genetic data for bull trout within these core areas. Estimating the number of local populations from surrogate information (e.g., general sub-watershed delineations, observed redd distributions, best professional judgment of basin biologists, etc.) involves uncertainty and may overestimate or underestimate the actual number of local populations for some core areas. We consider the number of local populations identified in the Recovery Unit Implementation Plans of the final bull trout recovery plan to be the best available information to complete our assessment of core area resiliency and have used range bins to estimate the number of local populations within our conceptual model to account for this uncertainty.

8.1.2 Data deficiencies Associated with Demographic and Habitat Indictors of Health

Given the size of the DPS and the core area scale of analysis, it is unlikely that a comprehensive set of both demographic and habitat data will ever be available that meets the

highest data quality standards at both spatial and temporal scales. In the face of this inevitable data limitation, we decided to use both demographic and habitat factors and to weigh these equally in our analyses of current and future conditions. Use of both habitat and demographic indicators of health is important given data gaps that are typical of the species. This approach is supported by our understanding of the interrelationships between habitat and demographic factors, and our review of numerous stressors that impact demographic factors by first impacting habitat factors. Habitat data accurately describe demographic health through a cause-and-effect relationship within core areas where habitat factors capture the cause of demographic factor response. Our goal was to integrate multiple data sources, which often differed across core areas, and was applied consistently through the SSA process.

Demographic factors are typically the best measure of current population resiliency. When demographic data are robust, factors such as growth rate, number of occupied local populations, and abundance may be the best measures of overall core area resiliency with less contribution from additional demographic measures or habitat factors. Given the lack of demographic data in numerous core areas within the DPS, we incorporated both demographic and habitat factors to rank resiliency, where habitat factors can help substantiate the current condition by highlighting the cause for demographic response.

If demographic data were consistently available across the DPS, the current condition model may have weighed demographic data more heavily. Conversely, if we lacked demographic data across all core areas for a single factor, the value of that factor would be diminished, and we would have removed it from the analysis. For the bull trout SSA, some core areas contained more robust demographic data, and some contained more robust habitat data, with the more common case involving more robust habitat data.

Because there are five demographic factors and six habitat factors, demographic factors were weighed slightly higher so that the overall resiliency score was comprised equally between the two categories. We chose not to weigh any single factor substantially higher to avoid overweighting the factor in some core areas without robust data or in core areas where that factor is not as influential. Since the current condition model is comprised of eleven factors the power of a single factor to disproportionately influence resiliency in a certain core area is small.

Our approach of equal weighting may over or underrepresent resiliency in a core area when a single factor or groups of factors are the primary driver of resiliency. Such is the case when quality and quantity of habitat overshadows declining demographics. The importance of understanding which factors are most important to a specific core area can help identify these situations and generate dialogue within core area working groups to best understand where recovery efforts should be focused. We do not believe this impacts the DPS analysis of viability and is isolated to few core areas.

8.2 Species-related Uncertainties

8.2.1 Migratory Life History Expression

A limitation of our scoring convention for the life history form is that it does not capture the full

life history diversity of the migratory form within individual core areas under current and future conditions. Bull trout are largely a migratory species across most of its range, sometimes expressing multiple migratory life histories when the appropriate habitat is present, including often diverse and complex migrations. However, we expect other demographic and habitat factors (i.e., genetic connectivity, access to FMO) will account for the additional resiliency provided by diverse migratory forms. Given our balanced use of several habitat and demographic factors, the implications for our estimate of viability across the DPS are minimal.

8.2.2 Life History Plasticity

Bull trout generally demonstrate plasticity in their life histories as described in section 2.3 (Life History). However, anecdotally some bull trout populations appear to express only migratory life histories. In some cases, (particularly in the Columbia Headwaters Representative Unit) when evaluating resiliency, we may have assumed that a resident form could be present or could arise should the migratory form(s) become no longer supported by available habitat or prevailing FMO habitat conditions within a core area. This is an unknown in several core areas and in many isolated local populations and may result in an overestimation of resiliency. We do not believe this impacts the DPS analysis of viability and is isolated to few core areas where working groups continue to discuss and collect information to better define core area life history diversity.

8.2.3 Resident Component of Adult Abundance

The resident component of adult abundance is typically more difficult to survey and account for in core area populations containing both resident and migratory life history forms. Resident-sized bull trout are smaller and are more likely to be missed in survey efforts, may be misidentified as subadult or immature migratory adults, and typically build smaller and less obvious redds, especially when other salmonids are present. For these reasons, the estimates of adult abundance within core areas may underestimate the contribution from the resident life history form in some core areas. However, we relied on the expertise of our regional bull trout working groups to account for this resident component (when known or assumed to be present) to the degree possible when generating the estimate of adult abundance. In addition, our use of range bins to estimate adult abundance within our conceptual model also helps account for this uncertainty.

8.2.4 Metapopulation Dynamics and Contribution to Viability

It is generally understood that bull trout may move from a local population into adjacent local populations however we know surprisingly little about the specifics of this process. We do not have the ability to know with certainty across the range if this process is consistent or largely random within or across core areas. We speculate that well connected drainages with suitable habitat allow for emitting and receiving emigrants and immigrants in equal measure but are uncertain about important dynamics such as when and whether small subsets of populations act as key source areas to support other populations. The continued use of genetics to answer these questions will likely assist in understanding the importance of one local population over another in a core area related to resiliency. The uncertainty surrounding these areas of metapopulations dynamics impacts our understanding of current condition but could be more important in understanding long-term resiliency, and thus viability of the species. While some core areas may

be more important to recover based on the quality of genetics, diversity of migratory life history forms, or habitat, understanding these differences across the range will be helpful for long term viability and recovery of the species.

8.2.1 Resiliency

8.3.1 Extirpation Triggers Prior to Scoring

To account for the risk associated with core areas which displayed extremely low demographic factors (or historical core areas), extirpation triggers were developed. Extirpation triggers were developed for the SSA to characterize core areas which no longer contained a reproductive population of bull trout but may have individuals present. A core area was considered extirpated if: (1) a core area was determined to have no reproducing occupied local population; or (2) abundance was reduced to the level where no reproduction was occurring in the core area. If either of these criteria were met a core area was considered extirpated regardless of other demographic or habitat factor scores and the core area was not scored in the current condition categorical model. These triggers were developed to signify there would be no contribution to resiliency in core areas where data or expert opinion from local bull trout working groups indicated a reproductive population of bull trout no longer existed even with adequate habitat present. Driven by data and expert opinion, we are confident this approach did not result in an overestimate or underestimate estimate of viability.

8.3.2 Effect on Simple Core Areas

We calibrated resiliency for the bull trout DPS using a current condition categorical model based on the condition of habitat and demographic factors that individual bull trout need to breed, feed, shelter, and migrate, and that core areas need to withstand stochastic events. The current condition categorical model ensures that we evaluate conditions, and ultimately resiliency, consistently across all core areas, which also ensures that we can compare resiliency across the DPS, currently and into the future. We note that as a result, some core areas, particularly simple core areas, may be scored as low resiliency due to their small geographic size, smaller habitat availability, and limited number of local populations. Simple core areas are important components of the DPS as potential reservoirs of genetic diversity and are also valuable resources at the local scale. However, while some simple core areas may have reached their demographic capacity and not have stressors, they would never receive a high or very high resiliency score, due to the limited availability of habitat and demographic factor potential. This low scoring may underrepresent their overall value and potential contribution to the viability of the species but would not misrepresent their resiliency.

8.4 Future Condition

Perhaps the greatest area of uncertainty in an SSA stems from the assumptions intrinsic to assessing the future. We developed five plausible future scenarios based on a combination of projected climate conditions and conservation efforts to assess the future condition of bull trout. Uncertainty will arise both from the likelihood of the individual scenarios and from variation in the predicted species response to a specific scenario (USFWS 2016, p. 19). The purpose of the scenarios when viewed as a group, is to capture the most plausible climate

conditions and conservation efforts, in essence bounding the range of future uncertainties that could impact species' viability. While uncertainties exist within the individual scenarios, taken together, the scenarios capture the plausible field of view in which to assess future viability.

The five scenarios do not cover every possible combination of climate conditions and conservation efforts. For example, we did not evaluate the effect of climate change with a continuation of current conservation efforts to then be able to contrast the effect of increased or substantially increased conservation efforts with that same level of climate change. It was not practical to examine every possible combination of climate and conservation futures, but we endeavored to capture the range of variability within our future projections. We acknowledge that the effectiveness of increased conservation efforts would likely not be the same if they were to occur under more as compared to less favorable climate scenarios given the different degrees of site-specific changes to bull trout habitats and/or broader landscape changes associated with more as compared to less climate disruption. Although we acknowledge the uncertainty, we have confidence that we have provided the best available information to consider a range of mixed scenarios and plausible outcomes in terms of future core area resiliency.

Habitat factors are more easily projected into the future than demographic factors. We have a more robust understanding of how future land management, climate change, and conservation efforts may influence future changes in habitat factors. Predicting future demographics is more challenging as we do not have a comprehensive understanding of demographics for the current condition, which future condition is based upon.

Though the future condition of bull trout is uncertain, we believe we have accurately captured the potential future condition of the species and characterized viability through this range of plausible scenarios.

Other specific uncertainties related to the future conditions analysis are discussed below.

8.4.1 Anadromous Life History Form

Our future resiliency projections for core areas containing the anadromous life history form do not explicitly incorporate the possible impacts to marine FMO habitat due to climate change nor what those impacts will likely be to bull trout. We expect that the projected resiliency for those core areas containing the anadromous life history form may be more optimistic given most of the anticipated climate change impacts to these marine habitats (Miller *et al.* 2013, entire; Mauger *et al.* 2015, pp. 11.1–11.8) are expected to largely be negative for bull trout. For example, although these core area populations may be projected to persist under future scenarios, they may have lost the anadromous life history component at some earlier point in time due to the impacts to their marine habitat.

8.4.2 Reintroduction to or Natural Recolonization of Historical Core Areas

Although we restricted re-establishment of historical core areas primarily to scenario 1, we were generally optimistic in the ability to successfully reintroduce populations or in their

likelihood to naturally reestablish at the core area scale with conservation efforts. To date, there are only two examples in progress that we can use to measure the degree of success in reestablishing a population in historical core areas. These are the Clackamas River reintroduction and the natural recolonization of the White Salmon River following the Condit Dam removal. At this time, neither has been determined to be fully successful in reestablishing a population of bull trout. In contrast, beginning in 1997 bull trout were reintroduced into a previously extirpated local population within the Upper Willamette core area, with recent indications that it has been successful in reestablishing a population (Zymonas *et al.* 2021, entire). There are also several other earlier attempts of bull trout reintroduction into other locally extirpated streams or areas that have been either unsuccessful or have had mixed results (Hayes and Banish 2017, entire).

This analysis does not consider opportunities for relocating bull trout outside of its recent native range. For recovery of the species, this should be considered where applicable and included in future analysis of viability.

8.4.3 Nonnative Fish and Invasive Species Introductions

Our assessment of resiliency only accounts for existing populations of nonnative fish species affecting bull trout core areas. The scoring of future scenarios only accounts for those currently established nonnative fish populations and how their impact to the fish community quality of a core area will either increase, decrease, or largely remain the same. We do not make predictions about future nonnative populations or the introduction of other invasive species becoming established in core areas where they currently do not exist given the level of uncertainty. However, we acknowledge this could occur in the future as a result of illegal introductions or the natural expansion into new areas as a result of changes in bull trout habitat due to climate change and/or actions that further alter/degrade habitat conditions. Having sufficient redundancy can provide long-term viability against invasive species including fish.

8.4.4 Increasing Climate Variance

Climate variance is increasing, where extreme environmental catastrophes are occurring more frequently, for a longer duration and at a greater intensity or magnitude. Examples of these events include heatwaves or heat domes, droughts, wildfires, storms, and associated flooding. These extreme events can disproportionately influence biological processes and impart long-lasting effects on entire ecosystems. Yet accounting for the unpredictable nature of these events both spatially and temporally made it difficult to project their impact consistently across the range in all scenarios and was beyond the scope of our analysis of future condition.

8.4.5 Hatchery Programs

Attempted rearing of bull trout in hatcheries dates to the 1940s. Though success of these efforts are not well known there is a continued interest and need to explore hatchery programs for conservation of the species. The analysis of future condition does not consider the benefits of a hatchery program due to the cost and commitment required as well as the lack of infrastructure in place currently.

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Glossary

Adfluvial bull trout. Bull trout that migrate from tributary streams to a lake or reservoir to mature (one of three commonly recognized bull trout life histories). Adfluvial bull trout return to a tributary to spawn.
Alevin. A newly-hatched trout or salmon still attached to the yolk sac.
Allacustrine. A fish that rears in lakes and spawns in outlet tributaries of lakes.
Allochthonous aquatic inputs. Materials, such as organics, which arrive into an aquatic habitat from outside of that habitat (a terrestrial or adjacent aquatic environment).
Alluvial. Pertaining to or composed of silts and clays (usually) deposited by a stream or flowing water. Alluvial deposits may occur after a flood event.
Amphidromous (fish). A fish that regularly migrates between freshwater and the sea (in both directions). May not be for spawning (reproduction).
Anadromous (fish). A fish that is born in fresh water, migrates to the ocean to grow and live as an adult, and then returns to fresh water to spawn (reproduce).
Char. A fish belonging to the genus Salvelinus and related to both the trout and salmon. The bull trout, Dolly Varden, and the Mackinaw (or lake trout) are all members of the char family. Char live in the icy waters (both fresh and marine) of North America and Europe.
Complex Core Area. A core area that contains multiple interacting bull trout local populations. Complex core areas contribute substantially to the viability of a recovery unit.
Connectivity. Demographic connectivity is the ability of individuals from one local population to be able to access other local populations within a core area to help maintain genetic diversity. Habitat connectivity refers to conditions that support migration between spawning and rearing habitats and feeding migrating and overwintering habitats which provided diverse resources. Barriers to connectivity include natural physical features such as waterfalls; river reaches that create mortality risks or prevent movement of adult fish because of entrainment; excessively warm water, or poor water quality; and human-made instream structures such as culverts, weirs, or dams.
Core area. The closest approximation of a biologically functioning unit for bull trout. The combination of core habitat (i.e., habitat that could supply all elements for the long-term security of bull trout) and a core population (a group of one or more local bull trout populations that exist within core habitat) which constitutes the basic unit on which to gauge recovery within a recovery unit. Core areas require both habitat and bull trout to function, and the number (replication) and characteristics of local populations inhabiting a core area provide a relative indication of the core area's likelihood to persist. Core areas are presumed to reflect the metapopulation structure of bull trout (see metapopulation).
Core habitat. Habitat that encompasses spawning and rearing (SR) habitat (for resident populations), with the addition of foraging, migrating, and overwintering (FMO) habitat if the population includes migratory fish. Core habitat is defined as habitat that contains, or if restored would contain, all of the essential physical elements to provide for the security of and allow for the full expression of life history forms of one or more local populations of bull trout. Core habitat may include currently unoccupied habitat if that habitat contains essential elements for bull trout to persist or is deemed critical to recovery.
Core population. A group of one or more bull trout local populations that exist within core habitat.

Demographically stable. A stable or increasing population scale status based on measurements and calculations of population size, density, and age structure (i.e., ecologically viable) that assumes bull trout populations at the local population, core area or recovery unit scale, interact with their surrounding environment.
Distinct Population Segment (DPS). A listable entity under the Endangered Species Act that meets tests of discreteness and significance according to Service policy.
Ecological Setting. Areas representing significant ecological, genetic, or life history variation.
Embeddedness. The degree to which large particles (boulders, gravel) are surrounded or covered by fine sediment, usually measured in classes according to percentage covered.
Effective population size. The number of breeding individuals that would give rise to the same amount of random genetic drift as the actual population if ideal conditions held.
Entrainment. Process by which aquatic organisms are pulled through a diversion, turbine, spillway, or other device.
Extirpation. The elimination of a species from a particular local area.
Fish ladder. A device to help fish swim around a dam.
Floodplain. Adjacent to stream channels, areas that are typified by flat ground and are periodically submerged by floodwater.
Fluvial bull trout. Bull trout that migrate from tributary streams to larger rivers to mature (one of three bull trout life histories). Fluvial bull trout migrate to tributaries to spawn.
Foraging, migrating, and overwintering habitat (FMO habitat). Relatively large streams and mainstem rivers, including lakes or reservoirs, estuaries, and nearshore environments, where subadult and adult migratory bull trout forage, migrate, mature, or overwinter. This habitat is typically downstream from spawning and rearing habitat and contains all the physical elements to meet critical overwintering, spawning migration, and subadult and adult rearing needs.
Foreseeable Future. The period of time over which events can be reasonably anticipated. For a threatened species, such as bull trout, the Service interprets the foreseeable future as the extent of time over which we can reasonably rely on predictions about the future in making determinations about the future conservation status of the species. The Act does not define the term “foreseeable future”.
Geographic Region. Comprised of neighboring core areas that share similar bull trout genetic, geographic (hydrographic), and/or habitat characteristics. See also Recovery Unit (bull trout).
Headwaters. The source of a stream. Headwater streams are the small swales, creeks, and streams that are the origin of most rivers. These small streams join together to form larger streams and rivers or run directly into larger streams and lakes.
Hybridization. Any crossing of individuals of different genetic composition, typically different species, that results in hybrid offspring.
Lacustrine. Relating to lake habitat.
Legacy effects. Impacts from past activities (usually a land use) that continue to affect a stream or watershed in the present day.
Local population. A group of bull trout that spawn within a particular stream or portion of a stream system. Multiple local populations may exist within a core area. A local population is the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (e.g., those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

Managed Threats. Threats to bull trout that are addressed (i.e., managed) so that ecologically viable populations of bull trout have: (1) stable or increasing trends, (2) a widespread distribution of the species as well as widespread quality habitat across the recovery unit, (3) diverse life history strategies within populations, and (4) connectivity between populations and core areas to the maximum extent possible.

Metapopulation. A population structure where a group of semi-isolated local populations of bull trout are interconnected and that probably share genetic material. Core areas represent the functional equivalent of a metapopulation structure for bull trout, and the local populations within these core areas are interconnected by occasional dispersal between them and therefore share some genetic characteristics.

Migratory corridor (bull trout). Stream reaches used by bull trout to move between habitats. A section of river or stream used by fish to access upstream spawning areas or downstream lake environments.

Migratory life history form (bull trout). Bull trout that migrate from spawning and rearing habitat to lakes, reservoirs, or larger rivers to grow and mature.

Nonnative species. Species not indigenous to an area, such as brook trout in the western United States. Also referred to as exotic or invasive species. Panmictic random mating and genetic mixing within a breeding population.

Piscicide. A chemical substance poisonous to fish.

Primary Threat. Threat listed under RUIPs -factors known or likely (i.e., non- speculative) to negatively impact bull trout populations at the core area level and require management actions to assure bull trout persistence and avoid risk of extirpation within that core area in the foreseeable future.

Recovery unit (general). A population unit of a listed entity that is geographically or otherwise, identifiable and is essential to the recovery of the entire listed entity. Recovery units are individually necessary to conserve genetic robustness, demographic robustness, important life history stages, or some other feature necessary for long-term. sustainability of the entire listed entity. Recovery criteria for the listed entity should address each identified recovery unit.

Recovery unit (bull trout). The major units for managing bull trout recovery efforts. Detailed description of recovery implementation for each recovery unit are provided in the bull trout recovery unit implementation plans (RUIP). Most recovery units consist of one or more major river basins. Several factors have been considered in identifying recovery units (biological and genetic factors, common threats, political and watershed boundaries, ongoing conservation efforts, and other logistical concerns). Recovery units may include portions of mainstem rivers (e.g., Columbia and Snake rivers) when biological evidence warrants inclusion. Biologically, bull trout recovery units are considered groupings of bull trout for which gene flow was historically, or is currently, possible.

Redd. A nest constructed by female fish of salmonid species in streambed gravels where eggs are deposited, and fertilization occurs. Redds can usually be distinguished in the streambed gravel by a cleared depression, and an associated mound of gravel directly downstream.

Research Needs Area. Geographic locations (e.g., watershed) where bull trout were known to occur historically, but the current status and historical use of the area for recovery are uncertain. These areas may have been historically occupied or had a few contemporary or historical observations.

Resident life history form. Bull trout that do not migrate, but that reside in tributary streams their entire lives (one of three bull trout life cycles).

Salmonid. Fish of the family Salmonidae, including trout, salmon, chars, grayling, and whitefish. In general usage, the term most often refers to salmon, trout, and chars.
Simple Core Area. A core area that contains one bull trout local population. Simple core areas are almost always small in scope, with a population size that is necessarily restricted by the size of the habitat. Typically, simple cores are ecologically if not physically isolated from other core areas by natural (natural barriers, thermal gradients, or large spatial separation from other core areas), not anthropogenic factors that have been operable for thousands of years.
Source population. Strong local populations within a metapopulation that contribute emigrating individuals to other local populations and reduce the risk of local extinctions (see stronghold).
Spawning and rearing habitat (SR habitat). Stream reaches and the associated watershed areas that provide all habitat components necessary for spawning and juvenile rearing for a local bull trout population. Spawning and rearing habitat generally supports multiple year classes of juveniles of resident or migratory fish and may also support subadults and adults from local populations of resident bull trout.
Spillway. That part of a dam that allows high water to flow (spill) over the dam.
Stochastic. Natural events or processes that are subject to random or unpredictable variation. Examples include environmental conditions such as rainfall, runoff, and storms, or life-cycle events, such as survival or fecundity rates.
Stronghold. A watershed, multiple watersheds, basin or other defined spatial units (e.g., core areas) where bull trout populations are strong and diverse, and the habitat has high intrinsic potential to support bull trout or suite of species. Important characteristics of bull trout strongholds include intact and well-connected habitat, presence of robust migratory populations, presence of the native fish fauna, resilience to perturbations, and retains the genetic and phenotypic diversity of the species. Strongholds can act as source populations.
Take. Activities that harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or attempt to engage in any such conduct to a species listed under the Endangered Species Act.
Water right. Any vested or appropriation right under which a person may lawfully divert and use water. It is a real property right appurtenant to and severable from the land on or in connection with which the water is used; such water right passes as an appurtenance with a conveyance of the land by deed, lease, mortgage, will, or inheritance.
Watershed. The area of land from which rainfall (and/or snow melt) drains into a stream or other water body. Watersheds are also sometimes referred to as drainage basins or drainage areas. Ridges of higher ground generally form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.
Year class (cohort). Fish in a stock born in the same year. For example, the 1987-year class of bull trout includes all bull trout born in 1987, which would be age 1 in 1988. Occasionally, a stock produces a very small or very large year class, which can be pivotal in determining stock abundance in later years.

Appendix A. Resource Needs

Habitat Factor	HABITAT NEED (RESOURCE NEEDS)						ADULTS	
		ALL LIFE STAGES	Egg / Embryo	Larva (Fry/Alevin)	Juvenile	Subadult	Resident	Migratory (Adfluvial, Fluvial, & Anadromous)
	General Description of Habitat Type	**Clean/Cold/Connected/Complex**	Well oxygenated, clean loose gravel with water temperature ranging from 1-6 degrees C. Typical of headwater stream sections. Typically classified as spawning and rearing habitat.	Similar to egg/embryo. Typical of spawning and rearing habitat.	Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, pp. 368-369).	Subadults need complex habitats with deep pools and cover (Monnet *et al.* 2008, pp. 235-	_	Adfluvial: Lake/Reservoir systems Fluvial: Large river systems Anadromous: Ocean, ocean productivity.
Water Quality	**Water temperature (B, F, S, M)**	**Needed by all life stages. B, F, S, M**	Incubation temperature 1-6 deg C (anchor ice if not insulated habitat, too cold, Survival of the egg decreases above 6 deg C). Depending on water temperature, egg incubation is normally 100 to 145 days (Pratt 1992, p. 5). Water temperatures of 1.2 to 5.4 °C (34.2 to 41.7 °F) have been reported for incubation, with an optimum (best embryo survivorship) temperature reported to be from 2 to 4 °C (36 to 39 °F) (Fraley and Shepard 1989, p. 138; McPhail and Baxter 1996, p. 10).	Temperature 1-6 deg C	temperatures above 15 °Celsius (C) (59F) while not lethal, are believed to limit bull trout juvenile distribution (Fraley and Shepard 1989, p. 138).	237; Al-Chokhachy *et al.* 2010, pp. 469–	4-20 deg C; optimum 12 deg C (15-20C, 59-68F Gamett 2002, pp. 30-32) (Goetz 1989,pp. 22-32) Spawning temps range from 4-10C(39 to 50F)) (Spawning temps 11-18C Howell et al. 2010)	4-20 deg C; optimum 12 deg C (15-20C, 59-68F Gamett 2002, pp. 30-32) (Goetz 1989,pp. 22-32) Spawning temps range from 4-10C(39 to 50F))(Spawning temps 11-18C Howell et al. 2010)
	Hyporheic exchange (B)	Important to Egg, Larva, and Adults when breeding. This is needed to establish the redd. Stabilizes temperature of the water. Improves the DO. Eggs sit in the gravel all winter long, and the hyporheic exchange can help persist over the winter.	Hyporheic exchange, springs, glacial snowmelt, groundwater upwelling (Rieman et al 1997, p.1121; Baxter er al. 1999, p. 137); Egg to hatch survival positively related to downwelling, Bowerman et al., 2014, pg.	Hyporheic exchange, springs, glacial snowmelt, groundwater upwelling (Rieman et al 1997, p.1121; Baxter er al. 1999, p. 137)	Provide thermal refugia for summer/winter rearing	Provide thermal refugia for summer/winter rearing	Provide thermal refugia for staging and rearing	n/a for Adfluvial and Anadromous Fluvial: Provide thermal refugia for staging and rearing
	Clean water (CLEAN)	There is uncertainty here, but we know that individual bull trout need the water to be free of contaminants, free of some level of toxins. (ants, works, other species). The need is toxic free water.	Some level of toxin free water.	Some level of toxin free water.	Some level of toxin free water.	Some level of toxin free water.	Some level of toxin free water.	Some level of toxin free water.
	Turbidity (CLEAR)	There is a range of what is tolerable by life stage, but in general, each life stage needs water that is sufficiently clear, and has low suspended sediments (low TSS or NTU values).	–	–	–	–	–	–
	Water Dissolved Oxygen (B, F, S, M)	Needed by all life stage for B, F, S, M. DO > 8 mg/l (Could be variations within life stages that could tolerate lower limits, but generally all life stages need more than 8. Metabolic needs of the fish increases with increasing temperature.	–	–	–	–	–	–
Instream Quality **(Clean, Complex Substrates)**	**Clean Substrates / Sediment on the bottom of the stream.**	This row is all about what is deposited on the stream bottom. Substrate composition. Right size, not too many fines.	low levels of fines (i.e., less than 12 percent of fines, substrates less than 0.85 mm or 0.03 inch in dia (WFPB 1997, pp.98, F-25); Survival of egg to fry negatively affected by fine sediment (Bowerman et al.. 2014, p	Fines <30%, <18% ideal	Fines <30%, <18% ideal	n/a	n/a	n/a

***Instream Quality* (Clean, Complex Substrates)**	**Substrate Composition: Small Gravel**	Diversity of gravel needed by all life stages. B, F, S, M	Egg deposition - Spawning Gravel size classes - 8mm to 64mm Dunham et al.. 2001, p 346, <20mm size (McPhail and Baxter 1996, p 5	Early rearing - Spawning Gravel size classes - 8mm to 64mm Dunham et al.. 2001, p 346, <20mm size. (McPhail and Baxter 1996, p 5	High quality habitat association with gravel in riffles (Dambacher and Jones 1997, p 355	High quality habitat association with gravel in riffles (Dambacher and Jones 1997, p 355	Spawning Gravel size classes - 8mm to 64mm Dunham et al.. 2001, p 346, <20mm size (McPhail and Baxter 1996, p 5	Spawning Gravel size classes - 8mm to 64mm Dunham et al.. 2001, p 346, <20mm size (McPhail and Baxter 1996, p 6
	Substrate Composition: Large Gravel	Needed by all life stages. B, F, S, M	Egg deposition - Spawning Gravel size classes - 8mm to 64mm Dunham et al.. 2001, p 346, <20mm size (McPhail and Baxter 1996, p 5	Early rearing - Spawning Gravel size classes - 8mm to 64mm Dunham et al.. 2001, p 346, <20mm size (McPhail and Baxter 1996, p 5	High quality habitat association with gravel in riffles (Dambacher and Jones 1997, p 355	High quality habitat association with gravel in riffles (Dambacher and Jones 1997, p 355	Spawning Gravel size classes - 8mm to 64mm Dunham et al.. 2001, p 346, <20mm size (McPhail and Baxter 1996, p 5	Spawning Gravel size classes - 8mm to 64mm Dunham et al.. 2001, p 346, <20mm size (McPhail and Baxter 1996, p 5
Water Quantity	**River/Stream Hydrograph: Influences the complexity of the habitat. Provides thermal refugia.**	Must have water in the system. Flow is influenced by geomorphic complexity of the streambed and recognized to be important for surface water/groundwater interaction. Spawning areas are often associated with cold-water springs, glacial and snow melt, or groundwater upwelling (Rieman et al. 1997, p. 1121; Baxter et al.. 1999, p. 137). Need water in the stream. Stable, natural hydrograph.	Need stable and persistent flows through the development of the embryo. The need is a stable hydrograph. Want a range. 5-year flow year events are infrequent or rare. (Min or max across the range). (Bull Trout vulnerability assessment). "Not too much not too little"	Need stable and persistent flows for eggs and larva to develop.	--	--	--	--
	Precipitation (snow and rain)	Snowpack levels that provide sufficient flows in streams. (Tied to Flows above) All life stages need sufficient flows.	--	--	--	--	--	--
	Lakes or Oceans	For Migratory populations, access to lakes or oceans	n/a	n/a	n/a	For Migratory populations, access to lakes or oceans	n/a	For Migratory populations, access to lakes or oceans
Forage Base	**Forage Fish**	n/a	n/a	n/a	small fish (Juv >110mm) Horner 1978; Shepard et al 1984; Pratt 1992	small fish (Juv >110mm) Horner 1978; Shepard et al 1984; Pratt 1993	small fish (Juv >110mm) Horner 1978; Shepard et al 1984; Pratt 1994	Predominately forage fish prey base
	Invertebrates	n/a	n/a	n/a	Invertebrate diet <110 mm, invertebrate/forage fish >110 mm (Horner 1978; Shepard et al 1984; Pratt 1992	Invertebrate diet <110 mm, invertebrate/forage fish >110 mm (Horner 1978; Shepard et al 1984; Pratt 1992	Invertebrate diet <110 mm, invertebrate/forage fish >110 mm (Horner 1978; Shepard et al 1984; Pratt 1992	Predominately invertebrate diet in spawning tributaries during staging (Schoby and Keeley 2011)
***Instream and Riparian Quality* (Complex Habitat)**	**Riparian Vegetation**	For all life stages for breeding, feeding, sheltering, and migration, sufficient levels of intact riparian conditions that provide sources of shade, cover, temperature control, allochthonous input, invertebrates, and large woody debris to the streams. High quality habitat association with shade (Dambacher and Jones 1997, p 355	--	--	--	--	--	--
	Scouring	(Complex Habitat) Large scour pools formed by natural flood events, large wood/boulder/structure elements that provide resting (migratory), feeding, and sheltering areas in stream/river habitat.	n/a	n/a	--	--	--	--
	Large woody debris	(Complex Habitat) Large wood aggregates that provide feeding, sheltering areas for migrating and rearing individuals.	n/a	_	High quality juvenile rearing habitat association with LWD (Dambacher and Jones 1997, p 355; Positive relationship between BT density and wood cover, (Watson and Hillman 1997, p 246)	Positive subadult selection of deep runs with LWD (Muhlfeld and Marotz 2005, p 804	Positive relationship between BT density and wood cover, (Watson and Hillman 1997, p 246); Provide shelter during spawning, recruit spawning size gravel	Provide shelter during spawning, recruit spawning size gravel

***Instream and Riparian Quality* (Complex Habitat)**	**Large Boulders**	(Complex Habitat) Boulders that provide resting and feeding areas for migrating and rearing individuals	n/a	n/a	Promote complex stream morphology which benefit hyporheic exchange, sheltering, and foraging in juvenile through adult life-stages	Promote complex stream morphology which benefit hyporheic exchange, sheltering, and foraging in juvenile through adult life stages	Promote complex stream morphology which benefit hyporheic exchange, sheltering, and foraging in juvenile through adult life stages	Promote complex stream morphology which benefit hyporheic exchange, sheltering, and foraging in juvenile through adult life stages
	Undercut banks	(Complex Habitat) Banks that have been undercut, providing feeding, and sheltering areas for migrating and feeding individuals	n/a	n/a	High quality habitat association with undercut banks (Dambacher and Jones 1997, p 355	Positive relationship between BT density and undercut banks, (Watson and Hillman 1997, p 246)	Positive relationship between BT density and undercut banks, (Watson and Hillman 1997, p 246)	Positive relationship between BT density and undercut banks, (Watson and Hillman 1997, p 246)
	Shade	(Complex Habitat) See riparian vegetation	--	--	--	--	--	--
	Deep Pools/Runs	(Complex Habitat) See above for Boulders, LWD, and Scouring)	n/a	n/a	BT selection for slow-water habitats (Watson and Hillman 1997, p 245)	Subadult selection for deep runs and pools (Muhlfeld and Marotz 2005, p 803	BT selection for slow-water habitats (Watson and Hillman 1997, p 245)	BT selection for slow-water habitats (Watson and Hillman 1997, p 245)
	Complex habitat (general description of scour, pools, woody debris, boulders, banks, vegetation,)	Diverse stream morphology associated with large substrate, clean gravel, LWD, and intact riparian habitat benefits all life stages.	Clean gravel creates interstitial spaces for the eggs to develop, positive relationship egg to hatch survival. (Bowerman et al. 2014)	Clean gravel creates interstitial spaces for the eggs to develop, positive relationship egg to hatch survival. (Bowerman et al. 2014)	Complex instream rearing habitat, LWD, visual cover/shading (Dambacher and Jones 1997, p 355	Positive subadult selection of complex habitat for holding areas (Muhlfeld and Marotz 2005, p 804	Complex instream habitat, LWD, visual cover/shading	Adfluvial: Lake/Reservoir systems Fluvial: Large river systems Anadromous: Ocean, ocean productivity
Access to FMO	**Connectivity**	Maintaining access to downstream rearing habitat for subadult and adult life histories provides population stability and increases persistence. Movement/connectivity help maintain population stability and persistence (Muhlfeld and Marotz 2005, p 805 Able to find food and mates, Barrier-free, no barriers. Accessing the FMO habitat, able to exploit habitats, within populations. both up and downstream.	n/a	n/a	Movement/connectivity (inter-core area) help maintain population stability and persistence (Muhlfeld and Marotz 2005, p 805	Movement/connectivity (between spawning to FMO habitat) help maintain population stability and persistence (Muhlfeld and Marotz 2005, p 805	Movement/connectivity help maintain population stability and persistence (Muhlfeld and Marotz 2005, p 805	Adfluvial: Lake/Reservoir systems Fluvial: Large river systems Anadromous: Ocean, ocean productivity.

Appendix B. Table of Conservation Efforts

		REGULATORY OR OTHER CONSERVATION PLANS				OTHER CONSERVATION MEASURES or CONSERVATION ACTIVITIES				
		Species Specific Protection Plans	**Land Management Protections**	**Water Management Protections (e.g. FERC Licenses)**	**State or Tribal Plan or other State, Tribal or other documents? (e.g. SWAP, or other State strategies)**	**Screen Program**	**Non-native Fish Management**	**Bull Trout Monitoring in Basin**	**Habitat Restoration Activities**	**Other**
RECOVERY UNIT	**CORE AREA**	*E.g.,BT Specific Plan or Salmonid Plan, Watershed plan that is species specific. Transcends multiple managers.*	*E.g., Designated Wilderness Areas, Proposed Wilderness, Inventoried Roadless Areas (IRAs), Designations, Easements, USFS, BLM, NPS RMPs, LMPs, Tribal etc. (provide percentages for each Core Area)*	*404, FEMA, EPA water quality standards exist and enforced, also potentially HCPs or other types of conservation plans.*		*Yes or No? Is there is Screen Program to reduce direct mortality of individual Bull Trout?*	*E.g., Actions actively Occurring or No current Actions*	*E.g., Actively monitored, not actively monitored*	*E.g., Restoration Networks, Restoration Projects, Restoration Activities, or None*	
Coastal	Chester Morse	Cedar River Watershed Habitat Conservation Plan (BT)	USFS - ACS	SPU - Water Supply	Yes - State	Yes	No	Yes, SPU	Yes	
Coastal	Chilliwack	None	USFS - Wilderness; NPS - North Cascades	None	Yes - State	Yes	No	Yes, in Canada	Yes	
Coastal	Clackamas	Lower Columbia C & R Plan (Salmon and ST)	USFS-ACS; NWSR (71 % Federal)	Willamette Basin TMDL (2006)	Oregon Conservation Strategy	Yes	No	Yes	None needed. Habitat in pristine condition.	Reintroduced population; monitoring to determine re-introduction success
Coastal	Dungeness	North Olympic Peninsula Salmon Recovery Strategy (Salmon and BT)	NPS - Olympic; USFS - Wilderness and ACS		Yes - State	Yes	No	Yes, WDFW/Tribe	Yes	
Coastal	Elwha	North Olympic Peninsula Salmon Recovery Strategy (Salmon and BT)	NPS - Olympic	FERC/City of PA	Yes - State	Yes	No	yes	yes	
Coastal	Hoh	PSP (older plans, mixed BT and Salmon)	NPS - Olympic; USFS - Wilderness and ACS	none	Yes - State	Yes	No	No	Yes	
Coastal	Hood River	Lower Columbia C&R Plan (Salmon and ST)	USFS-ACS, Wilderness; MF Hood River is a National Wild and Scenic River	Western Hood Subbasin TMDL (2001)	Oregon Conservation Strategy	Yes		Yes	Some	MFID dam safety and operational updates in progress including dam passage and downstream water quality measures.
Coastal	Klickitat	None	Yakama Nation- Yakama Nation Primitive Area	TMDL - Little Klickitat	Yes - State and Tribal	Yes	No	No	Yes	
Coastal	Lewis	Washington Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (BT and Salmon)	USFS - ACS	FERC/PacifiCorp; TMDL	Yes - State	Yes	No	Yes, USFWS/ PacifiCorp	Yes	Currently in design phase: migratory fish passage facilities at two hydroelectric dams on Lewis River.
Coastal	Lower Deschutes River	Oregon Mid-C Plan for Steelhead	USFS-ACS; Metolius & Deschutes are National Wild and Scenic Rivers	Deschutes Basin HCP; TMDL initiated	Oregon Conservation Strategy	Yes	No	Yes	Yes	Ongoing habitat restoration in tributary basins; Operation of fish collection facility at Penton Round Butte Dam
Coastal	Lower Skagit	PSP (older plans, mixed BT and Salmon)	USFS - ACS	FERC/PGE; FERC/SCL; TMDL	Yes - State	Yes	No	Yes, SCL	Yes	
Coastal	Nooksack	PSP (older plans, mixed BT and Salmon)	USFS - ACS	TMDL	Yes - State and Tribal	Yes	No		Yes	
Coastal	North Santiam River (historical)	Upper Willamette River C&R Plan (Salmon and ST)	USFS-ACS	Willamette Basin TMDL (2006); W	Oregon Conservation Strategy	Yes	No	-	Yes	Bull Trout re-introduction feasibility study in progress
Coastal	Odell Lake		USFS-ACS	None	Oregon Conservation Strategy	Yes	None	Yes	Yes - spawning habitat enhancement	Active research to determine limiting factors in lake and tributary habitats.
Coastal	Puyallup	PSP (older plan, mixed BT and Salmon)	USFS - Wilderness and ACS, Tribal, MRNP	FERC/Electron; TMDL	Yes - State	Yes	Yes	yes, Puyallup T; Corps (Buckley Dam); NPS	Yes	
Coastal	Queets	PSP (older plans, mixed BT and Salmon)	NPS - Olympic	None	Yes - State	Yes	No	No	Yes	
Coastal	Quinault	PSP (older plans, mixed BT and Salmon)	NPS - Olympic	none	Yes - State and Tribal	Yes	No	No	Yes	
Coastal	Skokomish	HCIWP (Chum focus)	NPS - Olympic; USFS - Wilderness and ACS	FERC/TPU; TMDL	Yes - State	Yes	No	Yes, TPU; NPS	Yes	
Coastal	Snohomish/Skykomish	PSP (older plans, mixed BT and Salmon)	USFS - ACS	TMDL	Yes - State	Yes	No	Yes, WDFW	Yes	
Coastal	South Santiam River (historical)	Upper Willamette River C&R Plan (Salmon and ST)	USFS-ACS	Willamette Basin TMDL (2006); Willamette River Basin Flood Control Project BiOp	Oregon Conservation Strategy	Yes		-	Yes	

		REGULATORY OR OTHER CONSERVATION PLANS				OTHER CONSERVATION MEASURES or CONSERVATION ACTIVITIES				
		Species Specific Protection Plans	**Land Management Protections**	**Water Management Protections (e.g. FERC Licenses)**	**State or Tribal Plan or other State, Tribal or other documents (e.g., SWAP, or other State strategies)**	**Screen Program**	**Non-native Fish Management**	**Bull Trout Monitoring in Basin**	**Habitat Restoration Activities**	**Other**
RECOVERY UNIT	**CORE AREA**	*E.g.,BT Specific Plan or Salmonid Plan, Watershed plan that is species specific. Transcends multiple managers.*	*E.g., Designated Wilderness Areas, Proposed Wilderness, Inventoried Roadless Areas (IRAs), Designations, Easements, USFS, BLM, NPS RMPs, LMPs, Tribal etc. (provide percentages for each Core Area)*	*404, FEMA, EPA water quality standards exist and enforced, also potentially HCPs or other types of conservation plans.*		*Yes or No? Is there is Screen Program to reduce direct mortality of individual Bull Trout?*	*E.g., Actions actively Occurring or No current Actions*	*E.g., Actively monitored, not actively monitored*	*E.g., Restoration Networks, Restoration Projects, Restoration Activities, or None*	
Coastal	Stillaguamish	Stillaguamish Watershed Chinook Salmon Recovery Plan (BT and Salmon)	USFS, Tribal	TMDL	Yes - State and Tribal	Yes	No	Yes, Stillaguamish/WDFW	Yes	
Coastal	Upper Deschutes River (historical)		USFS-ACS	Deschutes Basin HCP; TMDL initiated	Oregon Conservation Strategy	Yes		-		
Coastal	Upper Skagit	PSP (older plans, mixed BT and Salmon)	NPS - North Cascades, USFS-Wilderness and ACS	FERC/SCL; TMDL	Yes - State and Tribal	Yes	Yes	Yes, SCL, NPS	Yes	
Coastal	Upper Willamette River	Upper Willamette River C&R Plan (Salmon and ST)	USFS-ACS; Upper McKenzie NWSR(26% Federal; but CH 92 % public)	Willamette Basin TMDL (2006); W	Oregon Conservation Strategy	Yes	No	Yes	Yes	Large scale passage projects planned - trap & haul implemented in the meantime; Stage 0 restoration projects
Coastal	White Salmon (Historical)	Washington Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (BT and Salmon)	one	Condit Dam removal	Yes - State	Yes	No	No	Yes	Condit Dam removal, leading to reintroduction of salmonids to available spawning areas
Columbia Headwaters	Akokala Lake	Yes	NPS (100%)	State Water Plan / CWA	Yes	N/A	Yes	Yes	N/A	Demographic restoration
Columbia Headwaters	Big Salmon Lake	None	Wilderness (100%)	State Water Plan / CWA	Yes - State	N/A	No	Yes	N/A	
Columbia Headwaters	Bitterroot River	None	SR Wilderness/USFS/State HCP, FMO none	State Water Plan / CWA	Yes - State	No	No	Some	Yes	Water management and irrigation is the biggest stressor, Watershed forums are working to conserve water.
Columbia Headwaters	Blackfoot River	None	SR Wilderness USFS BLM/State HCP, FMO none	State Water Plan / CWA	N Yes - State	No	No	Yes	Yes	
Columbia Headwaters	Bowman Lake	Yes	SR/FMO NPS (100%)	State Water Plan / CWA	No	N/A	No	Yes	N/A	
Columbia Headwaters	Bull Lake	None	SR USFS/State HCP, FMO none	State Water Plan / CWA	Yes - State	No	No	Some	Yes	Current fishing regulation have no limit for northern pike.
Columbia Headwaters	Coeur d'Alene	None	USFS	No	No	No	Yes	Yes, IDFG, CDAT	Yes, CDAT	
Columbia Headwaters	Clark Fork River (Section 1/Upper)	None	SR USFS/State HCP, FMO none	State Water Plan /CWA	Yes - State	No	No	Some	Yes	
Columbia Headwaters	Clark Fork River (Section 2/Middle)	None	SR USFS/State HCP, FMO none	State Water Plan /CWA/FERC	Yes - State	No	No	Some	Yes	
Columbia Headwaters	Clearwater River and Lakes	None	SR Wilderness, USFS/State HCP, FMO none	State Water Plan /CWA	Yes - State	No	No	Some	Yes	
Columbia Headwaters	Cyclone Lake	None	SR/FMO USFS/ State HCP	State Water Plan /CWA	Yes - State	N/A	No	Some	None	
Columbia Headwaters	Doctor Lake	None	SR/FMO Wilderness USFS (100%)	State Water Plan /CWA	Yes - State	N/A	No	Yes	N/A	
Columbia Headwaters	Flathead Lake	Yes	SR USFS/ State HCP, FMO none	State Water Plan /CWA	Yes - State	No	Yes	Yes	Yes	
Columbia Headwaters	Frozen Lake	None	SR/FMO USFS	State Water Plan /CWA	Yes - State	N/A	No	No	None	
Columbia Headwaters	Harrison Lake	None	SR/FMO National Park (100%)	State Water Plan /CWA	Yes - State	N/A	No	Yes	N/A	
Columbia Headwaters	Holland Lake	None	SR/FMO USFS ACS	State Water Plan /CWA	Yes - State	N/A	No	Yes	None	
Columbia Headwaters	Hungry Horse Reservoir	None	SR Wilderness USFS, FMO USFS	State Water Plan /CWA/FERC	Yes - State	No	No	Yes	None	
Columbia Headwaters	Isabel Lake	None	NPA (100%)	State Water Plan /CWA	Yes - State	N/A	No	No	N/A	
Columbia Headwaters	Kootenai River	None	SR USFS , FMO none	State Water Plan /CWA/FERC	Yes - State	No	No	Some	Yes	
Columbia Headwaters	Lake Koocanusa	None	SR USFS, FMO COE	State Water Plan /CWA/FERC	Yes - State	No	No	Yes	Yes	
Columbia Headwaters	Lake Pend Oreille (LPO A) MT	None	SR USFS/State HCP, FMO FERC	State Water Plan /CWA/FERC	Yes - State	No	No	Some	Yes	Large-scale passage projects with both downstream transport of juveniles to FMO habitat and upstream transport of adults to SR habitat.
Columbia Headwaters	Lake Pend Oreille (LPO B) ID		USFS		Yes		Yes	Yes, IDFG	Yes, IDFG, Avista	
Columbia Headwaters	Lake Pend Oreille (LPO C) ID/WA	SLRIP - in Draft, Strategy for protection and improvement of native salmonid habitat in the Pend Oreille (BT)	USFS - ACS	FERC/SCL; FERC/POPUD; TMDL	Yes - State	Yes	Yes	Yes, SCL, POPUD, Kalispel	Yes	Reintroduction Effort beginning

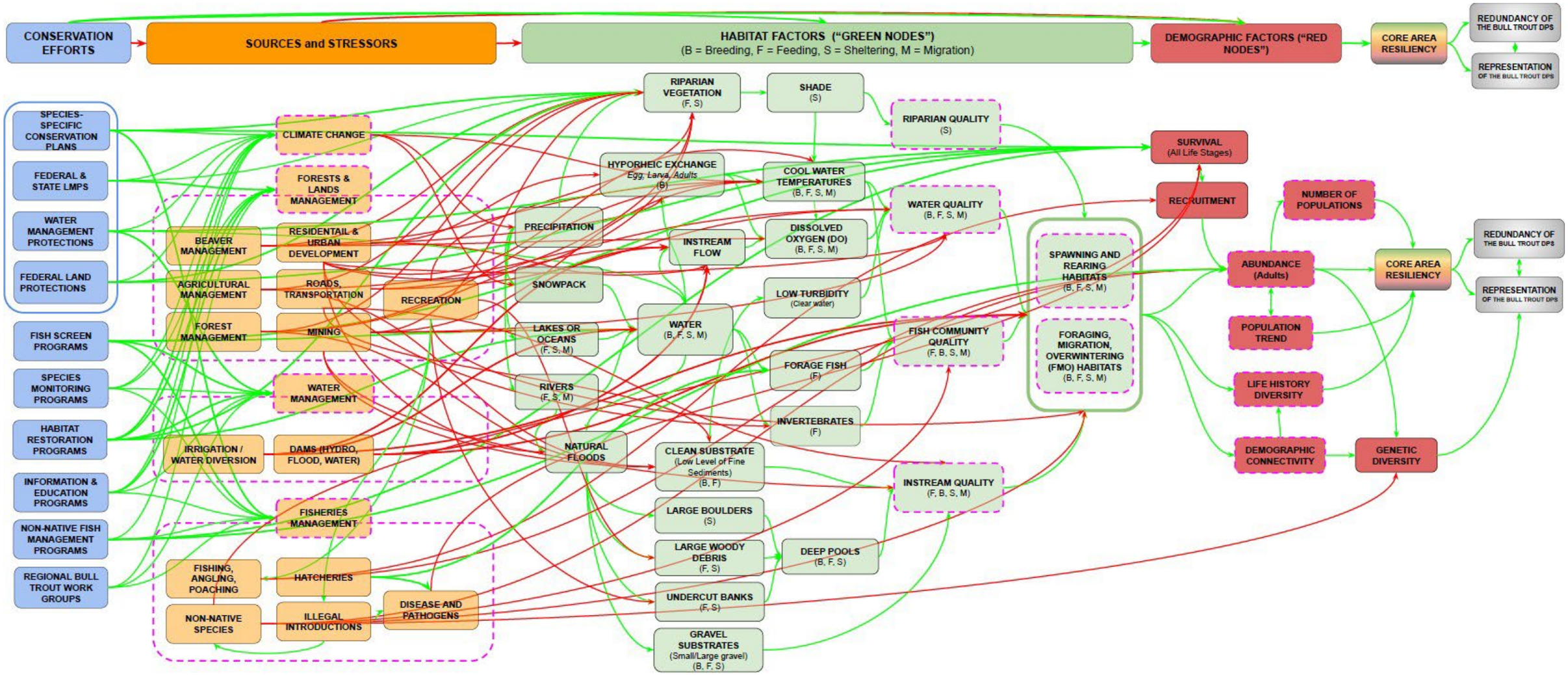
		REGULATORY OR OTHER CONSERVATION PLANS				OTHER CONSERVATION MEASURES or CONSERVATION ACTIVITIES				
		Species Specific Protection Plans	**Land Management Protections**	**Water Management Protections (e.g. FERC Licenses)**	**State or Tribal Plan or other State, Tribal or other documents (e.g. SWAP, or other State strategies)**	**Screen Program**	**Non-native Fish Management**	**Bull Trout Monitoring in Basin**	**Habitat Restoration Activities**	**Other**
RECOVERY UNIT	**CORE AREA**	*E.g., BT Specific Plan or Salmonid Plan, Watershed plan that is species specific. Transcends multiple managers.*	*E.g., Designated Wilderness Areas, Proposed Wilderness, Inventoried Roadless Areas (IRAs), Designations, Easements, USFS, BLM, NPS RMPs, LMPs, Tribal etc. (provide percentages for each Core Area)*	*404, FEMA, EPA water quality standards exist and enforced, also potentially HCPs or other types of conservation plans.*		*Yes or No? Is there is Screen Program to reduce direct mortality of individual Bull Trout?*	*E.g., Actions actively Occurring or No current Actions*	*E.g., Actively monitored, not actively monitored*	*E.g., Restoration Networks, Restoration Projects, Restoration Activities, or None*	
Columbia Headwaters	Lincoln Lake	None	SR/FMO National Park (100%)	State Water Plan /CWA	Yes	N/A	No	Yes	N/A	
Columbia Headwaters	Lindbergh Lake	None	SR Wilderness USFS, FMO USFS	State Water Plan /CWA	Yes	N/A	No	Some	None	
Columbia Headwaters	Logging Lake	Yes	SR/FMO National Park (100%)	State Water Plan /CWA	Yes	N/A	No	Yes	N/A	
Columbia Headwaters	Lower Quartz Lake	Yes	SR/FMO National Park (100%)	State Water Plan /CWA	Yes	N/A	No	Yes	N/A	
Columbia Headwaters	Priest Lakes	None	USFS		Yes	No	Yes	Yes, IDFG	None	
Columbia Headwaters	Quartz Lake	Yes	SR/FMO National Park (100%)	State Water Plan /CWA	Yes	N/A	No	Yes	N/A	
Columbia Headwaters	Rock Creek	None	SR USFS BLM, FMO USFS	State Water Plan /CWA	Yes - State	No	No	some	Yes	
Columbia Headwaters	Swan Lake	None	SR USFS, FMO USFS	State Water Plan /CWA/FERC	Yes - State	No	Yes	Yes	Yes	
Columbia Headwaters	Trout/Arrow Lakes	Yes	SR/FMO National Park (100%)	State Water Plan /CWA	Yes - State	N/A	No	Some	N/A	
Columbia Headwaters	Upper Kintla Lake	Yes	SR/FMO National Park (100%)	State Water Plan /CWA	Yes - State	N/A	No	Yes	N/A	
Columbia Headwaters	Upper Stillwater Lake	None	SR USFS, FMO none	State Water Plan /CWA	Yes - State	No	No	Some	Yes	
Columbia Headwaters	Upper Whitefish Lake	None	SR USFS, FMO USFS	State Water Plan /CWA	Yes - State	No	No	Some	Yes	
Columbia Headwaters	West Fork Bitterroot River	None	SR USFS, FMO USFS	State Water Plan /CWA	Yes - State	No	No	Some	Yes	
Columbia Headwaters	Whitefish Lake	None	SR USFS, FMO none	State Water Plan /CWA	Yes - State	No	No	Yes	Yes	
Klamath	Sycan River	None	USFS-ACS; TNC; NWSR (56% Federal)	Upper Klamath Lake Drainage TMDL & WQMP (2002)	Oregon Conservation Strategy; Upper Klamath Basin Watershed Action Plan	Yes	Some	No	Yes	Riparian Restoration and re-establishing connectivity; On-going brook trout suppression/control
Klamath	Upper Klamath Lake	None	USFS-ACS; NPS - Crater Lake (67% Federal)	Upper Klamath Lake Drainage TMDL & WQMP (2002)	Oregon Conservation Strategy; Upper Klamath Basin Watershed Action Plan	Yes	Yes - successful era	Yes	Yes	Chinook Salmon Re-introduction Plan; Planning Re-introduction into Annie Creek; Channel restoration in Sun Creek; successful suppression of Brook Trout in Threemile Creek
Klamath	Upper Sprague River	None	USFS-ACS; NF Sprague NWSR (48% Federal)	Upper Klamath Lake Drainage TMDL & WQMP (2002)	Oregon Conservation Strategy; Upper Klamath Basin Watershed Action Plan	Yes	Some	No	No?	Bootleg Fire in 2021

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		Species Specific Protection Plans	**Land Management Protections**	**Water Management Protections (e.g. FERC Licenses)**	**State or Tribal Plan or other State, Tribal or other documents (e.g. SWAP, or other State strategies)**	**Screen Programs**	**Non-native Fish Management**	**Bull Trout Monitoring in Basin**	**Habitat Restoration Activities**	**Other**
RECOVERY UNIT	**CORE AREA**	*E.g., BT Specific Plan or Salmonid Plan, Watershed plan that is species specific. Transcends multiple managers.*	*E.g., Designated Wilderness Areas, Proposed Wilderness, Inventoried Roadless Areas (IRAs), Designations, Easements, USFS, BLM, NPS RMPs, LMPs, Tribal etc. (provide percentages for each Core Area)*	*404, FEMA, EPA water quality standards exist and enforced, also potentially HCPs or other types of conservation plans.*		*Yes or No? Is there is Screen Program to reduce direct mortality of individual Bull Trout?*	*E.g., Actions actively Occurring or No current Actions*	*E.g., Actively monitored, not actively monitored*	*E.g., Restoration Networks, Restoration Projects, Restoration Activities, or None*	
Mid Columbia	Asotin	SRSRP (BT and Salmon)	USFS - ACS	none	Yes - State	Yes	No	IMW	Yes	
Mid Columbia	Entiat	Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (BT and Salmon)	USFS - ACS	FERC/Grant, Douglas, Chelan	Yes - State	Yes	No	Yes	Yes	
Mid Columbia	Lake Chelan (historical)	Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (BT and Salmon)	NCNP, USFS	FERC/Chelan PUD; TMDL	Yes - State	Yes	No	No	Yes	Reintroduction Effort beginning
Mid Columbia	Lochsa River	ATLAS, CLW Subbasin Plan NPCC	USFS/Wilderness		Yes			Yes, IDFG	Yes, NPT, USFS	Secondary effects associated with other listed species.
Mid Columbia	Methow	Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (BT and Salmon)	USFS - ACS	FERC/Grant, Douglas, Chelan	Yes - State	Yes	No	Yes	Yes	
Mid Columbia	NE WA RNA	None	NPS - Lake Roosevelt; USFS - ACS	TMDL	Yes - State and tribal	Yes	yes	No	Yes	Salmon reintroduction efforts, likely improvement of forage base for BT in area
Mid Columbia	NFK Clearwater	CLW Subbasin Plan NPCC	USFS,		Yes		Yes, Part of a Tiger Muskie evaluation. Mixed results depending on lake characteristics, one lake complete removal of BKT	Yes, IDFG USFS	Yes, USFS, IDFG	Secondary effects associated with other listed species.
Mid Columbia	S. Salmo	Salmo River BT Conservation status and threats Plan (BC, Canada)	USFS - Wilderness	None	Yes - State	Yes	No	Yes, in Canada	Yes	
Mid Columbia	Selway River	CLW Subbasin Plan NPCC	Wilderness		Yes			Yes, IDFG	Yes, NPT USFS	Secondary effects associated with other listed species.
Mid Columbia	SFK Clearwater	CLW Subbasin Plan NPCC	USFS/Wilderness		Yes			Yes, IDFG USFS	Yes, NPT, USFS	Secondary effects associated with other listed species.
Mid Columbia	Touchet	SRSRP (BT and Salmon)	USFS - ACS	TMDL	Yes - State	Yes	No	Yes	Yes	
Mid Columbia	Tucannon	SRSRP (BT and Salmon)	USFS - ACS	None	Yes - State	Yes	No	Yes	Yes	
Mid Columbia	Wenatchee	Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (BT and Salmon)	USFS - ACS	FERC/Grant, Douglas, Chelan; TMDL	Yes - State	Yes	No	Yes	Yes	
Mid Columbia	Yakima	YBIP (BT/Salmon); YBTAP	USFS - Wilderness and ACS	BOR/YBIP; TMDL	Yes - State and Tribal	Yes	No	Yes, everyone	Yes	Reintroduction/Supplementation Efforts in the works
Mid-Columbia	Eagle Creek (historical)		USFS-ACS; NWSR	TMDL in progress	Oregon Conservation Strategy	Yes	No	-		
Mid-Columbia	Imnaha River	Recovery Plan for NE Oregon Snake River Salmon and ST	USFS-ACS; Wilderness; NWSR	Lower Grande Ronde Subbasin TMDL (2010)	Oregon Conservation Strategy	Yes	No	Yes		
Mid-Columbia	Little Minam River		USFS-ACS; Wilderness		Oregon Conservation Strategy	Yes	No	Yes	-	
Mid-Columbia	Lookingglass / Wenaha	Recovery Plan for NE Oregon Snake River Salmon and ST	USFS-ACS; Wenaha in Wilderness & NWSR;	Upper Grande Ronde Subbasin TMDL (2000); Lower Grande Ronde Subbasin TMDL (2010)	Oregon Conservation Strategy	Yes	No	Yes		
Mid-Columbia	Middle Fork John Day River	Oregon Mid-C Plan for Steelhead	USFS-ACS	John Day Basin TMDL and WQMP (2010)	Oregon Conservation Strategy	Yes	No	Planned	Yes - CTWS & USFS	Extensive habitat restoration along mainstem Middle Fork
Mid-Columbia	North Fork John Day River	Oregon Mid-C Plan for Steelhead	USFS-ACS; NFJD Wilderness; NWSR	John Day Basin TMDL and WQMP (2010)	Oregon Conservation Strategy	Yes	No	Planned	Yes	Localized work to address habitat degradation in tributaries and along mainstem, especially to address mining impacts
Mid-Columbia	Pine Indian & Wildhorse Creeks		USFS-ACS	TMDL in progress; Hells Canyon FERC	Oregon Conservation Strategy	Yes	No	Not currently	Yes - IPC	

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		Species Specific Protection Plans	**Land Management Protections**	**Water Management Protections (e.g. FERC Licenses)**	**State or Tribal Plan or other State, Tribal or other documents (e.g. SWAP, or other State strategies)**	**Screen Program**	**Non-native Fish Management**	**Bull Trout Monitoring in Basin**	**Habitat Restoration Activities**	**Other**
RECOVERY UNIT	**CORE AREA**	*E.g., BT Specific Plan or Salmonid Plan, Watershed plan that is species specific. Transcends multiple managers.*	*E.g., Designated Wilderness Areas, Proposed Wilderness, Inventoried Roadless Areas (IRAs), Designations, Easements, USFS, BLM, NPS RMPs, LMPs, Tribal etc. (provide percentages for each Core Area)*	*404, FEMA, EPA water quality standards exist and enforced, also potentially HCPs or other types of conservation plans.*		*Yes or No? Is there is Screen Program to reduce direct mortality of individual Bull Trout?*	*E.g., Actions actively Occurring or No current Actions*	*E.g., Actively monitored, not actively monitored*	*E.g., Restoration Networks, Restoration Projects, Restoration Activities, or None*	
Mid-Columbia	Powder River		USFS-ACS; N. Powder NWSR;	TMDL in progress	Oregon Conservation Strategy	Yes	No	Some	Some - PBWC	
Mid-Columbia	Umatilla River	Oregon Mid-C Plan for Steelhead	USFS-ACS; S/R in Wilderness	Umatilla Basin TMDL and WQMP (2001)	Oregon Conservation Strategy	Yes	No	Yes	Yes - CTUIR	Large scale habitat projects in Umatilla and Meacham Creeks
Mid-Columbia	Upper Grande Ronde	Recovery Plan for NE Oregon Snake River Salmon and ST	USFS-ACS	Upper Grande Ronde Subbasin TMDL (2000)	Oregon Conservation Strategy	Yes	No	Some	Some	
Mid-Columbia	Upper Mainstem John Day River	Oregon Mid-C Plan for Steelhead	USFS-ACS	John Day Basin TMDL and WQMP (2010)	Oregon Conservation Strategy	Yes	No	Planned	Some	
Mid-Columbia	Walla Walla River	Oregon Mid-C Plan for Steelhead; SRSRP (BT and Salmon)	USFS-ACS	Walla Walla Subbasin TMDL and WQMP (2005 - OR, 2002 - WA); City of WW (Mill Creek) - Water Supply	Oregon Conservation Strategy	Yes	No	Some pops	Yes	
Mid-Columbia	Wallowa / Minam	Recovery Plan for NE Oregon Snake River Salmon and ST	USFS-ACS; Lostine & Minam NWSR; Headwaters in Wilderness	Lower Grande Ronde Subbasin TMDL (2010)	Oregon Conservation Strategy	Yes	No	Yes	Yes	
St Mary	Cracker Lake	None	NPS		No	n/a	No	Yes	None	
St Mary	Red Eagle Lake (simple)	None	NPS		No	n/a	No	Yes	None	
St Mary	Slide Lake	None	NPS		No	n/a	No	Yes	None	
St Mary	St Mary (complex)	None	NPS/BN		No	No	No	Yes	None	
Upper Snake	Anderson Ranch	None	USFS BOR		Yes	No	No	Yes, IDFG USFS	Yes, BOR, USFS	
Upper Snake	Arrowrock Res	None	USFS BOR		Yes	No	No	Yes, BOR IDFG	BOR?	
Upper Snake	Deadwood River	None	USFS BOR	No	Yes	No	NA	Yes, USFS, IDFG	Yes, USFS	
Upper Snake	Jarbidge	None	Wilderness	No	Yes	No	NA	Yes, NDOW	None	
Upper Snake	Lake Creek	None	USFS		Yes	No	No	No	None	
Upper Snake	Lemhi R.	USBWP	USFS BLM	Screen Program	Yes	Yes	Yes	Yes, IDFG USFS	Yes, IDFG USFS BLM	Secondary effects associated with other listed species.
Upper Snake	Little Lost	None	USFS BLM	Screen Program	Yes	Yes	Yes	Yes, IDFG USFS BLM	Yes IDFG, USFS, BLM	
Upper Snake	Little-Lower Salmon		HCNRA, USFS/Wilderness		Yes	Yes	No	Yes, IDFG	NPT?	Secondary effects associated with other listed species.
Upper Snake	Middle Fork Payette	None	USFS	No	Yes	No	No	Yes, USFS	Yes, USFS	
Upper Snake	Middle Fork Salmon	USBWP	Wilderness (95%)	Screen Program	Yes	Yes	No	Yes, IDFG, USFS, SBT	Yes USFS, BPA, BOR, SBT	Secondary effects associated with other listed species.
Upper Snake	Middle Salmon - Chamberlain		Wilderness	No	Yes	No	No	Yes, IDFG USFS	Yes, USFS	Secondary effects associated with other listed species.
Upper Snake	Middle Salmon - Panther	USBWP	USFS/Wilderness	Screen Program	Yes	Yes	Yes	Yes, IDFG SBT USFS	Yes, SBT, USFS	Secondary effects associated with other listed species.
Upper Snake	NFK Payette River	None	USFS	No	Yes	No	No	Yes, USFS IDFG	None	

		REGULATORY OR OTHER CONSERVATION PLANS				OTHER CONSERVATION MEASURES or CONSERVATION ACTIVITIES				
		Species Specific Protection Plans	**Land Management Protections**	**Water Management Protections (e.g. FERC Licenses)**	**State or Tribal Plan or other State, Tribal or other documents (e.g. SWAP, or other State strategies)**	**Screen Program**	**Non-native Fish Management**	**Bull Trout Monitoring in Basin**	**Habitat Restoration Activities**	**Other**
RECOVERY UNIT	**CORE AREA**	*E.g.,BT Specific Plan or Salmonid Plan, Watershed plan that is species specific. Transcends multiple managers.*	*E.g., Designated Wilderness Areas, Proposed Wilderness, Inventoried Roadless Areas (IRAs), Designations, Easements, USFS, BLM, NPS RMPs, LMPs, Tribal etc. (provide percentages for each Core Area)*	*404, FEMA, EPA water quality standards exist and enforced, also potentially HCPs or other types of conservation plans.*		*Yes or No? Is there is Screen Program to reduce direct mortality of individual Bull Trout?*	*E.g., Actions actively Occurring or No current Actions*	*E.g., Actively monitored, not actively monitored*	*E.g., Restoration Networks, Restoration Projects, Restoration Activities, or None*	
Upper Snake	North Fork Malheur		USFS-ACS; NWSR; BOR	Malheur River Basin TMDL and WQMP (2010)	Oregon Conservation Strategy	Yes	No	Yes	Yes - USFS	BOR management of reservoir
Upper Snake	Opal Lake (simple CA)	None	USFS	No	Yes	NA	NA	No	None	
Upper Snake	Pahsimeroi	USBWP	Roadless	Screen Program	Yes	Yes	No	Yes, IDFG USFS	Yes, IDFG, USFS, BLM, BOR, BPA	Secondary effects associated with other listed species.
Upper Snake	SFK Salmon River		USFS		Yes	No	No	Yes, IDFG NPT USFS	Yes, NPT, USFS	Secondary effects associated with other listed species.
Upper Snake	Chief Eagle Eye Cr. (rename '23)	None	USFS	No	Yes	No	No	Yes, USFS	Yes USFS	
Upper Snake	Upper Malheur		USFS-ACS	Malheur River Basin TMDL and WQMP (2010)	Oregon Conservation Strategy	Yes	Yes	No	Yes - BPT & USFS	Planning large scale Brook Trout eradication in tributaries
Upper Snake	Upper Salmon River	USBWP	USFS (SNRA)/Wilderness	State water quality standards, Screen Program	Yes	Yes	Yes	Yes, IDFG, USFS, SBT	Yes, IDFG, USFS, SBT, BOR, BPA	Secondary effects associated with other listed species.
Upper Snake	Upper South Fork Payette	None	Wilderness	No	Yes	No	No	Yes, USFS IDFG	Yes, USFS	
Upper Snake	Weiser River	None	USFS	No	Yes	NO	No	Yes, USFS	Yes USFS	

Appendix C. Detailed Bull Trout Conceptual Model



Appendix D. Growth Rate Analysis Summary

Trend analysis for USFWS species status assessment for bull trout (*Salvelinus confluentus*)

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Background

Bull trout (*Salvelinus confluentus*) in the western U.S. were listed as threatened under the U.S. Endangered Species Act in 1998. The purpose of this analysis is to estimate trends in the abundance (counts) of bull trout within predefined core areas spread across Oregon, Washington, Idaho, and Montana, as part of the current Species Status Assessment (SSA).

Data

I provided a MS Excel template for the desired data in a "tidy" format, which consisted of the following 8 fields (columns):

- `dataset` (i.e., integer value for unique ID)
- `recovery unit` (e.g., Mid Columbia)
- `core area` (e.g., South Fork Clearwater)
- `popn/stream` (e.g., Crooked River)
- `metric` (e.g., abundance)
- `method` (e.g., redd survey)
- `year`
- `value` (i.e., counts)

The data coordinators also provided me with some metadata indicating which of the data specific to a location were generally for adults versus juveniles. Data files were subsequently provided to me by data coordinators from each of the four states:

- Oregon: Stephanie Gunckel (ODFW)
- Washington: Marie Winkowski (WDFW)
- Idaho: Brett Bowersox (IDFG)
- Montana: Dan Brewer (USFWS)

The data from Montana came via biologists with the USGS (Clint Muhlfeld, Tim Cline), and did not conform to the template file I had provided. Thus, those data were subjected to additional cleaning prior to their inclusion with the data from other states (see below).

Prior to analysis, all of the count data were log-transformed and standardized to a mean of zero and variance of one, which aided in model fitting and, in particular, the estimation of the process and observation (sampling) variances.

Modeling framework

Population model

I fit discrete-time versions of exponential models for population growth (decline), such that the abundance of bull trout (N) is a function of the initial population size N_0, time (t), the population growth rate (u), and a time-dependent stochastic effect of the environment (w). Specifically, in continuous time the model is

$$N(t) = N_0 \exp(u) \exp(wt). \quad (1)$$

In discrete time, with a time step of 1 unit (e.g., a year), the model becomes

$$N_t = N_{t-1} \exp(u + w_t). \quad (2)$$

If we take the logarithm of both sides and define $x_t = \log(N_t)$, we have

$$x_t = x_{t-1} + u + w_t. \quad (3)$$

Further defining $w_t \sim \mathrm{N}(0, q)$ leads us to a so-called "biased random walk" model, where u is the tendency for the population to increase or decrease each time step (i.e., the bias), and w_t is some unknown stochastic aspect of the environment that partially drives population dynamics.

Observation model

The data available to us rarely come from complete censuses, and instead are typically derived from partial counts. Furthermore, mistakes may occur when counting individuals or redds. Thus, we should account for these possible sampling or observation errors with a so-called "data model".

In this case, we assume that the data in hand are a somewhat distorted view of the "true state of nature", such that the logarithm of the observed count at time t (y_t) equals that of the true count plus or minus some error. Specifically, we can write this as

$$y_t = x_t + a + v_t \quad (4)$$

where a is an offset to account for partial sampling, and $v_t \sim \mathrm{N}(0, r)$.

State-space model

We can combine equations (3) and (4), along with a definition for the initial state (x_0), into a so-called "state-space model", where

$$\begin{aligned} y_t &= x_t + a + v_t \\ x_t &= x_{t-1} + u + w_t \\ x_0 &\sim \mathrm{N}(\mu, \sigma) \end{aligned} \quad (5)$$

Multiple populations

Here we want to estimate the annual change in population size for each of the many different core areas across the four states. Furthermore, some core areas comprise several different populations/locations, so we need to frame our state-space model in a multivariate context.

Observation model

If we have n different populations within a core area, then our observation model becomes

$$y_{i,t} = x_{i,t} + a_i + v_{i,t} \tag{6}$$

where $y_{i,t}$ is the log-count for population i and year t, a_i is an offset to account for partial sampling in population i, and $v_{i,t} \sim \mathrm{N}(0, r_i)$. We can combine each of the population specific observation models into a matrix form, such that

$$\begin{aligned} y_{1,t} &= x_{1,t} + a_1 + v_{1,t} \\ y_{2,t} &= x_{2,t} + a_2 + v_{2,t} \\ &\vdots \\ y_{n,t} &= x_{n,t} + a_3 + v_{n,t} \end{aligned} \tag{7}$$

becomes

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}_t = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}_t + \begin{bmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{bmatrix} + \begin{bmatrix} v_1 \\ v_2 \\ \vdots \\ v_n \end{bmatrix}_t, \tag{8}$$

[1]Here the variance of the observation errors is assumed to be population specific, but it might be reasonable to assume that each survey/census type might have the same variance, such that $v_{i,t} \sim \mathrm{N}(0, r)$.

or more compactly in matrix notation as

$$\mathbf{y}_t = \mathbf{x}_t + \mathbf{a} + \mathbf{v}_t. \tag{9}$$

where $\mathbf{y}_t$, $\mathbf{x}_t$, $\mathbf{a}$, $\mathbf{v}_t$ are all $n \times 1$ vectors, and $\mathbf{w}_t \sim \mathrm{MVN}(\mathbf{0}, \mathbf{Q})$.

Population model

Just as we did for the observation model, we can write the models for population dynamics as

$$x_{j,t} = x_{j,t-1} + u_j + w_{j,t} \tag{10}$$

where u_i is the bias, which is unique to each population, and $w_{j,t} \sim \mathrm{N}(0, q)$}.

We can again express all of the population models in matrix form, such that

$$
\begin{aligned}
x_{1,t} &= x_{1,t-1} + u_1 + w_{1,t} \\
x_{2,t} &= x_{2,t-1} + u_2 + w_{2,t} \\
&\vdots \\
x_{n,t} &= x_{n,t-1} + u_3 + w_{n,t}
\end{aligned} \tag{11}
$$

becomes

$$
\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}_t = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}_t + \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_n \end{bmatrix} + \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}_t, \tag{12}
$$

or more compactly in matrix notation as

$$
\mathbf{x}_t = \mathbf{x}_{t-1} + \mathbf{u} + \mathbf{w}_t \tag{13}
$$

where $\mathbf{x}_t$, $\mathbf{x}_{t-1}$, $\mathbf{u}$, $\mathbf{w}_t$ are all $n \times 1$ vectors, and $\mathbf{w}_t \sim \text{MVN}(\mathbf{0}, \mathbf{Q})$.

[2]It might be reasonable to assume that some/all of the populations have the same bias, given their membership within a core area.

State-space forms

At this point, however, we are assuming that the monitoring data for each population is telling us something about only the specific population itself, rather than contributing information to the population trend at the larger scale of their core area, which is the really the scale of interest here. Thus, we need to modify our equations to accommodate this hierarchical framework.

For example, assume that we have $p = 2$ core areas (call them A and B), each with data from 2 representative populations. In this case, $n = 4$, but the number of states (i.e., the number of rows in $\mathbf{x}_t$) is 2, so we need a way to "map" each of the observed time series onto its respective core area. We begin by writing out the equations for the observations in long matrix form akin to equation (), such that

$$
\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix}_t = \begin{bmatrix} x_A \\ x_A \\ x_B \\ x_B \end{bmatrix}_t + \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix} + \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix}_t, \tag{14}
$$

Because both x_A and x_B appear twice in equation (14), we can use a 4×2 matrix of 1's and 0's as our map. Specifically, we have

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix}_t = \begin{bmatrix} 1 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x_A \\ x_B \end{bmatrix}_t + \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix} + \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix}_t, \tag{15}$$

We can write equation (15) more compactly in matrix notation as

$$\mathbf{y}_t = \mathbf{Z}\mathbf{x}_t + \mathbf{a} + \mathbf{v}_t. \tag{16}$$

where $\mathbf{y}_t$, $\mathbf{a}$, and $\mathbf{v}_t$ are all $n \times 1$ vectors, $\mathbf{Z}$ is an $n \times k$ matrix, and $\mathbf{x}_t$ is a $k \times 1$ vector.

The equation for the population dynamics in each of the 2 core areas then becomes

$$\begin{bmatrix} x_A \\ x_B \end{bmatrix}_t = \begin{bmatrix} x_A \\ x_B \end{bmatrix}_{t-1} + \begin{bmatrix} u_A \\ u_B \end{bmatrix} + \begin{bmatrix} w_A \\ w_B \end{bmatrix}_t, \tag{17}$$

which can be written more compactly in matrix notation as

$$\mathbf{x}_t = \mathbf{x}_{t-1} + \mathbf{u} + \mathbf{w}_t, \tag{18}$$

and combined with equation (16) to form the full multivariate state-space model

$$\begin{aligned} \mathbf{y}_t &= \mathbf{Z}\mathbf{x}_t + \mathbf{a} + \mathbf{v}_t \\ \mathbf{x}_t &= \mathbf{x}_{t-1} + \mathbf{u} + \mathbf{w}_t. \end{aligned} \tag{19}$$

Thus, by simply altering the dimensions of **Z**, and the locations of 1's and 0's within it, we can evaluate any number of different hypotheses about how the population dynamics are structured spatially. For example, if we set **Z** equal to an $n \times n$ identity matrix, where

$$\mathbf{Z} = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{bmatrix}, \tag{20}$$

then each of the time series of data is assumed to represent a unique state of nature. If, on the other hand, we set **Z** equal to an $n \times 1$ column vector of 1's, such that

$$\mathbf{Z} = \begin{bmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{bmatrix}, \tag{21}$$

then each of the time series of data is assumed to represent a sample from a single state of nature.

Variance specification

The multivariate state-space model allows us to be quite specific about how the observation errors ($\mathbf{v}_t$) and process errors ($\mathbf{w}_t$) are related to one another, if at all. In the most simple case, the errors could be independent and identically distributed (IID), such that (for the observation variance)

$$\mathbf{R} = \begin{bmatrix} r & 0 & \cdots & 0 \\ 0 & r & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & r \end{bmatrix}. \qquad (22)$$

Alternatively, the errors might be independent, but not identically distributed

$$\mathbf{R} = \begin{bmatrix} r_1 & 0 & \cdots & 0 \\ 0 & r_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & r_n \end{bmatrix}, \qquad (23)$$

or identically distributed, but not independent

$$\mathbf{R} = \begin{bmatrix} r & c & \cdots & c \\ c & r & \cdots & c \\ \vdots & \vdots & \ddots & \vdots \\ c & c & \cdots & r \end{bmatrix}. \qquad (24)$$

Model fitting

The adult data come from 244 populations within 62 core area spread across the 6 recovery domains. Thus, $\mathbf{y}_t$ is a 244×1 vector of transformed observed counts in year t, and $\mathbf{x}_t$ is a 62×1 vector of underlying states in year t. The matrix $\mathbf{Z}$ is a 244×62 matrix of 1's and 0's that maps each of the respective observations onto their respective states.

The juvenile data are much more restricted, coming from 31 populations within 15 core area spread across the 6 recovery domains. Thus, $\mathbf{y}_t$ is a 31×1 vector of transformed observed counts in year t, and $\mathbf{x}_t$ is a 15×1 vector of underlying states in year t. The matrix $\mathbf{Z}$ is a 31×15 matrix of 1's and 0's that maps each of the respective observations onto their respective states.

All trends were estimated for the period covering 2008-2020 to reflect the most recent data.

Because the source of the data varies by location, I estimated different variance terms for each of the methods (e.g., screw trap, snorkel survey, weir). Specifically, the covariance matrix is given by

$$\mathbf{R} = \begin{bmatrix} r_i & 0 & \cdots & 0 \\ 0 & r_i & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & r_i \end{bmatrix}. \qquad (25)$$

where i indicates the source of the data.

In this particular case, the data were standardized prior to model fitting, so I assumed that the process errors ($w_{j,t}$) were independent and identically distributed, such that

$$\mathbf{Q} = \begin{bmatrix} q & 0 & \cdots & 0 \\ 0 & q & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & q \end{bmatrix}. \qquad (26)$$

All models were fit using the {`MARSS`} package [@Holmes_2021; @Holmes_2021a; @Holmes_2012] for the **R** computing software [@R_Core_Team_2020]. I estimated 90% confidence intervals (CI's) around each of the estimated bias terms (u_j) using the `MARSSparamCIs()` function based upon an asymptotic variance assumption. All of the data and code necessary to reproduce the results of the analysis can be found online at https://github.com/mdscheuerell/bulltrout.

Results

Adult abundance

Adult bull trout dataset features, including number, duration, and spatial coverage of datasets are summarized in Table 1. Estimated trends in adult abundance were rather mixed. For trends fit over the entire time period, such that 37 out of 62 core areas showed decreasing trends, but only 3 of trends had 90% CI's that did not overlap 0 (Tables 1-4). The remaining 25 core areas had increasing trends, but only 5 of them had 90% CI's that did not overlap 0 (Tables (1-4). Fitted trend lines and their associated CI's are provided in Table 2. Visual depictions of data are shown in Figure 1.

For trends fit over the later time period from 2008-2020, the results were mixed but included a greater number of negative trends. There were negative trends in 41 of 62 core areas, and 12 of them were significantly so (Tables 6-9). The remaining 21 core areas had

generally positive trends, but only one of them was significant (Tables 6-9). Fitted trend lines and their associated CI's are provided in Table 2. Visual depictions of data are shown in Figure 1.

Juvenile abundance

Juvenile bull trout dataset features, including number, duration, and spatial coverage of datasets are summarized in Table 1. Estimated trends in juvenile abundance were also mixed. When fit over the entire time period, 10 of 19 core areas were decreasing, but only 4 of trends had 90% CI's that did not overlap 0 (Table 5). The remaining 9 core areas had increasing trends, and 6 of them had 90% CI's that did not overlap 0 (Tables 5). Fitted trend lines and their associated CI's are provided in Table 2. Visual depictions of data are shown in Figure 2.

For trends fit to the more later time period of 2008-2020, 11 of 19 core areas had decreasing trends, and 6 of them were significantly so. The remaining 8 core areas we generally increasing, but only 2 of them showed significant trends over time. Fitted trend lines and their associated CI's are provided in Table 2. Visual depictions of data are shown in Figure 2.

References

Holmes EE, Scheuerell MD, and Ward EJ. 2021a. Analysis of multivariate time-series using the MARSS package. Version 3.11.4.

Holmes EE, Ward EJ, Scheuerell MD, and Wills K. 2021b. MARSS: Multivariate autoregressive state-space modeling.

Holmes EE, Ward EJ, and Wills K. 2012. MARSS: Multivariate autoregressive state-space models for analyzing time-series data. *The R Journal* **4**: 30.

R Core Team. 2020. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing.

Table 1. Summary of core area juvenile and adult bull trout dataset features used in the SSA growth rate analysis.

Juvenile Data

Representative Unit	Core Area	Number of Datasets	Number of Local Populations Included	Longest Datasets (Years)	Number of Local Populations in the Core Area
Coastal	Odell Lake	1	1	22	1
Coastal	Dungeness	1	1	16	2
Coastal	Lower Skagit River	1	1	28	20
Mid-Columbia	Lochsa River	3	3	22	17
Mid-Columbia	Selway River	1	4	17	10
Mid-Columbia	South Fork Clearwater River	4	3	22	5
Mid-Columbia	Asotin Creek	2	1	17	1
Mid-Columbia	Entiat River	1	1	11	2
Mid-Columbia	Wenatchee River	4	7	24	7
Upper Snake	Lemhi River	3	3	16	6
Upper Snake	Little Lost River	1	3	12	10
Upper Snake	Little-Lower Salmon River	2	3	29	6
Upper Snake	Middle Salmon - Panther	1	4	18	18
Upper Snake	Middle Fork Salmon River	4	10	22	28
Upper Snake	Pahsimeroi River	1	2	13	9
Upper Snake	South Fork Salmon River	3	3	23	27
Upper Snake	Upper Salmon River	3	3	22	18
Upper Snake	Weiser River	1	3	10	5

Adult Data

Representative Unit	Core Area	Number of Datasets	Number of Local Populations Included	Longest Datasets (Years)	Number of Local Populations in the Core Area
Coastal	Hood River	1	1	15	1
Coastal	Lower Deschutes River	2	2	35	5
Coastal	Odell Lake	1	1	27	1
Coastal	Upper Willamette River	4	4	27	4
Coastal	Chester Morse Lake	2	2	12	4
Coastal	Lewis River	3	3	21	3
Coastal	Lower Skagit River	5	5	18	20
Coastal	Puyallup River	14	3	32	9
Coastal	Skokomish River	4	2	22	2
Coastal	Snohomish and Skykomish Rivers	3	3	31	4
Coastal	Stillaguamish River	1	1	18	3
Columbia Headwaters	Couer d'Alene	3	3	29	5
Columbia Headwaters	Kootenai	9	6	30	8
Columbia Headwaters	Lake Pend Oreille B	9	9	30	20
Columbia Headwaters	Priest Lakes	3	3	30	5
Columbia Headwaters	Canada	2	2	26	n/a
Columbia Headwaters	Big Salmon Lake	1	1	11	1
Columbia Headwaters	Bitterroot River	2	2	27	14
Columbia Headwaters	Blackfoot River	8	4	30	6
Columbia Headwaters	Bowman Creek	1	1	13	1
Columbia Headwaters	Bull Lake	3	1	24	1
Columbia Headwaters	Cerulean/Quartz Mid Lakes	1	1	17	1
Columbia Headwaters	Clearwater	4	3	19	4

Columbia Headwaters	Cyclone Lake	1	1	25	1
Columbia Headwaters	Flathead Lake	18	17	30	17
Columbia Headwaters	Harrison Lake	1	1	11	1
Columbia Headwaters	Holland Lake	1	1	30	1
Columbia Headwaters	Hungry Horse Reservoir	8	9	27	10
Columbia Headwaters	Lake Koocanusa	6	2	27	2
Columbia Headwaters	Lake Pend Oreille A	19	18	28	15
Columbia Headwaters	Lindbergh Lake	1	1	15	1
Columbia Headwaters	Logging Creek	1	1	15	1
Columbia Headwaters	Lower Quartz Lake	1	1	15	1
Columbia Headwaters	Middle Clark Fork River	3	3	21	10
Columbia Headwaters	Rock Creek	10	9	28	9
Columbia Headwaters	Swan Lake	11	9	30	9
Columbia Headwaters	Upper Clark Fork River	4	1	22	3
Columbia Headwaters	Upper Stillwater Lake	2	1	23	1
Columbia Headwaters	Upper Whitefish Lake	1	1	23	1
Columbia Headwaters	West Fork Bitterroot River	1	1	25	6
Columbia Headwaters	Whitefish Lake	1	1	26	1
Mid-Columbia	North Fork Clearwater	1	1	16	12
Mid-Columbia	Imnaha River	4	4	20	8
Mid-Columbia	Lookingglass/Wenaha	1	1	22	4
Mid-Columbia	Pine-Indian-Wildhorse Creeks	4	3	17	9
Mid-Columbia	Umatilla River	1	1	27	1
Mid-Columbia	Upper Grande Ronde	2	1	23	6
Mid-Columbia	Walla Walla River	3	2	28	3
Mid-Columbia	Wallowa/Minam	2	2	21	6
Mid-Columbia	Asotin Creek	1	1	17	1
Mid-Columbia	Entiat River	2	2	24	2

Mid-Columbia	Methow River	6	6	19	10
Mid-Columbia	Touchet River	2	2	20	3
Mid-Columbia	Tucannon River	2	2	21	5
Mid-Columbia	Wenatchee River	9	7	31	7
Mid-Columbia	Yakima River	13	11	35	15
St Mary	St. Mary River	2	2	20	
Upper Snake	Lemhi River	2	3	15	6
Upper Snake	Little-Lower Salmon River	1	1	29	6
Upper Snake	South Fork Salmon River	1	1	20	27
Upper Snake	Upper Salmon River	6	5	24	18

Table 2. Summary of bull trout SSA analysis growth rate trend biases and 90% upper and lower confidence intervals for juvenile and adult bull trout data collected in core areas.

Juvenile Datasets

		Full-period Population Trend (1991-2020)				**Later-period Population Trend (2008-2020)**			
Representative Unit	**Core Area**	**Lower 90% CI**	**Mean**	**Upper 90% CI**	**Trend**	**Lower 90% CI**	**Mean**	**Upper 90% CI**	**Trend**
Coastal	Odell Lake	0.037	0.097	0.158	+	-0.064	0.065	0.194	0
Coastal	Dungeness	-0.143	-0.064	0.014	0	-0.168	-0.084	0.000	-
Coastal	Lower Skagit River	-0.105	-0.071	-0.038	-	-0.171	-0.107	-0.044	-
Mid-Columbia	Lochsa River	-0.025	0.005	0.035	0	-0.056	0.007	0.070	0
Mid-Columbia	Selway River	-0.074	-0.022	0.029	0	-0.176	-0.088	0.000	0
Mid-Columbia	South Fork Clearwater	0.002	0.029	0.056	+	-0.027	0.036	0.099	0
Mid-Columbia	Asotin Creek	-0.178	-0.120	-0.061	-	-0.187	-0.123	-0.059	-
Mid-Columbia	Entiat River	-0.333	-0.202	-0.071	-	-0.344	-0.213	-0.082	-
Mid-Columbia	Tucannon River	-0.048	-0.012	0.024	0	-0.122	-0.069	-0.015	-

Mid-Columbia	Wenatchee River	-0.053	-0.019	0.016	0	-0.108	-0.050	0.009	0
Upper Snake	Lemhi River	0.001	0.049	0.097	+	-0.003	0.053	0.109	0
Upper Snake	Little Lost	0.005	0.075	0.145	+	-0.035	0.084	0.202	0
Upper Snake	Little-Lower Salmon River	-0.073	-0.044	-0.015	-	-0.143	-0.085	-0.026	-
Upper Snake	Mid Salmon - Panther	-0.084	-0.023	0.037	0	-0.140	-0.050	0.040	0
Upper Snake	Middle Fork Salmon River	-0.024	0.004	0.032	0	-0.098	-0.040	0.018	0
Upper Snake	Pahsimeroi	-0.012	0.087	0.186	0	-0.020	0.091	0.202	0
Upper Snake	South Fork Salmon River	0.052	0.086	0.121	+	0.058	0.163	0.268	+
Upper Snake	Upper Salmon	0.039	0.065	0.091	+	0.047	0.104	0.161	+
Upper Snake	Weiser River	-0.150	-0.038	0.074	0	-0.214	-0.084	0.046	0

Adult Datasets

		Full-period Population Trend (1991-2020)				Later-period Population Trend (2008 2020)			
Representative Unit	**Core Area**	**Lower 90% CI**	**Mean**	**Upper 90% CI**	**Trend**	**Lower 90% CI**	**Mean**	**Upper 90% CI**	**Trend**
Coastal	Hood River	-0.156	-0.030	0.097	0	-0.163	-0.040	0.084	0
Coastal	Lower Deschutes River	0.004	0.073	0.142	+	-0.132	-0.023	0.085	0
Coastal	Odell Lake	-0.054	0.023	0.100	0	-0.202	-0.087	0.029	0
Coastal	Upper Willamette River	0.009	0.082	0.154	+	-0.065	0.029	0.124	0
Coastal	Chester Morse Lake	-0.157	-0.061	0.035	0	-0.196	-0.088	0.021	0
Coastal	Lewis River	0.013	0.082	0.152	+	-0.093	0.010	0.112	0
Coastal	Lower Skagit River	-0.086	-0.017	0.053	0	-0.241	-0.141	-0.042	-
Coastal	Puyallup River	-0.022	0.045	0.112	0	-0.024	0.066	0.156	0
Coastal	Skokomish River	-0.089	-0.006	0.078	0	-0.089	0.029	0.147	0
Coastal	Snohomish and Skykomish Rivers	-0.078	-0.006	0.066	0	-0.255	-0.139	-0.023	-

Coastal	Stillaguamish River	-0.252	-0.145	-0.038	-	-0.334	-0.210	-0.086	-
Mid-Columbia	North Fork Clearwater	-0.187	-0.087	0.014	0	-0.296	-0.175	-0.054	-
Mid-Columbia	Imnaha River	-0.139	-0.051	0.037	0	-0.195	-0.091	0.014	0
Mid-Columbia	Lookingglass/Wenaha	-0.048	0.041	0.130	0	-0.071	0.043	0.156	0
Mid-Columbia	Pine-Indian-Wildhorse Creeks	-0.174	-0.084	0.006	0	-0.262	-0.132	-0.002	-
Mid-Columbia	Umatilla River	-0.126	-0.050	0.027	0	-0.154	-0.040	0.074	0
Mid-Columbia	Upper Grande Ronde	-0.038	0.045	0.127	0	-0.012	0.094	0.200	0
Mid-Columbia	Walla Walla River	-0.086	-0.015	0.055	0	-0.159	-0.051	0.058	0
Mid-Columbia	Wallowa/Minam	-0.061	0.025	0.110	0	-0.080	0.029	0.137	0
Mid-Columbia	Asotin Creek	-0.139	-0.028	0.083	0	-0.174	-0.058	0.059	0
Mid-Columbia	Entiat River	-0.040	0.031	0.101	0	-0.083	0.026	0.135	0
Mid-Columbia	Methow River	-0.031	0.043	0.118	0	-0.141	-0.046	0.049	0
Mid-Columbia	Touchet River	-0.097	-0.026	0.045	0	-0.050	0.056	0.161	0
Mid-Columbia	Tucannon River	-0.072	0.002	0.075	0	-0.101	0.007	0.114	0
Mid-Columbia	Wenatchee River	-0.080	-0.014	0.052	0	-0.132	-0.031	0.071	0
Mid-Columbia	Yakima River	-0.079	-0.013	0.054	0	-0.133	-0.036	0.061	0
St. Mary	St. Mary River	-0.105	-0.022	0.062	0	-0.210	-0.092	0.027	0
Upper Snake	Lemhi River	-0.140	-0.022	0.095	0	-0.140	-0.027	0.086	0
Upper Snake	Little-Lower Salmon River	-0.011	0.061	0.134	0	-0.066	0.055	0.176	0
Upper Snake	South Fork Salmon River	-0.063	0.034	0.130	0	0.003	0.125	0.246	+
Upper Snake	Upper Salmon	-0.049	0.019	0.086	0	-0.142	-0.049	0.044	0
Canada	Canada	0.014	0.086	0.159	+	-0.080	0.023	0.125	0
Columbia Headwaters	Couer d'Alene	-0.103	-0.036	0.032	0	-0.232	-0.135	-0.038	-
Columbia Headwaters	Kootenai	-0.225	-0.121	-0.018	-	-0.255	-0.137	-0.018	-
Columbia Headwaters	LPO	-0.057	0.007	0.070	0	-0.156	-0.067	0.023	0
Columbia Headwaters	Priest Lakes	-0.062	0.006	0.074	0	-0.067	0.032	0.130	0

Columbia Headwaters	Big Salmon Lake	-0.151	-0.065	0.021	0	-0.218	-0.062	0.094	0
Columbia Headwaters	Bitterroot River	-0.075	-0.002	0.071	0	-0.150	-0.042	0.066	0
Columbia Headwaters	Blackfoot River	-0.086	-0.022	0.043	0	-0.178	-0.088	0.003	0
Columbia Headwaters	Bowman Creek	-0.036	0.102	0.239	0	-0.070	0.114	0.297	0
Columbia Headwaters	Bull Lake	-0.148	-0.073	0.002	0	-0.234	-0.137	-0.039	-
Columbia Headwaters	Cerulean/Quartz Mid Lakes	-0.080	0.028	0.135	0	-0.083	0.034	0.152	0
Columbia Headwaters	Clearwater	-0.136	-0.044	0.049	0	-0.159	-0.062	0.035	0
Columbia Headwaters	Cyclone Lake	-0.126	-0.046	0.033	0	-0.227	-0.094	0.040	0
Columbia Headwaters	Flathead Lake	-0.079	-0.017	0.046	0	-0.119	-0.030	0.058	0
Columbia Headwaters	Harrison Lake	-0.207	-0.079	0.050	0	-0.265	-0.126	0.014	0
Columbia Headwaters	Holland Lake	-0.121	-0.049	0.022	0	-0.095	0.019	0.133	0
Columbia Headwaters	Hungry Horse Reservoir	-0.051	0.016	0.083	0	-0.163	-0.070	0.023	0
Columbia Headwaters	Kootenai River	-0.088	-0.024	0.041	0	-0.187	-0.096	-0.005	-
Columbia Headwaters	Lake Koocanusa	-0.101	-0.032	0.037	0	-0.254	-0.160	-0.067	-
Columbia Headwaters	Lake Pend Oreille	-0.080	-0.015	0.051	0	-0.147	-0.061	0.026	0
Columbia Headwaters	Lindbergh Lake	-0.144	-0.058	0.027	0	-0.154	-0.018	0.118	0
Columbia Headwaters	Logging	-0.233	-0.120	-0.006	-	-0.256	-0.135	-0.014	-
Columbia Headwaters	Lower Quartz Lake	-0.136	-0.018	0.099	0	-0.167	-0.043	0.082	0
Columbia Headwaters	Middle Clark Fork River	-0.110	-0.028	0.054	0	-0.139	-0.042	0.055	0
Columbia Headwaters	Rock Creek	-0.102	-0.035	0.032	0	-0.162	-0.071	0.019	0
Columbia Headwaters	Swan Lake	-0.083	-0.020	0.043	0	-0.193	-0.104	-0.015	-
Columbia Headwaters	Upper Clark Fork River	-0.067	0.008	0.083	0	-0.058	0.040	0.138	0
Columbia Headwaters	Upper Stillwater Lake	-0.008	0.066	0.139	0	-0.070	0.035	0.140	0
Columbia Headwaters	Upper Whitefish Lake	0.012	0.091	0.170	+	-0.065	0.051	0.168	0
Columbia Headwaters	West Fork Bitterroot River	-0.074	0.006	0.085	0	-0.146	-0.031	0.083	0
Columbia Headwaters	Whitefish Lake	-0.037	0.038	0.113	0	-0.083	0.034	0.150	0

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Figure 1. Summary plots of standardized indices of log-abundance for adult bull trout over time by core areas (i.e. location indicated on plots by State: Core Area). Fitted trend lines are shown in (black) and associated 90% confidence intervals are shown in gray. Growth rate factor scoring was based on late-period trends calculated from 2008-2020.

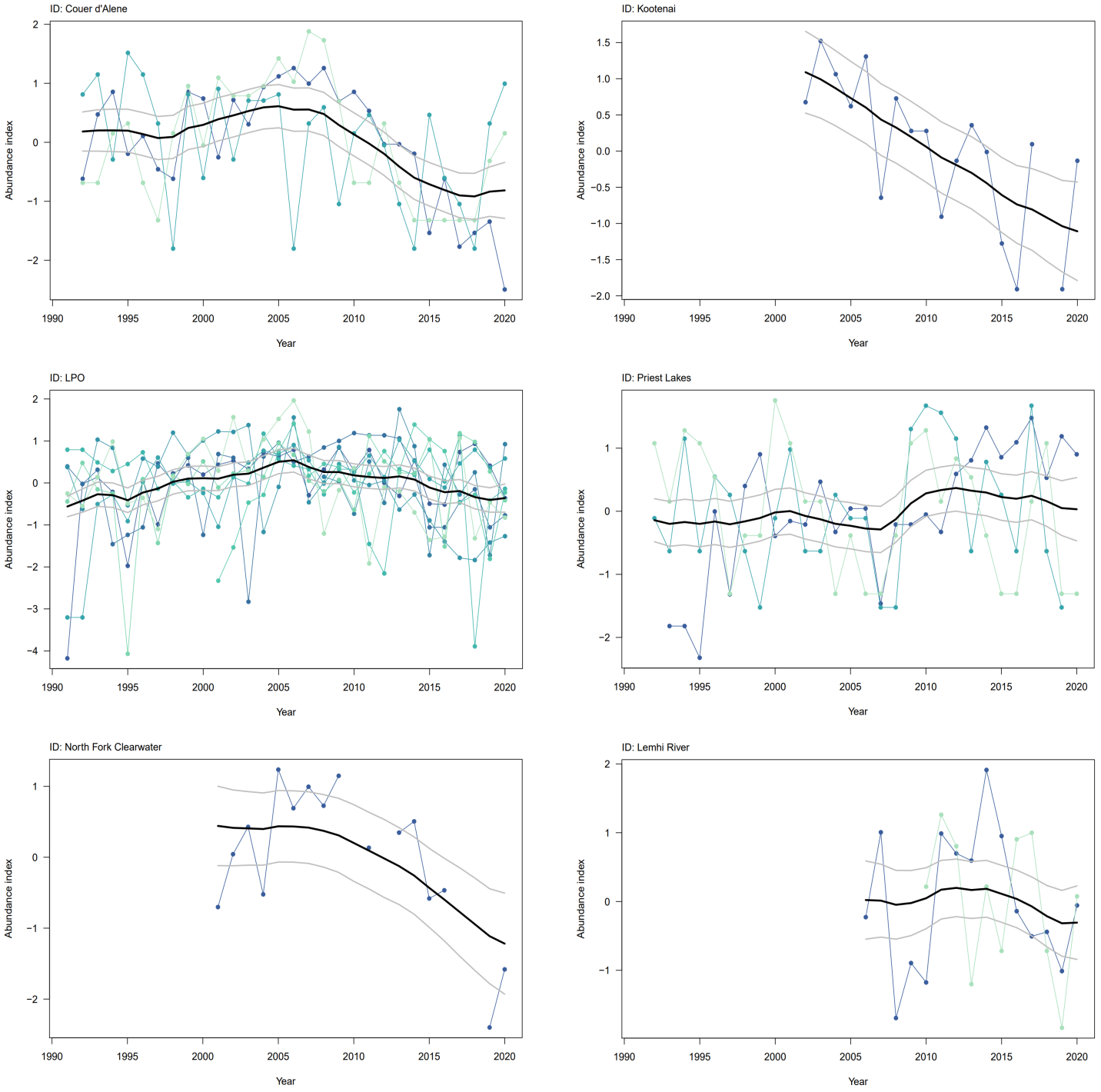
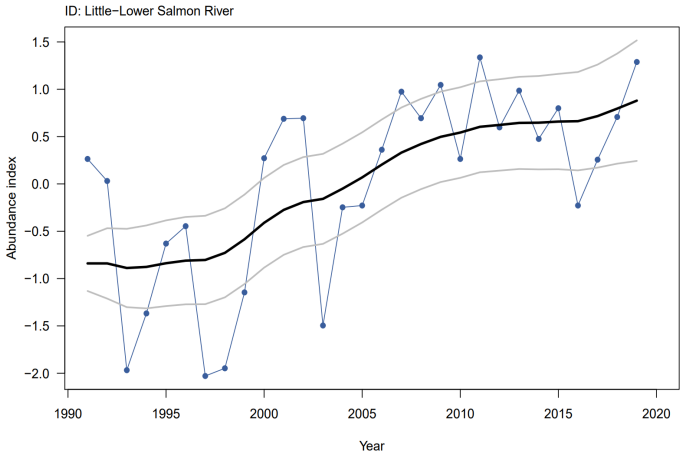
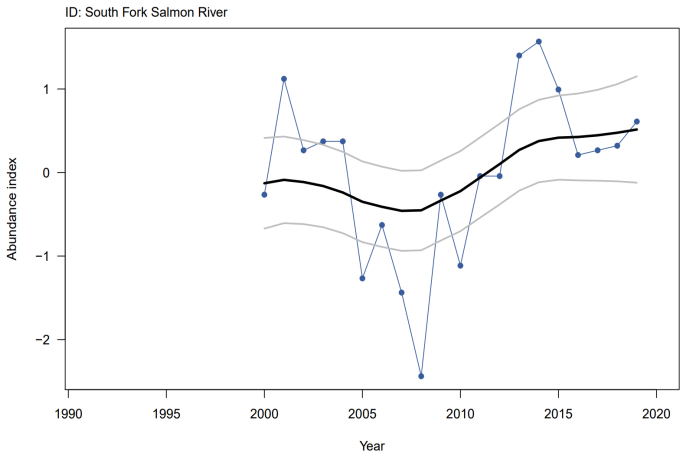
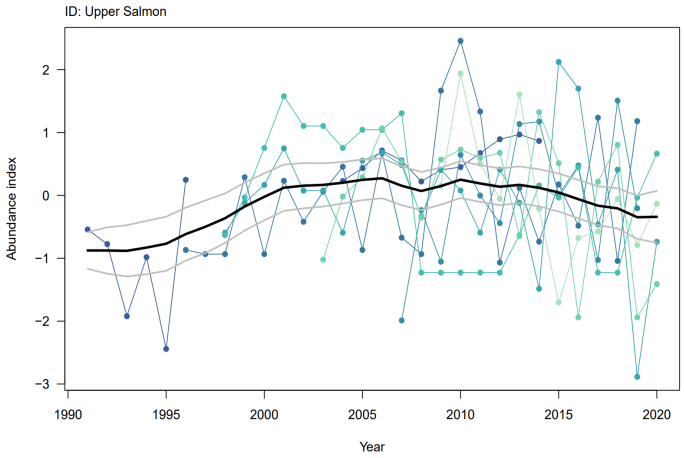
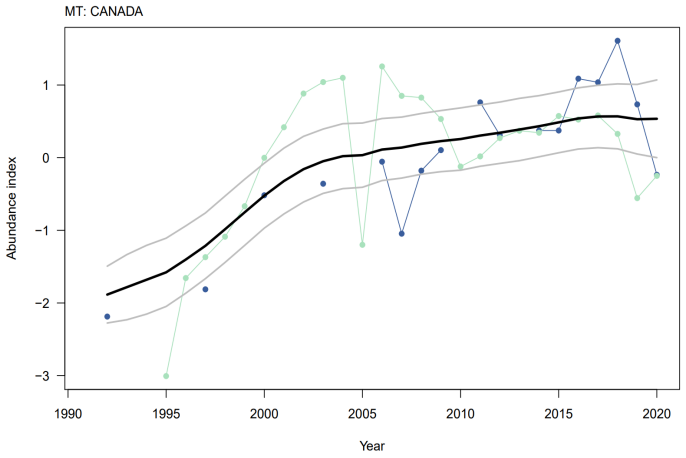


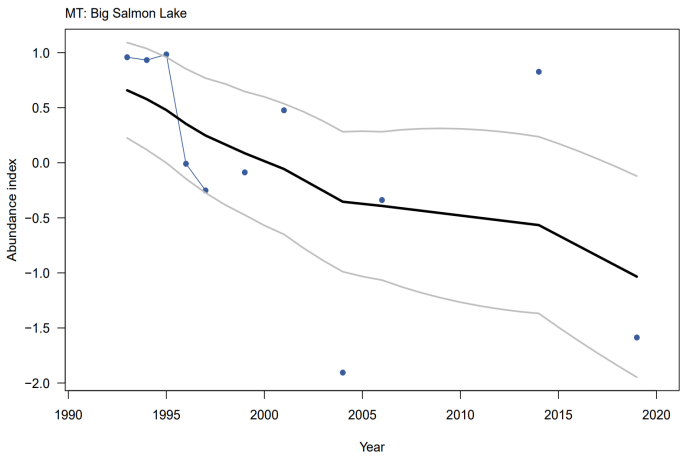
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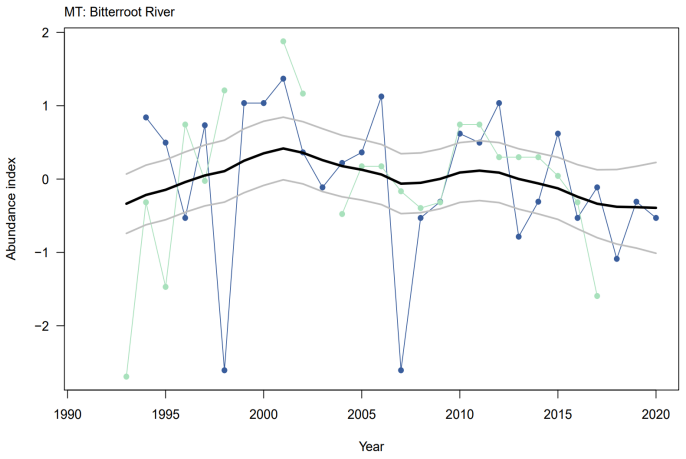


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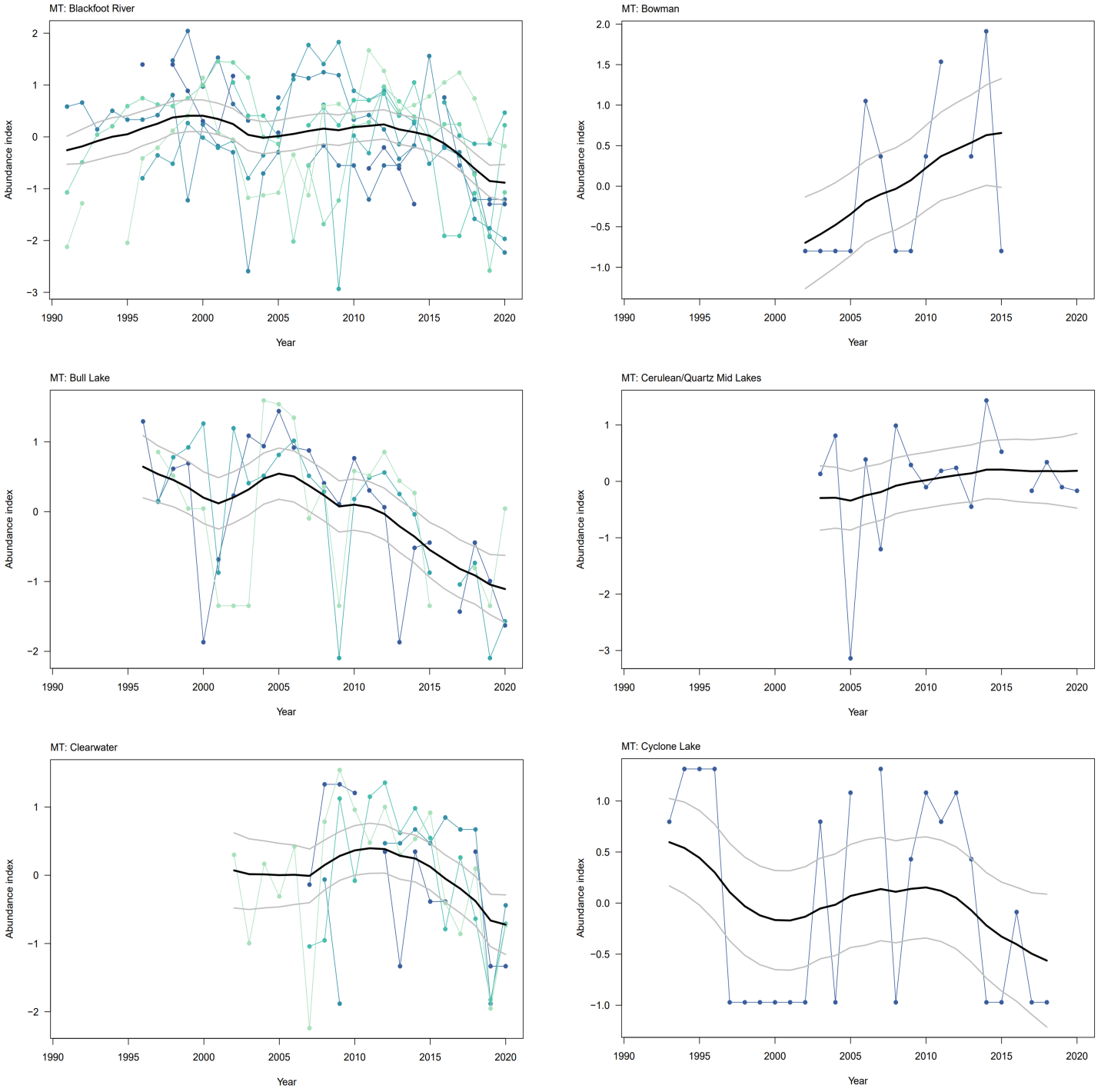
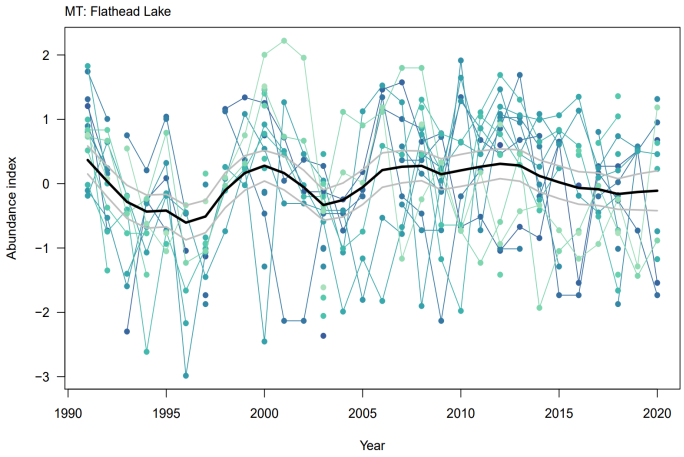
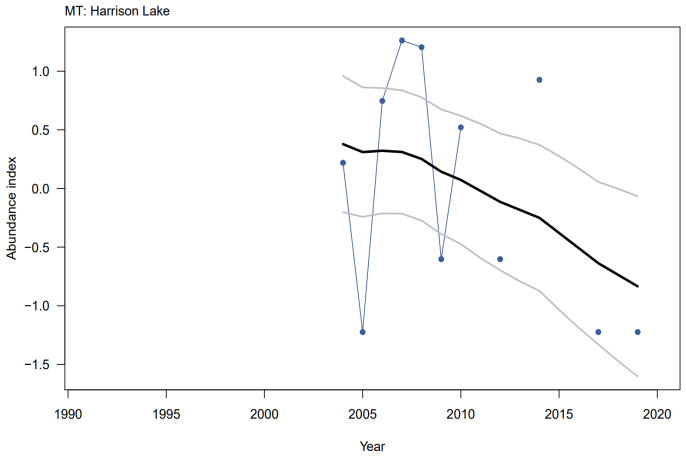
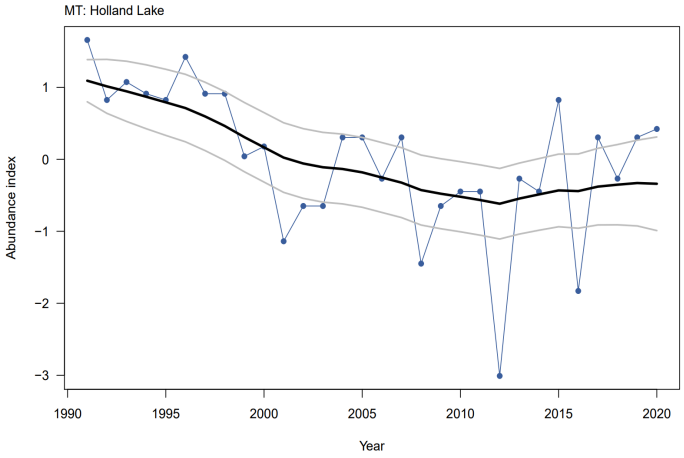
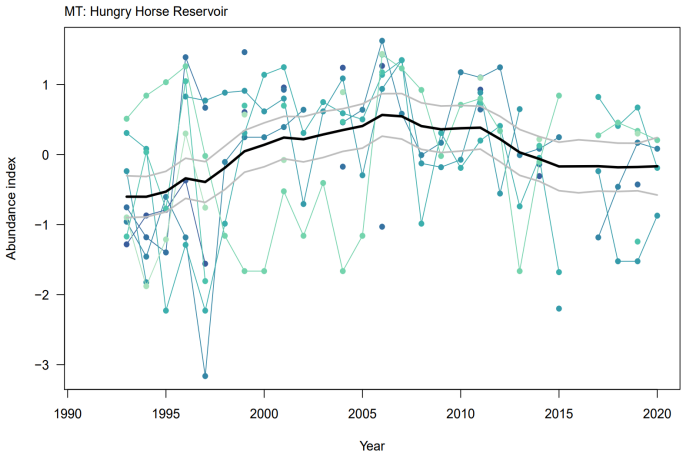


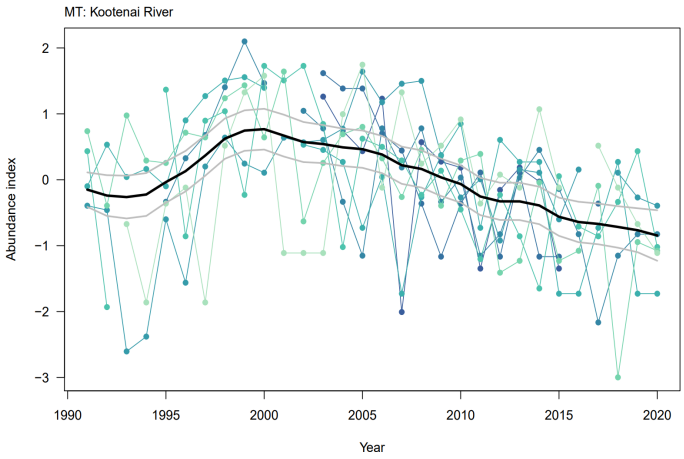
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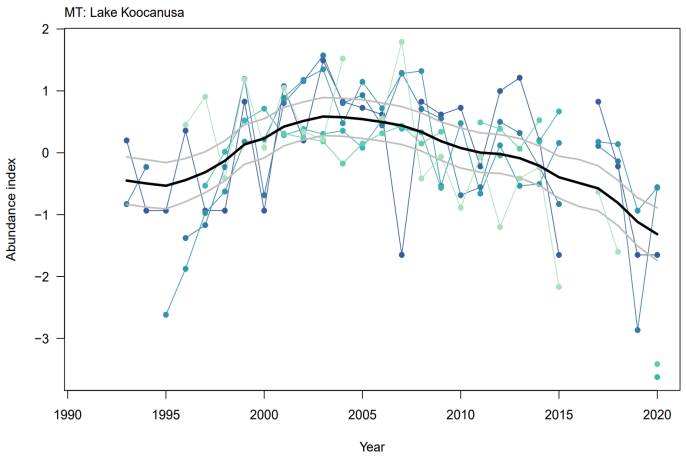
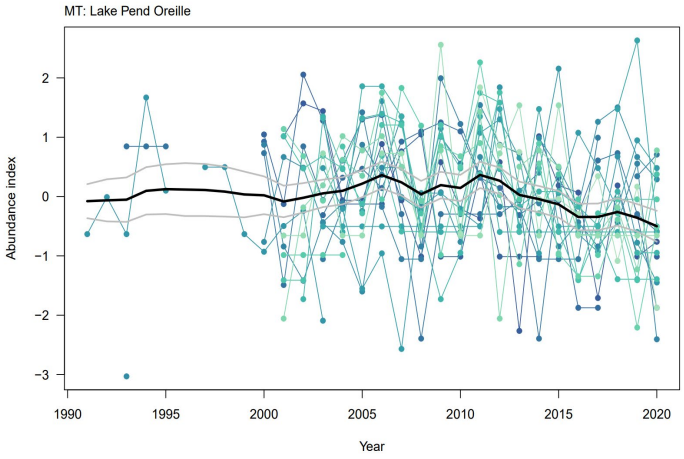
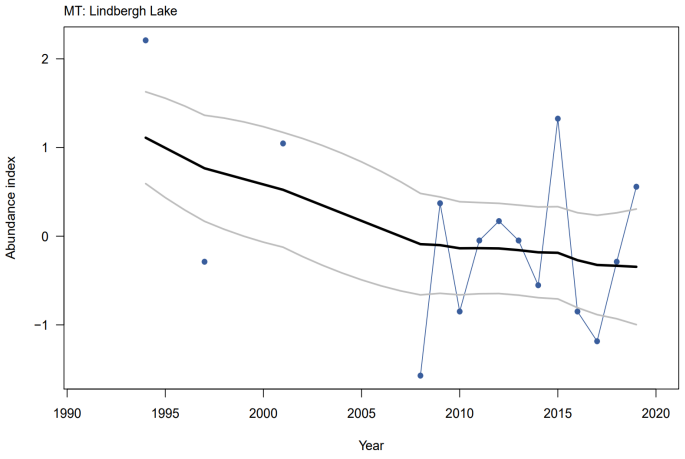
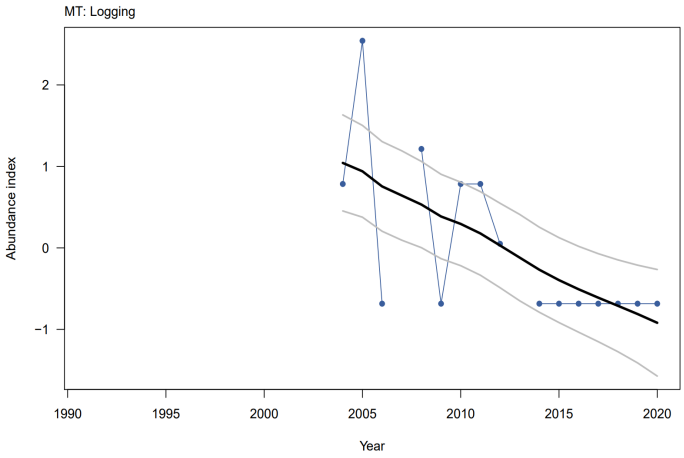
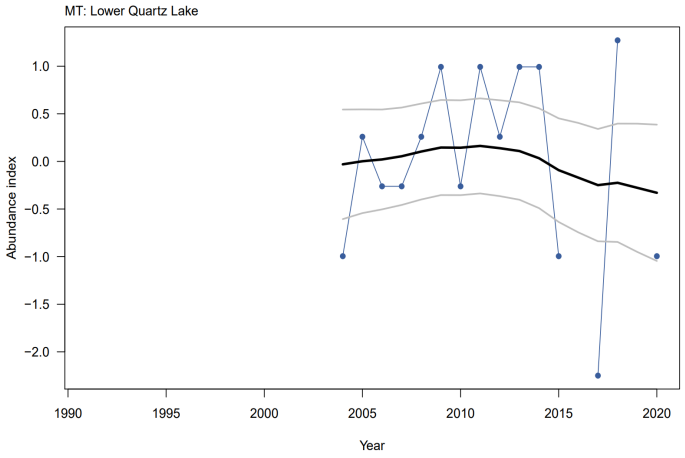


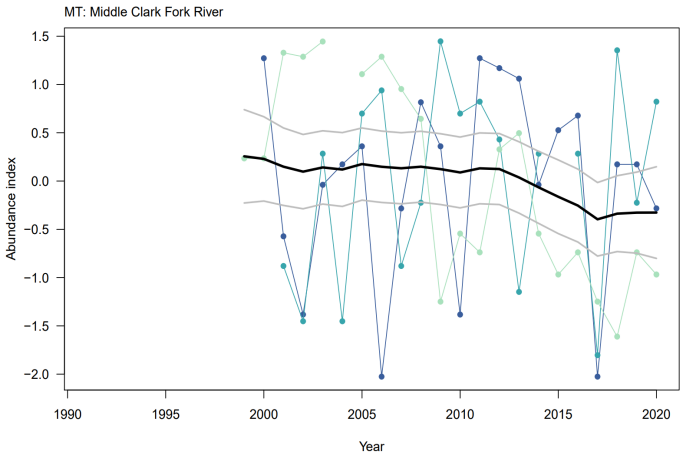
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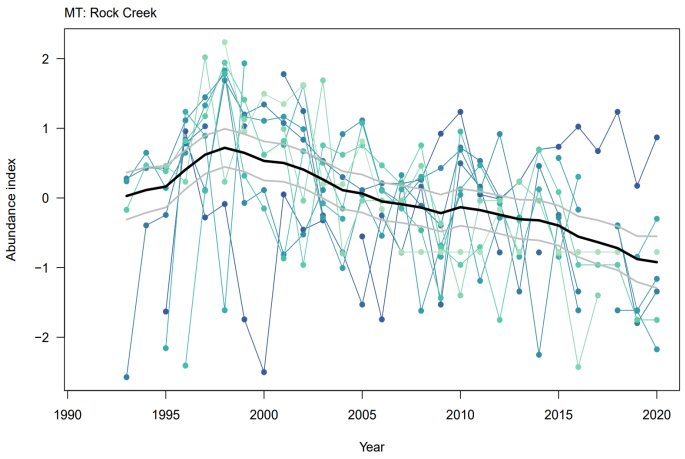
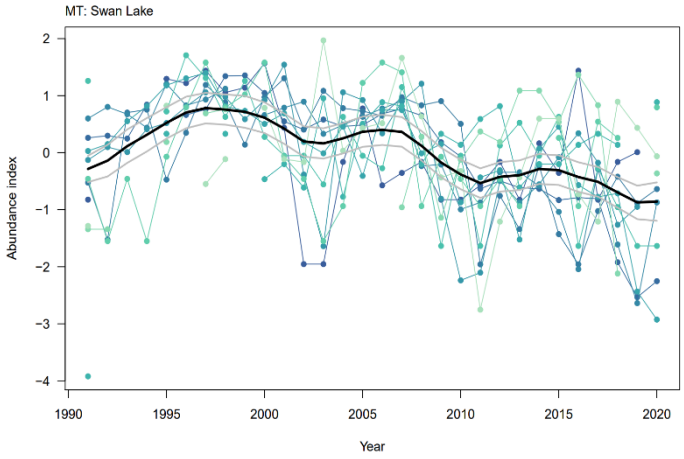
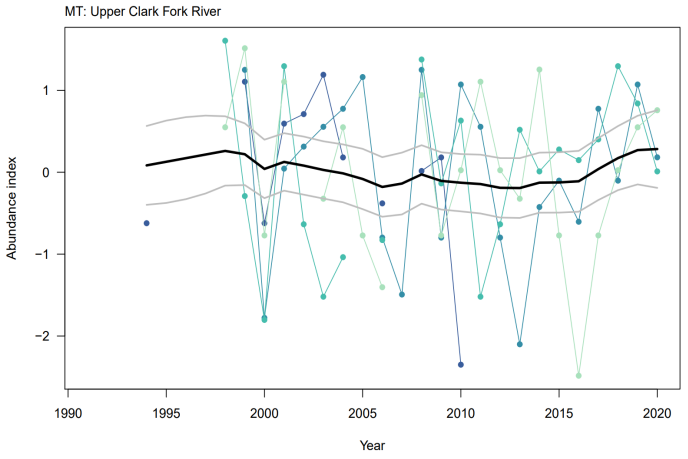
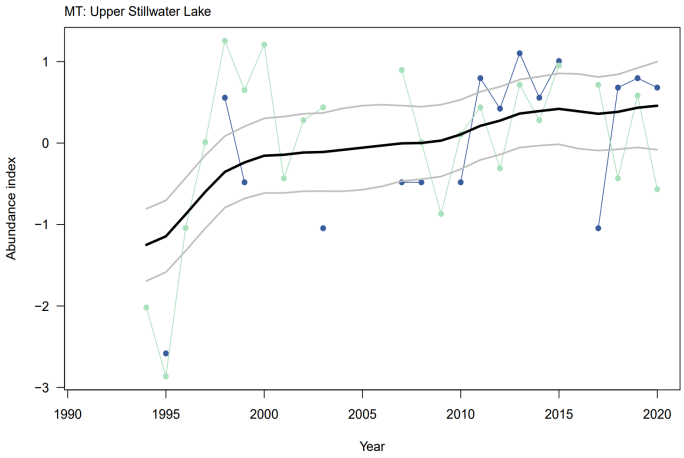
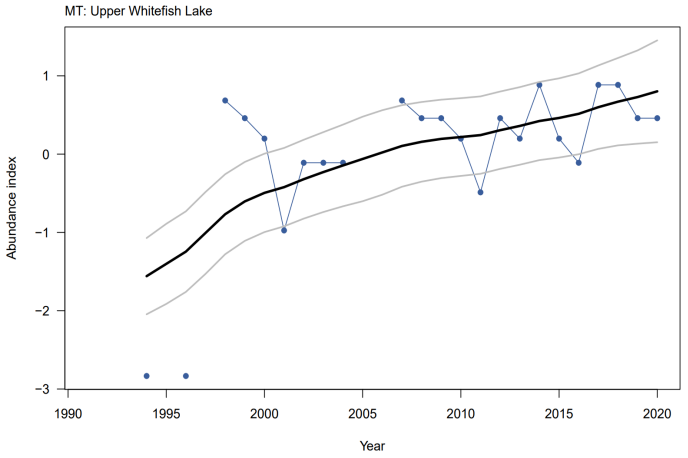


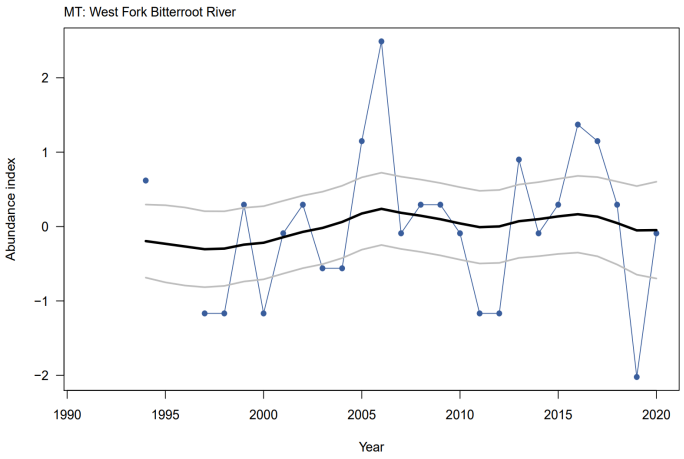
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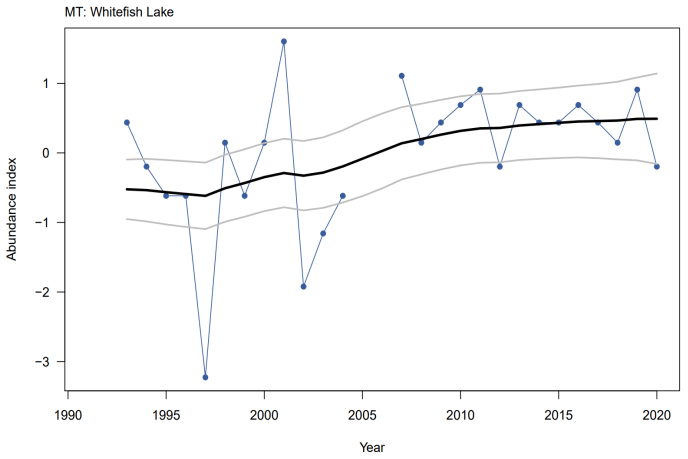
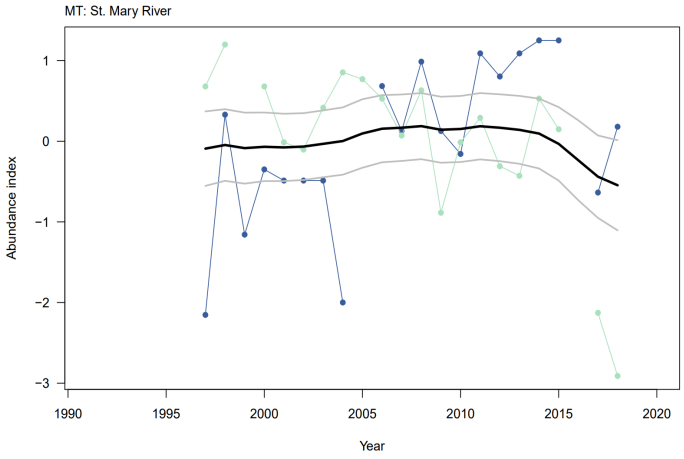
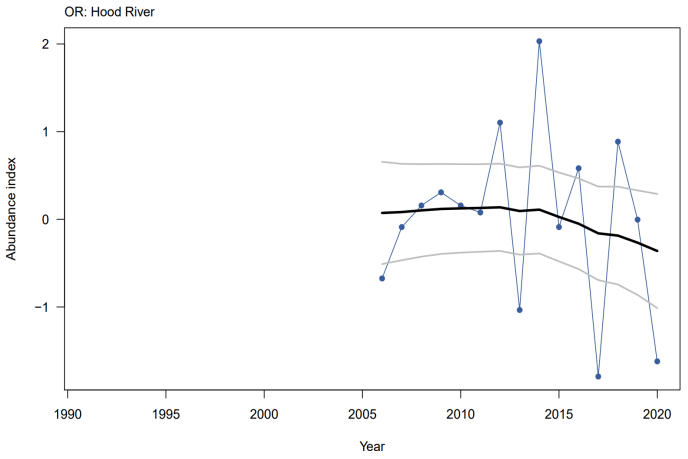
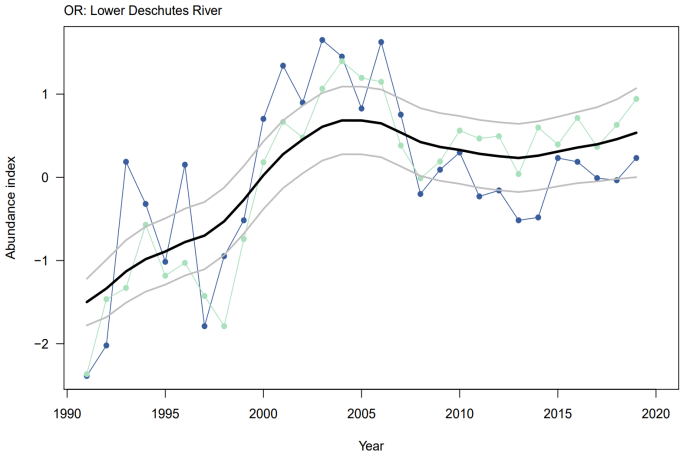
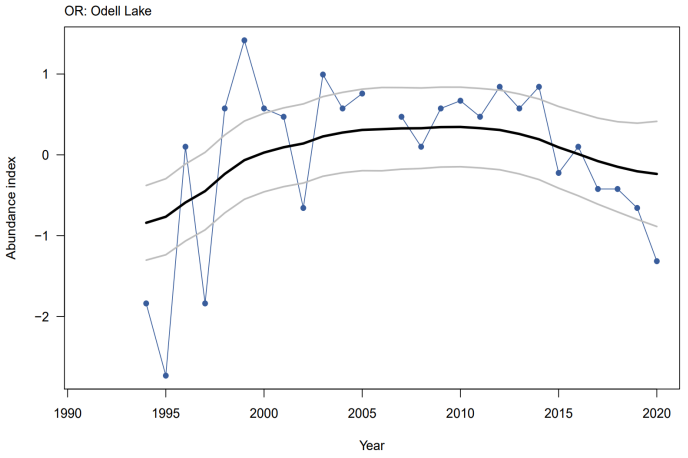


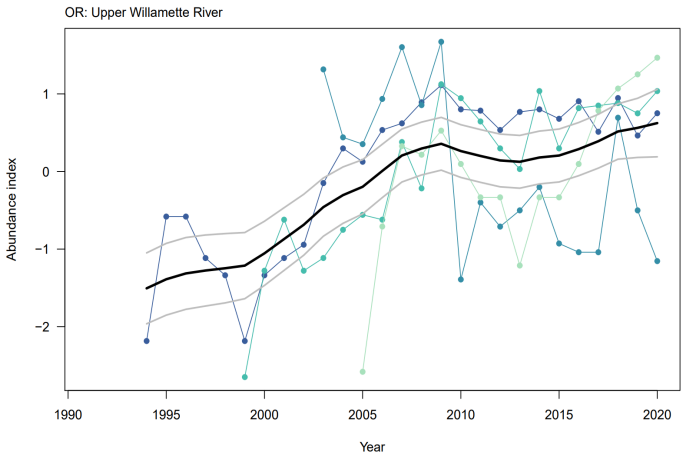
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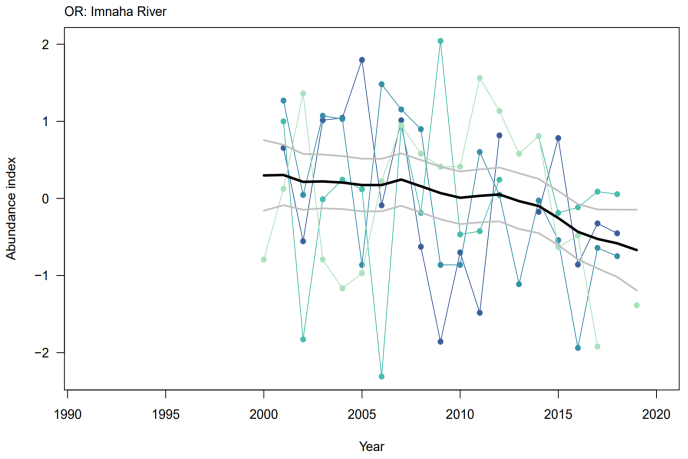


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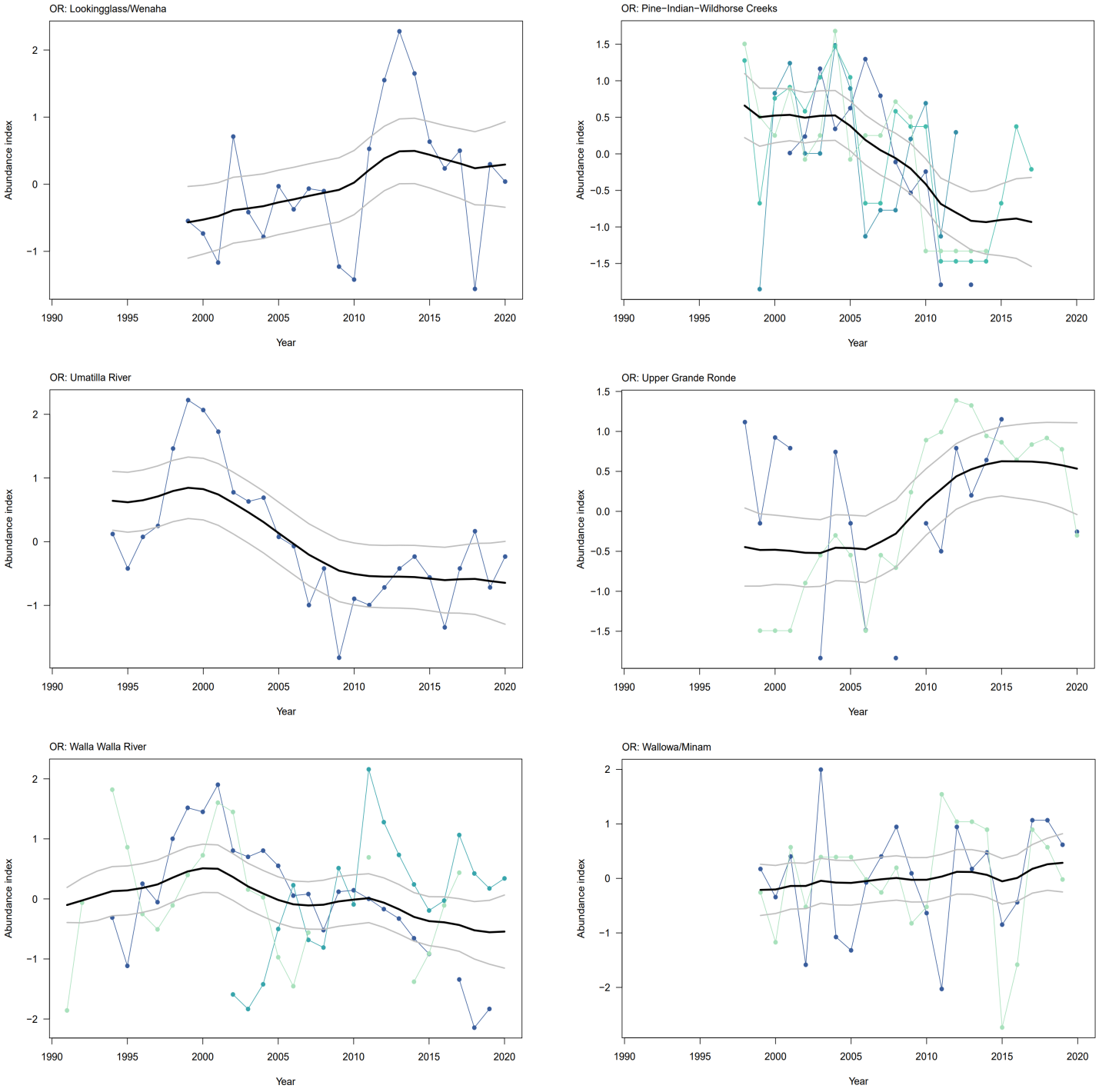
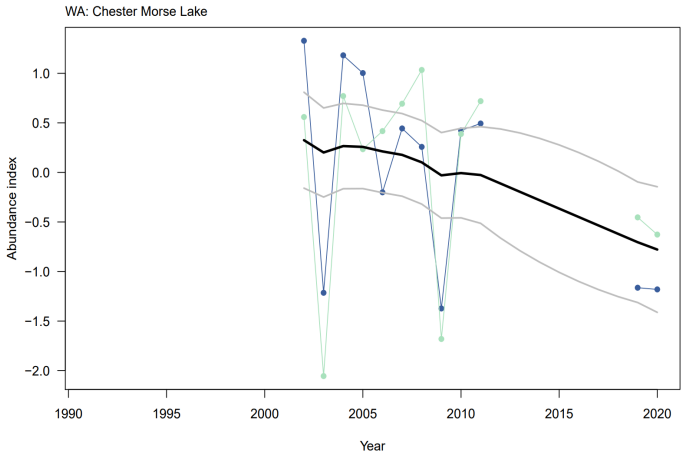
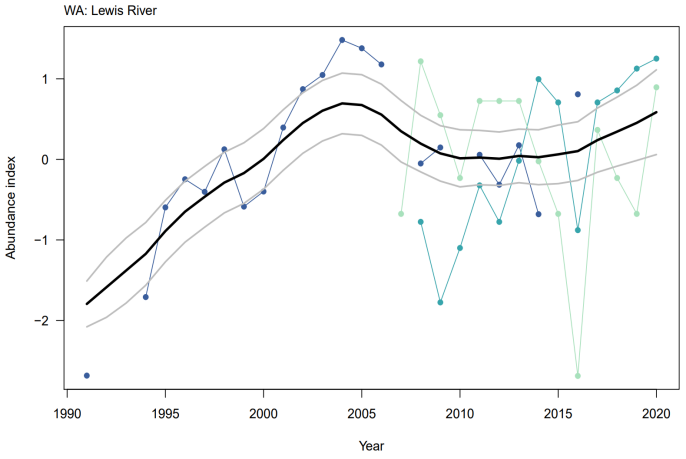
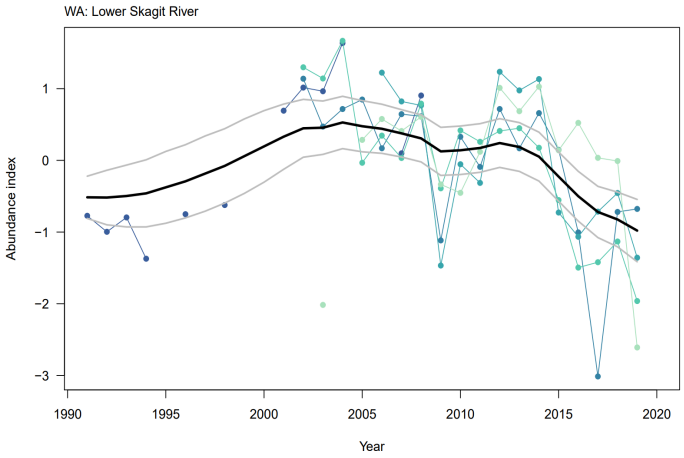
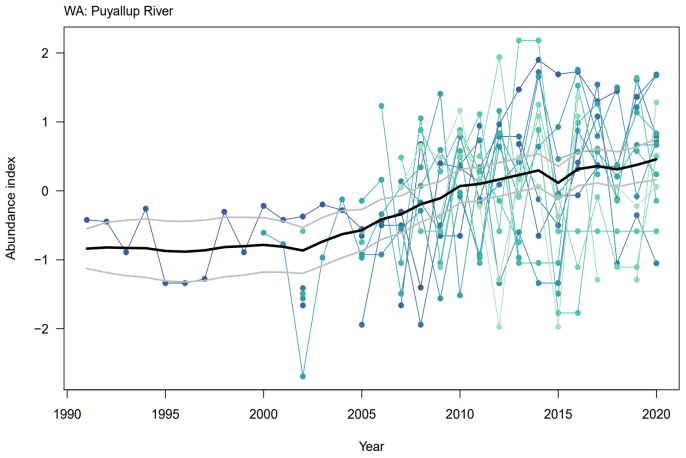


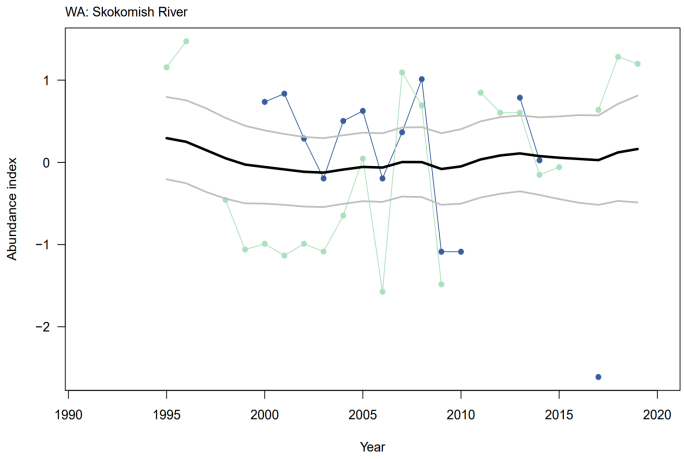
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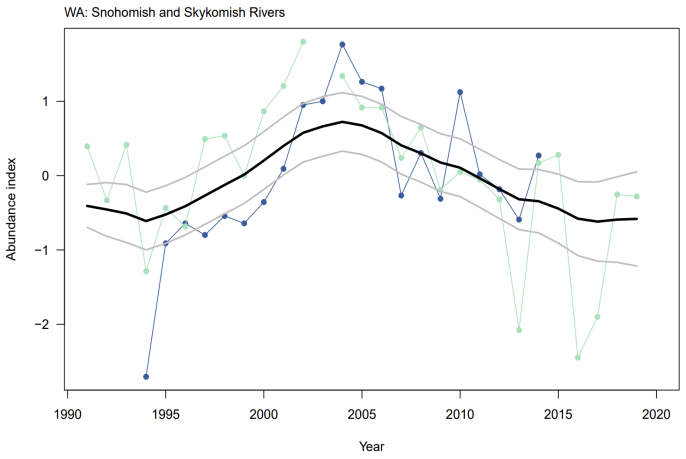


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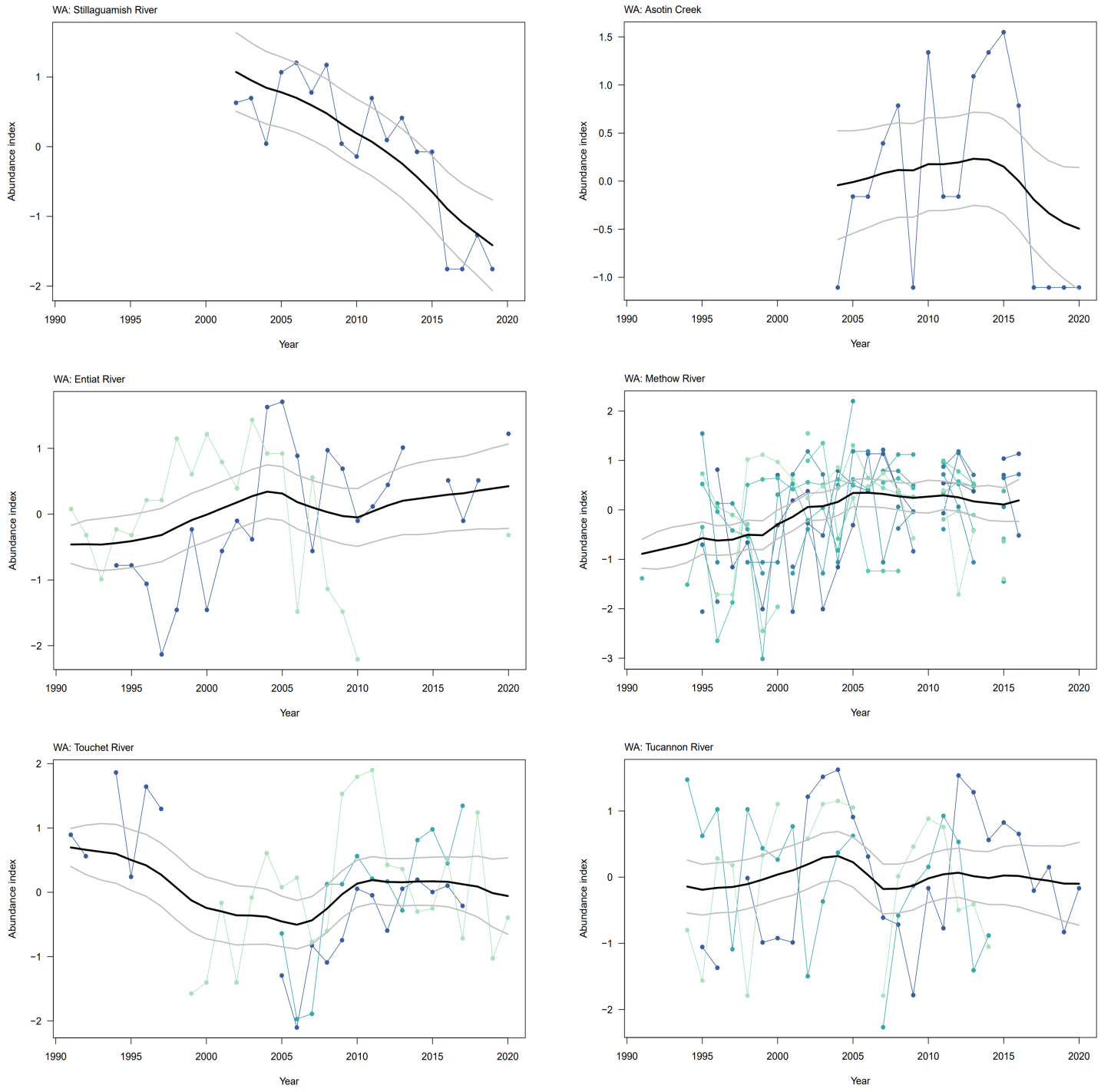
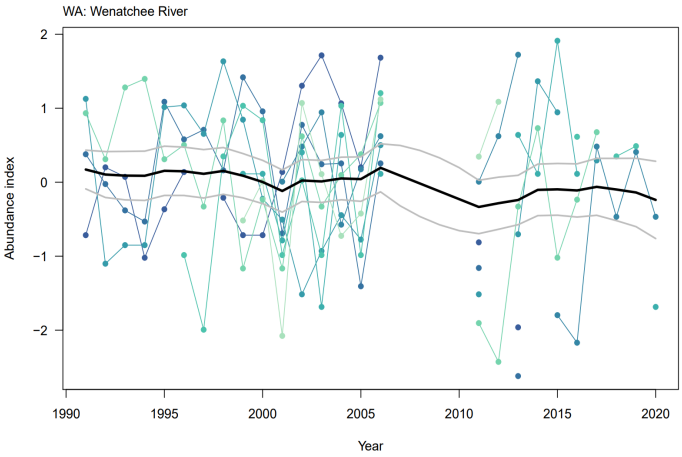


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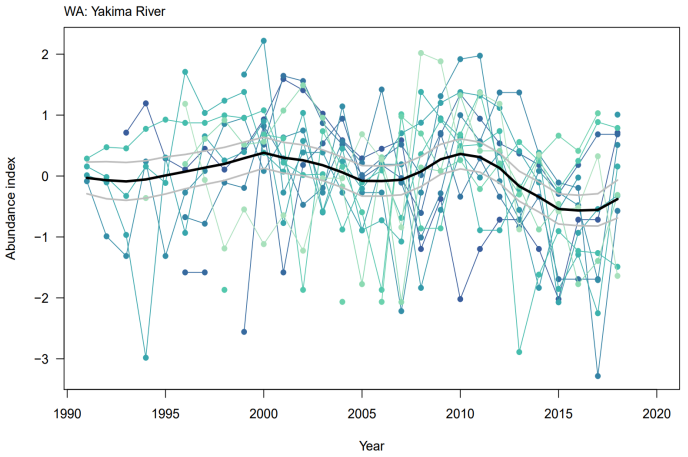


Figure 2. Summary plots of standardized indices of log-abundance for juvenile bull trout over time by core areas (i.e. location indicated on plots by State: Core Area). Fitted trend lines are shown in (black) and associated 90% confidence intervals are shown in gray. Growth rate factor scoring was based on late-period trends calculated from 2008-2020.

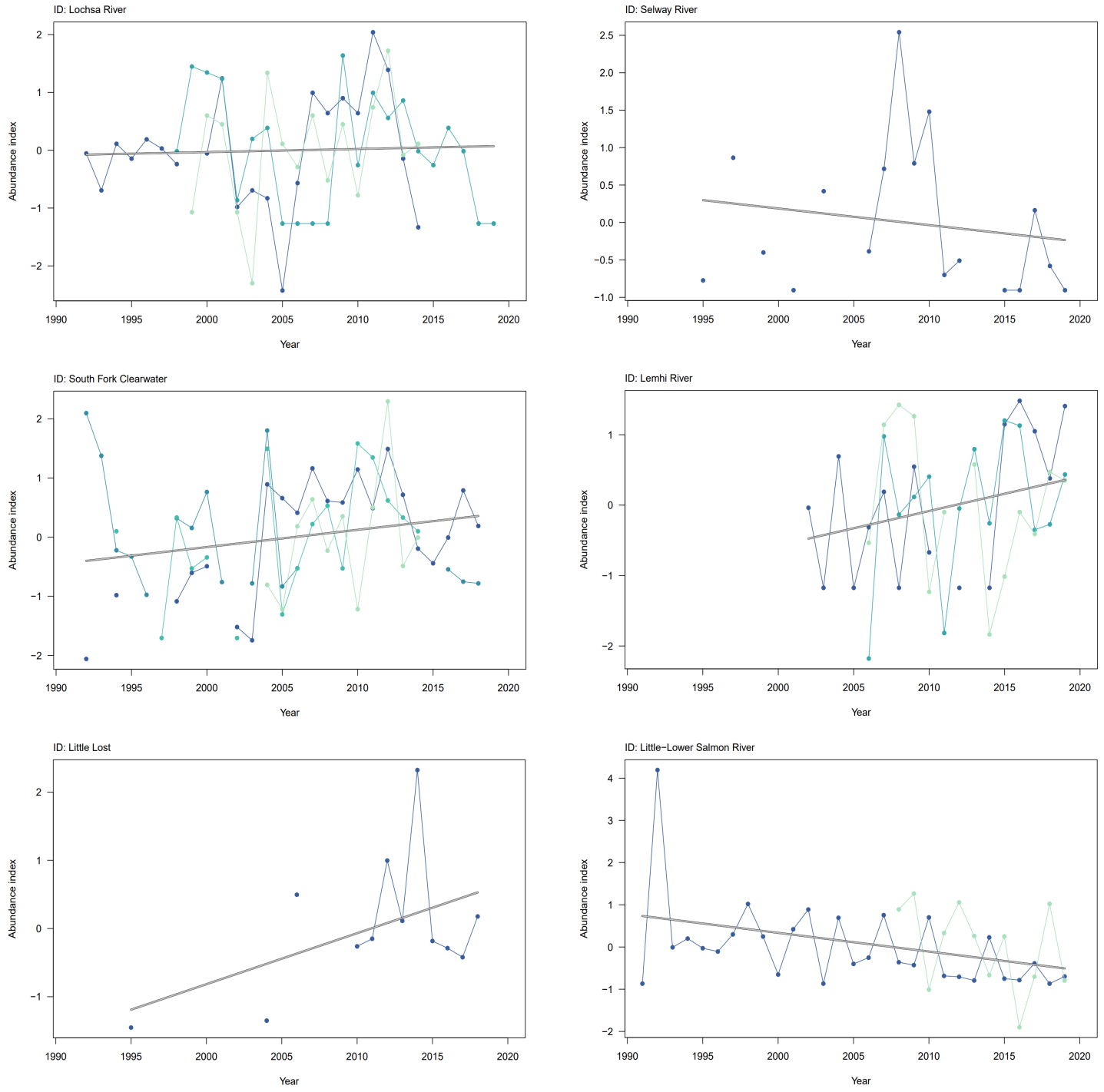
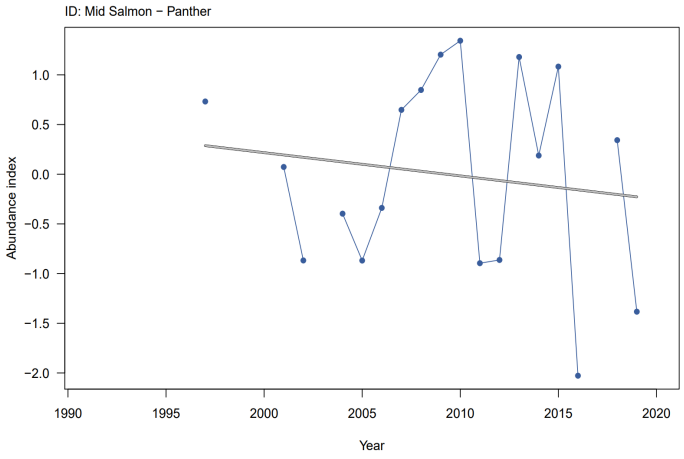
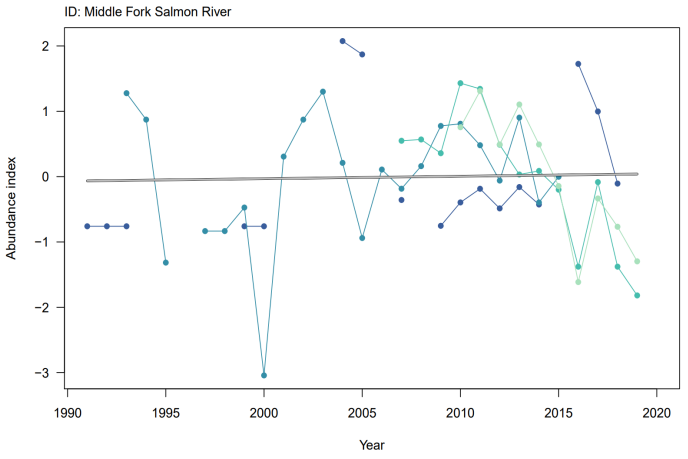
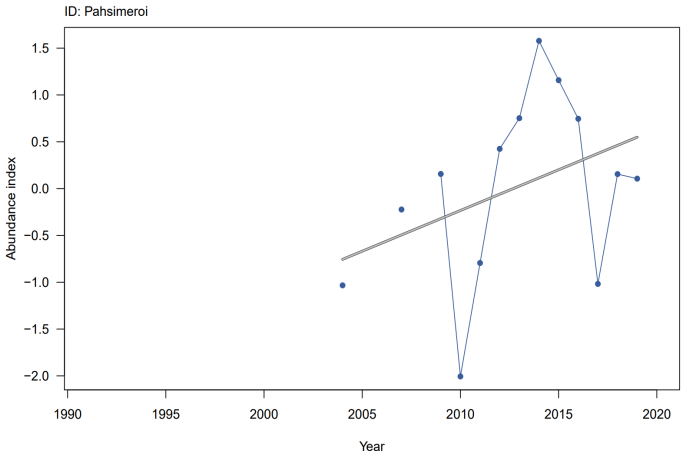
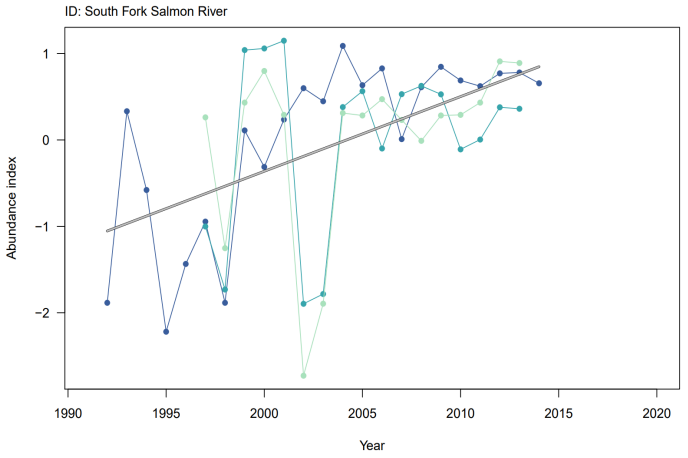


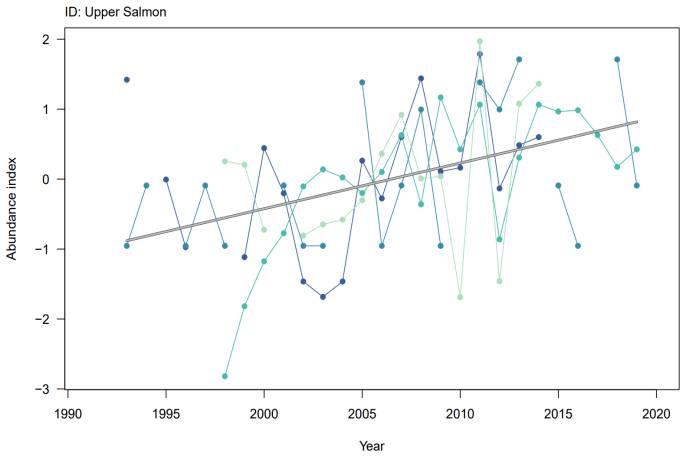
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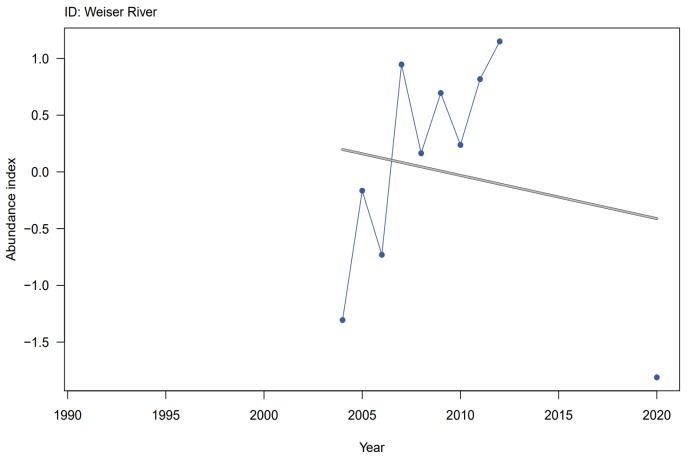
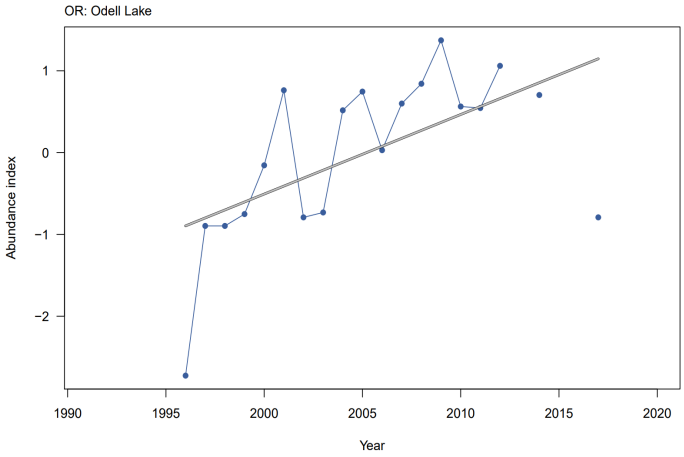
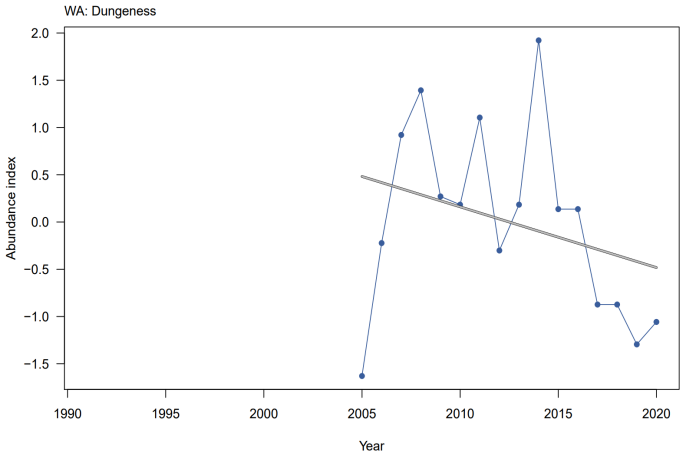
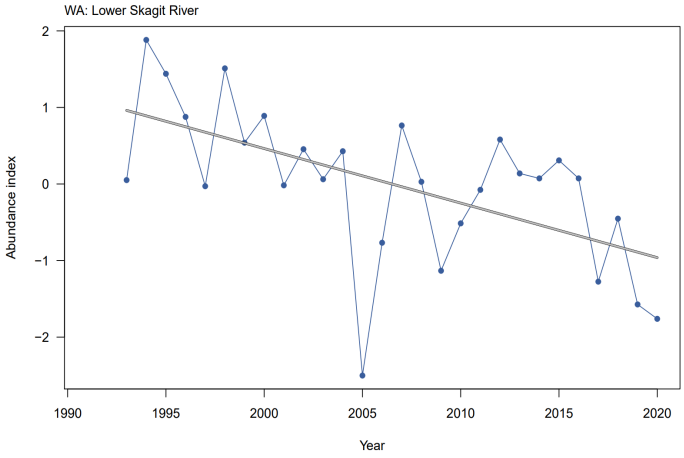
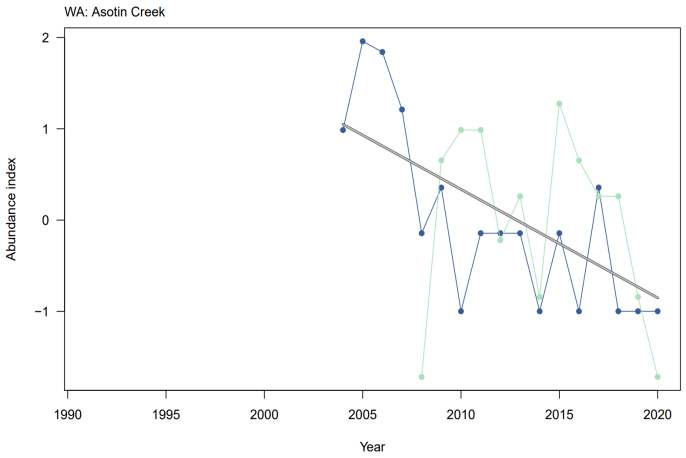


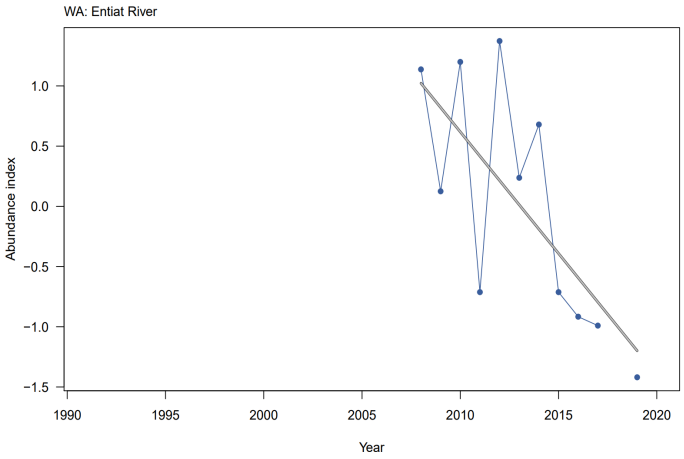
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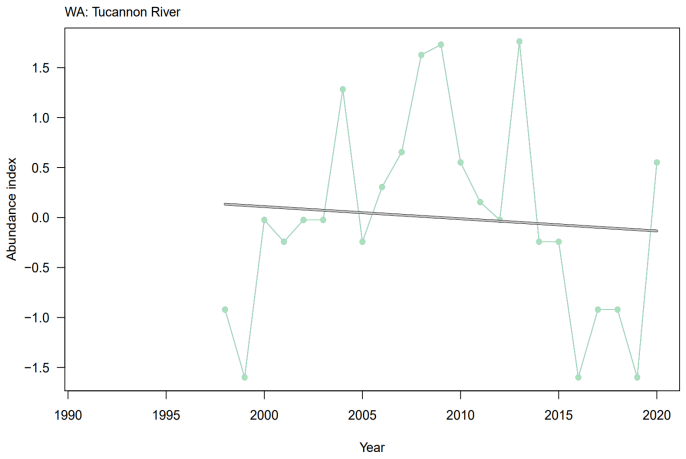
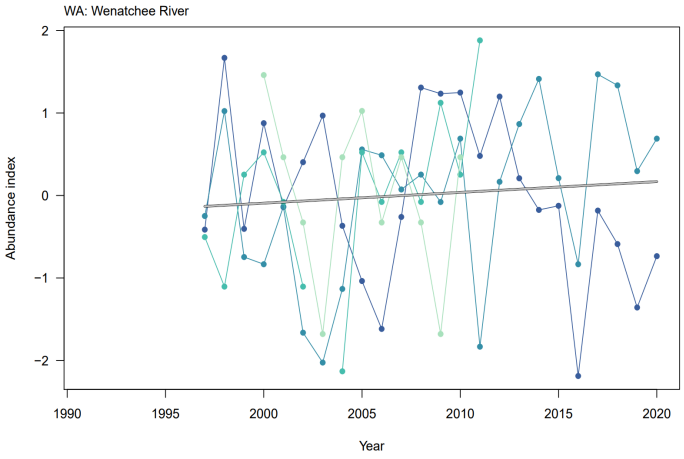


Figure 2. continued.



Appendix E. Current and Future Spawning and Rearing Habitat

Table 1. Total stream length (km) of bull trout (*Salvelinus confluentus*) spawning and rearing habitat in the Columbia Headwaters Recovery Unit, by Core Area for current (*ca* 2015), near term (2031-2050), and far term (2071-2090). Bull Trout Critical Habitat is defined by USFWS (USFWS 2010, USFWS 2015). All stream lengths are derived from the National Hydrography Dataset (NHD). Modeled stream temperature data derived from the NorWeST database (Isaak et al, 2017). Values for each Core Area indicate the cumulative distance of streams with mean August stream temperatures ≤13ºC, an indication of suitability for bull trout spawning and rearing (after Dunham et al. 2003, Isaak et al. 2015). 'Current' stream length values are approximate and not consistently equal to Critical Habitat values due to non-overlapping geometries among the two data sources. All units are in kilometers.

Recovery Unit	Core Area	State	Critical Habitat	Current	Near Term	Far Term
Columbia Headwaters	Akokala Lake	MT	5.04	5.05	5.00	5.00
Columbia Headwaters	Big Salmon Lake	MT	7.37	7.39	7.39	3.14
Columbia Headwaters	Bitterroot River	MT	411.62	411.58	223.78	182.84
Columbia Headwaters	Blackfoot River	MT	255.47	251.14	206.10	154.61
Columbia Headwaters	Bowman Lake	MT	14.23	14.24	12.20	12.20
Columbia Headwaters	Bull Lake	MT	15.25	15.32	15.32	4.04
Columbia Headwaters	Clark Fork River (Section 1)	MT	217.79	211.24	129.45	114.44
Columbia Headwaters	Clark Fork River (Section 2)	MT	272.48	272.65	184.20	138.20
Columbia Headwaters	Clearwater River & Lakes	MT	91.14	91.55	69.37	60.18
Columbia Headwaters	Coeur d'Alene Lake	ID	426.52	426.61	335.42	263.45
Columbia Headwaters	Cyclone Lake	MT	14.62	14.65	7.31	7.18
Columbia Headwaters	Doctor Lake	MT	7.70	7.71	5.06	4.04
Columbia Headwaters	Flathead Lake	MT	360.83	360.38	337.31	306.39
Columbia Headwaters	Frozen Lake	MT	4.88	4.88	4.88	4.88
Columbia Headwaters	Harrison Lake	MT	6.84	6.86	5.15	3.34
Columbia Headwaters	Holland Lake	MT	0.76	0.77	0.77	0.77
Columbia Headwaters	Hungry Horse Reservoir	MT	198.11	195.92	187.63	122.25
Columbia Headwaters	Isabel Lakes	MT	1.01	0.19	0.19	0.19
Columbia Headwaters	Kootenai River	MT	196.67	197.15	120.45	90.05

Recovery Unit	Core Area	State	Critical Habitat	Current	Near Term	Far Term
Columbia Headwaters	Lake Koocanusa	MT	40.76	40.77	40.77	35.15
Columbia Headwaters	Lake Pend Oreille A	MT	171.77	171.84	130.60	103.70
Columbia Headwaters	Lake Pend Oreille B	ID	124.35	122.40	71.89	52.88
Columbia Headwaters	Lake Pend Oreille C	WA	225.10	197.45	113.34	71.11
Columbia Headwaters	Lincoln Lake	MT	0.81	0.83	0.08	0.02
Columbia Headwaters	Lindbergh Lake	MT	7.60	7.60	0	0
Columbia Headwaters	Logging Lake	MT	1.82	1.84	0	0
Columbia Headwaters	Lower Quartz Lake	MT	1.47	1.46	0	0
Columbia Headwaters	Priest Lakes	ID	146.52	146.06	140.59	96.74
Columbia Headwaters	Quartz Lakes	MT	9.39	9.41	8.94	8.94
Columbia Headwaters	Rock Creek	MT	262.90	263.18	246.74	176.06
Columbia Headwaters	Swan Lake	MT	152.59	149.87	130.67	115.21
Columbia Headwaters	Trout / Arrow Lakes	MT	9.96	9.96	0	0
Columbia Headwaters	Upper Kintla Lake	MT	9.34	9.36	7.71	7.50
Columbia Headwaters	Upper Stillwater Lake	MT	44.74	44.75	29.58	24.87
Columbia Headwaters	Upper Whitefish Lake	MT	9.44	9.45	9.45	9.45
Columbia Headwaters	West Fork Bitterroot River	MT	141.15	141.26	117.26	93.96
Columbia Headwaters	Whitefish Lake	MT	12.60	12.61	12.61	12.61
Columbia Headwaters	TOTAL		3,880.6	3,835.4	2,917.2	2,285.4

Citations:

Dunham, J.B., B.E. Rieman, and G.L. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23: 894–904.

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Table 2. Total stream length (km) of bull trout (*Salvelinus confluentus*) spawning and rearing habitat in the Coastal Recovery Unit, by Core Area for current (*ca* 2015), near term (2031-2050), and far term (2071-2090). Bull Trout Critical Habitat is defined by USFWS (USFWS 2010, USFWS 2015). All stream lengths are derived from the National Hydrography Dataset (NHD). Modeled stream temperature data derived from the NorWeST database (Isaak et al, 2017). Values for each Core Area indicate the cumulative distance of streams with mean August stream temperatures ≤13ºC, an indication of suitability for bull trout spawning and rearing (after Dunham et al. 2003, Isaak et al. 2016). 'Current' stream length values are approximate and not consistently equal to Critical Habitat values due to non-overlapping geometries among the two data sources. All units are in kilometers.

Recovery Unit	Core Area	State	Critical Habitat	Current	Near Term	Far Term
Coastal	Chester Morse Lake	WA	20.12	19.21	15.63	2.05
Coastal	Chilliwack River	WA	47.97	48.01	48.01	48.01
Coastal	Dungeness River	WA	43.91	43.17	38.88	26.39
Coastal	Elwha River	WA	94.21	94.74	89.95	70.25
Coastal	Hoh River	WA	97.70	83.15	55.38	28.73
Coastal	Hood River	OR	23.37	21.86	21.86	21.40
Coastal	Klickitat River	WA	32.10	31.49	31.49	31.49
Coastal	Lewis River	WA	24.65	27.22	23.84	22.77
Coastal	Lower Deschutes River	OR	116.63	111.76	89.70	85.39
Coastal	Lower Skagit River	WA	310.58	295.55	245.07	192.95
Coastal	Nooksack River	WA	228.16	243.33	143.12	93.24
Coastal	Odell Lake	OR	11.49	9.01	8.99	8.99
Coastal	Puyallup River	WA	261.97	229.41	177.71	123.58
Coastal	Queets River	WA	47.17	41.68	37.60	27.58
Coastal	Quinault River	WA	61.01	57.90	49.13	27.72
Coastal	Skokomish River	WA	39.85	38.61	29.45	14.11
Coastal	Snohomish & Skykomish Rivers	WA	107.97	114.12	24.69	9.38
Coastal	Stillaguamish River	WA	145.53	155.39	30.63	15.16
Coastal	Upper Skagit River	WA	168.46	162.87	162.78	152.58
Coastal	Upper Willamette River	OR	25.57	19.63	12.63	9.14
Coastal	White Salmon River	WA	15.05	16.01	6.85	4.04

Citations:

Dunham, J.B., B.E. Rieman, and G.L. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23: 894–904.

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U.S. Fish and Wildlife Service. 2010. [https://www.fws.gov/pacific/bulltrout/FinalCH2010.html]

U.S. Fish and Wildlife Service. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). Portland, Oregon. xii + 179 pages.

Table 3. Total stream length (km) of bull trout (*Salvelinus confluentus*) spawning and rearing habitat in the Klamath Recovery Unit, by Core Area for current (*ca* 2015), near term (2031-2050), and far term (2071-2090). Bull Trout Critical Habitat is defined by USFWS (USFWS 2010, USFWS 2015). All stream lengths are derived from the National Hydrography Dataset (NHD). Modeled stream temperature data derived from the NorWeST database (Isaak et al, 2017). Values for each Core Area indicate the cumulative distance of streams with mean August stream temperatures ≤13ºC, an indication of suitability for bull trout spawning and rearing (after Dunham et al. 2003, Isaak et al. 2016). 'Current' stream length values are approximate and not consistently equal to Critical Habitat values due to non-overlapping geometries among the two data sources. All units are in kilometers.

Recovery Unit	Core Area	State	Critical Habitat	Current	Near Term	Far Term
Klamath	Sycan River	OR	53.88	53.95	43.92	41.04
Klamath	Upper Klamath Lake	OR	105.26	97.99	81.19	74.40
Klamath	Upper Sprague River	OR	84.13	84.26	66.95	59.28

Citations:

Dunham, J.B., B.E. Rieman, and G.L. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23: 894–904.

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U.S. Fish and Wildlife Service. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). Portland, Oregon. xii + 179 pages.

Table 4. Total stream length (km) of bull trout (*Salvelinus confluentus*) spawning and rearing habitat in the MidColumbia Recovery Unit, by Core Area for current (*ca* 2015), near term (2031-2050), and far term (2071-2090). Bull Trout Critical Habitat is defined by USFWS (USFWS 2010, USFWS 2015). All stream lengths are derived from the National Hydrography Dataset (NHD). Modeled stream temperature data derived from the NorWeST database (Isaak et al, 2017). Values for each Core Area indicate the cumulative distance of streams with mean August stream temperatures ≤13ºC, an indication of suitability for bull trout spawning and rearing (after Dunham et al. 2003, Isaak et al. 2016). 'Current' stream length values are approximate and not consistently equal to Critical Habitat values due to non-overlapping geometries among the two data sources. All units are in kilometers.

Recovery Unit	Core Area	State	Critical Habitat	Current	Near Term	Far Term
MidColumbia	Asotin Creek	WA	16.31	16.32	15.02	12.02
MidColumbia	Entiat River	WA	57.57	64.43	16.36	8.66
MidColumbia	Imnaha River	OR	126.28	126.47	72.70	63.13
MidColumbia	Little Minam River	OR	21.13	21.16	20.50	17.82
MidColumbia	Lochsa River	ID	285.99	286.32	178.53	101.31
MidColumbia	Lookingglass / Wenaha	OR	79.11	79.29	61.50	54.98
MidColumbia	Methow River	WA	381.81	390.27	245.18	191.63
MidColumbia	Middle Fork John Day River	OR	82.43	82.54	33.61	23.80
MidColumbia	North Fork Clearwater River	ID	503.24	504.00	295.43	196.94
MidColumbia	North Fork John Day River	OR	187.22	185.98	108.95	79.70
MidColumbia	Pine, Indian & Wildhorse Creeks	OR	142.11	142.13	96.31	86.39
MidColumbia	Powder River	OR	93.86	93.99	82.80	75.78
MidColumbia	Selway River	ID	437.38	437.96	184.18	84.67
MidColumbia	South Fork Clearwater River	ID	253.98	254.37	129.91	64.78
MidColumbia	Touchet River	WA	41.06	41.82	38.94	35.85
MidColumbia	Tucannon River	WA	71.63	71.67	67.34	58.68
MidColumbia	Umatilla River	OR	29.37	29.39	19.83	16.29
MidColumbia	Upper Grande Ronde	OR	152.76	152.96	85.70	59.21
MidColumbia	Upper Mainstem John Day River	OR	108.63	108.63	90.61	79.73
MidColumbia	Walla Walla River	WA	79.93	78.37	61.38	59.17
MidColumbia	Wallowa / Minam	OR	143.26	143.49	83.16	45.56
MidColumbia	Wenatchee River	WA	303.42	297.57	162.69	113.78
MidColumbia	Yakima River	WA	529.46	496.62	300.84	231.82
MidColumbia	Eagle Creek	OR	66.30	66.30	49.45	43.03

Citations:

Dunham, J.B., B.E. Rieman, and G.L. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23: 894–904.

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Table 5. Total stream length (km) of bull trout (*Salvelinus confluentus*) spawning and rearing habitat in the Saint Mary Recovery Unit, by Core Area for current (*ca* 2015), near term (2031-2050), and far term (2071-2090). Bull Trout Critical Habitat is defined by USFWS (USFWS 2010, USFWS 2015). All stream lengths are derived from the National Hydrography Dataset (NHD). Modeled stream temperature data derived from the NorWeST database (Isaak et al, 2017). Values for each Core Area indicate the cumulative distance of streams with mean August stream temperatures ≤13ºC, an indication of suitability for bull trout spawning and rearing (after Dunham et al. 2003, Isaak et al. 2016). 'Current' stream length values are approximate and not consistently equal to Critical Habitat values due to non-overlapping geometries among the two data sources. All units are in kilometers.

Recovery Unit	Core Area	State	Critical Habitat	Current	Near Term	Far Term
Saint Mary	Cracker Lake	MT	1.54	1.54	1.54	1.54
Saint Mary	Red Eagle Lake	MT	4.60	4.61	4.61	2.00
Saint Mary	Saint Mary River	MT	100.55	99.76	62.21	50.00
Saint Mary	Slide Lake	MT	5.96	6.00	6.00	6.00

Citations:

Dunham, J.B., B.E. Rieman, and G.L. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23: 894–904.

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U.S. Fish and Wildlife Service. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). Portland, Oregon. xii + 179 pages.

Table 6. Total stream length (km) of bull trout (*Salvelinus confluentus*) spawning and rearing habitat in the Upper Snake Recovery Unit, by Core Area for current (*ca* 2015), near term (2031-2050), and far term (2071-2090). Bull Trout Critical Habitat is defined by USFWS (USFWS 2010, USFWS 2015). All stream lengths are derived from the National Hydrography Dataset (NHD). Modeled stream temperature data derived from the NorWeST database (Isaak et al, 2017). Values for each Core Area indicate the cumulative distance of streams with mean August stream temperatures ≤13ºC, an indication of suitability for bull trout spawning and rearing (after Dunham et al. 2003, Isaak et al. 2016). 'Current' stream length values are approximate and not consistently equal to Critical Habitat values due to non-overlapping geometries among the two data sources. All units are in kilometers.

Recovery Unit	Core Area	State	Critical Habitat	Current	Near Term	Far Term
Upper Snake	Anderson Ranch Reservoir	ID	257.60	256.89	223.97	207.83
Upper Snake	Arrowrock Reservoir	ID	447.98	448.08	350.24	320.48
Upper Snake	Deadwood River	ID	70.81	70.87	70.87	70.87
Upper Snake	Jarbidge River	ID	55.99	54.67	48.75	41.40
Upper Snake	Lake Creek	ID	13.02	13.02	11.96	10.41
Upper Snake	Lemhi River	ID	243.60	239.45	207.96	180.32
Upper Snake	Little Lost River	ID	56.64	56.00	56.00	56.00
Upper Snake	Little-Lower Salmon River	ID	257.80	248.08	147.24	111.81
Upper Snake	Middle Fork Payette River	ID	115.28	115.30	99.63	86.34
Upper Snake	Middle Fork Salmon River	ID	1431.54	1431.40	1205.43	1058.69
Upper Snake	Middle Salmon River-Chamberlain	ID	273.44	273.44	140.47	83.11
Upper Snake	Middle Salmon River-Panther	ID	598.31	597.80	509.34	449.91
Upper Snake	North Fork Malheur	OR	72.06	72.14	47.60	41.12
Upper Snake	North Fork Payette River	ID	31.16	31.16	28.12	25.82
Upper Snake	Opal Lake	ID	3.48	3.48	3.48	3.48
Upper Snake	Pahsimeroi River	ID	217.29	214.97	174.48	149.17
Upper Snake	South Fork Salmon River	ID	654.44	651.10	523.98	437.41
Upper Snake	Chief Eagle Eye Creek (rename 2023)	ID	72.28	72.32	57.98	54.08
Upper Snake	Upper Malheur	OR	91.41	90.16	48.62	40.64
Upper Snake	Upper Salmon River	ID	724.05	719.42	644.79	586.91
Upper Snake	Upper South Fork Payette River	ID	251.14	251.25	230.90	213.69
Upper Snake	Weiser River	ID	92.43	89.22	73.55	62.03

Citations:

Dunham, J.B., B.E. Rieman, and G.L. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23: 894–904.

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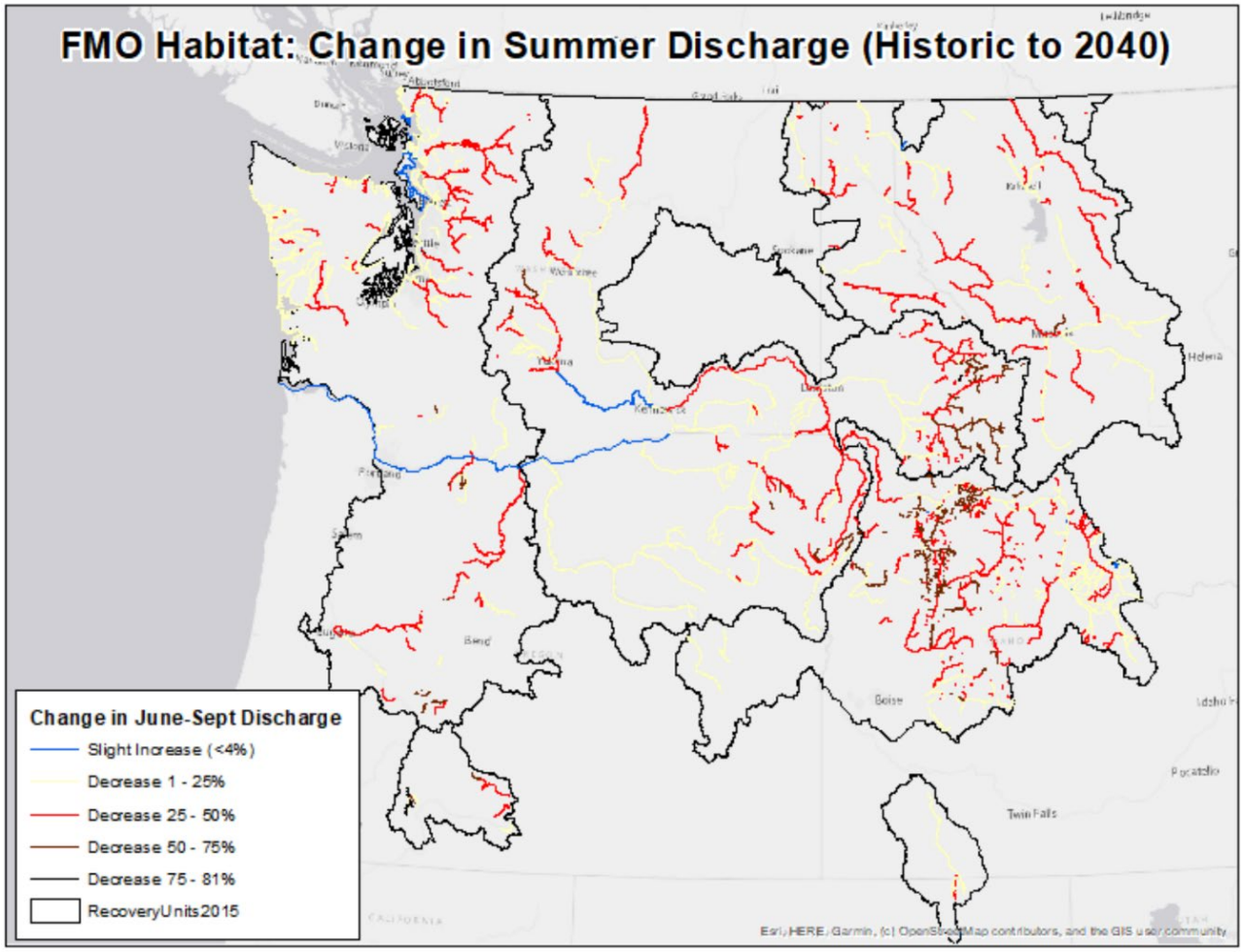
Isaak, D., S. Wenger, E. Peterson, J. Ver Hoef, D. Nagel, C. Luce, S. Hostetler, J. Dunham, B. Roper, S. Wollrab, G. Chandler, D. Horan, S. Parkes-Payne. 2017. The NorWeST summer stream temperature model and scenarios for the western U.S.: A crowd-sourced database and new geospatial tools foster a user community and predict broad climate warming of rivers and streams. Water Resources Research, 53: 9181-9205. https://doi.org/10.1002/2017WR020969.

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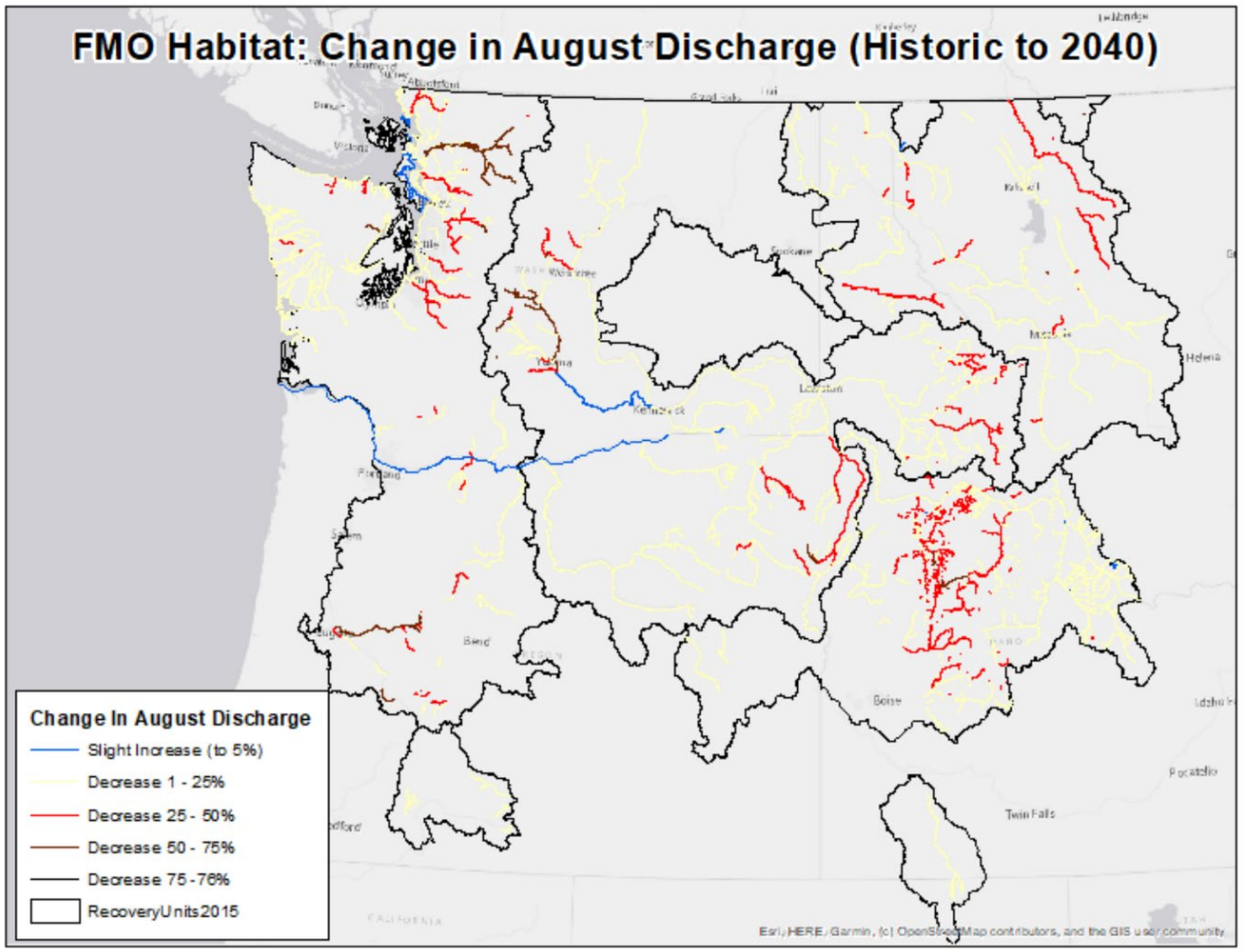
Appendix F. Future Change in FMO Discharge

Projected Change in Discharge [Summer (June-Sept) and August Only] from Historic (1976-2015) condition to 2040 (2030-2059).



Averaged decline in Bull Trout FMO-designated Summer (June-Sept) stream discharge between Historic (1976-2015) and 2040 (2030-2059), by Recovery Unit. N = number of designated FMO reaches. Change in discharge calculated as change in cubic feet per second as derived from Western Stream Flow Metrics data. Standard Deviation indicates variability within a Recovery Unit (biased by number of reaches (N).

Recovery Unit	N	Mean Change (%) in Summer FMO Discharge: Historic to 2040	Standard Deviation
Coastal	286	-27.6	0.13
Columbia Headwaters	118	-26.0	0.12
Klamath	17	-55.5	0.27
Mid-Columbia	296	-32.9	0.18
Saint Mary	1	-26.4	--
Upper Snake	465	-36.0	0.18



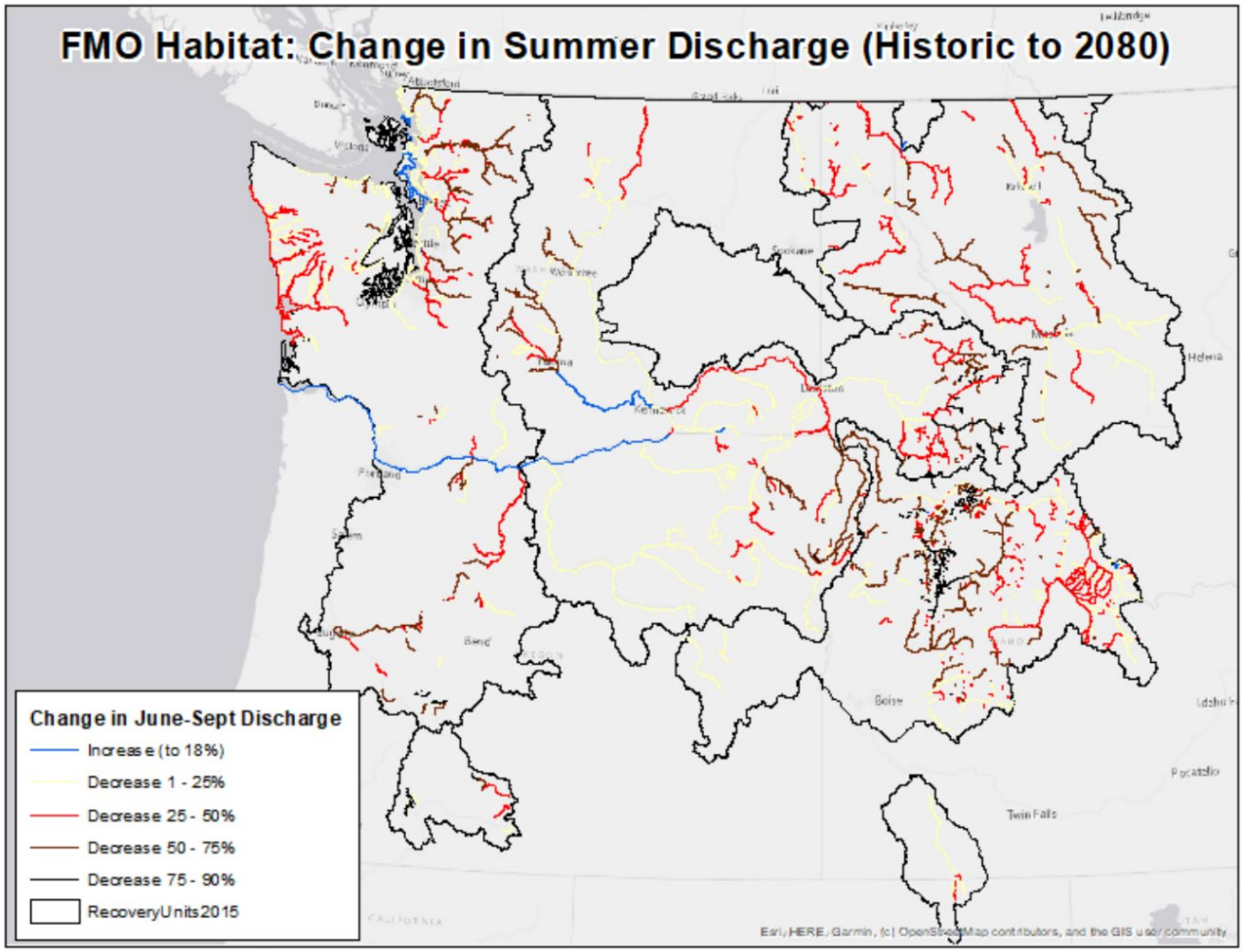
Averaged decline in Bull Trout FMO-designated August stream discharge between Historic (1976-2015) and 2040 (2030-2059), by Recovery Unit. N = number of designated FMO reaches. Change in discharge calculated as change in cubic feet per second as derived from Western Stream Flow Metrics data. Standard Deviation indicates variability within a Recovery Unit (biased by number of reaches (N).

Recovery Unit	N	Mean Change (%) in August FMO Discharge: Historic to 2040	Standard Deviation
Coastal	286	-26.2	0.11
Columbia Headwaters	118	-20.9	0.15
Klamath	17	-7.9	0.04
Mid-Columbia	296	-20.5	0.13
Saint Mary	1	-53.3	--
Upper Snake	465	-22.0	0.10

FOR COMPARISON: Change in Percent Discharge from Historic (1976-2015) and 2040 (2030-2059), by Recovery Unit
Comparing August changes to Summer (June-Sept) changes.

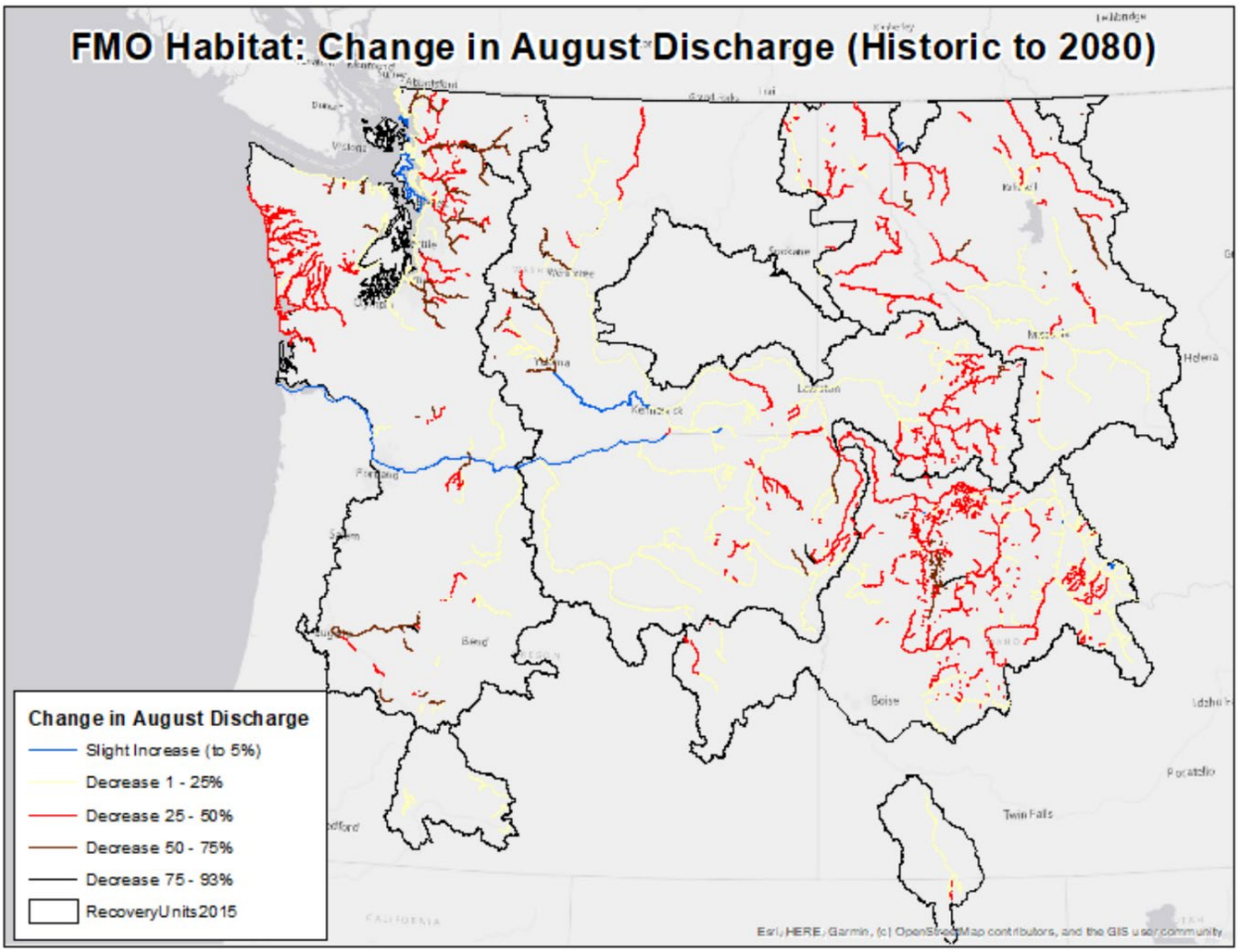
		Mean Change (%) in FMO Discharge: Historic to 2040	
Recovery Unit	N	August	Summer (June-Sept)
Coastal	286	-26.2	-27.6
Columbia Headwaters	118	-20.9	-26.0
Klamath	17	-7.9	-55.5
Mid-Columbia	296	-20.5	-32.9
Saint Mary	1	-53.3	-26.4
Upper Snake	465	-22.0	-36.0

**Projected Change in Discharge [Summer (June-Sept) and August Only]
from Historic (1976-2015) condition to 2080 (2070-2099).**



Averaged decline in Bull Trout FMO-designated Summer (June-Sept) stream discharge between Historic (1976-2015) and 2080 (2070-2099), by Recovery Unit. N = number of designated FMO reaches. Change in discharge calculated as change in cubic feet per second as derived from Western Stream Flow Metrics data. Standard Deviation indicates variability within a Recovery Unit (but biased by number of reaches (N).

Recovery Unit	N	Mean Change (%) in Summer FMO Discharge: Historic to 2080	Standard Deviation
Coastal	286	-38.7	0.18
Columbia Headwaters	118	-38.7	0.17
Klamath	17	-60.5	0.27
Mid-Columbia	296	-43.4	0.24
Saint Mary	1	-48.6	--
Upper Snake	465	-46.7	0.23



Averaged decline in Bull Trout FMO-designated August stream discharge between Historic (1976-2015) and 2080 (2070-2099), by Recovery Unit. N = number of designated FMO reaches. Change in discharge calculated as change in cubic feet per second as derived from Western Stream Flow Metrics data. Standard Deviation indicates variability within a Recovery Unit (biased by number of reaches (N).

Recovery Unit	N	Mean Change (%) in August FMO Discharge: Historic to 2080	Standard Deviation
Coastal	286	-41.6	0.17
Columbia Headwaters	118	-33.0	0.13
Klamath	17	-8.2	0.06
Mid-Columbia	296	-29.4	0.15
Saint Mary	1	-66.4	--
Upper Snake	465	-31.8	0.13

FOR COMPARISON: Change in Percent Discharge from Historic (1976-2015) and 2080 (2070-2099), by Recovery Unit Comparing August changes to Summer (June-Sept) changes.

		Mean Change (%) in FMO Discharge: Historic to 2080	
Recovery Unit	N	August	Summer (June-Sept)
Coastal	286	-41.6	-38.7
Columbia Headwaters	118	-33.0	-38.7
Klamath	17	-8.2	-60.5
Mid-Columbia	296	-29.4	-43.4
Saint Mary	1	-66.4	-48.6
Upper Snake	465	-31.8	-46.7

Appendix G. Future Scenario Scores

Scenario 1: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Coastal Representative Unit														
Chester Morse Lake	4	2	3	5	4	3.60	4.5	4.5	4.5	3	4.5	2	3.82	3.71
Chilliwack River	4	4	4	5	5	4.40	4.5	4.5	4.5	4.5	4.5	3	4.23	4.32
Clackamas River (historical)	4	2	2	1	3	2.40	4.5	4.5	3	4.5	4.5	3	3.98	3.19
Dungeness River	4	4	3	5	4	4.00	4.5	4.5	4.5	4.5	4.5	3	4.23	4.12
Elwha River	4	4	3	5	4	4.00	4.5	4.5	3	4.5	4.5	3	3.98	3.99
Hoh River	4	4	3	5	4	4.00	4.5	4.5	4.5	4.5	4.5	3	4.23	4.12
Hood River	4	2	2	1	3	2.40	3	4.5	4.5	3	4.5	2	3.57	2.98
Klickitat River	4	2	2	1	3	2.40	4.5	4.5	3	4.5	4.5	2	3.82	3.11
Lewis River	4	4	3	5	4	4.00	4.5	4.5	4.5	4.5	4.5	2	4.07	4.03
Lower Deschutes River	4	4	4	5	5	4.40	4.5	4.5	3	4.5	4.5	3	3.98	4.19
Lower Skagit River	3	4	5	5	5	4.40	3	3	4.5	4.5	4.5	4	3.90	4.15
Nooksack River	4	4	4	5	4	4.20	3	4.5	4.5	4.5	4.5	4	4.15	4.18
North Santiam River (historical)	3	2	2	1	2	2.00	4.5	4.5	3	4.5	4.5	2	3.82	2.91
Odell Lake (simple)	4	2	2	1	2	2.20	4.5	4.5	3	4.5	4.5	2	3.82	3.01
Puyallup River	4	4	3	5	4	4.00	4.5	4.5	3	3	3	4	3.65	3.83
Queets River (simple)	4	4	2	1	3	2.80	4.5	4.5	4.5	4.5	4.5	3	4.23	3.52
Quinault River	4	4	3	5	4	4.00	4.5	4.5	4.5	4.5	3	3	3.98	3.99
Skokomish River	4	4	3	5	3	3.80	4.5	3	4.5	4.5	4.5	3	3.98	3.89
Snohomish/Skykomish River	4	4	3	4	4	3.80	4.5	4.5	4.5	4.5	4.5	3	4.23	4.02
South Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Stillaguamish River	4	4	3	3	3	3.40	3	3	4.5	4.5	4.5	3	3.74	3.57

Scenario 1: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Upper Deschutes River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Upper Skagit River	3	4	5	5	5	4.40	4.5	4.5	4.5	4.5	4.5	4	4.40	4.40
Upper Willamette River	4	2	3	4	4	3.40	4.5	4.5	3	4.5	4.5	2	3.82	3.61
White Salmon River (historical)	4	2	2	1	3	2.40	3	4.5	3	3	3	2	3.07	2.74
Columbia Headwaters Representative Unit														
Akokala Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	2	4.07	3.03
Big Salmon Lake (simple)	4	2	2	1	3	2.40	4.5	4.5	4.5	4.5	4.5	1	3.90	3.15
Bitterroot River	3	4	4	4	5	4.00	4.5	4.5	3	4.5	4.5	4	4.15	4.08
Blackfoot River	4	4	4	5	5	4.40	4.5	3	3	4.5	4.5	4	3.90	4.15
Bowman Lake (simple)	4	4	2	1	4	3.00	4.5	4.5	4.5	4.5	4.5	2	4.07	3.53
Bull Lake (simple)	4	2	3	1	4	2.80	4.5	4.5	4.5	4.5	4.5	3	4.23	3.52
Clark Fork River (Section 1)	4	4	4	5	4	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
Clark Fork River (Section 2)	4	4	5	5	4	4.40	4.5	4.5	3	4.5	4.5	3	3.98	4.19
Clearwater River and Lakes	4	2	4	5	4	3.80	4.5	4.5	4.5	4.5	4.5	3	4.23	4.02
Cyclone Lake	4	2	2	1	2	2.20	4.5	4.5	4.5	4.5	4.5	2	4.07	3.13
Doctor Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	4.5	4.5	4.5	1	3.90	2.85
Flathead Lake	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4	4.15	4.38
Frozen Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	4.5	4.5	4.5	1	3.90	2.85
Harrison Lake (simple)	4	2	2	1	3	2.40	4.5	4.5	4.5	4.5	4.5	1	3.90	3.15
Holland Lake (simple)	4	2	2	1	2	2.20	4.5	4.5	3	4.5	4.5	1	3.65	2.93
Hungry Horse Reservoir	3	4	4	5	5	4.20	4.5	4.5	4.5	4.5	4.5	3	4.23	4.22
Isabel Lake (simple)	4	2	2	1	3	2.40	4.5	4.5	4.5	4.5	4.5	1	3.90	3.15
Kootenai River	4	4	4	4	4	4.00	3	3	3	4.5	4.5	4	3.65	3.83
Lake Coeur d'Alene	3	2	4	5	4	3.60	4.5	4.5	3	4.5	4.5	3	3.98	3.79
Lake Koocanusa	1	4	5	5	5	4.00	1.5	4.5	3	4.5	4.5	5	3.82	3.91

Scenario 1: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Lake Pend Oreille A	4	4	5	4	4	4.20	3	4.5	3	4.5	4.5	3	3.74	3.97
Lake Pend Oreille B	4	2	5	5	5	4.20	4.5	4.5	3	4.5	4.5	3	3.98	4.09
Lake Pend Oreille C	4	2	2	2	2	2.40	3	3	3	4.5	3	3	3.24	2.82
Lincoln Lake (simple)	4	2	2	1	1	2.00	4.5	4.5	4.5	4.5	4.5	1	3.90	2.95
Lindbergh Lake (simple)	4	2	2	1	3	2.40	4.5	4.5	3	4.5	4.5	1	3.65	3.03
Logging Lake	4	2	2	1	4	2.60	4.5	4.5	4.5	4.5	4.5	1	3.90	3.25
Lower Quartz Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	3	4.5	4.5	1	3.65	2.83
Priest Lakes	4	2	4	5	4	3.80	4.5	4.5	3	4.5	4.5	4	4.15	3.98
Quartz Lake (simple)	4	2	2	1	3	2.40	4.5	4.5	3	4.5	4.5	2	3.82	3.11
Rock Creek	4	4	4	5	3	4.00	3	4.5	3	4.5	4.5	3	3.74	3.87
Swan Lake	4	2	4	5	5	4.00	4.5	4.5	3	4.5	4.5	3	3.98	3.99
Trout/Arrow Lakes (simple)	4	2	2	1	3	2.40	4.5	4.5	4.5	4.5	4.5	1	3.90	3.15
Upper Kintla Lake (simple)	3	2	2	1	3	2.20	4.5	4.5	4.5	4.5	4.5	1	3.90	3.05
Upper Stillwater Lake	4	4	2	1	2	2.60	4.5	4.5	3	4.5	4.5	2	3.82	3.21
Upper Whitefish Lake	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	2	4.07	3.03
West Fork Bitterroot River	4	4	4	5	4	4.20	4.5	4.5	3	4.5	4.5	3	3.98	4.09
Whitefish Lake	4	4	2	1	2	2.60	4.5	4.5	3	4.5	4.5	2	3.82	3.21
Klamath Representative Unit														
Sycan River (simple)	3	4	2	1	4	2.80	4.5	4.5	1.5	4.5	4.5	3	3.74	3.27
Upper Klamath Lake	4	4	3	1	5	3.40	4.5	3	1.5	4.5	4.5	3	3.49	3.44
Upper Sprague River	4	2	3	3	3	3.00	4.5	4.5	1.5	3	3	3	3.24	3.12
Mid-Columbia Representative Unit														
Asotin Creek (simple)	3	2	2	1	2	2.00	4.5	4.5	3	4.5	4.5	2	3.82	2.91
Eagle Creek (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X

Scenario 1: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Entiat River	3	4	3	5	3	3.60	3	3	3	4.5	4.5	3	3.49	3.54
Imnaha River	3	4	4	4	5	4.00	4.5	4.5	4.5	4.5	4.5	3	4.23	4.12
Lake Chelan (historical)	4	2	2	1	3	2.40	4.5	4.5	3	4.5	4.5	3	3.98	3.19
Little Minam River (simple)	3	2	2	1	4	2.40	4.5	4.5	4.5	4.5	4.5	2	4.07	3.23
Lochsa River	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4	4.15	4.38
Lookingglass / Wenaha	3	4	3	4	5	3.80	4.5	4.5	4.5	4.5	4.5	3	4.23	4.02
Methow River	4	4	4	5	4	4.20	4.5	3	3	4.5	4.5	4	3.90	4.05
Middle Fork John Day River	3	2	2	5	2	2.80	1.5	3	3	3	3	2	2.57	2.69
North Fork Clearwater River	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4	4.15	4.38
North Fork John Day River	4	4	4	4	3	3.80	4.5	4.5	1.5	3	4.5	3	3.49	3.64
Northeast Washington RNA	4	2	2	1	3	2.40	4.5	3	3	4.5	4.5	3	3.74	3.07
Pine Indian & Wildhorse Creeks	4	4	4	4	5	4.20	4.5	3	3	4.5	4.5	3	3.74	3.97
Powder River	3	4	4	1	4	3.20	1.5	1.5	1.5	3	3	3	2.24	2.72
Selway River	4	4	4	5	5	4.40	4.5	4.5	3	4.5	4.5	4	4.15	4.28
South Fork Clearwater River	4	4	4	5	4	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
South Salmo River	4	4	3	4	3	3.60	4.5	4.5	3	4.5	4.5	3	3.98	3.79
Touchet River	4	4	3	5	3	3.80	3	3	3	3	3	3	2.99	3.39
Tucannon River	4	4	4	5	4	4.20	3	3	3	3	3	3	2.99	3.59
Umatilla River (simple)	3	2	2	1	1	1.80	1.5	3	3	3	3	2	2.57	2.19
Upper Grande Ronde River	3	4	3	4	4	3.60	3	3	3	3	3	3	2.99	3.29
Upper Mainstem John Day River	4	4	3	5	3	3.80	3	4.5	3	4.5	4.5	3	3.74	3.77
Walla Walla River	4	4	3	5	4	4.00	3	3	3	3	3	3	2.99	3.49
Wallowa / Minam Rivers	3	4	4	5	5	4.20	3	4.5	3	4.5	4.5	3	3.74	3.97
Wenatchee River	4	4	4	5	5	4.40	3	4.5	3	4.5	4.5	4	3.90	4.15
Yakima River	4	4	5	4	5	4.40	3	4.5	3	4.5	4.5	4	3.90	4.15

Scenario 1: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Saint Mary Representative Unit														
Cracker Lake	4	4	2	1	3	2.80	4.5	4.5	4.5	4.5	4.5	1	3.90	3.35
Red Eagle Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	1	3.90	2.95
Slide Lake	3	2	2	1	3	2.20	4.5	4.5	4.5	4.5	4.5	1	3.90	3.05
St Mary (complex)	4	4	4	5	4	4.20	4.5	4.5	4.5	4.5	4.5	3	4.23	4.22
Upper Snake Representative Unit														
Anderson Ranch Reservoir	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4	4.15	4.38
Arrowrock Reservoir	4	4	5	5	4	4.40	4.5	4.5	3	4.5	4.5	4	4.15	4.28
Chief Eagle Eye Creek	4	2	3	3	2	2.80	4.5	3	3	4.5	4.5	3	3.74	3.27
Deadwood River	4	4	4	5	4	4.20	4.5	4.5	4.5	4.5	4.5	3	4.23	4.22
Jarbidge River	3	4	4	3	2	3.20	4.5	4.5	4.5	4.5	4.5	3	4.23	3.72
Lake Creek (simple)	4	4	2	1	4	3.00	4.5	4.5	4.5	4.5	4.5	2	4.07	3.53
Lemhi River	4	4	4	4	5	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
Little Lost River	4	4	4	4	5	4.20	4.5	4.5	3	4.5	4.5	3	3.98	4.09
Little-Lower Salmon River	3	4	4	5	5	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
Middle Fork Payette River	4	4	3	5	3	3.80	4.5	4.5	3	4.5	4.5	3	3.98	3.89
Middle Fork Salmon River	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	5	4.32	4.46
Middle Salmon - Chamberlain	4	4	4	5	4	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
Middle Salmon - Panther	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4	4.15	4.38
North Fork Malheur River	4	4	4	5	4	4.20	3	4.5	4.5	4.5	3	3	3.74	3.97
North Fork Payette River	4	4	2	1	3	2.80	4.5	3	3	4.5	4.5	2	3.57	3.18
Opal Lake (simple)	4	4	2	1	4	3.00	4.5	4.5	4.5	4.5	4.5	1	3.90	3.45
Pahsimeroi River	4	4	4	3	5	4.00	4.5	4.5	4.5	4.5	4.5	4	4.40	4.20
South Fork Salmon River	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4	4.15	4.38

Scenario 1: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Upper Malheur River	4	2	3	4	2	3.00	3	4.5	3	4.5	4.5	3	3.74	3.37
Upper Salmon River	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4	4.15	4.38
Upper South Fork Payette River	4	4	5	5	5	4.60	4.5	4.5	4.5	4.5	4.5	4	4.40	4.50
Weiser River	4	4	4	4	3	3.80	4.5	4.5	3	4.5	4.5	3	3.98	3.89

Scenario 2: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Coastal Representative Unit														
Chester Morse Lake	3	2	3	4	3	3.00	4.5	4.5	4.5	3	4.5	2	3.82	3.41
Chilliwack River	3	4	4	5	5	4.20	4.5	4.5	4.5	4.5	4.5	3	4.23	4.22
Clackamas River (historical)	3	2	2	1	2	2.00	4.5	4.5	3	4.5	4.5	2	3.82	2.91
Dungeness River	3	4	3	5	3	3.60	3	4.5	3	3	4.5	3	3.49	3.54
Elwha River	4	4	3	5	4	4.00	4.5	4.5	3	4.5	4.5	3	3.98	3.99
Hoh River	3	4	3	5	3	3.60	4.5	4.5	4.5	4.5	4.5	3	4.23	3.92
Hood River	3	2	2	1	2	2.00	3	1.5	4.5	3	3	2	2.82	2.41
Klickitat River	3	2	2	1	2	2.00	4.5	3	3	4.5	4.5	2	3.57	2.78
Lewis River	3	4	3	5	4	3.80	3	4.5	4.5	4.5	4.5	2	3.82	3.81
Lower Deschutes River	3	4	4	5	5	4.20	4.5	4.5	3	4.5	4.5	3	3.98	4.09
Lower Skagit River	3	4	5	5	5	4.40	3	3	3	4.5	4.5	4	3.65	4.03
Nooksack River	3	4	4	5	4	4.00	3	4.5	3	4.5	3	3	3.49	3.74
North Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Odell Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	1.5	3	4.5	2	3.32	2.56
Puyallup River	4	4	3	4	4	3.80	4.5	4.5	1.5	3	3	3	3.24	3.52
Queets River (simple)	3	4	2	1	2	2.40	4.5	4.5	4.5	4.5	4.5	3	4.23	3.32
Quinault River	3	4	3	5	3	3.60	4.5	4.5	4.5	4.5	3	3	3.98	3.79
Skokomish River	4	4	3	5	3	3.80	4.5	3	4.5	3	3	2	3.32	3.56
Snohomish/Skykomish River	3	4	3	4	3	3.40	4.5	3	3	4.5	4.5	2	3.57	3.48
South Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Stillaguamish River	3	4	2	3	2	2.80	1.5	3	4.5	3	4.5	2	3.07	2.94
Upper Deschutes River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Upper Skagit River	3	4	5	5	4	4.20	3	4.5	3	3	3	4	3.40	3.80
Upper Willamette River	3	2	3	3	3	2.80	4.5	3	1.5	3	4.5	2	3.07	2.94

Scenario 2: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
White Salmon River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	2	0.33	X
Columbia Headwaters Representative Unit														
Akokala Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	2	4.07	3.03
Big Salmon Lake (simple)	3	2	2	1	3	2.20	4.5	4.5	4.5	4.5	4.5	1	3.90	3.05
Bitterroot River	3	4	4	3	4	3.60	3	3	3	4.5	3	4	3.40	3.50
Blackfoot River	3	4	4	5	5	4.20	4.5	3	3	4.5	4.5	4	3.90	4.05
Bowman Lake (simple)	4	4	2	1	2	2.60	4.5	4.5	3	4.5	4.5	2	3.82	3.21
Bull Lake (simple)	1	2	2	1	3	1.80	3	4.5	3	3	3	1	2.91	2.35
Clark Fork River (Section 1)	3	4	3	3	3	3.20	3	3	3	3	3	3	2.99	3.09
Clark Fork River (Section 2)	4	4	4	4	3	3.80	3	4.5	3	4.5	4.5	3	3.74	3.77
Clearwater River and Lakes	3	2	3	5	3	3.20	4.5	4.5	3	4.5	4.5	3	3.98	3.59
Cyclone Lake	4	2	2	1	1	2.00	4.5	4.5	4.5	4.5	4.5	2	4.07	3.03
Doctor Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	4.5	4.5	4.5	1	3.90	2.85
Flathead Lake	3	4	4	5	5	4.20	3	4.5	3	4.5	4.5	4	3.90	4.05
Frozen Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	4.5	4.5	4.5	1	3.90	2.85
Harrison Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	1	3.90	2.95
Holland Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	3	4.5	4.5	1	3.65	2.73
Hungry Horse Reservoir	3	4	4	5	5	4.20	4.5	4.5	4.5	4.5	4.5	3	4.23	4.22
Isabel Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	1	3.90	2.95
Kootenai River	3	4	4	4	3	3.60	1.5	1.5	1.5	3	3	3	2.24	2.92
Lake Coeur d'Alene	4	2	3	5	3	3.40	3	4.5	3	4.5	4.5	3	3.74	3.57
Lake Koocanusa	1	4	4	5	5	3.80	1.5	4.5	1.5	4.5	4.5	5	3.57	3.68
Lake Pend Oreille A	3	4	5	3	3	3.60	3	3	1.5	3	3	3	2.74	3.17
Lake Pend Oreille B	3	2	5	5	5	4.00	4.5	4.5	3	4.5	4.5	3	3.98	3.99
Lake Pend Oreille C	4	2	2	2	2	2.40	3	1.5	1.5	3	3	3	2.49	2.45

Scenario 2: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Lincoln Lake (simple)	4	2	2	1	1	2.00	4.5	4.5	3	4.5	4.5	1	3.65	2.83
Lindbergh Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	3	4.5	4.5	1	3.65	2.83
Logging Lake	4	2	2	1	3	2.40	4.5	4.5	3	4.5	4.5	1	3.65	3.03
Lower Quartz Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	3	4.5	4.5	1	3.65	2.83
Priest Lakes	3	2	3	5	4	3.40	4.5	4.5	3	4.5	4.5	3	3.98	3.69
Quartz Lake (simple)	4	2	2	1	3	2.40	4.5	4.5	3	4.5	4.5	2	3.82	3.11
Rock Creek	3	4	3	5	2	3.40	3	4.5	3	3	4.5	3	3.49	3.44
Swan Lake	3	2	4	5	4	3.60	4.5	4.5	3	4.5	4.5	3	3.98	3.79
Trout/Arrow Lakes (simple)	4	2	2	1	3	2.40	4.5	4.5	4.5	4.5	4.5	1	3.90	3.15
Upper Kintla Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	1	3.90	2.95
Upper Stillwater Lake	3	2	2	1	2	2.00	4.5	4.5	3	4.5	4.5	2	3.82	2.91
Upper Whitefish Lake	3	2	2	1	1	1.80	4.5	4.5	4.5	4.5	4.5	2	4.07	2.93
West Fork Bitterroot River	3	4	4	5	4	4.00	3	3	3	3	3	3	2.99	3.49
Whitefish Lake	3	2	2	1	1	1.80	4.5	4.5	3	4.5	4.5	2	3.82	2.81
Klamath Representative Unit														
Sycan River (simple)	3	4	2	1	3	2.60	4.5	3	1.5	4.5	3	3	3.24	2.92
Upper Klamath Lake	4	4	3	1	5	3.40	4.5	1.5	1.5	3	4.5	3	2.99	3.19
Upper Sprague River	3	2	3	3	3	2.80	4.5	4.5	1.5	1.5	3	3	2.99	2.89
Mid-Columbia Representative Unit														
Asotin Creek (simple)	3	2	2	1	1	1.80	4.5	3	3	4.5	3	2	3.32	2.56
Eagle Creek (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Entiat River	1	4	3	5	2	3.00	3	3	1.5	4.5	4.5	2	3.07	3.04
Imnaha River	3	4	4	3	5	3.80	4.5	3	4.5	3	4.5	3	3.74	3.77
Lake Chelan (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X

Scenario 2: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Little Minam River (simple)	3	2	2	1	4	2.40	4.5	4.5	4.5	4.5	4.5	2	4.07	3.23
Lochsa River	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	4	4.15	4.28
Lookingglass / Wenaha	3	4	3	4	5	3.80	4.5	4.5	3	4.5	4.5	3	3.98	3.89
Methow River	4	4	4	5	4	4.20	3	3	1.5	3	3	4	2.91	3.55
Middle Fork John Day River	1	2	2	5	1	2.20	1.5	3	3	3	3	2	2.57	2.39
North Fork Clearwater River	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	4	4.15	4.28
North Fork John Day River	3	4	4	4	3	3.60	4.5	4.5	1.5	3	3	3	3.24	3.42
Northeast Washington RNA	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Pine Indian & Wildhorse Creeks	3	2	4	4	5	3.60	4.5	1.5	1.5	3	4.5	3	2.99	3.29
Powder River	3	2	4	1	3	2.60	1.5	1.5	1.5	3	3	3	2.24	2.42
Selway River	3	4	4	5	5	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
South Fork Clearwater River	4	4	4	5	4	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
South Salmo River	3	4	3	4	3	3.40	4.5	3	3	4.5	3	3	3.49	3.44
Touchet River	3	4	3	5	3	3.60	3	3	1.5	3	3	3	2.74	3.17
Tucannon River	3	4	4	5	3	3.80	3	3	1.5	3	3	3	2.74	3.27
Umatilla River (simple)	1	2	2	1	1	1.40	1.5	3	3	3	3	2	2.57	1.99
Upper Grande Ronde River	1	4	3	3	3	2.80	3	3	3	3	3	3	2.99	2.89
Upper Mainstem John Day River	3	4	3	5	2	3.40	3	4.5	1.5	4.5	4.5	3	3.49	3.44
Walla Walla River	3	4	3	5	3	3.60	3	3	3	3	3	3	2.99	3.29
Wallowa / Minam Rivers	3	4	4	5	5	4.20	3	4.5	1.5	4.5	4.5	3	3.49	3.84
Wenatchee River	4	4	4	5	5	4.40	3	4.5	1.5	4.5	4.5	4	3.65	4.03
Yakima River	3	4	5	4	4	4.00	3	3	1.5	4.5	4.5	4	3.40	3.70
Saint Mary Representative Unit														
Cracker Lake	4	4	2	1	3	2.80	4.5	4.5	4.5	4.5	4.5	1	3.90	3.35
Red Eagle Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	1	3.90	2.95

Scenario 2: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Slide Lake	3	2	2	1	3	2.20	4.5	4.5	4.5	4.5	4.5	1	3.90	3.05
St Mary (complex)	3	4	4	5	3	3.80	3	4.5	3	3	4.5	3	3.49	3.64
Upper Snake Representative Unit														
Anderson Ranch Reservoir	4	4	5	4	4	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
Arrowrock Reservoir	4	4	5	5	4	4.40	4.5	4.5	3	4.5	4.5	4	4.15	4.28
Chief Eagle Eye Creek	3	2	3	2	2	2.40	4.5	3	3	4.5	4.5	3	3.74	3.07
Deadwood River	4	4	4	5	3	4.00	4.5	4.5	4.5	4.5	4.5	3	4.23	4.12
Jarbidge River	3	4	4	3	2	3.20	4.5	4.5	4.5	4.5	4.5	3	4.23	3.72
Lake Creek (simple)	3	4	2	1	4	2.80	4.5	4.5	4.5	4.5	4.5	2	4.07	3.43
Lemhi River	3	4	4	4	5	4.00	4.5	4.5	3	4.5	4.5	4	4.15	4.08
Little Lost River	4	4	4	4	5	4.20	4.5	4.5	3	4.5	4.5	3	3.98	4.09
Little-Lower Salmon River	3	4	4	5	4	4.00	4.5	4.5	3	4.5	4.5	4	4.15	4.08
Middle Fork Payette River	3	4	3	5	3	3.60	4.5	4.5	3	4.5	4.5	3	3.98	3.79
Middle Fork Salmon River	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	5	4.32	4.46
Middle Salmon - Chamberlain	3	4	4	5	4	4.00	4.5	4.5	3	4.5	4.5	4	4.15	4.08
Middle Salmon - Panther	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	4	4.15	4.28
North Fork Malheur River	3	4	4	5	3	3.80	3	4.5	4.5	4.5	3	3	3.74	3.77
North Fork Payette River	4	2	2	1	2	2.20	4.5	3	3	4.5	4.5	2	3.57	2.88
Opal Lake (simple)	3	4	2	1	4	2.80	4.5	4.5	4.5	4.5	4.5	1	3.90	3.35
Pahsimeroi River	3	4	4	3	5	3.80	4.5	4.5	4.5	4.5	4.5	4	4.40	4.10
South Fork Salmon River	4	4	5	5	5	4.60	4.5	4.5	3	4.5	4.5	4	4.15	4.38
Upper Malheur River	4	2	3	5	2	3.20	3	4.5	1.5	4.5	3	3	3.24	3.22
Upper Salmon River	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	4	4.15	4.28
Upper South Fork Payette River	3	4	5	5	4	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
Weiser River	3	2	4	3	3	3.00	4.5	3	3	4.5	4.5	3	3.74	3.37

Scenario 3: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Coastal Representative Unit														
Chester Morse Lake	1	2	2	1	2	1.60	3	4.5	4.5	1.5	4.5	1	3.15	2.38
Chilliwack River	3	4	4	5	5	4.20	4.5	4.5	4.5	4.5	4.5	3	4.23	4.22
Clackamas River (historical)	1	2	X	1	1	X	4.5	4.5	3	4.5	4.5	2	3.82	X
Dungeness River	3	4	3	5	3	3.60	3	3	3	3	4.5	2	3.07	3.34
Elwha River	4	4	3	5	3	3.80	3	4.5	1.5	3	4.5	3	3.24	3.52
Hoh River	3	4	3	5	3	3.60	3	4.5	4.5	3	3	2	3.32	3.46
Hood River	1	2	2	1	2	1.60	1.5	1.5	4.5	3	3	2	2.57	2.09
Klickitat River	3	2	2	1	2	2.00	4.5	3	1.5	4.5	4.5	2	3.32	2.66
Lewis River	3	4	3	5	3	3.60	3	3	3	3	4.5	2	3.07	3.34
Lower Deschutes River	3	4	3	5	5	4.00	4.5	4.5	3	4.5	4.5	3	3.98	3.99
Lower Skagit River	1	4	5	5	4	3.80	1.5	3	3	3	3	3	2.74	3.27
Nooksack River	1	4	4	4	3	3.20	1.5	3	3	3	3	3	2.74	2.97
North Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Odell Lake (simple)	1	0	X	0	0	X	4.5	4.5	1.5	3	4.5	2	3.32	X
Puyallup River	3	4	3	3	3	3.20	3	3	1.5	3	3	3	2.74	2.97
Queets River (simple)	3	4	2	1	2	2.40	3	4.5	4.5	3	3	2	3.32	2.86
Quinault River	3	4	3	5	3	3.60	3	4.5	4.5	3	1.5	2	3.07	3.34
Skokomish River	3	4	3	1	3	2.80	3	3	3	3	3	2	2.82	2.81
Snohomish/Skykomish River	1	4	3	3	2	2.60	3	3	3	3	3	2	2.82	2.71
South Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Stillaguamish River	1	2	2	2	1	1.60	1.5	3	4.5	3	3	2	2.82	2.21
Upper Deschutes River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Upper Skagit River	1	4	5	5	4	3.80	3	3	3	3	3	4	3.15	3.48
Upper Willamette River	3	2	3	3	3	2.80	4.5	3	1.5	3	4.5	2	3.07	2.94

Scenario 3: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
White Salmon River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	2	0.33	X
Columbia Headwaters Representative Unit														
Akokala Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	4.5	4.5	4.5	2	4.07	2.93
Big Salmon Lake (simple)	3	2	2	1	3	2.20	4.5	4.5	4.5	4.5	4.5	1	3.90	3.05
Bitterroot River	1	2	3	2	2	2.00	1.5	1.5	1.5	1.5	3	3	1.99	2.00
Blackfoot River	1	4	3	3	3	2.80	3	3	1.5	3	3	4	2.91	2.85
Bowman Lake (simple)	1	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	2	3.57	X
Bull Lake (simple)	1	2	X	1	1	X	1.5	3	1.5	1.5	1.5	1	1.66	X
Clark Fork River (Section 1)	3	4	3	2	2	2.80	3	1.5	3	3	3	3	2.74	2.77
Clark Fork River (Section 2)	1	4	3	4	2	2.80	1.5	1.5	1.5	3	3	3	2.24	2.52
Clearwater River and Lakes	1	2	3	3	3	2.40	3	4.5	1.5	4.5	1.5	3	2.99	2.69
Cyclone Lake	3	2	2	1	1	1.80	4.5	4.5	3	4.5	4.5	2	3.82	2.81
Doctor Lake (simple)	2	2	2	1	1	1.60	4.5	4.5	4.5	4.5	4.5	1	3.90	2.75
Flathead Lake	1	4	4	5	3	3.40	3	4.5	1.5	3	3	4	3.15	3.28
Frozen Lake (simple)	2	2	2	1	1	1.60	3	4.5	3	4.5	4.5	1	3.40	2.50
Harrison Lake (simple)	1	2	X	1	1	X	4.5	4.5	4.5	4.5	4.5	1	3.90	X
Holland Lake (simple)	3	2	X	1	1	X	3	4.5	1.5	4.5	4.5	1	3.15	X
Hungry Horse Reservoir	3	4	4	5	4	4.00	4.5	4.5	4.5	4.5	4.5	3	4.23	4.12
Isabel Lake (simple)	3	2	2	1	1	1.80	4.5	4.5	3	4.5	4.5	1	3.65	2.73
Kootenai River	1	2	X	4	2	X	1.5	1.5	1.5	1.5	3	3	1.99	X
Lake Coeur d'Alene	1	2	3	5	2	2.60	3	4.5	1.5	4.5	4.5	2	3.32	2.96
Lake Koocanusa	1	4	4	5	5	3.80	1.5	4.5	1.5	3	3	5	3.07	3.44
Lake Pend Oreille A	3	4	4	2	3	3.20	1.5	3	1.5	1.5	1.5	3	1.99	2.60
Lake Pend Oreille B	3	2	5	5	5	4.00	4.5	4.5	3	4.5	4.5	3	3.98	3.99
Lake Pend Oreille C	3	2	2	1	2	2.00	1.5	1.5	1.5	3	1.5	3	1.99	2.00

Scenario 3: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Lincoln Lake (simple)	1	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	1	3.40	X
Lindbergh Lake (simple)	1	2	X	1	2	X	3	4.5	1.5	4.5	4.5	1	3.15	X
Logging Lake	3	2	2	1	3	2.20	4.5	4.5	3	4.5	4.5	1	3.65	2.93
Lower Quartz Lake (simple)	3	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	1	3.40	X
Priest Lakes	3	2	3	5	3	3.20	4.5	4.5	1.5	4.5	4.5	3	3.74	3.47
Quartz Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	3	4.5	4.5	2	3.82	2.91
Rock Creek	1	4	2	5	2	2.80	1.5	3	1.5	1.5	3	3	2.24	2.52
Swan Lake	1	2	3	5	3	2.80	3	4.5	1.5	3	3	3	2.99	2.89
Trout/Arrow Lakes (simple)	4	2	2	1	3	2.40	4.5	4.5	4.5	4.5	4.5	1	3.90	3.15
Upper Kintla Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	1	3.90	2.95
Upper Stillwater Lake	1	2	2	1	1	1.40	3	4.5	1.5	3	3	2	2.82	2.11
Upper Whitefish Lake	1	2	X	1	1	X	3	4.5	3	3	3	2	3.07	X
West Fork Bitterroot River	1	4	3	5	4	3.40	1.5	3	1.5	3	3	3	2.49	2.95
Whitefish Lake	1	2	X	1	1	X	3	4.5	1.5	3	3	2	2.82	X
Klamath Representative Unit														
Sycan River (simple)	1	2	2	1	2	1.60	4.5	3	1.5	4.5	3	2	3.07	2.34
Upper Klamath Lake	4	4	3	1	5	3.40	4.5	1.5	1.5	3	3	3	2.74	3.07
Upper Sprague River	3	2	3	1	2	2.20	3	4.5	1.5	1.5	1.5	2	2.32	2.26
Mid-Columbia Representative Unit														
Asotin Creek (simple)	1	0	X	0	0	X	3	3	3	3	3	2	2.82	X
Eagle Creek (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Entiat River	1	4	2	1	2	2.00	1.5	3	1.5	3	3	2	2.32	2.16
Imnaha River	3	4	4	3	5	3.80	4.5	3	4.5	3	4.5	3	3.74	3.77
Lake Chelan (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X

Scenario 3: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Little Minam River (simple)	3	2	2	1	4	2.40	4.5	4.5	4.5	4.5	4.5	2	4.07	3.23
Lochsa River	3	4	5	5	4	4.20	4.5	4.5	3	4.5	4.5	3	3.98	4.09
Lookingglass / Wenaha	3	4	3	4	5	3.80	4.5	4.5	3	4.5	4.5	3	3.98	3.89
Methow River	3	4	4	4	3	3.60	3	3	1.5	3	3	3	2.74	3.17
Middle Fork John Day River	1	0	X	0	0	X	1.5	3	3	3	3	2	2.57	X
North Fork Clearwater River	1	4	4	5	4	3.60	4.5	4.5	3	4.5	4.5	3	3.98	3.79
North Fork John Day River	1	4	4	4	3	3.20	4.5	4.5	1.5	3	3	3	3.24	3.22
Northeast Washington RNA	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Pine Indian & Wildhorse Creeks	3	2	4	4	4	3.40	3	1.5	1.5	3	3	3	2.49	2.95
Powder River	1	2	3	1	3	2.00	1.5	1.5	1.5	3	3	3	2.24	2.12
Selway River	3	4	4	5	4	4.00	4.5	4.5	3	4.5	4.5	3	3.98	3.99
South Fork Clearwater River	3	4	3	5	4	3.80	3	4.5	3	4.5	4.5	3	3.74	3.77
South Salmo River	3	4	3	4	3	3.40	4.5	3	1.5	3	3	3	2.99	3.19
Touchet River	3	4	3	5	3	3.60	3	1.5	1.5	1.5	3	2	2.08	2.84
Tucannon River	3	4	3	5	3	3.60	3	1.5	1.5	3	1.5	3	2.24	2.92
Umatilla River (simple)	1	2	X	1	1	X	1.5	3	3	3	3	2	2.57	X
Upper Grande Ronde River	1	4	2	1	2	2.00	1.5	1.5	3	3	3	3	2.49	2.25
Upper Mainstem John Day River	3	4	3	5	2	3.40	3	4.5	1.5	3	3	3	2.99	3.19
Walla Walla River	1	4	3	5	3	3.20	3	3	3	3	3	3	2.99	3.09
Wallowa / Minam Rivers	3	4	3	4	5	3.80	3	4.5	1.5	4.5	4.5	3	3.49	3.64
Wenatchee River	3	4	4	4	5	4.00	1.5	3	1.5	4.5	4.5	3	2.99	3.49
Yakima River	3	4	5	3	4	3.80	1.5	1.5	1.5	3	3	4	2.41	3.10
Saint Mary Representative Unit														
Cracker Lake	4	4	2	1	3	2.80	4.5	3	4.5	4.5	4.5	1	3.65	3.23
Red Eagle Lake (simple)	2	2	2	1	2	1.80	4.5	4.5	3	4.5	4.5	1	3.65	2.73

Scenario 3: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Slide Lake	3	2	2	1	3	2.20	4.5	4.5	4.5	4.5	4.5	1	3.90	3.05
St Mary (complex)	2	4	3	5	3	3.40	3	4.5	1.5	3	3	3	2.99	3.19
Upper Snake Representative Unit														
Anderson Ranch Reservoir	3	4	5	4	3	3.80	4.5	4.5	3	4.5	4.5	4	4.15	3.98
Arrowrock Reservoir	3	4	5	4	3	3.80	3	3	3	4.5	3	4	3.40	3.60
Chief Eagle Eye Creek	3	2	3	2	1	2.20	3	1.5	1.5	3	3	3	2.49	2.35
Deadwood River	3	4	4	5	3	3.80	3	4.5	4.5	4.5	4.5	3	3.98	3.89
Jarbidge River	1	4	3	2	2	2.40	3	3	4.5	3	3	3	3.24	2.82
Lake Creek (simple)	3	4	2	1	3	2.60	4.5	4.5	4.5	4.5	4.5	2	4.07	3.33
Lemhi River	3	4	4	3	5	3.80	4.5	4.5	3	4.5	3	3	3.74	3.77
Little Lost River	3	4	4	4	4	3.80	4.5	4.5	3	4.5	4.5	3	3.98	3.89
Little-Lower Salmon River	3	4	3	5	4	3.80	4.5	4.5	3	4.5	4.5	3	3.98	3.89
Middle Fork Payette River	3	4	3	4	3	3.40	3	4.5	3	4.5	4.5	3	3.74	3.57
Middle Fork Salmon River	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	5	4.32	4.36
Middle Salmon - Chamberlain	3	4	4	4	3	3.60	3	4.5	3	4.5	4.5	3	3.74	3.67
Middle Salmon - Panther	3	4	5	4	5	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
North Fork Malheur River	3	4	4	5	3	3.80	3	4.5	3	4.5	3	3	3.49	3.64
North Fork Payette River	3	2	2	1	1	1.80	4.5	1.5	1.5	4.5	4.5	2	3.07	2.44
Opal Lake (simple)	3	4	2	1	4	2.80	4.5	4.5	4.5	4.5	4.5	1	3.90	3.35
Pahsimeroi River	3	4	4	2	4	3.40	4.5	3	3	4.5	4.5	3	3.74	3.57
South Fork Salmon River	3	4	5	5	5	4.40	4.5	4.5	3	4.5	4.5	4	4.15	4.28
Upper Malheur River	3	2	3	5	1	2.80	1.5	4.5	1.5	3	3	3	2.74	2.77
Upper Salmon River	3	4	5	4	5	4.20	4.5	4.5	3	4.5	4.5	4	4.15	4.18
Upper South Fork Payette River	3	4	5	5	4	4.20	4.5	4.5	1.5	4.5	4.5	4	3.90	4.05
Weiser River	3	2	3	3	3	2.80	3	1.5	1.5	3	3	3	2.49	2.65

Scenario 4: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Coastal Representative Unit														
Chester Morse Lake	1	0	X	0	0	X	3	3	4.5	1.5	4.5	1	2.91	X
Chilliwack River	1	4	4	4	4	3.40	3	3	4.5	3	3	3	3.24	3.32
Clackamas River (historical)	0	0	X	0	0	X	4.5	4.5	3	4.5	3	2	3.57	X
Dungeness River	1	4	3	5	2	3.00	1.5	3	1.5	1.5	3	2	2.08	2.54
Elwha River	3	4	3	5	3	3.60	3	3	1.5	3	4.5	3	2.99	3.29
Hoh River	1	4	3	5	2	3.00	3	3	4.5	3	3	2	3.07	3.04
Hood River	1	2	2	1	1	1.40	1.5	1.5	4.5	1.5	3	2	2.32	1.86
Klickitat River	1	0	X	0	0	X	4.5	3	1.5	3	3	2	2.82	X
Lewis River	1	4	3	4	2	2.80	1.5	3	1.5	3	3	2	2.32	2.56
Lower Deschutes River	1	4	3	4	5	3.40	4.5	4.5	3	4.5	4.5	3	3.98	3.69
Lower Skagit River	1	4	5	4	4	3.60	1.5	3	3	1.5	3	3	2.49	3.05
Nooksack River	1	4	4	4	3	3.20	1.5	3	1.5	1.5	1.5	2	1.83	2.51
North Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Odell Lake (simple)	0	0	X	0	0	X	4.5	4.5	1.5	1.5	4.5	2	3.07	X
Puyallup River	1	2	3	3	3	2.40	3	1.5	1.5	1.5	3	3	2.24	2.32
Queets River (simple)	1	4	2	1	2	2.00	3	3	4.5	3	3	2	3.07	2.54
Quinault River	1	4	3	5	2	3.00	3	3	4.5	1.5	1.5	2	2.57	2.79
Skokomish River	1	2	2	1	2	1.60	3	1.5	3	1.5	1.5	2	2.08	1.84
Snohomish/Skykomish River	1	2	3	2	2	2.00	1.5	1.5	1.5	1.5	3	1	1.66	1.83
South Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Stillaguamish River	1	2	2	1	1	1.40	1.5	1.5	4.5	1.5	3	1	2.16	1.78
Upper Deschutes River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Upper Skagit River	1	4	4	4	4	3.40	3	3	1.5	3	3	3	2.74	3.07
Upper Willamette River	3	2	3	3	3	2.80	4.5	3	1.5	3	4.5	2	3.07	2.94

Scenario 4: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
White Salmon River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	1	0.17	X
Columbia Headwaters Representative Unit														
Akokala Lake (simple)	1	2	2	1	1	1.40	4.5	3	3	4.5	4.5	1	3.40	2.40
Big Salmon Lake (simple)	3	2	2	1	2	2.00	4.5	4.5	4.5	4.5	4.5	1	3.90	2.95
Bitterroot River	1	2	3	1	2	1.80	1.5	1.5	1.5	1.5	1.5	3	1.74	1.77
Blackfoot River	1	2	2	3	1	1.80	1.5	1.5	1.5	1.5	1.5	3	1.74	1.77
Bowman Lake (simple)	1	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	2	3.57	X
Bull Lake (simple)	1	2	X	1	1	X	1.5	1.5	1.5	1.5	1.5	1	1.41	X
Clark Fork River (Section 1)	1	2	2	1	1	1.40	3	1.5	1.5	1.5	1.5	3	1.99	1.70
Clark Fork River (Section 2)	1	2	2	3	1	1.80	1.5	1.5	1.5	1.5	1.5	3	1.74	1.77
Clearwater River and Lakes	1	2	2	3	2	2.00	1.5	4.5	1.5	3	1.5	3	2.49	2.25
Cyclone Lake	1	2	X	1	1	X	3	3	3	3	3	2	2.82	X
Doctor Lake (simple)	2	2	2	1	1	1.60	3	3	4.5	3	3	1	2.91	2.25
Flathead Lake	1	4	3	4	3	3.00	1.5	4.5	1.5	3	3	4	2.91	2.95
Frozen Lake (simple)	2	2	X	1	1	X	3	4.5	3	3	3	1	2.91	X
Harrison Lake (simple)	1	2	X	1	1	X	3	3	3	3	3	1	2.66	X
Holland Lake (simple)	1	2	X	1	1	X	3	4.5	1.5	3	3	1	2.66	X
Hungry Horse Reservoir	1	4	4	5	4	3.60	3	4.5	3	3	3	3	3.24	3.42
Isabel Lake (simple)	1	2	X	1	1	X	3	3	1.5	3	3	1	2.41	X
Kootenai River	1	2	X	3	1	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X
Lake Coeur d'Alene	1	2	3	4	2	2.40	3	3	1.5	4.5	4.5	2	3.07	2.74
Lake Koocanusa	1	2	4	5	5	3.40	1.5	3	1.5	1.5	1.5	4	2.16	2.78
Lake Pend Oreille A	1	4	4	1	2	2.40	1.5	1.5	1.5	1.5	1.5	3	1.74	2.07
Lake Pend Oreille B	1	2	5	5	5	3.60	4.5	4.5	1.5	4.5	4.5	3	3.74	3.67
Lake Pend Oreille C	1	0	X	0	0	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X

Scenario 4: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Lincoln Lake (simple)	1	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	1	3.40	X
Lindbergh Lake (simple)	1	2	X	1	1	X	3	4.5	1.5	3	3	1	2.66	X
Logging Lake	1	2	X	1	2	X	4.5	4.5	1.5	4.5	4.5	1	3.40	X
Lower Quartz Lake (simple)	1	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	1	3.40	X
Priest Lakes	1	2	3	4	3	2.60	4.5	4.5	1.5	3	3	2	3.07	2.84
Quartz Lake (simple)	1	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	2	3.57	X
Rock Creek	1	4	2	4	2	2.60	1.5	3	1.5	1.5	3	3	2.24	2.42
Swan Lake	1	2	2	4	3	2.40	1.5	4.5	1.5	1.5	1.5	3	2.24	2.32
Trout/Arrow Lakes (simple)	1	2	X	1	1	X	3	3	3	3	3	1	2.66	X
Upper Kintla Lake (simple)	1	2	2	1	1	1.40	4.5	4.5	3	3	3	1	3.15	2.28
Upper Stillwater Lake	1	2	2	1	1	1.40	1.5	4.5	1.5	1.5	1.5	2	2.08	1.74
Upper Whitefish Lake	1	2	X	1	1	X	1.5	4.5	1.5	1.5	1.5	2	2.08	X
West Fork Bitterroot River	1	2	2	4	3	2.40	1.5	1.5	1.5	1.5	1.5	3	1.74	2.07
Whitefish Lake	1	2	X	1	1	X	1.5	4.5	1.5	1.5	1.5	2	2.08	X
Klamath Representative Unit														
Sycan River (simple)	1	2	2	1	2	1.60	3	3	1.5	3	1.5	2	2.32	1.96
Upper Klamath Lake	3	2	3	1	5	2.80	4.5	1.5	1.5	1.5	3	2	2.32	2.56
Upper Sprague River	1	2	2	1	1	1.40	1.5	4.5	1.5	1.5	1.5	2	2.08	1.74
Mid-Columbia Representative Unit														
Asotin Creek (simple)	1	0	X	0	0	X	1.5	1.5	3	3	1.5	2	2.08	X
Eagle Creek (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Entiat River	1	2	2	1	1	1.40	1.5	1.5	1.5	1.5	3	1	1.66	1.53
Imnaha River	3	4	4	3	5	3.80	4.5	3	4.5	3	4.5	2	3.57	3.68
Lake Chelan (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X

Scenario 4: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Little Minam River (simple)	1	2	2	1	3	1.80	3	4.5	4.5	4.5	4.5	1	3.65	2.73
Lochsa River	1	4	4	4	4	3.40	3	4.5	3	3	3	3	3.24	3.32
Lookingglass / Wenaha	3	4	3	4	5	3.80	3	4.5	3	4.5	4.5	2	3.57	3.68
Methow River	1	4	4	4	3	3.20	3	3	1.5	3	3	3	2.74	2.97
Middle Fork John Day River	0	0	X	0	0	X	1.5	1.5	3	1.5	1.5	1	1.66	X
North Fork Clearwater River	1	4	4	4	4	3.40	3	4.5	3	3	3	3	3.24	3.32
North Fork John Day River	1	4	3	3	2	2.60	3	3	1.5	3	3	2	2.57	2.59
Northeast Washington RNA	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Pine Indian & Wildhorse Creeks	1	2	4	4	4	3.00	3	1.5	1.5	1.5	3	2	2.08	2.54
Powder River	1	2	2	1	2	1.60	1.5	1.5	1.5	1.5	1.5	2	1.58	1.59
Selway River	1	4	3	4	3	3.00	3	4.5	3	3	4.5	3	3.49	3.24
South Fork Clearwater River	3	2	3	4	3	3.00	3	4.5	1.5	3	3	3	2.99	2.99
South Salmo River	1	4	3	3	2	2.60	3	3	1.5	3	3	2	2.57	2.59
Touchet River	1	2	3	4	2	2.40	1.5	1.5	1.5	1.5	1.5	2	1.58	1.99
Tucannon River	1	2	3	4	2	2.40	1.5	1.5	1.5	1.5	1.5	3	1.74	2.07
Umatilla River (simple)	0	0	X	0	0	X	1.5	3	3	1.5	1.5	1	1.91	X
Upper Grande Ronde River	1	0	X	0	0	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X
Upper Mainstem John Day River	1	4	2	1	2	2.00	1.5	3	1.5	3	3	3	2.49	2.25
Walla Walla River	1	2	3	4	3	2.60	1.5	1.5	3	3	3	3	2.49	2.55
Wallowa / Minam Rivers	1	4	3	4	4	3.20	1.5	3	1.5	3	4.5	2	2.57	2.89
Wenatchee River	1	4	4	4	4	3.40	1.5	3	1.5	3	3	3	2.49	2.95
Yakima River	1	4	4	2	3	2.80	1.5	1.5	1.5	1.5	1.5	3	1.74	2.27
Saint Mary Representative Unit														
Cracker Lake	3	2	2	1	2	2.00	4.5	3	3	4.5	4.5	1	3.40	2.70
Red Eagle Lake (simple)	2	2	2	1	1	1.60	4.5	4.5	3	4.5	3	1	3.40	2.50

Scenario 4: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Slide Lake	1	2	2	1	2	1.60	4.5	4.5	4.5	4.5	4.5	1	3.90	2.75
St Mary (complex)	1	2	3	4	2	2.40	3	3	1.5	3	3	3	2.74	2.57
Upper Snake Representative Unit														
Anderson Ranch Reservoir	3	4	5	4	3	3.80	3	3	1.5	3	3	4	2.91	3.35
Arrowrock Reservoir	1	4	5	4	3	3.40	3	3	1.5	3	3	4	2.91	3.15
Chief Eagle Eye Creek	1	2	2	1	1	1.40	3	1.5	1.5	3	3	3	2.49	1.95
Deadwood River	1	4	4	4	3	3.20	3	3	4.5	3	3	3	3.24	3.22
Jarbidge River	1	2	3	2	1	1.80	3	3	4.5	3	3	2	3.07	2.44
Lake Creek (simple)	1	4	2	1	3	2.20	3	4.5	4.5	4.5	4.5	2	3.82	3.01
Lemhi River	3	4	4	3	4	3.60	4.5	4.5	1.5	3	3	3	3.24	3.42
Little Lost River	3	4	4	3	4	3.60	3	3	1.5	3	3	2	2.57	3.09
Little-Lower Salmon River	3	4	3	4	4	3.60	3	3	1.5	3	3	3	2.74	3.17
Middle Fork Payette River	1	4	3	4	3	3.00	3	3	1.5	3	3	3	2.74	2.87
Middle Fork Salmon River	1	4	5	4	5	3.80	3	4.5	3	3	3	4	3.40	3.60
Middle Salmon - Chamberlain	1	4	4	4	3	3.20	3	3	3	3	3	3	2.99	3.09
Middle Salmon - Panther	3	4	5	4	4	4.00	3	3	3	3	3	4	3.15	3.58
North Fork Malheur River	1	4	4	5	2	3.20	1.5	4.5	3	3	1.5	2	2.57	2.89
North Fork Payette River	1	2	X	1	1	X	3	1.5	1.5	3	3	2	2.32	X
Opal Lake (simple)	1	4	2	1	3	2.20	4.5	4.5	4.5	4.5	4.5	1	3.90	3.05
Pahsimeroi River	3	4	3	3	4	3.40	3	3	3	3	3	3	2.99	3.19
South Fork Salmon River	3	4	5	4	5	4.20	3	4.5	3	3	3	4	3.40	3.80
Upper Malheur River	1	2	3	5	1	2.40	1.5	3	1.5	3	1.5	2	2.08	2.24
Upper Salmon River	3	4	5	4	4	4.00	3	3	3	4.5	4.5	4	3.65	3.83
Upper South Fork Payette River	1	4	5	4	3	3.40	3	4.5	1.5	3	3	4	3.15	3.28
Weiser River	1	2	3	2	2	2.00	3	1.5	1.5	3	3	2	2.32	2.16

Scenario 5: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Coastal Representative Unit														
Chester Morse Lake	1	0	X	0	0	X	1.5	3	4.5	1.5	3	1	2.41	X
Chilliwack River	1	4	3	3	4	3.00	3	3	4.5	3	3	2	3.07	3.04
Clackamas River (historical)	0	0	X	0	0	X	3	4.5	3	3	3	2	3.07	X
Dungeness River	1	2	3	1	2	1.80	1.5	1.5	1.5	1.5	1.5	2	1.58	1.69
Elwha River	3	4	3	5	3	3.60	1.5	3	1.5	3	4.5	3	2.74	3.17
Hoh River	1	2	3	5	1	2.40	1.5	3	4.5	3	3	2	2.82	2.61
Hood River	0	0	X	0	0	X	1.5	1.5	4.5	1.5	1.5	1	1.91	X
Klickitat River	1	0	X	0	0	X	4.5	3	1.5	3	3	2	2.82	X
Lewis River	1	4	2	1	1	1.80	1.5	3	1.5	1.5	3	2	2.08	1.94
Lower Deschutes River	1	4	3	4	4	3.20	3	4.5	3	3	3	3	3.24	3.22
Lower Skagit River	1	4	4	3	3	3.00	1.5	1.5	1.5	1.5	1.5	3	1.74	2.37
Nooksack River	1	2	3	3	2	2.20	1.5	1.5	1.5	1.5	1.5	2	1.58	1.89
North Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Odell Lake (simple)	0	0	X	0	0	X	3	4.5	1.5	1.5	3	1	2.41	X
Puyallup River	1	2	3	2	3	2.20	1.5	1.5	1.5	1.5	1.5	3	1.74	1.97
Queets River (simple)	1	2	2	1	1	1.40	3	3	4.5	3	1.5	2	2.82	2.11
Quinault River	1	4	3	5	1	2.80	1.5	3	4.5	1.5	1.5	2	2.32	2.56
Skokomish River	1	2	2	1	2	1.60	1.5	1.5	3	1.5	1.5	2	1.83	1.71
Snohomish/Skykomish River	1	2	2	1	1	1.40	1.5	1.5	1.5	1.5	1.5	1	1.41	1.41
South Santiam River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Stillaguamish River	1	0	X	0	0	X	1.5	1.5	4.5	1.5	1	1	1.83	X
Upper Deschutes River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Upper Skagit River	1	4	4	4	3	3.20	1.5	3	1.5	1.5	1.5	3	1.99	2.60
Upper Willamette River	1	2	3	1	2	1.80	4.5	1.5	1.5	3	3	2	2.57	2.19

Scenario 5: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
White Salmon River (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	1	0.17	X
Columbia Headwaters Representative Unit														
Akokala Lake (simple)	1	2	X	1	1	X	3	3	1.5	4.5	4.5	1	2.91	X
Big Salmon Lake (simple)	1	2	2	1	1	1.40	3	3	3	3	3	1	2.66	2.03
Bitterroot River	1	2	2	1	1	1.40	1.5	1.5	1.5	1.5	1.5	3	1.74	1.57
Blackfoot River	1	2	2	3	1	1.80	1.5	1.5	1.5	1.5	1.5	3	1.74	1.77
Bowman Lake (simple)	1	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	2	3.57	X
Bull Lake (simple)	1	2	X	1	1	X	1.5	1.5	1.5	1.5	1.5	1	1.41	X
Clark Fork River (Section 1)	1	2	X	1	1	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X
Clark Fork River (Section 2)	1	2	X	1	1	X	1.5	1.5	1.5	1.5	1.5	3	1.74	X
Clearwater River and Lakes	1	2	2	1	1	1.40	1.5	4.5	1.5	1.5	1.5	3	2.24	1.82
Cyclone Lake	1	2	X	1	1	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X
Doctor Lake (simple)	2	2	X	1	1	X	1.5	3	4.5	3	3	1	2.66	X
Flathead Lake	1	4	3	4	2	2.80	1.5	4.5	1.5	1.5	1.5	3	2.24	2.52
Frozen Lake (simple)	1	2	X	1	1	X	1.5	3	3	1.5	1.5	1	1.91	X
Harrison Lake (simple)	1	2	X	1	1	X	3	3	3	3	3	1	2.66	X
Holland Lake (simple)	1	2	X	1	1	X	1.5	4.5	1.5	1.5	1.5	1	1.91	X
Hungry Horse Reservoir	1	4	3	4	3	3.00	3	3	3	1.5	1.5	3	2.49	2.75
Isabel Lake (simple)	1	2	X	1	1	X	3	3	1.5	3	3	1	2.41	X
Kootenai River	1	2	X	2	1	X	1.5	1.5	1.5	1.5	1.5	1	1.41	X
Lake Coeur d'Alene	1	2	X	3	1	X	1.5	3	1.5	3	3	2	2.32	X
Lake Koocanusa	1	2	3	3	4	2.60	1.5	3	1.5	1.5	1.5	4	2.16	2.38
Lake Pend Oreille A	1	2	3	1	1	1.60	1.5	1.5	1.5	1.5	1.5	2	1.58	1.59
Lake Pend Oreille B	1	2	4	4	4	3.00	3	4.5	1.5	3	3	3	2.99	2.99
Lake Pend Oreille C	1	0	X	0	0	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X

Scenario 5: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Lincoln Lake (simple)	1	2	X	1	1	X	4.5	4.5	1.5	4.5	4.5	1	3.40	X
Lindbergh Lake (simple)	1	2	X	1	1	X	1.5	3	1.5	3	3	1	2.16	X
Logging Lake	1	2	X	1	2	X	4.5	4.5	1.5	4.5	4.5	1	3.40	X
Lower Quartz Lake (simple)	1	2	X	1	1	X	3	3	1.5	3	3	1	2.41	X
Priest Lakes	1	2	2	4	2	2.20	3	4.5	1.5	3	3	2	2.82	2.51
Quartz Lake (simple)	1	2	X	1	1	X	3	3	1.5	4.5	4.5	2	3.07	X
Rock Creek	1	4	X	2	1	X	1.5	3	1.5	1.5	1.5	3	1.99	X
Swan Lake	1	2	2	4	2	2.20	1.5	3	1.5	1.5	1.5	3	1.99	2.10
Trout/Arrow Lakes (simple)	1	2	X	1	1	X	1.5	1.5	3	1.5	1.5	1	1.66	X
Upper Kintla Lake (simple)	1	2	X	1	1	X	3	3	1.5	1.5	1.5	1	1.91	X
Upper Stillwater Lake	1	2	X	1	1	X	1.5	3	1.5	1.5	1.5	2	1.83	X
Upper Whitefish Lake	1	2	X	1	1	X	1.5	3	1.5	1.5	1.5	2	1.83	X
West Fork Bitterroot River	1	2	X	4	2	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X
Whitefish Lake	1	2	X	1	1	X	1.5	3	1.5	1.5	1.5	2	1.83	X
Klamath Representative Unit														
Sycan River (simple)	0	0	X	0	0	X	3	1.5	1.5	3	1.5	2	2.08	X
Upper Klamath Lake	1	2	2	1	4	2.00	3	1.5	1.5	1.5	1.5	2	1.83	1.91
Upper Sprague River	0	2	X	0	1	X	1.5	3	1.5	1.5	1.5	2	1.83	X
Mid-Columbia Representative Unit														
Asotin Creek (simple)	1	0	X	0	0	X	1.5	1.5	3	1.5	1.5	2	1.83	X
Eagle Creek (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Entiat River	1	0	X	0	0	X	1.5	1.5	1.5	1.5	1.5	1	1.41	X
Imnaha River	1	4	4	3	4	3.20	3	1.5	4.5	3	3	2	2.82	3.01
Lake Chelan (historical)	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X

Scenario 5: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Little Minam River (simple)	1	2	2	1	3	1.80	3	4.5	4.5	3	3	1	3.15	2.48
Lochsa River	1	4	3	4	3	3.00	3	4.5	1.5	3	3	2	2.82	2.91
Lookingglass / Wenaha	3	4	3	3	4	3.40	3	3	3	3	3	2	2.82	3.11
Methow River	1	4	3	3	2	2.60	1.5	3	1.5	1.5	1.5	3	1.99	2.30
Middle Fork John Day River	0	0	X	0	0	X	1.5	1.5	1.5	1.5	1.5	1	1.41	X
North Fork Clearwater River	1	4	3	4	4	3.20	3	4.5	1.5	1.5	1.5	3	2.49	2.85
North Fork John Day River	1	2	3	3	2	2.20	3	3	1.5	1.5	1.5	2	2.08	2.14
Northeast Washington RNA	X	X	X	X	X	X	NA	NA	NA	NA	NA	NA	0.00	X
Pine Indian & Wildhorse Creeks	1	2	3	3	3	2.40	3	1.5	1.5	1.5	1.5	2	1.83	2.11
Powder River	0	0	X	0	0	X	1.5	1.5	1.5	1.5	1.5	1	1.41	X
Selway River	1	4	3	4	3	3.00	3	4.5	1.5	3	4.5	2	3.07	3.04
South Fork Clearwater River	1	2	3	4	3	2.60	1.5	3	1.5	1.5	1.5	2	1.83	2.21
South Salmo River	1	4	3	3	2	2.60	3	1.5	1.5	1.5	1.5	2	1.83	2.21
Touchet River	1	2	3	1	1	1.60	1.5	1.5	1.5	1.5	1.5	2	1.58	1.59
Tucannon River	1	2	3	3	1	2.00	1.5	1.5	1.5	1.5	1.5	3	1.74	1.87
Umatilla River (simple)	0	0	X	0	0	X	1.5	1.5	3	1.5	1.5	1	1.66	X
Upper Grande Ronde River	0	0	X	0	0	X	1.5	1.5	1.5	1.5	1.5	1	1.41	X
Upper Mainstem John Day River	1	2	2	1	1	1.40	1.5	1.5	1.5	1.5	1.5	2	1.58	1.49
Walla Walla River	1	2	3	4	2	2.40	1.5	1.5	1.5	3	3	2	2.08	2.24
Wallowa / Minam Rivers	1	4	3	4	4	3.20	1.5	3	1.5	3	3	2	2.32	2.76
Wenatchee River	1	4	3	3	3	2.80	1.5	3	1.5	3	3	2	2.32	2.56
Yakima River	1	2	3	2	2	2.00	1.5	1.5	1.5	1.5	1.5	3	1.74	1.87
Saint Mary Representative Unit														
Cracker Lake	1	2	2	1	1	1.40	4.5	3	3	3	3	1	2.91	2.15
Red Eagle Lake (simple)	1	2	2	1	1	1.40	3	3	3	3	3	1	2.66	2.03

Scenario 5: Categorical Model Scores for Demographic, Habitat, and Total Resiliency for Each Core Area

Core Area	Demographic						Habitat							
	Growth Rate	Life History Diversity	Occupied Local Pops.	Genetic Connect	Abund-ance	Demogr-aphic Score	Water Quality	Access to FMO	Fish Community	Instream Quality	Riparian Quality	Habitat Quantity	Habitat Score	Resiliency Score
Slide Lake	1	2	2	1	1	1.40	4.5	4.5	4.5	3	3	1	3.40	2.40
St Mary (complex)	1	2	3	3	1	2.00	1.5	1.5	1.5	1.5	1.5	3	1.74	1.87
Upper Snake Representative Unit														
Anderson Ranch Reservoir	1	4	4	3	3	3.00	3	3	1.5	3	3	3	2.74	2.87
Arrowrock Reservoir	1	4	4	3	3	3.00	1.5	1.5	1.5	3	3	3	2.24	2.62
Chief Eagle Eye Creek	1	2	X	1	1	X	1.5	1.5	1.5	3	1.5	2	1.83	X
Deadwood River	1	2	3	4	2	2.40	3	3	3	3	3	3	2.99	2.69
Jarbidge River	1	2	3	2	1	1.80	1.5	3	4.5	1.5	1.5	2	2.32	2.06
Lake Creek (simple)	1	4	2	1	3	2.20	1.5	3	3	3	3	2	2.57	2.39
Lemhi River	1	4	4	3	4	3.20	3	3	1.5	3	3	3	2.74	2.97
Little Lost River	1	4	4	3	4	3.20	1.5	3	1.5	3	1.5	2	2.08	2.64
Little-Lower Salmon River	1	4	3	3	3	2.80	1.5	3	1.5	3	3	3	2.49	2.65
Middle Fork Payette River	1	4	3	4	2	2.80	3	3	1.5	3	3	3	2.74	2.77
Middle Fork Salmon River	1	4	4	4	4	3.40	3	3	1.5	3	3	4	2.91	3.15
Middle Salmon - Chamberlain	1	4	3	3	3	2.80	3	3	1.5	3	3	3	2.74	2.77
Middle Salmon - Panther	1	4	4	4	3	3.20	3	3	1.5	3	3	4	2.91	3.05
North Fork Malheur River	1	2	3	5	2	2.60	1.5	3	3	3	1.5	2	2.32	2.46
North Fork Payette River	1	2	X	1	1	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X
Opal Lake (simple)	1	4	2	1	2	2.00	3	4.5	4.5	3	3	1	3.15	2.58
Pahsimeroi River	1	2	3	2	4	2.40	3	3	3	3	3	3	2.99	2.69
South Fork Salmon River	1	4	4	4	4	3.40	3	3	1.5	3	1.5	4	2.66	3.03
Upper Malheur River	1	2	2	5	1	2.20	1.5	3	1.5	3	1.5	2	2.08	2.14
Upper Salmon River	1	4	5	4	4	3.60	3	3	3	3	3	4	3.15	3.38
Upper South Fork Payette River	1	4	4	4	3	3.20	3	4.5	1.5	3	3	4	3.15	3.18
Weiser River	1	2	X	2	1	X	1.5	1.5	1.5	1.5	1.5	2	1.58	X

Appendix H. Summary reports of current condition factor scoring for bull trout core areas analyzed within the Bull Trout SSA

Coastal Representative Unit:

(CO1) Chester Morse Lake Core Area

Growth Rate: Analysis detected no trend in adult abundance within the core area

Life History Diversity: Only adfluvial bull trout have been documented, no resident form appears to be present

Number of Occupied Local Populations: 4 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat (naturally isolated adfluvial population)

Quality of Fish Community: No deleterious species present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~19 km of S&R Designated Critical Habitat

Additional Comments:

- Chester Morse Lake Core Area is 100% Local Government Lands and is the protected Municipal Watershed for the City of Seattle.
- Future condition modeling projected a 89% loss of spawning and rearing habitat by 2071-2090 resulting in ~2 km remaining.

(CO2) Chilliwack River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Adfluvial, fluvial, and anadromous bull trout have been documented

Number of Occupied Local Populations: Transboundary core area with 3 occupied

Local Populations within the U.S. (one is transboundary with Canada) and 7 occupied Local Populations within B.C., Canada (one potentially transboundary with U.S.)

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present in US portion of core area, however, at least one isolated lake population of brook trout is present within the B.C. portion of the core area

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~48 km of S&R Designated Critical Habitat (U.S. local populations only)

Additional Comments:

- The U.S. portion of the Chilliwack River Core Area is approximately 67% Federal Lands including a large portion of the headwaters in North Cascades National Park. Some parts of the core area within Canada are within a Provincial Park and an Ecological Reserve.
- Future condition modeling projected no loss of spawning and rearing habitat by 2071-2090 within the U.S. portion of the core area.
- Scoring of habitat quantity adjusted to reflect spawning and rearing habitat available in Canada. Because critical habitat was not designated in the British Columbia portion of the functional core area, habitat quantity included estimates from previous status assessments that did include the associated local populations within Canada (Fredenberg et al. 2005). Percent loss from future condition modeling was applied to this revised overall habitat quantity estimate.

(CO4) Dungeness River Core Area

Growth Rate: Analysis shows a declining trend in juvenile abundance within the core area

Life History Diversity: Anadromous and fluvial bull trout have been documented, and resident form is suspected

Number of Occupied Local Populations: 2 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout are present within the core area, however, no hybridization with bull trout has been detected. Dungeness River core area also

contains resident populations of native Dolly Varden.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~43 km of S&R Designated Critical Habitat

Additional Comments:

- Dungeness River Core Area is approximately 80% Federal Lands including a large portion of the headwaters within Olympic National Park and within Designated Wilderness.
- Future condition modeling projected a 39% loss of spawning and rearing habitat by 2071-2090 resulting in ~26 km remaining.

(CO5) Elwha River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Anadromous, fluvial, and resident bull trout have been documented (an adfluvial form no longer remains following dam removal)

Number of Occupied Local Populations: 2 occupied Local Populations, 1 potential Local Population

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat, fully restored in 2015 with the Elwha and Glines Canyon dam removals

Quality of Fish Community: Brook trout present in the system (lower watershed), however, no documented hybridization

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~95 km of S&R Designated Critical Habitat

Additional Comments:

- Elwha River Core Area is approximately 91% Federal Lands all contained within Olympic National Park.
- Future condition modeling projected a 26% loss of spawning and rearing habitat by 2071-2090 resulting in ~70 km remaining.

(CO6) Hoh River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Anadromous and fluvial bull trout have been documented

Number of Occupied Local Populations: 2 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to

each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~83 km of S&R Designated Critical Habitat

Additional Comments:

- Hoh River Core Area is approximately 58% Federal Lands including all of the headwaters within Olympic National Park. However, the anadromous form forages and overwinters in a number of non-natal coastal river and creek systems along the Washington coast.
- Future condition modeling projected a 65% loss of spawning and rearing habitat by 2071-2090 resulting in ~29 km remaining.

(CO7) Hood River Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend

Life History Diversity: Migratory bull trout

Number of Occupied Local Populations: 1 occupied local population

Genetic Connectivity: This population is not connected to other populations.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group based on monitoring data.

Water Quality: Based on Threats Assessment.

Access to FMO: This population does not have access to FMO habitat in Lower Hood and Columbia rivers due to Clear Branch Dam.

Quality of Fish Community: Nonnative fish are not present.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~22 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The Hood River Core Area is comprised of approximately 52% federal, 44% private and 3% local government owned land. Current spawning and rearing occurs within designated Wilderness.
- Future condition modeling projected a 0.05% loss of spawning and rearing habitat by 2071-2090 resulting in ~21 km remaining.

(CO8) Klickitat River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident bull trout have been documented, persistence of a fluvial form in the lower watershed remains unconfirmed.

Number of Occupied Local Populations: 1 occupied Local Population

Genetic Connectivity: A single resident population is internally connected, however, it has no connectivity with other Local Populations.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout are present within the single Local Population with suspected hybridization.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~31.5 km of S&R Designated Critical Habitat

Additional Comments:

- Klickitat River Core Area is approximately 56% Tribal lands and 34% private lands and only 1% Federal Lands. The single local population is entirely on Tribal lands.
- Future condition modeling projected no loss of spawning and rearing habitat by 2071-2090.

(CO9) Lewis River Core Area

Growth Rate: Analysis could not determine a trend in adult abundance within the core area

Life History Diversity: Only adfluvial bull trout have been documented, no resident form appears to be present. Prior to construction of dams within the system, the fluvial form existed.

Number of Occupied Local Populations: 3 occupied Local Populations

Genetic Connectivity: 2 of the occupied Local Populations are well connected, with limited connectivity between the third local population which resides within a different reservoir.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Existing dam facilities hinder access to some potential Feeding/Migratory/Overwintering habitat in the lower Lewis River and mainstem Columbia River.

Quality of Fish Community: Brook trout present within some S&R habitats in the core area, however, no documented hybridization

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~27 km of S&R Designated Critical Habitat

Additional Comments:

- Lewis River Core Area is approximately 61% Federal Lands.
- Future condition modeling projected only a 16 % loss of spawning and rearing habitat by 2071- 2090 resulting in ~22 km remaining.

(CO10) Lower Deschutes Core Area

Growth Rate: Analysis of long-term monitoring data from the Metolius River populations determined non-significant or stable trend

Life History Diversity: Migratory and resident bull trout detected

Number of Occupied Local Populations: 5 occupied local populations

Genetic Connectivity: Each population is connected to at least one other population in the core area. The Pelton Round Butte Hydroelectric Project compromises connectivity between the Metolius River populations and the Warm Springs Populations.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group based on long-term monitoring data.

Water Quality: Based on Threats Assessment. Water quality is not a primary threat in this core area.

Access to FMO: All populations have access to FMO habitat.

Quality of Fish Community: Nonnative fish are present in high abundance in the Warm Springs River local population and in low levels in the Metolius River populations.

Instream Quality: Based on Threats Assessment. Instream impacts not a primary threat in this basin.

Riparian Quality: Based on Threats Assessment. Riparian habitat quality not a primary threat.

Habitat Quantity: ~112 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The Upper Deschutes Core Area is comprised of approximately 26% federal, 48% private, 24% Tribal and 3% state government owned land. All spawning and rearing distribution is on USFS or Tribal land.
- Future condition modeling projected a 24% loss of spawning and rearing habitat by 2071-2090 resulting in ~85 km remaining.
- Lake Billy Chinook is the only Oregon water body where bull trout harvest is allowed.

(CO11) Lower Skagit River Core Area

Growth Rate: Analysis shows a declining trend in both juvenile and adult abundance within the core area

Life History Diversity: Anadromous, adfluvial, fluvial, and resident bull trout have been documented

Number of Occupied Local Populations: 20 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some current conditions (e.g., instream conditions in lower river, Baker River Dams) may hinder access to some potential Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout present within portions of the core area, however, no documented hybridization.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~310.5 km of S&R Designated Critical Habitat

Additional Comments:

- Lower Skagit River Core Area is approximately 67% Federal Lands including a large portion of headwater areas within Designated Wilderness and North Cascades National Park.
- Future condition modeling projected a 35% loss of spawning and rearing habitat by 2071-2090 resulting in ~193 km remaining.

(CO12) Nooksack River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Anadromous and fluvial bull trout have been documented, presence of a resident form unknown

Number of Occupied Local Populations: 10 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout present within a number of S&R habitats in the core area, however, no documented hybridization

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~243 km of S&R Designated Critical Habitat

Additional Comments:

- Nooksack River Core Area is approximately 33% Federal Lands and 47% private lands. including portion of the headwaters in Designated Wilderness.
- Future condition modeling projected a 62% loss of spawning and rearing habitat by 2071-2090 resulting in ~93 km remaining.

(CO13) Odell Lake Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend

Life History Diversity: Migratory (adfluvial) bull trout detected

Number of Occupied Local Populations: 1 occupied local population

Genetic Connectivity: This population is not connected to other populations.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group based on long-term monitoring data.

Water Quality: Based on Threats Assessment. Water quality is not a primary threat in this core area.

Access to FMO: No obstructions to needed FMO habitat exist.

Quality of Fish Community: Lake trout are present in Odell Lake. Brook trout are present in tributary streams and hybridization has been detected.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment. Riparian habitat quality not a primary threat.

Habitat Quantity: ~9 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The Odell Lake Core Area is comprised of 100% federally owned land.
- Future condition modeling projected a 0% loss of spawning and rearing habitat by 2071-2090 resulting in ~9 km remaining.

(CO14) Puyallup River Core Area

Growth Rate: Analysis could not determine a trend in adult abundance within the core area

Life History Diversity: Fluvial, anadromous, and resident bull trout have been documented

Number of Occupied Local Populations: 4 occupied Local Populations

Genetic Connectivity: 3 of the occupied Local Populations are suspected to be connected to each other, however, there is likely limited to no connectivity with the remaining occupied local population (Carbon River)

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (e.g., dams/diversions, instream conditions) that hinder access to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout present within a number of S&R habitats in the core areas, however, no hybridization documented

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~229 km of S&R Designated Critical Habitat

Additional Comments:

- Puyallup River Core Area is approximately 41% Federal Lands including a large portion of the headwaters in Mount Rainier National Park and some within Designated Wilderness.
- Future condition modeling projected a 46% loss of spawning and rearing habitat by 2071-2090 resulting in ~123.5 km remaining.

(CO15) Queets River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Anadromous and fluvial bull trout have been documented, presence of a resident form unknown

Number of Occupied Local Populations: 1 occupied Local Population (may be an artifact of insufficient bull trout genetic and spawning and rearing distribution data)

Genetic Connectivity: The occupied Local Population well connected internally

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~42 km of S&R Designated Critical Habitat

Additional Comments:

- Queets River Core Area is approximately 49% Federal Lands including a large portion of the headwaters and mainstem corridor within Olympic National Park.
- Future condition modeling projected a 34% loss of spawning and rearing habitat by 2071-2090 resulting in ~27.5 km remaining.

(CO16) Quinault River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Adfluvial and fluvial bull trout have been documented and anadromous bull trout suspected, presence of a resident form unknown. Dolly Varden also present within East Fork Quinault River.

Number of Occupied Local Populations: 2 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~58 km of S&R Designated Critical Habitat

Additional Comments:

- Quinault River Core Area is approximately 63% Federal Lands including a portion of the headwaters in Olympic National Park.
- Future condition modeling projected a 52% loss of spawning and rearing habitat by 2071-2090 resulting in ~28 km remaining.

(CO17) Skokomish River Core Area

Growth Rate: Analysis could not determine a trend in adult abundance within the core area

Life History Diversity: Adfluvial and fluvial bull trout have been documented, unknown if anadromous bull trout persist, presence of a resident form unknown.

Number of Occupied Local Populations: 2 occupied Local Populations

Genetic Connectivity: Occupied Local Populations currently have limited connectivity to one another

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (e.g., dams and instream conditions) to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout present within the core area, however, no hybridization documented

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~39 km of S&R Designated Critical Habitat

Additional Comments:

- Skokomish River Core Area is approximately 69% Federal Lands including a large portion of the North Fork Skokomish headwaters within Olympic National Park.
- Future condition modeling projected a 63% loss of spawning and rearing habitat by 2071-2090 resulting in ~14 km remaining.

(CO18) Snohomish & Skykomish Rivers Core Area

Growth Rate: Analysis shows a declining trend in adult abundance within the core area

Life History Diversity: Anadromous, fluvial, and resident bull trout have been documented

Number of Occupied Local Populations: 4 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other, with one local population (Troublesome Creek) likely having limited connectivity. It is largely composed of the resident life history form.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (Sunset Falls trap and haul, instream water quality) to needed Feeding/Migratory/Overwintering habitat with the core area

Quality of Fish Community: Brook trout are present in the core area, however, no hybridization has been documented.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~114 km of S&R Designated Critical Habitat

Additional Comments:

- Snohomish & Skykomish Rivers Core Area is approximately 42% Federal Lands including a large portion of the headwaters in Designated Wilderness and 40% private lands.
- Future condition modeling projected a 92% loss of spawning and rearing habitat by 2071-2090 resulting in ~9 km remaining.

(CO19) Stillaguamish River Core Area

Growth Rate: Analysis shows a declining trend in abundance within the core area

Life History Diversity: Anadromous, fluvial, and resident bull trout have been documented

Number of Occupied Local Populations: 3 occupied Local Populations and 1 potential Local Population

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Largely no known obstructions to needed Feeding/Migratory/Overwintering habitat, although Granite Falls Fishway may only provide partial passage during some flow conditions.

Quality of Fish Community: Brook trout are present in the core area, however, no hybridization has been documented.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 155 km of S&R Designated Critical Habitat

Additional Comments:

- Stillaguamish River Core Area is approximately 39% Federal Lands and 41% private

lands.

- Future condition modeling projected a 90% loss of spawning and rearing habitat by 2071-2090 resulting in ~15 km remaining.
- The Upper Deer Creek local population may have recently become extirpated, leaving only 2 occupied Local Populations.

(CO20) Upper Skagit River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Adfluvial and fluvial bull trout have been documented, resident bull trout are suspected

Number of Occupied Local Populations: Transboundary core area with 9 occupied Local Populations within the U.S. and 6 occupied Local Populations within B.C., Canada

Genetic Connectivity: All but three occupied Local Populations are suspected to be connected to each other. Panther Creek appears to be a resident population with limited or no connectivity to others, and Stetattle Creek and Thunder Creek local populations are isolated in separate reservoirs (Gorge and Diablo, respectively) downstream from the remaining connected populations within the Ross Lake/Reservoir system.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (Diablo and Ross dams) to Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout are present, which currently includes larger lacustrine individuals. Hybridization with bull trout has been detected in Ross Lake. Upper Skagit core area also contains native Dolly Varden, with some bull trout-Dolly Varden and some brook trout-Dolly Varden hybrids detected.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~163 km of S&R Designated Critical Habitat (U.S. local populations only)

Additional Comments:

- The U.S. portion of the Upper Skagit River Core Area is approximately 100% Federal Lands including a large portion of the headwaters in North Cascades National Park and Designated Wilderness. Some parts of the core area within Canada are within Provincial parks.
- Future condition modeling projected only a 6% loss of spawning and rearing habitat by 2071- 2090 resulting in ~152.5 km remaining within the U.S. portion of the core area.
- Scoring of habitat quantity adjusted to reflect spawning and rearing habitat available in Canada. Because critical habitat was not designated in the British Columbia portion of the functional core area, habitat quantity included estimates from previous status assessments that did include the associated local populations within Canada (Fredenberg et al. 2005). Percent loss from future condition modeling was applied to this revised

overall habitat quantity estimate.

(CO21) Upper Willamette River Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend

Life History Diversity: Migratory bull trout

Number of Occupied Local Populations: 4 occupied local populations

Genetic Connectivity: Two of the four population are connected to at least one other.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group based on monitoring data.

Water Quality: Based on Threats Assessment. Water Quality is not identified as a primary threat.

Access to FMO: No known obstructions to habitat that supports FMO needs, however Hills Creek Dam blocks access to FMO Critical Habitat and Trail Bridge Dam partially blocks access to FMO habitat in McKenzie River.

Quality of Fish Community: Brook trout present in spawning and rearing habitat and warm water fish are present in some FMO habitats.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~19 km of spawning and rearing designated Critical Habitat. Current estimate of spawning and rearing habitat is not representative of juvenile rearing habitat available throughout the core area.

Additional Comments:

- The Upper Willamette Core Area is comprised of approximately 74% federal and 25% private owned land.
- Future condition modeling projected a 53% loss of spawning and rearing habitat by 2071-2090 resulting in ~9 km remaining.

(CO22h) Clackamas Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Migratory bull trout

Number of Occupied Local Populations: Evidence of a self-sustaining population does not exist in this core area.

Genetic Connectivity: This population is not connected to other bull trout populations.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group based on the number of introduced individuals

Water Quality: Based on Threats Assessment. Water Quality is not identified as a primary threat.

Access to FMO: No obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout and brown trout are present in the basin at low levels of abundance.

Instream Quality: Based on Threats Assessment. Instream Quality not identified as a primary threat.

Riparian Quality: Based on Threats Assessment. Riparian Quality not identified as a primary threat.

Habitat Quantity: ~39 km of spawning and rearing habitat estimated by the working group. Critical habitat has not been designated for this core area.

Additional Comments:

- This is a historical core area. Bull trout were last detected in the Clackamas Basin in 1960.
- A bull trout re-introduction project is currently underway. Future projections are based on the likelihood of success of this project under conditions outlined in each scenario.
- The Clackamas Core Area is comprised of approximately 71% federal, 25% private, and 3% tribal owned land.

(CO23h) North Santiam Core Area

Additional Comments:

- This is a historical core area. Bull trout were last detected in the North Santiam Basin in 1945.
- A North Santiam bull trout re-introduction feasibility assessment is in progress. Future projections under Scenario 1 assumes re-introduction efforts are implemented and likely successful.
- The North Santiam Core Area is comprised of approximately 65% federal, 29% private, and 6% state owned land.

(CO24h) South Santiam Core Area

Additional Comments:

- This is a historical core area. Bull trout were last detected in the South Santiam Basin in 1953.
- Re-introduction of bull trout into this core area is not currently under consideration. The core area is expected to remain extirpated under all future scenarios.
- The South Santiam Core Area is comprised of approximately 32% federal, 67% private, and 1% state owned land.

(CO25h) Upper Deschutes Core Area

Additional Comments:

- This is a historical core area. Bull trout were last detected above Big Falls in 1959.
- Re-introduction of bull trout into this core area is not currently under consideration. The core area is expected to remain extirpated under all future scenarios.
- The Upper Deschutes Core Area is comprised of approximately 78% federal and 21% private owned land.

(CO26h) White Salmon River Historical Core Area

Additional Comments:

- This is a historical core area. Fluvial bull trout have been detected entering the watershed post- dam removal (Condit Dam).
- Current approach to restoring this historical core area is to allow for passive reestablishment of a population.
- White Salmon River Core Area is comprised of approximately 47% Federal Lands, 34% private lands, and 19% State lands.
- ~16 km of critical habitat was designated within the White Salmon historical core area, and future condition modeling projected a 75% loss of spawning and rearing habitat by 2071-2090 resulting in ~4 km remaining.

Columbia Headwaters Representative Unit:

CH01: Akokala Lake Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Migratory (adfluvial)

Number of Occupied Local Populations: 1 occupied local population (simple core area)

Genetic Connectivity: Only one local population present

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 5.04 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- Core area entirety within GNP
- In 2015 a fish passage barrier was constructed below the lake to to protect native fish populations, including bull trout and pure Westslope cutthroat trout, from the potentially significant detrimental effects of non-native invasive fish species, including lake trout, rainbow and possibly brook trout.
- Meeuwig et al. (2004) surveyed Akokala Lake as part of a systematic research effort to evaluate the population ecology of bull trout on the west side of Glacier National Park. Sampling of Akokala Lake and the inlet and outlet streams resulted in capture of 22 bull trout, with both juveniles and adults (to nearly 800 mm in length) well represented. The remote location of this lake makes routine assessment problematic. The population is healthy and functioning within historic levels of natural abundance. Due to the small size of the core area, the adult bull trout population may have never exceeded 100 fish.(Meeuwig, M. H., C. S. Guy. and W. Fredenberg 2004. Evaluation and action plan for protection of 15 threatened adfluvial populations of bull trout in Glacier National Park, Montana. Final scientific report of U.S. Geological Survey to US Fish and Wildlife Service, Kalispell, MT.).

CH02: Big Salmon Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial).

Number of Occupied Local Populations: 1 occupied local population (simple core area).

Genetic Connectivity: Only one local population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: No deleterious species present.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 7.37 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- Core area located entirely within the wilderness.

03: Bitterroot River Core Area

Growth Rate: Significantly decreasing.

Life History Diversity: Resident and migratory (fluvial) bull trout have been documented.

Number of Occupied Local Populations: 14 occupied Local Populations based on the 2015 Recovery Plan.

Genetic Connectivity: One to 25% of the Local Populations are suspected to be connected to each other based on Core Area Working Group.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: Based on Threats Assessment

Access to FMO: Access to and from FMO is completely impaired.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 411.62 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Access to FMO is impeded as the result of connectivity to core areas downstream from large main stem dams.
- Most locals' population in this core area have numerous unscreened irrigation ditches.
- Only one of the 14 local population has Redd count data and overlaps with brook trout. Making redd count data difficult interpret.
- All local populations overlap with one or more nonnative competitor's

- Numerous populations have declined since listing and are now at levels that are difficult to detect.

CH04: Blackfoot River Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend. This score was changed to Significantly Decreasing because populations have declined since listing (Gold Creek, Belmont Creek, and Monture Creek).

Life History Diversity: Resident and fluvial bull trout have been documented.

Number of Occupied Local Populations: 6 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Limited or seasonal access to FMO habitat. No known obstructions to needed Feeding/Migratory/Overwintering habitat within the core area. Some known obstructions outside of core area.

Quality of Fish Community: Deleterious non-natives are present. Brook and brown trout present in FMO and SR habitats.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 255.47 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Redds have not been detected in Gold Creek and Belmont Creek Local Populations since 2018 and 2014, respectively. Redds in these populations have been detected since the mid 1990's and are now considered functionally extinct.

CH05: Bowman Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend. However, redd counts range from 1 to 4 redds annually and were likely much higher before lake trout entered the system.

Life History Diversity: Migratory (adfluvial) bull trout have been documented

Number of Occupied Local Populations: One occupied Local Populations

Genetic Connectivity: Only one local population present

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat within the core area.

Quality of Fish Community: Deleterious species (lake trout) present in

Feeding/Migratory/Overwintering.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 14.23 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Core area located entirely within Glacier National Park.
- Lake trout were first detected in Bowman Lake in 1962, apparently as a result of upstream invasion from Flathead Lake or other waters. In 1969, gill net sampling in Bowman Lake captured 97 bull trout and no lake trout and the lake had a reputation as a premier bull trout fishery. A similar survey in 1977 captured 41 bull trout and still no lake trout. In 2000, in sampling designed to replicate the 1977 methodology, a total of 57 lake trout were captured and only 10 bull trout. Indicators suggest that lake trout are now dominant and bull trout have declined in this core area.

CH06: Bull Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined significantly declining trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No evidence of resident life history in core area based on Core Area Working Group.

Number of Occupied Local Populations: One occupied Local Population present

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Deleterious species present in Spawning and Rearing and Foraging, Migratory and Overwintering habitats

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 15.25 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- This population is unique because bull trout migrate from Bull Lake downstream before tuning up stream to the natal spawning stream (Keeler Creek).
- Nonnative pike have likely affected recent declining trend.

CH07: Clark Fork River (Section 1, upstream of the Blackfoot River) Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend

Life History Diversity: Resident and migratory (adfluvial and fluvial) bull trout have been documented

Number of Occupied Local Populations: Three occupied Local Populations

Genetic Connectivity: All occupied Local Populations are not connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Known obstructions to needed Feeding/Migratory/Overwintering habitat within the core area. Some known obstructions downstream of core area (lower Clark Fork River dams.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 217.79 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- This core area supports a population of bull trout in Harvey Creek and is designated as critical habitat (SR). The 2015 Recovery Plan did not include Harvey Creek as a Local Population.
- Recovery efforts in Harvey Creek and Warm Sprigs Creek include maintaining fish passage barriers to reduce the impacts from nonnative competitors (brook trout and brown trout).
- Large scale (120 river miles) environmental cleanup/remediation efforts aimed at improving water quality will continue in this core area at least until 2028.
- In April of 2022, two bull trout were documented (photographed and genetic samples taken) in the Clark Fork River between the town of Deer Lodge and Warm Springs Creek for the first time in over 100 years.
- Benefits of restoring fish passage throughout the system (Lake Pend Oreille to the Upper Clark Fork River Core Area), over four major dams as a result of both the Avista and Thompson Falls projects as well as the Milltown Dam removal, cannot be fully anticipated, nor will they be fully realized for several bull trout generations.

CH08: Clark Fork River, Section 2 (Flathead River to Blackfoot River) Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend. This score was changed to Significantly Decreasing because several local populations have declined since listing (Trout Creek, Ward Creek, Petty Creek and Ward Creek).

Life History Diversity: Resident and Migratory life histories have been documented in this core area.

Number of Occupied Local Populations: 10 designated Local Populations based on the 2015 Recovery Plan, one is no longer considered occupied (Petty Creek).

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: Based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: Deleterious non-natives are present in both FMO and SR habitats.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: 272.48 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- Six of the 10 Local Populations support viable populations based and four local populations are functionally extirpated, or individuals are difficult to detect using electrofishing sampling equipment.

CH09: Clearwater River & Lakes Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented

Number of Occupied Local Populations: 4 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat, based on Working Group

Quality of Fish Community: Deleterious non-natives are present in Feeding/Migratory/Overwintering and Spawning/Raring habitats.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 91.14 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- One of the three Local Populations monitored, have declined and is now functionally extirpated (no redds observed from 2019 to 2021 for the East Fork Clearwater Local populations).
- This core area consists of a chain of lakes (Salmon Lake Seely Lake, Lake Inez, Alva Lake Rainy Lake, Placid Lake). Many of these lakes support

population of competitive nonnatives.

(CH10) Coeur d'Alene Lake Core Area

Growth Rate: Data contribution to analysis determined declining trend. Analysis was conducted using index redd survey data from the Core Area.

Life History Diversity: Adfluvial bull trout are thought to be the primary life history (resident fish unknown)

Number of Occupied Local Populations: 4 occupied Local Populations. Adjusted down from RUIP, work group cited loss of Bean Creek local population since publication of RUIP.

Genetic Connectivity: 100% of occupied Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group supported by redd surveys.

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat. Seasonal thermal barriers are a concern in the lower reaches of the river.

Quality of Fish Community: several non-native fish impacting bull trout are present (most notable- northern pike)

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: <200 km of occupied S&R Habitat (occupation of designated habitat is unknown) - designated habitat includes unoccupied S&R habitat in both the St. Joe and Coeur d'Alene River basins.

Additional Comments:

- Coeur d'Alene Lake Core Area is approximately 57% Federal, 8% Tribal, and 5% State. 29% is private.
- Only the St Joe River system is occupied in this CA. The Coeur d'Alene River system populations of bull trout have been extirpated.
- Most data on bull trout in this Core Area are current and supported by the St. Joe River Working Group as well as the larger North Idaho Area Bull Trout Work Group. Demographic data is based largely on redd surveys which have shown continuing declines to very low numbers.
- Small population size and declining growth rate are suggestive of this Core Area being very vulnerable to extirpation regardless of having quality S&R habitat spread widely across the Core Area.
- Future condition suitable S&R habitat was modeled and shows a decline of ~38% across the entire Core Area (including the CDA R. basin), both occupied and unoccupied. A 38% decline in occupied S&R habitat would result in ~124 km of occupied S&R habitat.
- This CA has poor demographics with quality S&R habitat. There is continued interest in the negative role of non-native fishes within the FMO habitat (lake) and their impact on bull trout recruitment.

CH12: Cyclone Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend

Life History Diversity: Migratory (adfluvial) bull trout have been documented

Number of Occupied Local Populations: One occupied Local Populations

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 14.62 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

CH13: Doctor Lake Core Area (simple)

Growth Rate: No data contribution to trend analysis.

Life History Diversity: Migratory (adfluvial) bull trout have been documented.

Number of Occupied Local Populations: One occupied Local Populations present.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: No deleterious species present.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 7.70 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- Core area is located entirely within wilderness.

CH14: Flathead Lake Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented.

Number of Occupied Local Populations: 17 occupied Local Populations.

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: Based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: Deleterious species present in FMO and SR habitats.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: 3650.83 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- The Flathead Lake watershed is one of the largest, most complex, and best-documented bull trout core areas in the upper Columbia River watershed, encompassing 125,000-acre Flathead Lake (the largest freshwater lake in the U.S. west of the Mississippi River) and a large portion of northwest Montana extending into British Columbia, Canada. An extensive redd count monitoring program was devised by Montana Fish, Wildlife, and Parks and has been in place since 1980's. Based on the redd count data collected from eight index tributary streams in the North Fork and Middle Fork Flathead River (collectively representing about half the known spawning in the basin), bull trout index redd counts ranged from about 300-600 in the 1980's (averaging 392), then dropped drastically in the early 1990's, to a range of 83-243 in the seven years prior to listing (averaging 137 between 1991 and 1997). Form 1998-2002, a brief rebound was experienced (range 187-251; average 215), but the 2003 redd count was only 130 and in 2004 only 136 redds were found. Redd counts from 2017 to 2022 ranged from 128 to 154 across index reaches and averaged 146 redds (2021 Montana BC Bull Trout Redd Counts).

CH15: Frozen Lake Core Area (simple)

Growth Rate: No data contribution to trend analysis

Life History Diversity: Migratory (adfluvial) bull trout have been documented

Number of Occupied Local Populations: One occupied Local Populations

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat within core area.

Quality of Fish Community: No deleterious species present

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 4.88 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- This core area straddles the international border with Canada and is in a remote area. There is little information on threats, species complex, or abundance.

CH16: Harrison Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented.

Number of Occupied Local Populations: One occupied Local Populations.

Genetic Connectivity: Only one local population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat within core area.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality No identified threats in this category based on Threats Assessment.

Habitat Quantity: 6.84 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- Core area is located entirely within Glacier National Park therefore habitats are in pristine conditions however, nonnative species are significantly impacting population size.
- Single local population size lower than what may be sustainable or viable (i.e., formerly robust population is now zero to single digit redd counts, possibly extirpated). Non-native fish species are the primary driver for low population size.

CH17: Holland Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Only one local population present**.**

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area

Working Group.

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat within core area.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering habitat.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 0.76 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- Holland Lake is a simple core area with the presence of low numbers of nonnative Lake Trout in FMO habitats.

CH18: Hungry Horse Reservoir Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history based on Core Area Working Group.

Number of Occupied Local Populations: 10 occupied Local Populations.

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other within the core area.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: No identified threats in this category based on Threats Assessment.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 198.11 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- Core Area Working Group identified one threat (fisheries management recreational fishing pressure). The entire headwaters of this core area are in wilderness. This core area supports an experimental recreational fishery.

CH19: Isabel Lakes Core Area (simple)

Growth Rate: No data contribution to trend analysis.

Life History Diversity: migratory (adfluvial) bull trout have been documented.

Number of Occupied Local Populations: One occupied Local Populations.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: No deleterious species present.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 1.01 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- Core area is located entirely within Glacier National Park.

CH20: Kootenai River Core Area

Growth Rate: Analysis shows a declining trend based on redd surveys within the core area**.**

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident populations present based on Core Area Working Group.

Number of Occupied Local Populations: 8 occupied Local Populations

Genetic Connectivity: Fifty-one to 75% of occupied Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: Deleterious species present.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 196.67 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

CH21: Lake Koocanusa Core Area

Growth Rate: *The a*nalysis of the U.S. portion of the population shows a declining trend based on redd surveys within the core area**.**

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident populations present based on Core Area Working Group.

Number of Occupied Local Populations: Two occupied Local Populations in the US.

Genetic Connectivity: All occupied Local Populations are suspected to be connected to

each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group for US portion of the core area

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat within the core area.

Quality of Fish Community: Deleterious species present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 40.76 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Lake Koocanusa is a trans boundary core area with most of the populations supporting this core area located in Canada. Redd counts in the Canada portion of the core area within the Wigwam River (CA), from 2016 to 2021 range from 888 to 1,561 redds annually. The Growth Rate analysis did not include the redd counts in Canada.
- Libby Dam, completed in 1972, isolates Lake Koocanusa and the upper portions of the Kootenai River drainage, mostly in British Columbia, from its' former connectivity with Kootenay Lake downstream.
- Grave Creek is the only local population for this core area in the U.S.

CH22: Lake Pend Oreille - A (Montana portion) Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Resident and migratory (adfluvial) bull trout have been documented

Number of Occupied Local Populations: 15 occupied Local Populations

Genetic Connectivity: One to 25% of the occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Limited and seasonal access to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 171.77 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Three large mainstem dams significantly impact up and downstream fish passage within this core area. To mitigate for impacts large scale fish passage programs were developed. Mitigation efforts include capture and transport of bull trout both up and downstream of these mainstem dams
- Bull trout captured below Cabinet Gorge dam, have been genetically assigned to local populations upstream of the dam (including local populations within the Lake Pend Oreille, Rock Creek, Blackfoot River, and Clark Fork River Section 2 core areas).

(CH23) Lake Pend Oreille B Core Area

Growth Rate: Growth rate is stable based on index redd survey data.

Life History Diversity: Adfluvial bull trout have been documented. No evidence of other life history in core area.

Number of Occupied Local Populations: 19 occupied Local Populations

Genetic Connectivity: No known local population scale connectivity issues. 76-100% of Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by IDFG Integrated Population Model.

Water Quality: No identified threats in this category based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Lake trout present in core area. Active suppression program in place to manage threat.

Instream Quality: No identified threats in this category based on Threats Assessment

Riparian Quality: No identified threats in this category based on Threats Assessment

Habitat Quantity: 122.4 km of S&R Designated Critical Habitat

Additional Comments:

- Lake Pend Oreille B Core Area is approximately 50% public land (Federal and State).
- Index redd surveys in Lake Pend Oreille B tributaries expected to maintain Bull Trout monitoring in core area in the future.
- Bull trout remain a native fish priority in the management of Lake Pend Oreille. Population health is well documented and monitored.
- Continued management of non-native predators is key to maintaining resiliency of the core area.
- Future condition modeling projected a 57% loss of spawning and rearing habitat by 2071-2090 resulting in 52.88 km remaining. However, modeling does not account for FMO habitat within Lake Pend Oreille.

(CH24) Lake Pend Oreille C Core Area (Lower Pend Oreille River)

Growth Rate: No data contribution to trend analysis

Life History Diversity: Fluvial and possibly resident bull trout historically present

Number of Occupied Local Populations: Currently no occupied Local Populations

Genetic Connectivity: Currently no connectivity

Abundance/Number of Breeding Adults: Individuals periodically detected, but currently does not support a spawning population

Water Quality: Based on Threats Assessment

Access to FMO: Known obstructions (dams and high water temperatures) impair or hinder access to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout and northern pike present in the system, including within historically occupied spawning and rearing habitats.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~197.5 km of S&R Designated Critical Habitat

Additional Comments:

- The Lower Pend Oreille River Core Area is approximately 60% Federal Lands (U.S. Forest Service) and 35% Private Lands.
- Future condition modeling projected a 64% loss of available spawning and rearing habitat by 2071-2090 resulting in ~71 km remaining.
- Reintroduction efforts actively being considered for the core area.

CH25: Lincoln Lake Core Area (simple)

Growth Rate: Significantly declining trend based on Core Area Working Group.

Life History Diversity: Migratory (adfluvial) bull trout have been documented.

Number of Occupied Local Populations: One occupied Local Populations.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 0.81 kms of Spring/Rearing Designated Critical Habitat.

Additional Comments:

- Sampling efforts in 2004 (Meeuwig et al. 2004) of Lincoln Lake and the inlet and outlet streams resulted in capture of 12 bull trout, with subadults (300 mm) and adults (to 700 mm in length) represented. Sampling in 2004 indicated nonnative brook trout are more numerous than bull trout in Lincoln Lake and an upstream source population of brook trout exists (Lake Ellen Wilson).

- Brook trout were detected in Lincoln Lake starting 2010, no bull trout were detected during the 2010 (pers. comm. Vincent D'Angelo USGS Fisheries Biologist).
- GNP staff sampled Lincoln using park-standard 150' sinking, experimental, multifilament gill nets to sample Lincoln Lake in 2017. A total of 8 sets over 2 nights were completed. We captured bull trout, brook trout, longnose suckers, mountain whitefish, and westslope cutthroat trout. Of the 11-bull trout captured, 8 appeared to be hybridized with brook trout. Three fish that did not appear to be hybrids were released alive while the others died in the netting operation. We sent seven samples off for genetic testing which confirmed the seven fish we identified based on visual characteristics were hybrids. Six appeared to be F1 hybrids and one appeared to be a later generation back-cross (2017 Annual Report for Bull Trout Recovery Actions Conducted in Glacier National Park, Montana, U.S. Fish and Wildlife Service Recovery Permit Number TE191853-1, Prepared by Chris Downs and Jon McCubbins).

CH26: Lindbergh Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented

Number of Occupied Local Populations: One occupied Local Populations

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 7.60 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

CH27: Logging Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined significantly declining trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history identified.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area

Working Group.

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering habitats.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 1.82 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Core area is located entirely within Glacier National Park.
- Lake trout were first detected in Logging Lake in 1984, apparently as a result of upstream invasion from Flathead Lake or other waters. In 1969, gill net sampling in Logging Lake captured 61 bull trout and the lake had a reputation as a premier bull trout fishery. In 1977, gill net sampling captured 6 bull trout and no lake trout. In 2000, in sampling designed to replicate the 1977 methodology, a total of 12 lake trout were captured and only 7 bull trout.
- Lake trout suppression efforts began in 2015, bull trout reintroduction efforts occurred from 2017-2020 with age-0 and age-1 bull trout reintroduced from the USFWS hatchery at Creston, MT.
- A total of 18 redds have been detected between 2008 and 2022, in seven of those years zero redds were detected.

CH28: Lower Quartz Lake Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history identified.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Simple core area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering habitats.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 1.47 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Core area is located entirely within Glacier National Park

(CH31) Priest Lakes Core Area

Growth Rate: Stable growth rate, based on index redd count data from core area

Life History Diversity: Adfluviall bull trout have been documented and are dominant or only life history in core area. Limited evidence of resident life history, not substantial enough to designate as multiple life history core area.

Number of Occupied Local Populations: 5 occupied Local Populations

Genetic Connectivity: No known local population scale connectivity issues. 76-100% of Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment

Access to FMO: No known obstructions to Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout and Lake Trout are present in the core area. Lake trout in FMO habitat represent a significant threat in the absence of management action.

Instream Quality: No identified threats in this category based on Threats Assessment

Riparian Quality: No identified threats in this category based on Threats Assessment

Habitat Quantity: ~146 km of S&R Designated Critical Habitat

Additional Comments:

- The Priest Lakes Core Area is approximately 89% public land (Federal and State).
- Index redd surveys in upper Priest Lake tributaries expected to maintain Bull Trout monitoring in core area in the future.
- Maintenance or improvement of future core area resiliency dependent on continued suppression Lake Trout netting in upper Priest Lake.
- Land use related habitat conditions have improved since listing. Would have to diminish in scenarios 4 and 5 to reduce resilience of core area.
- Future condition modeling projected a 34% loss of spawning and rearing habitat by 2071-2090 resulting in ~97 km remaining. However, modeling does not account for FMO habitat in Priest Lakes

CH32: Quartz Lakes Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history identified.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area

Working Group.

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering habitats.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 9.39 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

- This core area is located entirely within Glacier National Park (GNP).
- A barrier was constructed in 2004 between Lower Quartz and Quartz Lake to minimize lake trout movement.
- GNP started Lake Trout suppression efforts in 2012, these efforts have likely resulted int the maintaining a viable population.

CH33: Rock Creek Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend. This rating was changed to a significantly declining trend.

Life History Diversity: Resident and migratory (fluvial and adfluvial) bull trout have been documented

Number of Occupied Local Populations: 9 occupied Local Populations

Genetic Connectivity: Seventy-six to 100% of occupied Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat within the core area, obstructions occur outside of core area.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 262.90 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- The growth rate analysis for this core area included both the Rock Creek and East Fork Reservoir redd count data. While these two populations are identified/maped as a single core area, East Fork Reservoir functions as an isolated simple core area with one local population. The reminder of the Rock Creek core area supports 8 local population that have significantly declined.

- Within the Rock Creek core area (excluding East Fork Reservoir), bull Trout catch-per-unit effort (CPUE) has been assessed based on the number of fish greater than 175 mm caught in the main stem of Rock Creek over the past 45 years. Comparison of this data indicates that CPUE has dropped substantially. Bull Trout CPUE in the sample reach (Fish and Game section) was typically between 30 and 40 fish per pass in the 1970's and early 1980's with catch dropping to around 15 fish per pass in the early 1990's. Another substantial drop in catch rates was observed in 2004-2021 when catch rates dropped to around 2-3 fish per pass. Bull Trout CPUE in a second sample reach (Hogback section) shows similar trends with catch rates being about 20-30 fish per pass in the 1970's and early 1980's and an apparent drop in catch rates in the late 1980's to 10-20 fish per pass. The catch rates continued to decline in the 1990's to 5-10 fish per pass and further eroded in the 2000's and 2010's (through 2021) to less than 5 fish per pass. The synchronicity of these trends between sample site suggests that these trends in Bull Trout abundance are truly occurring (MFWP 2022. Analysis and management implications of multiple decades of fisheries population surveys on rock creek in western Montana prepared by: Bradley w. Liermann, fisheries biologist Montana Fish, Wildlife, and Parks February 2022).
- Redd count information show similar trends. Redd counts in the 90's often exceeded 100 redds. Over the last three years redd counts ranged from 18 to 25 redds.
- Redd counts for the East Fork Reservoir population has ranges from 12 to 99 redds over the past 27 years. Since 2008 East Fork Reservoir has average 65 redd per year (MFWP 2022).
- Bull trout have been recently documented in Moose Lake and Kaiser Lakes.

CH34: Swan Lake Core Area

Growth Rate: Analysis of long-term monitoring data determined significantly declining trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history identified.

Number of Occupied Local Populations: 9 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other within core area.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 152.59 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Lake trout and Pike predation are likely driving recent declines in growth rate.

CH35: Trout / Arrow Lakes Core Area (simple)

Growth Rate: No data contribution to trend analysis.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history identified.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present.

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 9.96 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

CH36: Upper Kintla Lake Core Area (simple)

Growth Rate: No data contribution to trend analysis.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history identified.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present

Instream Quality: No identified threats in this category based on Threats Assessment.

Riparian Quality: No identified threats in this category based on Threats Assessment.

Habitat Quantity: 9.34 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- This core area is located entirely with Glacier National Park.
- Demographic data for this core area consists of two data points (redd counts) completed in 1994 and 2010, 52 and 25 redds were observed respectively.

CH37: Upper Stillwater Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

***Life History* Diversity:** Resident and Migratory bull trout have been documented.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 44.74 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

CH38: Upper Whitefish Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history identified.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 9.44 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

CH39: West Fork Bitterroot River Core Area

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented. No resident life history identified.

Number of Occupied Local Populations: 6 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other within the core area.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat within the core area, obstructions outside of core area.

Quality of Fish Community: Deleterious species present in Spawning/Rearing habitats

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 141.15 kms of Spawning/Rearing Designated Critical Habitat

Additional Comments:

- Painted Rocks Dam isolates the upper West Fork Bitterroot River from downstream waters. The effects of the passage barrier on either the upstream or downstream core area are not documented.

CH40: Whitefish Lake Core Area (simple)

Growth Rate: Analysis of long-term monitoring data determined non-significant or stable trend.

Life History Diversity: Migratory (adfluvial) bull trout have been documented.

Number of Occupied Local Populations: One occupied Local Population.

Genetic Connectivity: Simple Core Area, only one Local Population present.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group.

Water Quality: Based on Threats Assessment.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat.

Quality of Fish Community: Deleterious species present in Feeding/Migratory/Overwintering and Spawning/Rearing habitats.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: 12.60 kms of Spawning/Rearing Designated Critical Habitat.

Additional Comments:

(CH23) Lake Pend Oreille B Core Area

Growth Rate: Growth rate is stable based on index redd survey data.

Life History Diversity: Adfluvial bull trout have been documented. No evidence of other life history in core area.

Number of Occupied Local Populations: 19 occupied Local Populations

Genetic Connectivity: No known local population scale connectivity issues. 76-100% of Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by IDFG Integrated Population Model.

Water Quality: No identified threats in this category based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Lake trout present in core area. Active suppression program in place to manage threat.

Instream Quality: No identified threats in this category based on Threats Assessment

Riparian Quality: No identified threats in this category based on Threats Assessment

Habitat Quantity: 122.4 km of S&R Designated Critical Habitat

Additional Comments:

- Lake Pend Oreille B Core Area is approximately 50% public land (Federal and State).
- Index redd surveys in Lake Pend Oreille B tributaries expected to maintain Bull Trout monitoring in core area in the future.
- Bull trout remain a native fish priority in the management of Lake Pend Oreille. Population health is well documented and monitored.
- Continued management of non-native predators is key to maintaining resiliency of the core area.
- Future condition modeling projected a 57% loss of spawning and rearing habitat by 2071-2090 resulting in 52.88 km remaining. However, modeling does not account for FMO habitat within Lake Pend Oreille.

(CH24) Lake Pend Oreille C Core Area (Lower Pend Oreille River)

Growth Rate: No data contribution to trend analysis

Life History Diversity: Fluvial and possibly resident bull trout historically present

Number of Occupied Local Populations: Currently no occupied Local Populations

Genetic Connectivity: Currently no connectivity

Abundance/Number of Breeding Adults: Individuals periodically detected, but currently does not support a spawning population

Water Quality: Based on Threats Assessment

Access to FMO: Known obstructions (dams and high water temperatures) impair or hinder access to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout and northern pike present in the system, including within historically occupied spawning and rearing habitats.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~197.5 km of S&R Designated Critical Habitat

Additional Comments:

- The Lower Pend Oreille River Core Area is approximately 60% Federal Lands (U.S. Forest Service) and 35% Private Lands.
- Future condition modeling projected a 64% loss of available spawning and rearing habitat by 2071-2090 resulting in ~71 km remaining.
- Reintroduction efforts actively being considered in the core area.

(CH31) Priest Lakes Core Area

Growth Rate: Stable growth rate, based on index redd count data from core area

Life History Diversity: Adfluviall bull trout have been documented and are dominant or only life history in core area. Limited evidence of resident life history, not substantial enough to designate as multiple life history core area.

Number of Occupied Local Populations: 5 occupied Local Populations

Genetic Connectivity: No known local population scale connectivity issues. 76-100% of Local Populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment

Access to FMO: No known obstructions to Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout and Lake Trout are present in the core area. Lake trout in FMO habitat represent a significant threat in the absence of management action.

Instream Quality: No identified threats in this category based on Threats Assessment

Riparian Quality: No identified threats in this category based on Threats Assessment

Habitat Quantity: ~146 km of S&R Designated Critical Habitat

Additional Comments:

- The Priest Lakes Core Area is approximately 89% public land (Federal and State).
- Index redd surveys in upper Priest Lake tributaries expected to maintain Bull Trout monitoring in core area in the future.
- Maintenance or improvement of future core area resiliency dependent on continued suppression Lake Trout netting in upper Priest Lake.
- Land use related habitat conditions have improved since listing. Would have to diminish in scenarios 4 and 5 to reduce resilience of core area.

- Future condition modeling projected a 34% loss of spawning and rearing habitat by 2071-2090 resulting in ~97 km remaining. However, modeling does not account for FMO habitat in Priest Lakes

Mid-Columbia Representative Unit:

(MC1) Asotin Creek Core Area

Growth Rate: Analysis showed a declining trend in juvenile abundance within the core area, but detected no trend in adult abundance

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 1 occupied Local Population

Genetic Connectivity: The single Local Population is dominated by resident individuals which remain internally connected, however, the persistence of the migratory form is tenuous.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions to needed Feeding/Migratory/Overwintering habitat both inside (low instream flows, intermittent flows, dam) and outside of the core area.

Quality of Fish Community: Some deleterious (predacious) species present in FMO habitats outside of core area

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~16 km of S&R Designated Critical Habitat

Additional Comments:

- Asotin Creek Core Area is approximately 70% private lands and 26% Federal Lands. Majority of the headwaters is within the Umatilla National Forest. Watershed was recently impacted by major fire and flood events.
- Future condition modeling projected a 26% loss of spawning and rearing habitat by 2071-2090 resulting in ~12 km remaining.

(MC2) Entiat River Core Area

Growth Rate: Analysis detected declining trend for juvenile abundance and no trend for adult abundance

Life History Diversity: Adfluvial, fluvial, and resident bull trout have been documented

Number of Occupied Local Populations: 2 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (dams managed for irrigation and fish management) and seasonal barriers to needed Feeding/Migratory/Overwintering habitat within core area and outside of core area (mainstem Columbia River dams)

Quality of Fish Community: Brook trout are present in the core area and overlap in spawning, rearing, and Feeding/Migratory/Overwintering habitats. Genetic analyses have identified brook trout/bull trout hybrids within the basin

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~64 km of S&R Designated Critical Habitat

Additional Comments:

- Entiat River Core Area is approximately 80% Federal,12% Private, and 8% State Lands including a portion of the headwaters in Designated Wilderness.
- Future condition modeling projected an 87% loss of spawning and rearing habitat by 2071-2090 resulting in ~9 km remaining.

(MC3) Imnaha River Core Area

Growth Rate: Analysis detected no significant trend for adult abundance based on redd surveys.

Life History Diversity: Fluvial and resident bull trout are present.

Number of Occupied Local Populations: 8 occupied local populations.

Genetic Connectivity: 4 populations do not have connectivity to other populations.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment; not a primary threat.

Access to FMO: All populations have access to needed FMO habitats.

Quality of Fish Community: Based on Threats Assessment.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment; not a primary threat.

Habitat Quantity: ~126 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 72% federal and 22% private owned land.
- Future condition modeling projected a 50% loss of spawning and rearing habitat by 2071-2090 resulting in ~63 km remaining.

(MC5) Little Minam River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident bull trout are present

Number of Occupied Local Populations: 1 occupied local population.

Genetic Connectivity: Population is upstream of a natural barrier and isolated from others.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment. Water quality not identified as a primary threat.

Access to FMO: As a resident population it has access to needed FMO habitat.

Quality of Fish Community: Based on Threats Assessment. No non-native fish present

Instream Quality: Based on Threats Assessment; not identified as a primary threat.

Riparian Quality: Based on Threats Assessment; not identified as a primary threat.

Habitat Quantity: ~21 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 100% federally owned land.
- Future condition modeling projected a 14% loss of spawning and rearing habitat by 2071-2090 resulting in ~18 km remaining.

(MC6) Lochsa River Core Area

Growth Rate: Stable growth rate, based on snorkel and screw trap survey data from Core Area

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 17 occupied Local Populations

Genetic Connectivity: No known local population scale connectivity issues. 76-100% of Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment

Access to FMO: No known obstructions to Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout are present in the Core Area, however distribution is spatially limited at this time.

Instream Quality: No identified threats in this category based on Threats Assessment

Riparian Quality: No identified threats in this category based on Threats Assessment

Habitat Quantity: ~286 km of S&R Designated Critical Habitat

Additional Comments:

- Lochsa River Core Area is approximately 95% Federal Lands. Core Area is partially contained within the Selway-Bitterroot Designated Wilderness.
- Limited Bull Trout monitoring in Core Area, predominately collected as secondary priority to other native species monitoring.
- Future condition modeling projected a 65% loss of spawning and rearing habitat by 2071-2090 resulting in ~101 km remaining.
- Due to expected future land protections and limited influence by non-natives, future scenario scoring most effected by projected spawning and rearing habitat reductions through climate change.

(MC7) Lookingglass-Wenaha Core Area

Growth Rate: Analysis detected no significant trend for adult abundance based on

Lookingglass weir counts.

Life History Diversity: Fluvial and resident bull trout are present.

Number of Occupied Local Populations: 4 occupied local populations.

Genetic Connectivity: 1 population isolated above a natural barrier falls.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment; not a primary threat.

Access to FMO: All populations have access to needed FMO habitats.

Quality of Fish Community: Based on Threats Assessment. Brook Trout present in Langdon Lake.

Instream Quality: Based on Threats Assessment; not a primary threat.

Riparian Quality: Based on Threats Assessment; not a primary threat.

Habitat Quantity: ~79 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 93% federal, 6% private, and 1% state owned land.
- Future condition modeling projected a 30% loss of spawning and rearing habitat by 2071-2090 resulting in ~55 km remaining.

(MC8) Methow River Core Area

Growth Rate: Analysis detected no trend for adult abundance

Life History Diversity: Adfluvial, fluvial, and resident bull trout have been documented

Number of Occupied Local Populations: 10 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (dams managed for irrigation and fish management) and seasonal barriers to needed Feeding/Migratory/Overwintering habitat within core area and outside of core area (mainstem Columbia River dams)

Quality of Fish Community: Brook trout are present in the core area and overlap in spawning, rearing, and Feeding/Migratory/Overwintering habitats. Genetic analyses have identified brook trout/bull trout hybrids within the basin

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~390 km of S&R Designated Critical Habitat

Additional Comments:

- Methow River Core Area is approximately 84% Federal Lands including a

large portion of the headwaters in Designated Wilderness.
- Future condition modeling projected a 51% loss of spawning and rearing habitat by 2071-2090 resulting in ~192 km remaining.

(MC9) Middle Fork John Day River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident bull trout are present. Fluvial bull trout were detected historically.

Number of Occupied Local Populations: 3 occupied local populations

Genetic Connectivity: All local populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment.

Access to FMO: No obstructions to needed FMO habitat exist.

Quality of Fish Community: Based on Threats Assessment. Warm water species present in FMO habitats.

Instream Quality: Based on Threats Assessment. Not identified as a primary threat.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~83 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 58% federal and 42% private owned land.
- Future condition modeling projected a 71% loss of spawning and rearing habitat by 2071-2090 resulting in ~24 km remaining.

(MC10) North Fork Clearwater River Core Area

Growth Rate: Declining growth rate, based on index redd survey data from core area

Life History Diversity: Resident and adfluvial bull trout have been documented. Creation of Dworshak Reservoir in early 1970's resulted in adfluvial life history adaptation of migratory individuals.

Number of Occupied Local Populations: 12 occupied Local Populations

Genetic Connectivity: No known local population scale connectivity issues. 76-100% of Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment

Access to FMO: No known obstructions to Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout are present in the Core Area, however distribution is spatially limited at this time.

Instream Quality: No identified threats in this category based on Threats Assessment

Riparian Quality: No identified threats in this category based on Threats Assessment

Habitat Quantity: ~504 km of S&R Designated Critical Habitat

Additional Comments:

- North Fork Clearwater River Core Area is approximately 77% public land (Federal and State). The core area also has a significant amount of land in private timber ownership.
- Index redd surveys in North Fork Clearwater River tributaries expected to maintain Bull Trout monitoring in core area in the future.
- Future condition modeling projected a 61% loss of spawning and rearing habitat by 2071-2090 resulting in ~197 km remaining.
- Due to expected future land protections and limited influence by non-natives, future scenario scoring most effected by projected spawning and rearing habitat reductions through climate change.

(MC11) North Fork John Day River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident and fluvial bull trout are present.

Number of Occupied Local Populations: 7 occupied local populations

Genetic Connectivity: 2 local populations are isolated from others.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment. Not identified as a primary threat.

Access to FMO: The Clear/Lightning population does not have access to needed FMO habitat.

Quality of Fish Community: Based on Threats Assessment. Brook trout are abundant and widespread. Warm water species present in FMO habitats.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~186 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 65% federal, 34% private and 1% state owned land.
- Future condition modeling projected a 57% loss of spawning and rearing habitat by 2071-2090 resulting in ~80 km remaining.

(MC13) Pine, Indian and Wildhorse Creeks Core Area

Growth Rate: Analysis shows a declining trend based on redd surveys within the core area

Life History Diversity: Resident bull trout are present.

Number of Occupied Local Populations: 7 occupied local populations.

Genetic Connectivity: 2 populations isolated above barrier falls.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group and based on abundance surveys.

Water Quality: Based on Threats Assessment; not a primary threat.

Access to FMO: 3 populations do not have access to needed FMO habitats.

Quality of Fish Community: Based on Threats Assessment; brook trout in spawning and rearing habitats and hybridization detected.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~142 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 77% federal, 22% private and 1% state owned land.
- Future condition modeling projected a 39% loss of spawning and rearing habitat by 2071-2090 resulting in ~86 km remaining.

(MC14) Powder River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident bull trout are present.

Number of Occupied Local Populations: 10 occupied local populations.

Genetic Connectivity: All populations isolated from others within the core area.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment.

Access to FMO: Populations do not have access to needed FMO habitats.

Quality of Fish Community: Based on Threats Assessment; brook trout widespread

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~94 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 39% federal, 60% private and 1% state owned land.
- Future condition modeling projected a 19% loss of spawning and rearing habitat by 2071-2090 resulting in ~76 km remaining.

(MC15) Selway River Core Area

Growth Rate: Stable growth rate, based on snorkel survey data from Core Area

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 10 occupied Local Populations

Genetic Connectivity: No known local population scale connectivity issues. 76-100% of Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment

Access to FMO: No known obstructions to Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout are present in the Core Area, however distribution is spatially limited at this time.

Instream Quality: No identified threats in this category based on Threats Assessment

Riparian Quality: No identified threats in this category based on Threats Assessment

Habitat Quantity: ~438 km of S&R Designated Critical Habitat

Additional Comments:

- Selway River Core Area is approximately 100% Federal Lands. Core Area is almost entirely contained within the Selway-Bitterroot Designated Wilderness.
- Limited Bull Trout monitoring in Core Area, predominately collected as secondary priority to other native species monitoring.
- Future condition modeling projected a 81% loss of spawning and rearing habitat by 2071-2090 resulting in ~85 km remaining.

(MC16) South Fork Clearwater River Core Area

Growth Rate: Stable growth rate, based on snorkel and screw trap survey data from Core Area

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 5 occupied Local Populations

Genetic Connectivity: No known local population scale connectivity issues. 76-100% of Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: No identified threats in this category based on Threats Assessment

Access to FMO: No known obstructions to Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout are present in the Core Area

Instream Quality: No identified threats in this category based on Threats Assessment

Riparian Quality: No identified threats in this category based on Threats Assessment

Habitat Quantity: ~254 km of S&R Designated Critical Habitat

Additional Comments:

- South Fork Clearwater River **C**ore Area is approximately 89% Federal Lands. Core Area is partially contained within the Gospel Hump Designated Wilderness.
- Bull Trout monitoring in the core area is associated with ongoing salmon

and steelhead projects. Weir, screw trap and snorkel monitoring in the Crooked River drainage expected to continue. Snorkel surveys elsewhere in the Core Area expected to continue.

- South Fork Clearwater River Core Area has active habitat restoration program in place with past, current and planned future projects by the Nez Perce Tribe and U.S. Forest Service.
- Future condition modeling projected a 81% loss of spawning and rearing habitat by 2071-2090 resulting in ~65 km remaining.

(MC17) Salmo River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Primarily fluvial, but also resident bull trout have been documented

Number of Occupied Local Populations: 4 occupied Local Populations

Genetic Connectivity: Working Group estimates between 50-75% of the Local Populations are likely connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group, redd counts suggest low 100s.

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (high water temperatures) that hinder access to needed Feeding/Migratory/Overwintering habitat, which has also been significantly altered due to lack of prey fish from the loss of anadromous steelhead and possibly salmon as a result of dams on the Columbia River.

Quality of Fish Community: Brook trout present in high numbers within the mainstem including other nonnatives, however, no documented hybridization

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: Between 41-200 km of occupied habitat based on input from bull trout work group that updated information from Hagen and Decker (2011) assessment.

Additional Comments:

- Salmo River Core Area is approximately 98% Federal Lands within the U.S. portion of the core area, largely within the Salmo Priest Wilderness Area.
- No future condition modeling could be used to project changes for the spawning and rearing habitat by 2071-2090, as the Salmo River core area was not identified at the time critical habitat was designated for bull trout. In lieu of this, we looked at modeled future habitat quantity projections for two adjacent or similar core areas and then applied the average to the Salmo core area. We looked at the Priest Lake and Entiat core areas with 33.8% and 86.4% projected losses in habitat quantity, respectively. We applied a 60% loss of habitat quantity for the Salmo core area under scenario 3, but conservatively did not reduce the habitat quantity score until scenario 4 and 5 due to the degree of uncertainty in using these surrogates.

(MC18) Touchet River Core Area

Growth Rate: Analysis detected no trend for adult abundance

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 3 occupied Local Population

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Barriers at the Dayton Steelhead Acclimation Pond Dam and on private property prevent or limit free movement and connectivity between Feeding/Migratory/Overwintering and spawning/rearing areas, as well as movement between Walla Walla and Touchet Core Areas.

Quality of Fish Community: Some deleterious (predacious) species present in FMO habitats inside and outside of core area

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~42 km of S&R Designated Critical Habitat

Additional Comments:

- Touchet River Core Area is approximately 7% Federal, 92% Private, and 1% State Lands.
- Future condition modeling projected a 14% loss of spawning and rearing habitat by 2071-2090 resulting in ~36 km remaining.

(MC19) Tucannon River Core Area

Growth Rate: Analysis detected no trend for adult or juvenile data

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 5 occupied Local Population

Genetic Connectivity: Most occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Thermal and manmade barriers prevent or limit free movement and connectivity between Feeding/Migratory/Overwintering and spawning/rearing areas. Hydropower facilities on the mainstem Snake River delay migration or hinder free movement of bull trout between core areas.

Quality of Fish Community: Some deleterious (predacious) species present in FMO habitats inside and outside of core area

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~72 km of S&R Designated Critical Habitat

Additional Comments:

- Tucannon River Core Area is approximately 24% Federal, 73% Private, and 3% State Lands.
- Future condition modeling projected a 18% loss of spawning and rearing habitat by 2071-2090 resulting in ~59 km remaining.

(MC20) Umatilla River Core Area

Growth Rate: Analysis detected no trend for adult abundance

Life History Diversity: Fluvial bull trout are present. Resident bull trout were present historically.

Number of Occupied Local Populations: 1 occupied local population

Genetic Connectivity: This population is not connected to other populations within the core area. Bull Trout from neighboring core areas have been detected in FMO habitats

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group based on redd surveys, snorkel observations and dam counts.

Water Quality: Based on Threats Assessment.

Access to FMO: This population has access to needed FMO habitat.

Quality of Fish Community: Based on Threats Assessment. Brook trout are present in the core area but do not overlap spawning and rearing habitat. Predatory species are present in FMO habitats.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~30 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 12% federal, 77% private and 11% tribal owned land.
- Future condition modeling projected a 47% loss of spawning and rearing habitat by 2071-2090 resulting in ~16 km remaining.

(MC21) Upper Grande Ronde River Core Area

Growth Rate: Analysis detected no significant trend for adult abundance based on weir counts and redd surveys in Catherine Creek. May not be reflective of all populations in the core area.

Life History Diversity: Fluvial and resident bull trout are present.

Number of Occupied Local Populations: 7 occupied local populations including Hoodoo Creek.

Genetic Connectivity: Indian Creek population isolated from other populations.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment. Water quality not identified as a primary

threat.

Access to FMO: Working Group believes only Catherine Creek bull trout have access to adequate FMO habitats.

Quality of Fish Community: Based on Threats Assessment.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~153 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 47% federal, 51% private and 1% state owned land.
- Future condition modeling projected a 61% loss of spawning and rearing habitat by 2071-2090 resulting in ~59 km remaining.

(MC22) Upper Mainstem John Day River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Fluvial and resident bull trout are present

Number of Occupied Local Populations: 2 occupied local populations

Genetic Connectivity: Both local populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment.

Access to FMO: No obstructions to needed FMO habitat exist.

Quality of Fish Community: Based on Threats Assessment. Brook trout are present in low abundance and not expanding in distribution.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~109 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 46% federal, 52% private and 2% state owned land.
- Future condition modeling projected a 26% loss of spawning and rearing habitat by 2071-2090 resulting in ~80 km remaining.

(MC21) Upper Grande Ronde River Core Area

Growth Rate: Analysis detected no significant trend for adult abundance based on weir counts and redd surveys in Catherine Creek. Scored as 'no data or data limited' since Catherine Creek is not reflective of all populations in the core area.

Life History Diversity: Fluvial and resident bull trout are present.

Number of Occupied Local Populations: 7 occupied local populations including

Hoodoo Creek.

Genetic Connectivity: Very limited genetic connectivity. Indian Creek, Catherine and Hoodoo populations likely isolated from other populations due to thermal barriers and distance.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Water quality not identified as a primary threat related to instream habitat and connectivity.

Access to FMO: Working Group believes only Catherine Creek bull trout have access to adequate FMO habitats.

Quality of Fish Community: Based on Threats Assessment.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~153 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 47% federal, 51% private and 1% state owned land.
- Future condition modeling projected a 61% loss of spawning and rearing habitat by 2071-2090 resulting in ~59 km remaining.

(MC23) Walla Walla River Core Area

Growth Rate: Analysis detected no trend for adult abundance.

Life History Diversity: Fluvial and resident bull trout are present.

Number of Occupied Local Populations: 3 occupied local populations

Genetic Connectivity: All local populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group based on redd surveys and dam counts.

Water Quality: Based on Threats Assessment.

Access to FMO: All populations have access to needed FMO habitat though diversions and barriers could result in entrainment.

Quality of Fish Community: Based on Threats Assessment. Brook trout are present in the core area but unlikely to expand into spawning and rearing habitat. Predatory species are present in FMO habitats.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~78 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 12% federal, 87% private and 1% state owned land.
- Future condition modeling projected a 24% loss of spawning and rearing

habitat by 2071-2090 resulting in ~59 km remaining.

(MC24) Wallowa-Minam Core Area

Growth Rate: Analysis detected no significant trend for adult abundance based on redd surveys in Bear Creek and Lostine River. May not be reflective of all populations in the core area.

Life History Diversity: Fluvial and resident bull trout are present.

Number of Occupied Local Populations: 6 occupied local populations.

Genetic Connectivity: 2 population are isolated from others.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment. Water quality not identified as a primary threat.

Access to FMO: 1 population, Hurricane Creek, does not have access to adequate FMO habitats.

Quality of Fish Community: Based on Threats Assessment. Brook Trout present and widespread.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~143 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 45% federal and 55% private owned land.
- Future condition modeling projected a 68% loss of spawning and rearing habitat by 2071-2090 resulting in ~46 km remaining.

(MC25) Wenatchee River Core Area

Growth Rate: Analysis detected no trend for either juvenile or adult abundance

Life History Diversity: Adfluvial, fluvial, and resident bull trout have been documented

Number of Occupied Local Populations: 7 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (dams managed for irrigation and fish management) to needed Feeding/Migratory/Overwintering habitat within core area and outside of core area (mainstem Columbia River dams)

Quality of Fish Community: Brook trout are present in the core area and hybridization has been detected in at least one local population (Icicle Creek).

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~297.5 km of S&R Designated Critical Habitat

Additional Comments:

- Wenatchee River Core Area is approximately 80% Federal Lands including a large portion of the headwaters in Designated Wilderness.
- Future condition modeling projected a 62% loss of spawning and rearing habitat by 2071-2090 resulting in ~114 km remaining.

(MC26) Yakima River Core Area

Growth Rate: Analysis detected no trend for adult abundance

Life History Diversity: Adfluvial, fluvial, and resident bull trout have been documented

Number of Occupied Local Populations: 15 occupied Local Populations

Genetic Connectivity: Some occupied Local Populations are connected to each other with Gold Creek, Ahtanum Creek, and Cle Elum River presumed to be disconnected. Downstream passage is available, but no return passage upstream. Some Local Populations are also disconnected seasonally.

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Some known obstructions (dams managed for irrigation and fish management) and seasonal barriers caused reduced or limited access to needed Feeding/Migratory/Overwintering habitat within core area and outside of core area (mainstem Columbia River dams)

Quality of Fish Community: Nonnative predators including brook, lake, and brown trout are present in the core area and genetic analyses has identified brook trout/bull trout hybrids within the basin.

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~497 km of S&R Designated Critical Habitat

Additional Comments:

- Yakima River Core Area is approximately 32% Federal, 32% Private, 23% Tribal, and 13% State Lands including a large portion of the headwaters in Designated Wilderness.
- Future condition modeling projected an 53% loss of spawning and rearing habitat by 2071-2090 resulting in ~232 km remaining.

(MC27h) Lake Chelan Core Area

Additional Comments:

- This is a historical core area that once supported an adfluvial population. The last verified observation was in 1957. The exact cause or causes leading to the extirpation of this core population remain undetermined (Nelson 2012).

- A reintroduction feasibility assessment was initiated by the National Park Service in 2021.
- Nonnative brook trout and lake trout are currently present within the watershed.
- Lake Chelan Core Area is approximately 89% Federal Lands, 10% Private Lands, and 1% State Lands, including the majority of the headwaters in North Cascades National Park and Designated Wilderness.

Nelson, M.C. 2012. What happened to bull trout in Lake Chelan: an examination of the historical evidence. U.S. Fish and Wildlife Service, Mid Columbia River Fishery Resource Office. Leavenworth, Washington. 40 pp.

(MC28h) Eagle Creek Core Area

Additional Comments:

- This is a historical core area. Bull trout were last documented in the Eagle Creek Basin in 1965 and anglers reported bull trout in the mid-1980s.
- Re-introduction of bull trout into this core area is not currently under consideration given brook trout are widespread and abundant. The core area is expected to remain extirpated under all future scenarios.
- The Eagle Creek Core Area is comprised of approximately 88% federal and 12% private owned land.

(MC29h) Northeast Washington Research Needs Area (RNA)

Additional Comments:

- This area has limited but consistent observations of subadult and adult bull trout, particularly within Lake Roosevelt and occasionally near the mouths of tributaries to the Lake. However, no known spawning or early rearing areas have been identified to date.
- Additional research is needed to determine the origin of these bull trout and whether or not the area supports its own local population(s) and potentially be identified as a core area.
- Northeast Washington RNA is approximately 18% Federal Lands, 51% Private Lands, 25% Tribal Lands, and 6% State.
- The presence of nonnative fish species is one of the primary prevailing stressors for bull trout in this area. State and Tribal fishery managers have ongoing projects to actively eradicate northern pike from the system.

Klamath Representative Unit:

(KL1) Sycan River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Primarily *r*esident life history. Recent loss of migratory life history. Some migratory fluvial fish have been documented but not to a degree to contribute to persistence.

Number of Occupied Local Populations: 1 occupied local population

Genetic Connectivity: This population is not connected to other populations

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group

Water Quality: Based on Threats Assessment. Water Quality is not identified as a primary threat.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat, however FMO habitat in marsh is drying up and beaver ponds are dominated by brook trout.

Quality of Fish Community: Brook trout present in spawning and rearing habitat and FMO and are a significant threat to bull trout in this core area. Recent substantial increase in brook trout abundance.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~54 km of S&R Designated Critical Habitat

Additional Comments:

- The Sycan River Core Area is comprised of approximately 56% federal, 29% private, and 15% NGO owned land.
- Future condition modeling projected a 24% loss of spawning and rearing habitat by 2071-2090 resulting in ~41 km remaining.

(KL2) Upper Klamath Lake Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident bull trout have been documented. Recent observations of migratory individuals in Sun Creek.

Number of Occupied Local Populations: 2 occupied Local Populations

Genetic Connectivity: None of the populations are connected. Connectivity limited by brook trout exclusion barriers

Abundance/Number of Breeding Adults: Abundance estimate provided by the National Park Service and the Core Area Working Group

Water Quality: Based on Threats Assessment. Water Quality is not identified as a primary threat.

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat for resident life history.

Quality of Fish Community: Brook trout and brown trout present in spawning and rearing habitat and FMO

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~98 km of S&R Designated Critical Habitat

Additional Comments:

- The Upper Klamath Core Area is comprised of approximately 67% Federal, 27 % Private, 5% State and 1% NGO owned land. Most of the bull trout distribution in Sun Creek is on NPS owned property.
- Future condition modeling projected a 24% loss of spawning and rearing habitat by 2071-2090 resulting in ~74 km remaining.

(KL3) Upper Sprague River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident bull trout

Number of Occupied Local Populations: 2 occupied local populations; 3 were functionally extirpated in the Bootleg Fire.

Genetic Connectivity: Neither population is connected to the other. Demig creek is isolated.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group

Water Quality: Based on Threats Assessment. Water quality is not identified as a primary threat (prior to the Bootleg Fire).

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: Brook trout present in spawning and rearing habitat and FMO and are a significant threat to bull trout in this core area.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~84 km of S&R Designated Critical Habitat

Additional Comments:

- The Upper Sprague River Core Area is comprised of approximately 48% federal and 52% private owned land.
- Future condition modeling projected a 30% loss of spawning and rearing habitat by 2071-2090 resulting in ~59 km remaining.
- This core area was significantly impacted by the Bootleg Fire in 202, resulting in the extirpation of three populations.

Upper Snake Representative Unit:

(US1) Anderson Ranch Reservoir Core Area

Growth Rate: Data contribution to analysis determined non-significant or stable trend

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 11 occupied Local Populations

Genetic Connectivity: 51-75% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~257 km of S&R Designated Critical Habitat

Additional Comments:

- Anderson Ranch Reservoir Core Area is approximately 88% Federal Lands
- Most information on bull trout in this Core Area are current
- Future condition suitable S&R habitat was modeled and shows a decline of ~50kms, resulting in a remaining ~207 km.

(US2) Arrowrock Reservoir Core Area

Growth Rate: No data contribution to analysis

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 18 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~448 km of S&R Designated Critical Habitat

Additional Comments:

- Arrowrock Reservoir Core Area is approximately 92% Federal Lands
- Most information on bull trout in this Core Area is qualitative and provided by Core Area experts.
- Future condition suitable S&R habitat was modeled and shows a decline of ~128kms, resulting in a remaining ~320 km.

(US3) Deadwood River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Migratory and resident bull trout are documented in the Core Area

Number of Occupied Local Populations: 6 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: no non-native fish impacting bull trout are present in this Core Area

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~71 km of occupied S&R Habitat

Additional Comments:

- Deadwood River Core Area is approximately 100% Federal land.
- Future condition suitable S&R habitat was modeled and shows little to no decline across the Core Area.

(US4) Jarbidge River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 6 occupied Local Populations

Genetic Connectivity: All occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: No deleterious species present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~56 km of S&R Designated Critical Habitat

Additional Comments:

- Jarbidge River Core Area is approximately 89% Federal Lands including a large portion of the headwaters in Designated Wilderness.
- Most information on bull trout in this Core Area are dated
- Future condition suitable S&R habitat was modeled and shows a decline of ~14kms, resulting in a remaining ~41 km.

(US5) Lake Creek Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Migratory and resident bull trout are documented in the Core Area

Number of Occupied Local Populations: 1 occupied Local Population (Simple Core Area)

Genetic Connectivity: Simple Core Area-only one local population

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: no non-native fish impacting bull trout are present in this Core Area

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~13 km of occupied S&R Habitat

Additional Comments:

- Lake Creek Core Area is approximately 98% Federal land.
- Future condition suitable S&R habitat was modeled and shows a decline of 2.5 rkm across the Core Area, resulting in ~10.5 km of suitable S&R habitat in the future.

(US6) Lemhi River Core Area

Growth Rate: Data contribution to analysis determined non-significant or stable trend

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 6 occupied Local Populations

Genetic Connectivity: 26-50% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~240 km of S&R Designated Critical Habitat

Additional Comments:

- Lemhi River Core Area is approximately 78% Federal Lands
- Most information on bull trout in this Core Area are current
- Future condition suitable S&R habitat was modeled and shows a decline of ~60kms, resulting in a remaining ~180 km.
- Core area contains an active restoration and monitoring network for Chinook salmon, steelhead and bull trout.

(US7) Little Lost River Core Area

Growth Rate: Increasing growth rate

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 10 occupied Local Populations

Genetic Connectivity: 51-75% of Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present and are being effectively managed in some areas

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: 57 km of S&R Designated Critical Habitat

Additional Comments:

- Little Lost River Core Area is approximately 89% Federal Lands
- Most data on bull trout in this Core Area are current due to an active working group
- Future condition suitable S&R habitat was modeled and shows less than a km of decline

(US8) Little-Lower Salmon River Core Area

Growth Rate: Data contribution to analysis determined non-significant or stable trend

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 6 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~250 km of S&R Designated Critical Habitat

Additional Comments:

- Little-Lower Salmon River Core Area is approximately 54% Federal and 38% Private Lands
- Most information on bull trout in this Core Area is current.
- Future condition suitable S&R habitat was modeled and shows a decline of ~140kms, resulting in a remaining ~110 km.

(US9) Middle Fork Payette River Core Area

Growth Rate: No data contribution to analysis

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 3 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~115 km of S&R Designated Critical Habitat

Additional Comments:

- Middle Fork Payette River Core Area is approximately 90% Federal Lands
- Most information on bull trout in this Core Area is qualitative and provided

by Core Area experts.
- Future condition suitable S&R habitat was modeled and shows a decline of ~29kms, resulting in a remaining ~86 km.

(US10) Middle Fork Salmon River Core Area

Growth Rate: Data contribution to analysis determined non-significant or stable trend

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 28 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~1431 km of S&R Designated Critical Habitat

Additional Comments:

- Middle Fork Salmon River Core Area is approximately 99% Federal Lands, with a large portion of the Core Area within Wilderness
- Most information on bull trout in this Core Area are current
- Future condition suitable S&R habitat was modeled and shows a decline of ~400kms, resulting in a remaining ~1050 km.

(US11) Middle Salmon River-Chamberlain Core Area

Growth Rate: No data contribution to analysis

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 9 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~273 km of S&R Designated Critical Habitat

Additional Comments:

- Middle Salmon River-Chamberlain Core Area is approximately 99% Federal Lands, with a large portion of the Core Area within Wilderness
- Most information on bull trout in this Core Area have been provided as qualitative from our Core Area experts
- Future condition suitable S&R habitat was modeled and shows a decline of ~190kms, resulting in a remaining ~83 km.

(US12) Middle Salmon River-Panther Core Area

Growth Rate: Data contribution to analysis determined non-significant or stable trend

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: **1**8 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~598 km of S&R Designated Critical Habitat

Additional Comments:

- Middle Salmon River-Panther Core Area is approximately 95% Federal Lands
- Most information on bull trout in this Core Area are current
- Future condition suitable S&R habitat was modeled and shows a decline of ~148kms, resulting in a remaining ~450 rkm.

(US13) North Fork Malheur River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Resident and migratory bull trout have been detected.

Number of Occupied Local Populations: 5 occupied local populations based on the RUIP.

Genetic Connectivity: All populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment.

Access to FMO: 3 populations do not have access to needed FMO habitats.

Quality of Fish Community: Based on Threats Assessment; predatory fish in FMO habitat, brook trout detected using eDNA in tributary basin.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~72 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 76% federal and 24% private owned land.
- Future condition modeling projected a 43% loss of spawning and rearing habitat by 2071-2090 resulting in ~41 km remaining.

(US14) North Fork Payette River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Migratory and resident bull trout are documented in the Core Area

Number of Occupied Local Populations: 1 occupied Local Population (Simple Core Area)

Genetic Connectivity: Simple Core Area-only one local population

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Access to and from beneficial FMO is completely impeded

Quality of Fish Community: Brook trout are present and scored greater than 1.2 in the treats assessment

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~31 km of occupied S&R Habitat

Additional Comments:

- North Fork Payette River Core Area is approximately 51% Federal and 38% Private lands.
- Future condition suitable S&R habitat was modeled and shows a decline of 5 rkm across the Core Area, resulting in ~26 km of suitable S&R habitat in the future.

(US15) Opal Lake Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: Migratory and resident bull trout are thought to be present in the Core Area

Number of Occupied Local Populations: 1 occupied Local Population (Simple Core Area)

Genetic Connectivity: Simple Core Area-only one local population

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: no non-native fish impacting bull trout are present in this Core Area

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~3.5 km of occupied S&R Habitat

Additional Comments:

- Opal Lake Core Area is 100% Federal land.
- Future condition suitable S&R habitat was modeled and shows no decline of suitable S&R habitat across the Core Area.

(US16) Pahsimeroi River Core Area

Growth Rate: Data contribution to analysis determined non-significant or stable trend

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 9 occupied Local Populations

Genetic Connectivity: Under 25% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Limited or seasonal access to Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~217 km of S&R Designated Critical Habitat

Additional Comments:

- Pahsimeroi River Core Area is approximately 88% Federal Lands
- Most information on bull trout in this Core Area are current but from a small portion of the Core Area
- Future condition suitable S&R habitat was modeled and shows a decline of ~67kms, resulting in a remaining ~149 km.

(US17) South Fork Salmon River Core Area

Growth Rate: Data contribution to analysis determined increasing trend

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 27 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~651 km of S&R Designated Critical Habitat

Additional Comments:

- South Fork Salmon River Core Area is approximately 99% Federal Lands
- Most information on bull trout in this Core Area is current.
- Future condition suitable S&R habitat was modeled and shows a decline of ~214rkm, resulting in a remaining ~437 km.

(US18) Chief Eagle Eye Creek Core Area

Growth Rate: No data contribution to analysis

Life History Diversity: Resident bull trout have been documented- no migratory fish present

Number of Occupied Local Populations: 4 occupied Local Populations

Genetic Connectivity: 1-25% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Access to and from Feeding/Migratory/Overwintering habitat is impeded

Quality of Fish Community: brook trout are present and a threats score of greater than 1.2 exists

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~72 km of S&R Designated Critical Habitat

Additional Comments:

- Chief Eagle Eye Creek Core Area is approximately 46% Federal and 47% Private Lands

- Most information on bull trout in this Core Area is qualitative and provided by Core Area experts.
- Future condition suitable S&R habitat was modeled and shows a decline of ~18rkm, resulting in a remaining ~54 km.

(US19) Upper Malheur River Core Area

Growth Rate: No data contribution to trend analysis

Life History Diversity: All populations are comprised of resident bull trout.

Number of Occupied Local Populations: 3 occupied local populations.

Genetic Connectivity: All populations are suspected to be connected to each other.

Abundance/Number of Breeding Adults: Abundance estimate provided by the Core Area Working Group.

Water Quality: Based on Threats Assessment.

Access to FMO: All populations have access to needed FMO habitats.

Quality of Fish Community: Based on Threats Assessment; brook trout widespread and abundant.

Instream Quality: Based on Threats Assessment.

Riparian Quality: Based on Threats Assessment.

Habitat Quantity: ~90 km of spawning and rearing designated Critical Habitat

Additional Comments:

- The core area is comprised of 79% federal, 20% private and 1% state owned land.
- Future condition modeling projected a 56% loss of spawning and rearing habitat by 2071-2090 resulting in ~40 km remaining.

(US20) Upper Salmon River Core Area

Growth Rate: Data contribution to analysis determined non-significant or stable trend

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 18 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~720 km of S&R Designated Critical Habitat

Additional Comments:

- Upper Salmon River Core Area is approximately 94% Federal Lands
- Most information on bull trout in this Core Area are current
- Future condition suitable S&R habitat was modeled and shows a decline of ~133rkm, resulting in a remaining ~587 km.

(US21) Upper South Fork Payette River Core Area

Growth Rate: No data contribution to analysis

Life History Diversity: Resident and fluvial bull trout have been documented

Number of Occupied Local Populations: 11 occupied Local Populations

Genetic Connectivity: 76-100% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: No known obstructions to needed Feeding/Migratory/Overwintering habitat

Quality of Fish Community: brook trout are present and scored above a 1.2 in the threats assessment

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~251 km of S&R Designated Critical Habitat

Additional Comments:

- Upper South Fork Payette River Core Area is approximately 98% Federal Lands
- Most information on bull trout in this Core Area is qualitative and provided by Core Area experts.
- Future condition suitable S&R habitat was modeled and shows a decline of ~37rkm, resulting in a remaining ~214 km.

(US22) Weiser River Core Area

Growth Rate: Data contribution to analysis determined non-significant or stable trend

Life History Diversity: Resident bull trout have been documented- no migratory fish present

Number of Occupied Local Populations: 5 occupied Local Populations

Genetic Connectivity: 1-25% of occupied Local Populations are suspected to be connected to each other

Abundance/Number of Breeding Adults: Abundance estimate provided by Core Area Working Group

Water Quality: Based on Threats Assessment

Access to FMO: Access to and from Feeding/Migratory/Overwintering habitat is impeded

Quality of Fish Community: brook trout are present and a threats score of greater than 1.2 exists

Instream Quality: Based on Threats Assessment

Riparian Quality: Based on Threats Assessment

Habitat Quantity: ~92 km of S&R Designated Critical Habitat

Additional Comments:

- Weiser River Core Area is approximately 51% Federal and 39% Private Lands
- Most information on bull trout in this Core Area is qualitative and provided by Core Area experts.
- Future condition suitable S&R habitat was modeled and shows a decline of ~30rkm, resulting in a remaining ~62 km.

Appendix I. Description of the threats assessment tool

1. Methodology
2. Example: 5 Tally Cheat Sheet
3. Example: Core Area Threats Assessment Worksheet
4. Threats Assessment Results
    a. Coastal Representative Unit
    b. Columbia Headwaters Representative Unit
    c. Klamath Representative Unit
    d. Mid-Columbia Representative Unit
    e. Saint Mary Representative Unit
    f. Upper Snake Representative Unit

Introduction

Completed in 2015, the final Bull Trout recovery plan (Plan, USFWS 2015) defines a threats-based strategy for recovery of the species. There are four elements to the strategy: 1) conserve bull trout so that they are geographically widespread across representative habitats and are demographically stable; 2) manage and ameliorate the primary threats in each of the six recovery units at the core area scale such that bull trout will persist well into the future; 3) work cooperatively with partners to develop and implement recovery actions; and 4) apply adaptive management principles to implementing the bull trout recovery program to account for new information.

The Plan revises the recovery criteria proposed in the 2002 and 2004 draft plans by focusing on the effective management of threats to bull trout and eliminating the adult abundance targets and other demographic criteria. The final recovery criteria specify primary threats must be effectively managed in at least 75 percent of all core areas, representing 75 percent or more of bull trout local populations in the Coastal, Mid-Columbia, and Upper Snake Recovery Units. In the Columbia Headwaters Recovery Unit, the criteria specify primary threats need to be effectively managed in at least 75 percent of all complex and 75 percent of simple core areas. For the Klamath and St. Mary Recovery Units 100 percent of primary threats must be effectively managed and additional populations identified or established before delisting may be warranted. Primary threats in each core area and the recovery actions necessary to ameliorate those threats are described in the 2015 Recovery Unit Implementation Plans (RUIPs).

Threats Assessment Tool

Given the key strategy of the Plan is to manage and ameliorate primary threats in each core area, the Service developed a Threats Assessment Tool (TAT) to objectively evaluate the status of threats identified in the Recovery Unit Implementation Plans (RUIPs). The goal is to establish a structured, consistent, and semi-quantitative approach to determine whether primary threats are being effectively managed at the core area scale. Comprised of four components, the TAT incorporates a threats assessment workshop attended by professional biologists during which a decision matrix for each threat is completed using both the best available data and scientific expert opinion. Conceptually, the results generated in the workshop are then considered by Service managers and rolled up into a recovery unit and range-wide level evaluation of status. Fully described in Appendix E of the Plan, the TAT is only summarized here to provide appropriate context.

The four components of the TAT include:

- **Assessment Workshop Process** – Core area specific workshops that include broad representation of fisheries biologists knowledgeable about bull trout issues within the recovery unit. Participants include biologists from USFWS, USGS, Federal land managers, State management agencies, tribal entities, and Universities. The objective is to characterize the status of threats to bull trout as objectively as possible with

acknowledgment that there are inherent differences among experts in data interpretation and professional opinion.

- **Threats Assessment Decision Matrix** – As part of the assessment workshops in each core area, participants evaluate the primary threats according to a Decision Matrix composed of two axes describing threat severity and management effectiveness. The matrix is attributed using existing empirical data on population level demographics, occurrence and magnitude of threats, and specific conservation measures in effect, as well as professional judgement. The matrix summarizes how well current management or conservation actions effectively ameliorate the threat.
- **Assessment of Threats Effectively Managed** – USFWS will make a determination of whether threats are effectively managed in a core area. This assessment may include a collective evaluation of all threats within the area to ensure that interactions and possible cumulative effects of even minor threats are considered. Population level demographic information is also evaluated as part of the assessment.
- **Evaluation of Recovery Unit Status** – After determining whether threats are effectively managed for a core area, USFWS will produce a tally for the entire recovery unit that shows all core areas in a recovery unit and the number of local populations in each core area. For each recovery unit, the recovery criteria will be assessed based on the number of core areas (and populations) where primary threats have been effectively managed.

Methods

Threats Assessment Decision Matrix

Inter-agency bull trout working groups were convened to implement the Assessment Workshop Process and the Threats Assessment Decision Matrix for every extant core area. Working group members and participating experts were asked to evaluate all threats in their core areas using the threats assessment decision matrix (Figure 1). In addition to primary threats, we asked the working groups to identify and evaluate threats in the core areas that may not meet criteria for being a primary threat. Many of these additional threats only impacted a portion of the populations in the core area (e.g., specific passage barriers) or could foreseeably become more severe over time even though they weren't currently significant (e.g., sympatric brook trout in one population). These threats were included to provide a complete inventory of threats in a core area and to serve as a mechanism to track their status over time.

		Threat Severity			
		Minor	Moderate	High	Severe
Management Effectiveness	None or Ineffective				
	Partially Effective				
	Mostly Effective				
	Effective				

Figure 1. Example of the Threats Assessment Decision Matrix.

The matrix consists of two independent axes: threat severity and management effectiveness. Threat severity describes the degree to which a specific threat would affect bull trout survival and persistence over the next 50 years in the absence of management actions to eliminate or mitigate the threat. This assessment considers both the impacts on persistence of local populations and the spatial distribution and extent of the threat within a core area. In addition to evaluating the severity of a threat in the absence of management actions, participants must also consider the threat in isolation from other, potentially interacting threats, but considering climate projections and small population size.

The threat severity axis consists of 4 categories: minor, moderate, high, and severe, and are defined according to the following guidelines:

- **Minor** – If unmanaged, threat is not expected to appreciably reduce persistence of bull trout local populations within the core area for the foreseeable future (50 years). If threat occurs broadly throughout the core area, its population-level impacts on local populations are expected to be minor or transient. If any local populations are expected to be substantially reduced, but not extirpated, by the threat, they are geographically localized (less than approximately 25 percent of local populations in the core area) and the threat is not expected to spread in the absence of management.
- **Moderate** – If unmanaged, threat is expected to slightly to moderately reduce persistence of bull trout local populations within the core area for the foreseeable future (50 years). Impacts on bull trout in the core area have either been documented or are supported by professional opinion and/or evidence from other Core Areas. Impacts from the threat are moderate but geographically widespread within the core area (more than approximately 25 percent of the local populations in the core area are expected to be substantially reduced but are generally not expected to be extirpated); or else the threat is more geographically restricted, but the affected local populations are expected to be severely reduced and are at some risk of extirpation in the foreseeable future. There may be risk of the threat spreading to currently unaffected local populations in the foreseeable future. Few local populations are expected to be

extirpated in the foreseeable future by this threat alone, although it may substantially contribute to extirpation risk for local populations in combination with other threats.

- **High** – If unmanaged, threat is expected to substantially reduce persistence of bull trout local populations within the core area for the foreseeable future (50 years). Impacts on bull trout in the core area have either been documented or are supported by professional opinion and/or evidence from other Core Areas. Impacts are geographically widespread (affecting most or all local populations). Without active management affected local populations are generally expected to be severely reduced and are at some risk of extirpation in the foreseeable future. Threat substantially contributes to extirpation risk for local populations, alone or in combination with other threats.
- **Severe** – If unmanaged, threat is expected to severely reduce persistence of bull trout local populations within the core area for the foreseeable future (50 years). Impacts on bull trout in the core area have either been documented or are supported by professional opinion and/or evidence from other Core Areas. Impacts affect all local populations. Threat substantially contributes to extirpation risk for local populations. Without active management all local populations are expected to be severely reduced, and most or all local populations are expected to be extirpated in the foreseeable future.

The Management Effectiveness axis evaluates the extent to which current management of the specific threat is 'effective' in reducing the degree of threat or mitigating its impact with respect to bull trout. The axis reflects a gradient from the baseline of nonexistent or ineffective management, which does not alter the degree of the threat to management that entirely removes the threat or fully prevents or mitigates its effect on bull trout. The management effectiveness axis consists of 4 categories: none or ineffective, partially effective, mostly effective, and effective, which are defined according to the following definitions.

- **None or Ineffective** – No significant management of the threat is taking place in this core area, or there is little or no evidence that existing management actions are effectively reducing threat severity.
- **Partially Effective** – Management of the threat is being done with moderate effectiveness or within a limited portion of the core area, including at least some of the local populations affected by the threat. There is evidence that threat severity is being reduced, but this reduction is localized or moderate.
- **Mostly Effective** – Management of the threat is being done in most or all of the core area, including most or all local populations affected by the threat. Threat severity is substantially reduced throughout the core area, but some lesser negative effects persist; or comparably, the core area is divided between a majority of local populations where the threat has been effectively neutralized and a minority where management remains absent or ineffective.
- **Effective** – Management of this threat reduces risk to all affected local populations, and the threat is largely or completely neutralized, with existing effects on bull trout

being minor or absent. Ongoing management may or may not be necessary to maintain this condition.

Facilitation

In preparation for each working group meeting, participants were provided a copy of Appendix E from the Plan, a cheat sheet, and a set of worksheets specific to the primary threats in that core area (examples provided in next section), as well as the portion of the RUIP relevant to their core area including the primary threats table. Appendix E was modified to include only the sections that were relevant to the threats assessment workshop. The cheat sheet served as a quick reference; a one-page guide that summarized the steps of the assessment and the definitions of each category to assist participants in filling out the threat matrix quickly and consistently. The worksheets were created specifically for each core area and included a severity and management effectiveness axis for each threat listed in the primary threats table and examples of conditions that would warrant a rating of each severity category for that specific threat. Each participant had 5 tallies to distribute among the 4 categories on each axis according to the uncertainty of their assessment. For example, if a participant was very certain the threat equated to a 'high' severity rating, they would put all 5 tallies in the 'high' box. However, if their uncertainty was greater, they might put 2 tallies in the 'moderate' box and 3 in the 'high' box. Using this method scores were calculated by multiplying the number of tallies in each category by the value of that category, summing those scores and dividing by the total number of tallies. The scores for each axis were multiplied to obtain a threat level score for that participant. Space was provided for participants to explain their reasoning and reference datasets, experience or observations that supported their ratings. Participants were asked to complete the worksheets prior to attending the meeting.

Every workshop was run generally in the same manner (same process, materials, and approach) and workshops in each state were run by the same facilitators who were members of the SSA writing team. This ensured a relative degree of consistency in the application of the TAT range wide. The workshop opened with a presentation detailing background and methods as described in Appendix E, as well as a review of the primary threats identified in the core area. The remaining portion of the workshop was spent working through the assessment, threat by threat. The threat severity ratings for all threats were discussed first, followed by discussions of management effectiveness. Separating the discussions of the two axes ensured that threat severity was evaluated in isolation of management, management effectiveness was not double-counted, and that all threats were assessed similarly and accurately. Participants discussed their ratings and justification for each threat until all viewpoints were shared. Tallies of individual scores were projected on a screen so participants could see the diversity of scores within and among the threats. If new information was revealed during the discussions, participants were able to record or change their ratings after all perspectives were vetted. During scoring, the facilitators often referred participants back to the definitions as there was a tendency to drift from the quantitative sideboards within each category. It is important to note that this was not a consensus driven process and group agreement was not an objective of the workshop. All participant worksheets were collected for scoring at the end of the meeting.

Scoring and Interpretation

A method for combining individual participant ratings into a single rating for the threat and rolling up the threat ratings into an overall score for the core area was not provided in Appendix E of the Plan. In the absence of such guidance, we developed a simple scoring system to objectively and consistently calculate an overall score for each core area, being careful not to overly quantify a subjective process. A value was calculated for each cell in the matrix by multiplying values assigned to the corresponding categories on both axes. The values assigned to categories on the threat severity axis ranged between 1 and 4 (Figure 2). The values assigned to categories on the management effectiveness axis ranged from 0.2 to 0.8. A participant's rating for a particular threat was given the corresponding numerical value of that cell.

			Threat Severity			
			Minor	Moderate	High	Severe
			1	2	3	4
Management Effectiveness	None or Ineffective	0.8	0.8	1.6	2.4	3.2
	Partially Effective	0.6	0.6	1.2	1.8	2.4
	Mostly Effective	0.4	0.4	0.8	1.2	1.6
	Effective	0.2	0.2	0.4	0.6	0.8

Figure 2. Scoring of the Threats Assessment Decision Matrix.

Scores from all participants in a workshop were treated equally and averaged for each threat (i.e., no weighting among participants). The standard deviation was used to represent the variability, or disagreement, among participants. Scores from particular participants were not given greater weight, or influence, than those of others. An argument could be made that participants with more experience in the core area, more knowledge of the species and the basin, or primary fisheries management responsibilities should have greater weight over those with less experience or who only work peripherally in the basin. However, when reviewing the data and supporting evidence it was apparent developing even a simple weighting system would not derive the desired results. In several instances those with less experience or new(er) to the area gave more thorough and well supported arguments than those with more experience. Developing a rule set to consistently, objectively, and correctly weight the score of participants would likely more often miss the mark. The standard deviation was used to represent the variability, or disagreement, among participants.

Application to the SSA

The first two components of the TAT, the assessment workshop and threats assessment decision matrix, provided the foundation of the evaluation for four of the habitat factors in the

bull trout Species Status Assessment: water quality, instream habitat quality, fish community quality, and riparian habitat quality. Threats associated with each factor were generally categorized as in Table 1. In cases where there were multiple threats for each factor the highest threat score was used to score the condition category analysis in the SSA. In a few core areas, climate change was included as a primary threat. In these cases, climate change was also incorporated into the assessment of threat severity, consistent with other core areas in the DPS.

Table 1. Habitat factors assessed in the Condition Category Analysis and associated threats as described in the RUIPs.

Habitat Factor	Threat
Upland/Riparian Land Management	• Agriculture Practices • Forest Management Practices (forest roads, recreation) • Livestock grazing • Mining (oil and gas) • Residential Development and Urbanization • Transportation Networks (highways, railroads) • Loss of beaver • Recreation
Instream Impacts	• Mining (oil and gas) • Transportation Networks (highways, railroads) • Dewatering • Altered Flows (water management-related) • Entrainment (hydropower and diversions) • Fish Passage Issues • Flood control
Water Quality	• Agricultural Practices • Forest Management Practices (forest roads, recreation) • Livestock grazing • Mining (oil and gas) • Residential Development and Urbanization

	• Transportation Networks (highways, railroads) • Dewatering • Altered Flows (water management-related) • Water Quality Impairment (from non-specific or multiple sources) • Fish Diseases • Climate Change

Fish Community Quality	• Nonnative Species
	  o Introduced Species/Fisheries Management
	  o Predation/Competition
	  o Hybridization

Threats Assessment Matrix – Cheat Sheet

Threat Severity: The degree to which a specific threat would affect bull trout survival and persistence in the absence of management actions or other threats.

1. Consider the threat in isolation of other threats and in the absence of management actions.

- If a habitat-related threat, then consider threat severity prior to the implementation of restoration or mitigation actions. The impact of restoration actions should be reflected under management effectiveness.
- If a passage-related threat, then consider volitional passage (i.e., ladders) under threat severity and facilitated passage (e.g., trap and haul) under management effectiveness.



2. Consider how climate change might influence this threat in the future (e.g., expansion of nonnative predators).



3. Then evaluated the severity of the threat on persistence of all populations in the core area in <u>50 years</u> on a gradient ranging between the two extremes of persistence of all local populations at viable levels (minor) and extirpation of all local populations (severe).

Minor	Moderate	High	Severe
ALL populations ←			→ Extirpation of all local populations

4. Distribute **5** tallies across the cells depending on your certainty in ranking severity.

Example: **Uncertain** *of severity.*

Minor	Moderate	High	Severe
I	**III**	**I**	

Example: **Certain** *of severity.*

Minor	Moderate	High	Severe
	IIII		

Management Effectiveness: The extent to which current management of this specific threat is effective in reducing the degree of the threat or mitigating its impact with respect to bull trout.

1. Evaluate the management effectiveness of management actions implemented according to the following guidelines.

None or Ineffective	Partially Effective	Mostly Effective	Effective
• No significant management is taking place. • Little or no evidence that existing actions are effectively reducing threat severity.	• Management is being done with moderate effectiveness or in a limited portion of the core area. • Some evidence that severity is reduced but the reduction is located or moderate.	• Management is being done in most or all of the core area. • Threat severity is substantially reduced but some lesser effects may persist **OR** the threat has been effectively managed in a majority of the populations and remains absent or ineffective in a minority.	• Management reduces risk to all affected local populations. • Threat is largely or completely neutralized. • Ongoing management may or may not be necessary to maintain this condition.

2. Distribute tallies according to the same guidelines as those for threat severity.

Data Type

1. Identify the appropriate data type used to evaluate each axis (i.e., threat severity and management effectiveness) according to the following definitions.

- **Adequate Data** – The score is based on data which have been observed, modeled or empirically measured for the species in question and comes from a reputable source.
- **Limited Data** – The score is based on data which has a higher degree of uncertainty. The data used to score the attribute may be based on related or similar species, come from outside the study area, or the reliability of the source may be limited.
- **Expert Judgment** – The attribute score reflects the expert judgment of the reviewer and is based on their general knowledge of the species, or other related species, and their relative role in the ecosystem.
- **No Data** – No information to base an attribute score on. Very little is known about the species or related species and there is no basis for forming an expert opinion.

Habitat Threats:

1.1 Upland/Riparian Land Management Legacy forest management and agricultural practices – Channelization and habitat degradation.

Threat Severity: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Minor	Moderate	High	Severe	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

***Threat Specific Examples from Appendix E**:*

- **Minor** – *Habitat impairment from anthropogenic effects has little or no impact on habitat suitability and distribution for bull trout.*
- **Moderate** – *Habitat impairment is either 1) localized but reduces probability of persistence (50 years) of affected populations or 2) widespread and may reduce abundance of affected populations but are not expected to decrease probability of persistence within 50 years.*
- **High** – *Most or all local populations within a core area have negative habitat effects, probability of persistence is substantially decreased, one or more local populations will be extirpated within 50 years without active management.*
- **Severe** – *Habitat conditions in the core area are generally not suitable for bull trout, such that all populations will be extirpated within 50 years without active management.*

Management Effectiveness: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Effective	Mostly Effective	Partially Effective	None or Ineffective	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

Provide your reasoning and justification. Provide citations or datasets when possible. (Circle on back if you need more room.)

Habitat Threats:

1.2 Instream Impacts The lower reaches of many creeks have been altered where they meet the floor of the Wood River Valley due to agricultural practices. At these locations, streams have been diverted, channelized, and lost riparian habitat.

Threat Severity: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Minor	Moderate	High	Severe	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

***Threat Specific Examples from Appendix E**:*

- **Minor** – *Instream impacts have little or no effect on habitat suitability and distribution for bull trout.*
- **Moderate** – *Instream impacts are either 1) localized but reduce probability of persistence of affected populations or 2) widespread and may reduce abundance of affected populations but are not expected to decrease probability of persistence within 50 years.*
- **High** – *The majority of local populations within a core area experience instream impacts, which could result in extirpation of some local populations in 50 years without active management.*
- **Severe** – *Instream impacts will cause extirpation of all local populations within 50 years.*

Management Effectiveness: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Management Effectiveness: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Effective	Mostly Effective	Partially Effective	None or Ineffective	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

Provide your reasoning and justification. Provide citations or datasets when possible. (Circle on back if you need more room.)

Demographic Threats:

1.2 Connectivity Entrainment and dewatering – Unscreened irrigation diversions exist within the Annie Creek, Sun Creek, Sevenmile Creek, Cherry Creek, and the Wood River that result in fish entrainment and lack of connectivity to foraging, migrating, and overwintering (FMO) habitat.

Threat Severity: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Minor	Moderate	High	Severe	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

***Threat Specific Examples from Appendix E**:*

- **Minor** – *Entrainment or dewatering has negligible effects on population persistence.*
- **Moderate** – *Entrainment or dewatering is either 1) localized but reduces probability of persistence of affected populations by causing additive mortality or decreasing life history diversity or 2) widespread and may reduce abundance of affected populations via the same mechanisms but is not expected to decrease probability of persistence within 50 years.*
- **High** – *The majority of local populations within a core area experience entrainment or dewatering of habitat, which could result in extirpation of some local populations in 50 years because of additive mortality or loss of life history diversity.*
- **Severe** – *Entrainment and dewatering will result in extirpation of all local populations within 50 years because of additive mortality or loss of life history diversity.*

Management Effectiveness: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Effective	Mostly Effective	Partially Effective	None or Ineffective	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

Provide your reasoning and justification. Provide citations or datasets when possible. (Circle on back if you need more room.)

Demographic Threats:

2.3 Small Population Size The two local populations have small population sizes, particularly Threemile Creek.

Threat Severity: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Minor	Moderate	High	Severe	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

***Threat Specific Examples from Appendix E**:*

- **Minor** – *When all existing threats are managed effectively the populations will be of sufficient size and have sufficient connectivity that inbreeding depression and stochastic disturbance will have a negligible effect on local population persistence.*
- **Moderate** – *When all existing threats are managed effectively some local populations are expected to be small. Inbreeding depression or stochastic disturbance will slightly decrease the probability of persistence within the next 50 years, but will not lead to extirpation of any local populations.*
- **High** – *When all existing threats are managed effectively all local populations are expected to be small and some will be extirpated because of inbreeding depression or stochastic disturbance.*
- **Severe** – *When all existing threats are managed effectively the habitat supporting each local population and the level of connectivity between local populations will not be sufficient to prevent inbreeding depression or mitigate against stochastic disturbance and will lead to extirpation of all local populations within 50 years.*

Management Effectiveness: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Effective	Mostly Effective	Partially Effective	None or Ineffective	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

Provide your reasoning and justification. Provide citations or datasets when possible. (Circle on back if you need more room.)

Threats of Nonnative Fishes:

3.1 Brook Trout Brook trout are numerous in all historically occupied and suitable spawning and rearing (SR) and FMO habitat.

Threat Severity: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Minor	Moderate	High	Severe	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

***Threat Specific Examples from Appendix E**:*

- **Minor** – *Brook trout occur in a core area but are not actively expanding and do not overlap with any bull trout local populations; or brook trout overlap but significant negative competitive interactions and hybridization are not believed to exist.*
- **Moderate** – *Brook trout co-occur with the majority of bull trout local populations, some negative competitive interactions are likely or confirmed but hybridization is absent or minimal, and local bull trout populations are expected to persist at current or slightly lower abundance for the next 50 years.*
- **High** – *Brook trout co-occur with all bull trout local populations, hybridization or competition is occurring and will substantially lower the probability of persistence of local populations and/or lead to extirpation of at least one local population within 50 years.*
- **Severe** – *Brook trout co-occur with all local bull trout populations and all populations are expected to be extirpated within 50 years because of hybridization or competition.*

Management Effectiveness: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Effective	Mostly Effective	Partially Effective	None or Ineffective	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

Provide your reasoning and justification. Provide citations or datasets when possible. (Circle on back if you need more room.)

Threats of Nonnative Fishes:

3.2 Brown Trout Brown trout are overlapping in some occupied and suitable spawning/rearing and FMO habitat.

Threat Severity: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Minor	Moderate	High	Severe	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

***Threat Specific Examples from Appendix E**:*

- **Minor** – *Brown trout occur in a core area but are not actively expanding and do not overlap with any bull trout local populations; or brown trout overlap but significant negative competitive interactions are not believed to exist.*
- **Moderate** – *Brown trout co-occur with bull trout local populations, some negative competitive interactions are likely or confirmed, but all local bull trout populations are expected to persist for the next 50 years.*
- **High** – *Brown trout co-occur with all bull trout local populations, competition is occurring and will substantially reduce the probability of persistence of local populations during the next 50 years and/or lead to extirpation of some local populations within 50 years.*
- **Severe** – *Brown trout co-occur with bull trout populations with complete or near-complete overlap in distribution, competition is occurring and will lead to extirpation of all local populations within 50 years.*

Management Effectiveness: Place **5** tallies in the appropriate box/es based on definitions provided in Appendix E and circle the type of data used to reach your decision.

Effective	Mostly Effective	Partially Effective	None or Ineffective	**Data Type** (Circle one)
				Adequate data Limited Data Expert Judgement No Data

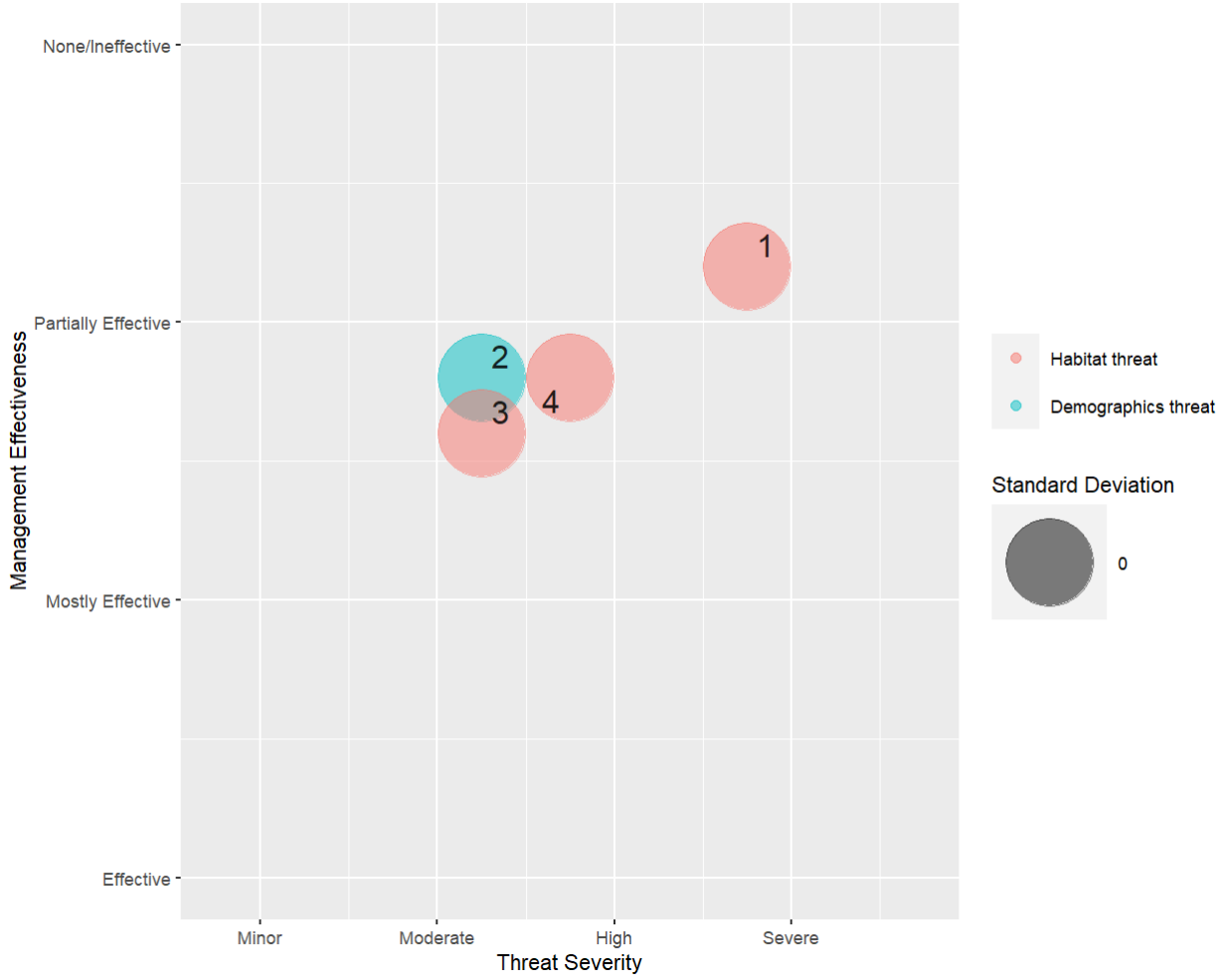
Provide your reasoning and justification. Provide citations or datasets when possible. (Circle on back if you need more room.)

Threats Assessment Results

Coastal Representative Unit

CO01 – Chester Morse Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Floodplain Connectivity/Road Density and Location/Watershed Disturbance Regime/Watershed Disturbance History – some portions of habitat become isolated during base flows due to substantial lengths of surface-dry channels. This is thought to be a legacy effect from historical land use practices, but in some cases may be

attributed to undersized road crossings (bridges) located in highly dynamic alluvial fans, constricting the channel and piling alluvium deeply.

Instream Impacts

- (2) Flow and Hydrology – habitat suitability for spawners and embryos fluctuates widely in the inundation zone where the reservoir inundates redds; inundation also causes sand and fines to deposit on top of redds, entombing embryos, but these sediments can also be frequently flushed away as the reservoir drops.

Water Quality

- (3) Climate Change – could lead to changes in reservoir management that in turn could further reduce area of suitable habitat for spawning and incubating life stages.

Demographic

Connectivity Impairment

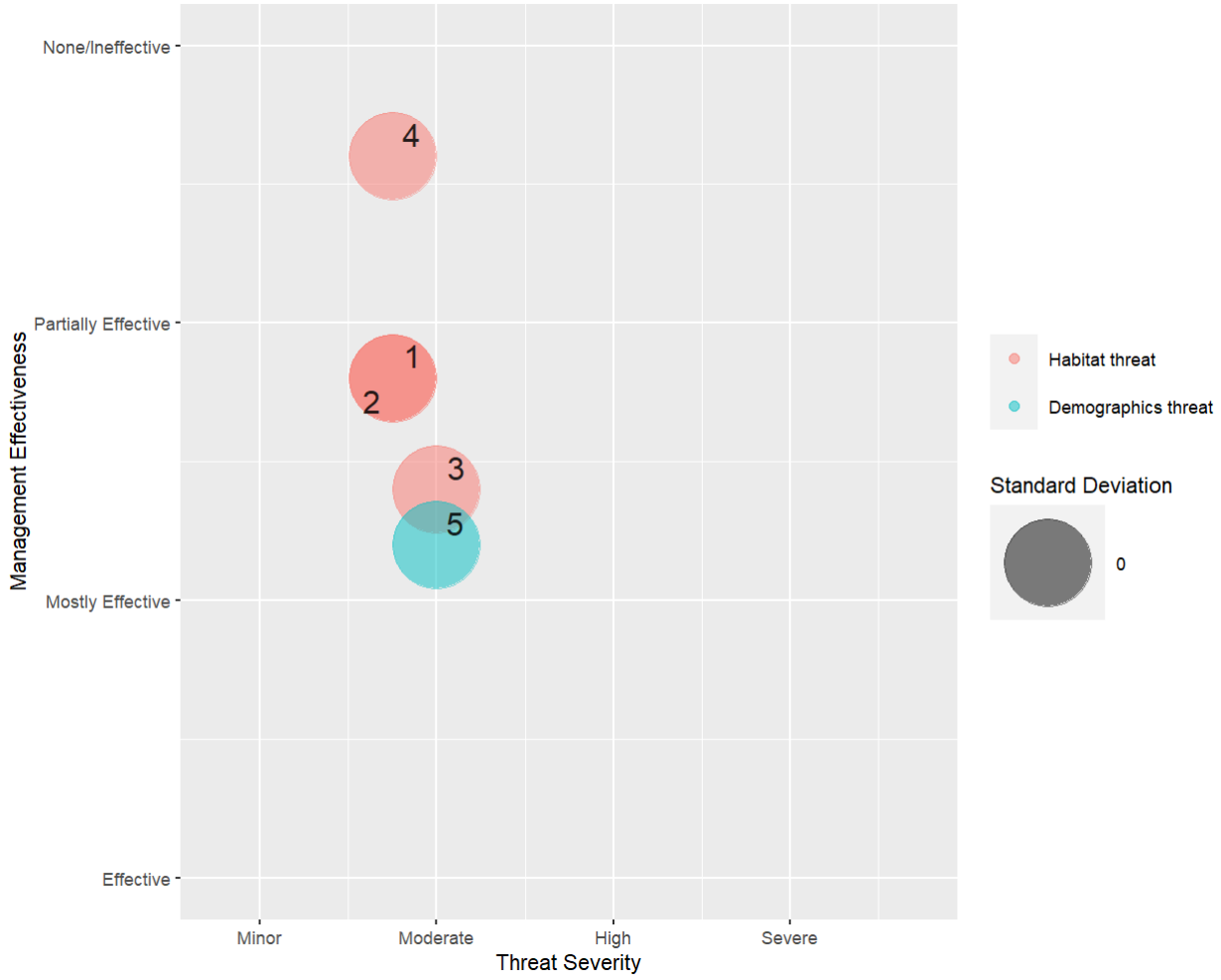
- (*Not scored/plotted*) Fish Passage Issues – migration between the lake and tributary spawning habitats is tied directly to ongoing reservoir operations. Any significant changes to current reservoir operating regimes could impact migration and availability of their primary forage fish, pygmy whitefish; anticipated to be further exacerbated by climate change.

Small Population Size

- (4) Life History Diversity and Isolation, Persistence, and Genetic Integrity – a majority of spawning occurs in the Cedar River followed by the Rex River. Potential changes in reservoir management brought on by climate change could render greater impacts to the already limited SR habitat that exists, potentially reducing population size.

CO02 – Chilliwack River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Forest Management – legacy and ongoing degradation of habitat and water quality in SR tributaries outside of designated protected areas; coordinate with British Columbia.

Instream Impacts

- (2) Flood Control – Flood and erosion control associated with agricultural practices, transportation corridors, residential development and urbanization continues to result in poor structural complexity within lower river FMO habitats.

Water Quality

- (3) Agriculture Practices and Residential Development and Urbanization-related activities have resulted in sediment and temperature impairment in the Chilliwack River.
- (4) Climate Change – increasing variability in flows (higher peak and lower base flows) are anticipated to significantly impact both spatial and life history diversity of bull trout within the core area.

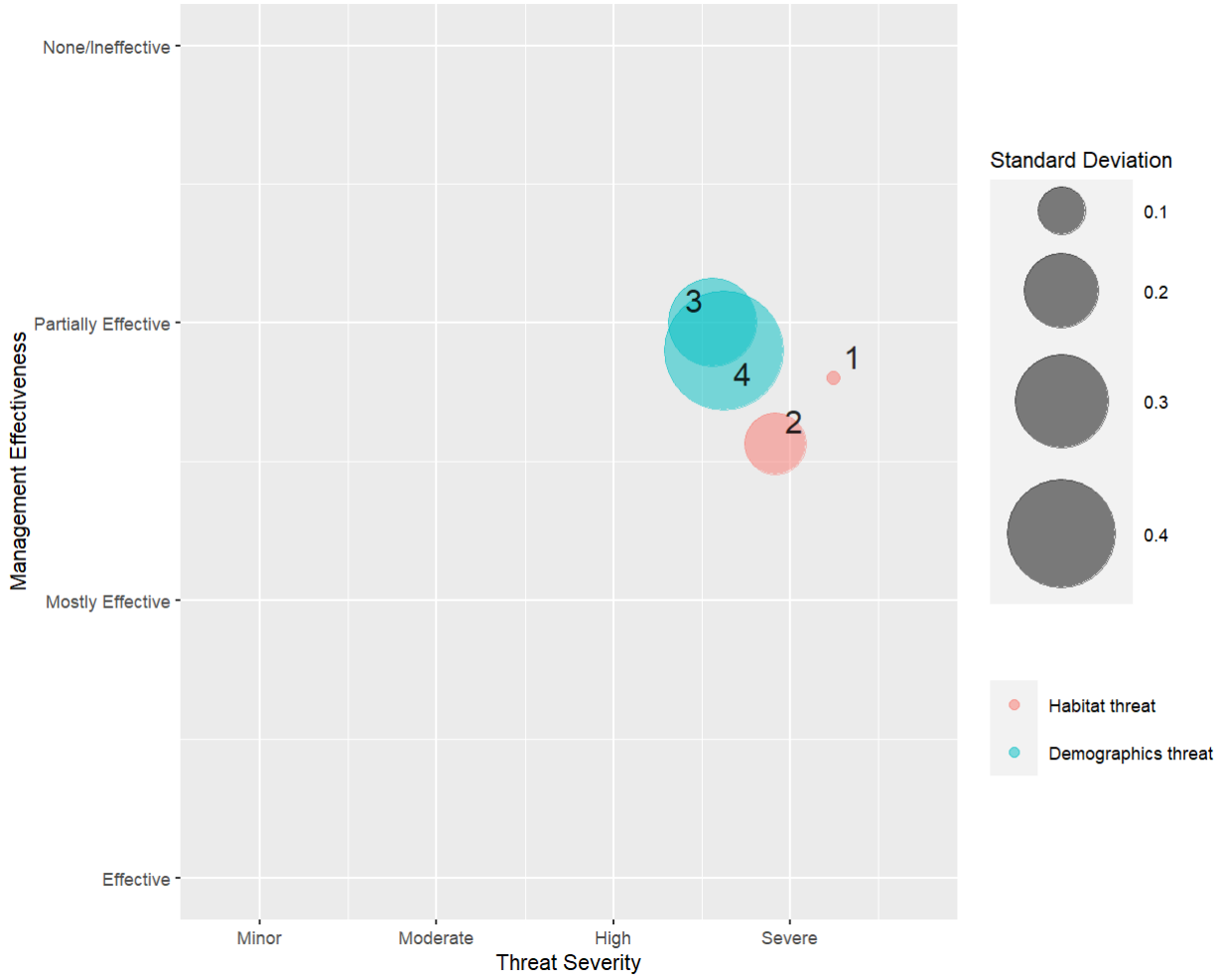
Demographic

Connectivity Impairment

- (5) Fish Passage Issues – upstream and downstream connectivity impairment could be found at stream/ road crossings (bridges, culverts), and possibly at dewatered stream segments during years of drought. No dams impair connectivity in the Chilliwack system.

CO04 – Dungeness River Core Area

Threats Assessment Results



Threats Summary

Habitat

Instream Impacts

- (1) Flood Control – flood and erosion control associated with agricultural and residential development continue to result in poor structural complexity and high water temperatures within the lower river, a migration corridor key to the persistence of the anadromous life history form. Floodplain restoration, large wood recovery, and riparian conservation are critical needs.

Water Quality

- (2) Altered Flows – agricultural and residential water use continue to result in poor instream flow and dewatering within the lower Dungeness River, impairing FMO habitat.

Demographic

Small Population Size

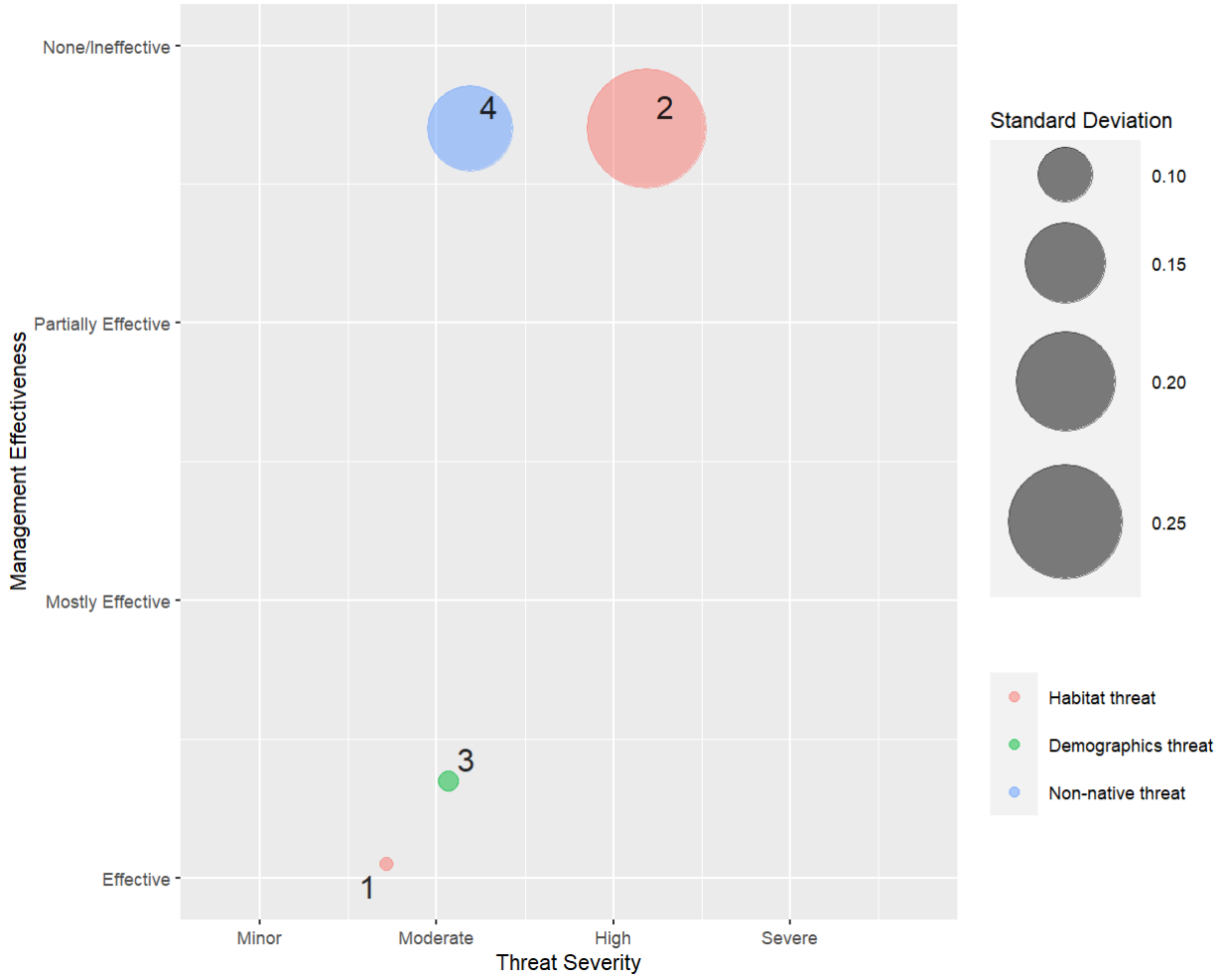
- (3) Genetic and Demographic Stochasticity – available spawner abundance data indicates the low number of adults in increased genetic and demographic stochasticity in both the Dungeness River and Gray Wolf River local populations.

Forage Fish Availability

- (4) Preybase – depressed populations of salmon and steelhead limit the available freshwater preybase in this system even though abundance of some species (e.g., pink salmon) has significantly improved.

CO05 – Elwha River Core Area

Threats Assessment Results



Threats Summary

Habitat

Instream Impacts

- (1) Fish Passage Issues – fish passage difficulty at former dam sites.

Water Quality

- (2) Instream Flows – adequate water quantity within the lower Elwha River will need to be maintained in the future, as municipal water rights currently exceed summer flows. Exercising full water rights will seasonally alter instream habitat and impair connectivity for migration; ongoing loss of glaciers associated with climate change is expected to exacerbate low instream flows.

Demographic
Forage Fish Availability

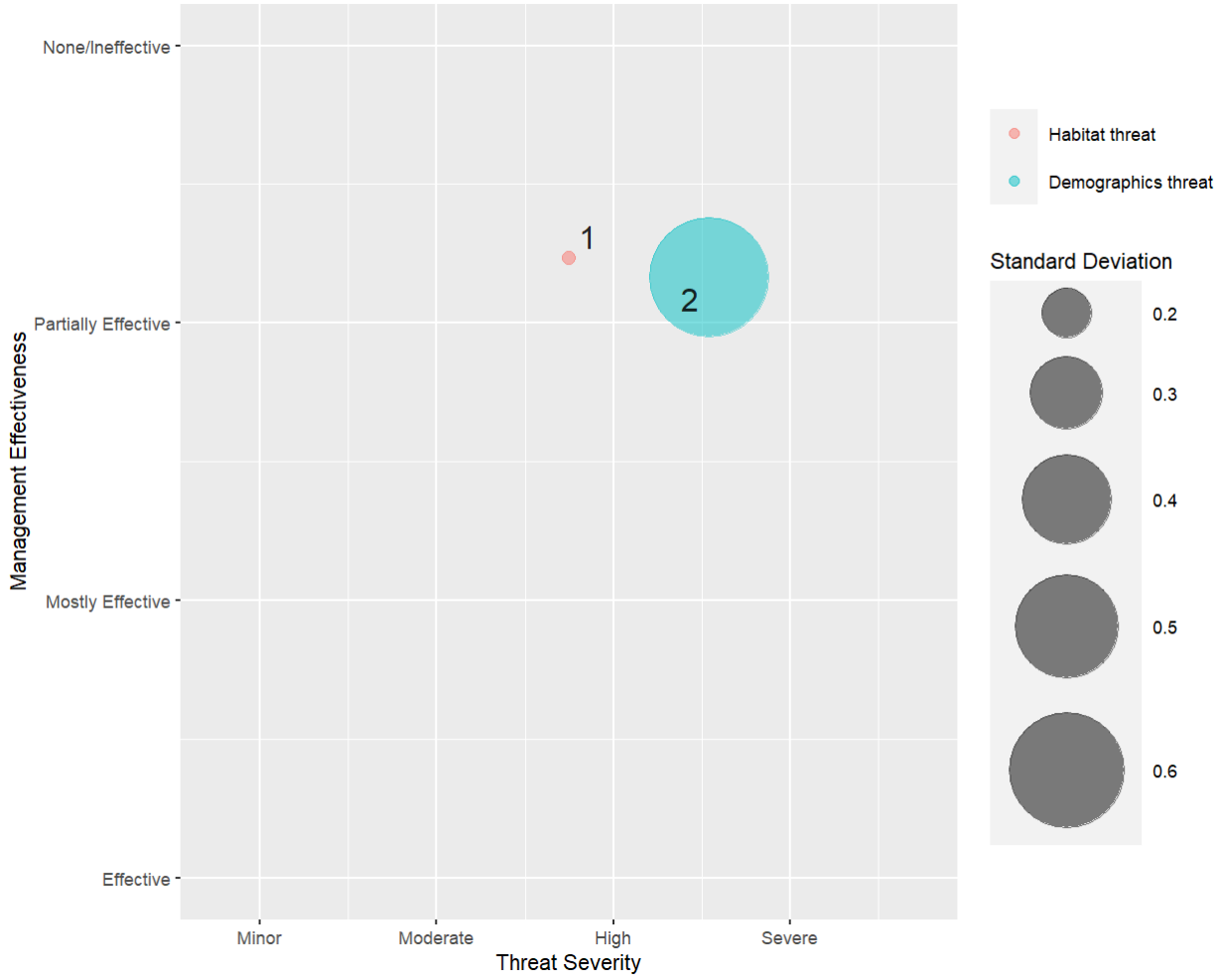
- (3) Preybase – although dam removal has been completed, salmon and steelhead populations are only in the early rebuilding phase and may require additional habitat and/or fish management intervention to fully restore freshwater preybase in this system.

Nonnatives
Nonnative Fishes

- (4) Competition and Hybridization – brook trout now overlap tributary spawning areas for bull trout in Indian, Griff, and Hughes Creeks, and Little River, creating significant potential for species competition and hybridization; additional concern with potential upstream expansion following dam removal.

CO06 – Hoh River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

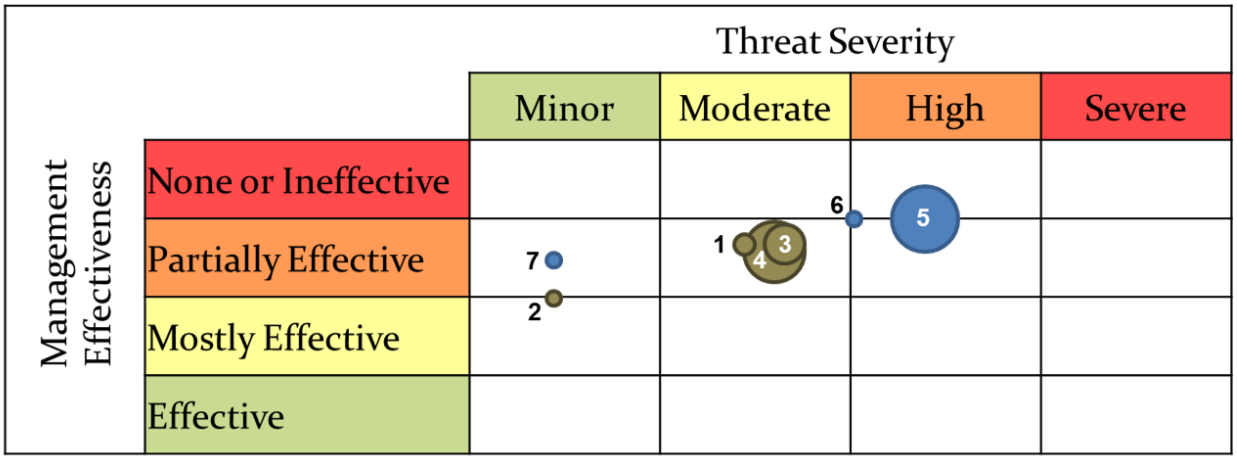
- (1) Transportation Networks – improved roads paralleling the river continue to impact habitat within stream corridors through loss of riparian areas, bank stability efforts, channel simplification of FMO habitat, and altered tributary connectivity.

Demographic
Fisheries Management

- (2) Angling or Harvest – incidental catch from other fisheries has been amplified by regional salmon and steelhead ESA-listings that have shifted regional recreational angling efforts to coastal streams, and it has been demonstrated to be significant in some Tribal fisheries.

CO07 – Hood River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Legacy Forest Management – impacts from these activities have resulted in high road densities and a lack of instream structure and complexity.
- (2) Agriculture Practices – impacts from the conversion of the riparian and other practices have resulted in the simplification of habitat.

Instream Impacts

- (3) Water Management – water withdrawal at irrigation dams and diversions decrease flow and alter sediment and wood routing.

Water Quality

- (4) Water Management – operations at Clear Branch Dam increase downstream water temperatures.

Demographic

Connectivity Impairment

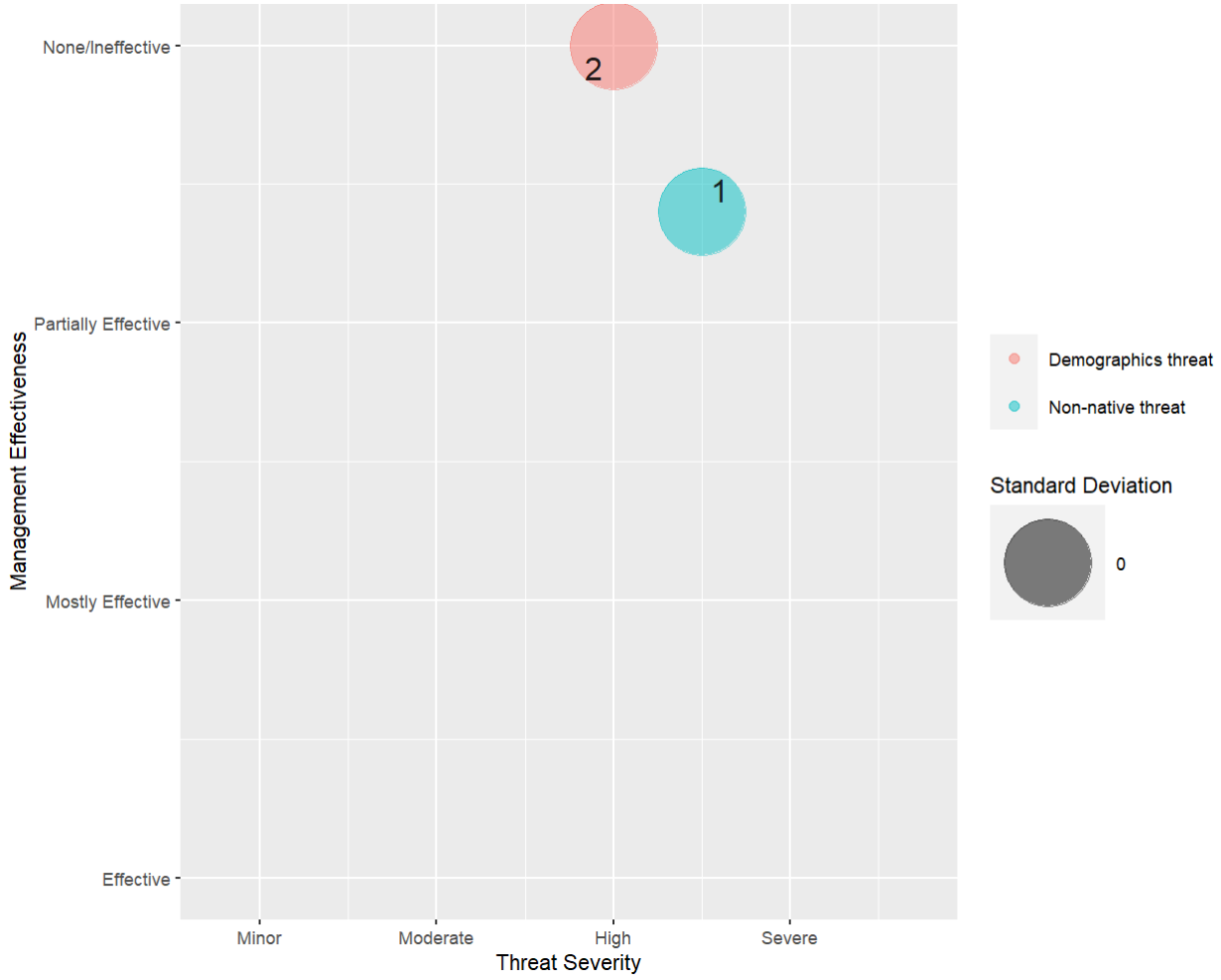
- (5) Fish Passage Issues – impeded fish passage at Clear Branch Dam isolates a population of bull trout above the dam; low flow out of the reservoir prevents downstream passage during summer and fall.
- (6) Fish Passage Issues – Erosional events caused by glacial outbursts have resulted in passage barriers, specifically on Middle Fork Hood River (Middle Fork Falls).

Fisheries Management

- (7) Angling or Harvest – bull trout are handled through incidental catch in the recreational fisheries on Laurance Lake.

CO08 – Klickitat River Core Area

Threats Assessment Results



Threats Summary

Demographic
Small Population Size

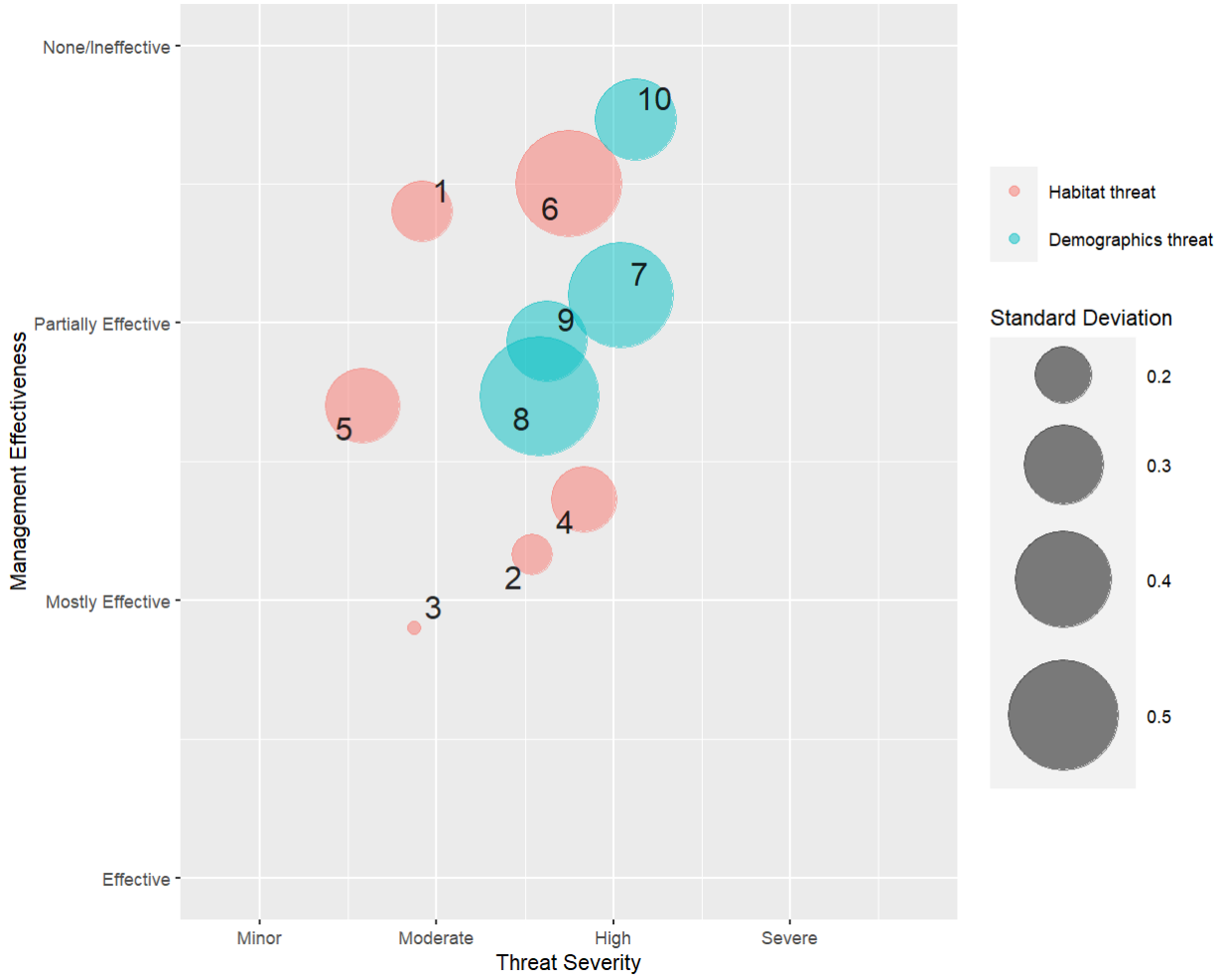
- (2) Genetic and Demographic Stochasticity – low population size and unknown fluvial migratory life history presence have led to reduced genetic diversity and demographic stability.

Nonnatives
Nonnative Fishes

- (1) Hybridization and Competition – presence of brook trout poses significant risk of hybridization in the West Fork Klickitat River local population, which is composed of the resident life history.

CO09 – Lewis River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Natural Event – Mount St. Helens eruption in 1980 has resulted in persistent adverse impacts to hillslope processes, stream corridor structure and function, and channel structure and stability.
- (2) Forest Practices – past timber harvest practices on Federal land have adversely impacted hillslope processes; timber harvest practices on private land adversely impact hillslope processes.
- (3) Transportation – road system in forested land adversely impacts hillslope processes and access to productive habitat.

Instream Impacts

- (4) Entrainment – current facility operations reduce juvenile to adult survival rates.

Water Quality

- (5) Residential and Recreational Development – adversely impacts hillslope processes and stream corridor structure and function.
- (6) Climate Change – predicted changes expected to adversely impact hillslope processes, water temperature, and instream flows in the basin.

Demographic

Connectivity Impairment

- (7) Fish Passage Issues – the system of dams on the mainstem Lewis River limits genetic exchange between local populations and suppresses opportunity for expression of the anadromous life history.
- (8) Limited Extent of Habitat – degraded watershed processes limit extent of habitat quantity and quality available for bull trout spawning.

Fisheries Management

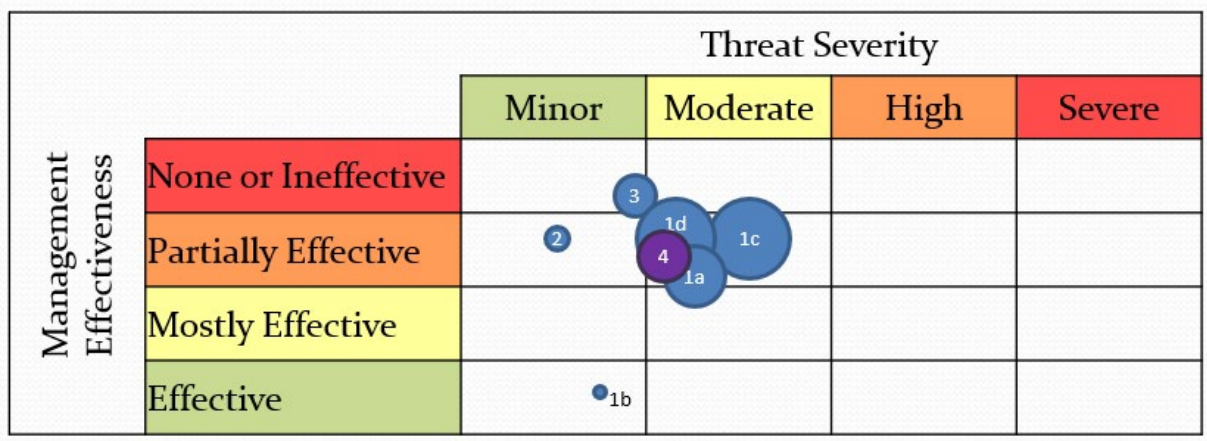
- (9) Angling or Harvest – release mortalities and illegal retention of bull trout in fisheries targeting other species reduces population abundance and productivity.

Small Population Size

- (10) Genetic and Demographic Stochasticity – current low abundance levels limit the effective breeding population size, which adversely impacts population productivity through potential inbreeding and genetic drift.

CO10 – Lower Deschutes River Core Area

Threats Assessment Results



Threats Summary

Demographic
Connectivity Impairment

- (1a) Partial connectivity at the Pelton Round Butte Project limits connection between the Metolius River populations and Warm Springs River and Shitike Creek populations.
- (1b) Lack of connectivity at Opal Springs to FMO habitat in Crooked River.
- (1c) The Warm Spring National Fish Hatchery limits upstream and downstream connectivity of fluvial fish from the Warm Spring River to the Deschutes River.
- (1d) Limited passage at the Warm Spring National Fish Hatchery impairs connectivity between the Shitike Creek and Warm Springs River populations.

Fisheries Management

- (2) Management of kokanee in Lake Billy Chinook impacts available forage base for Metolius River bull trout populations.

Small Population Size

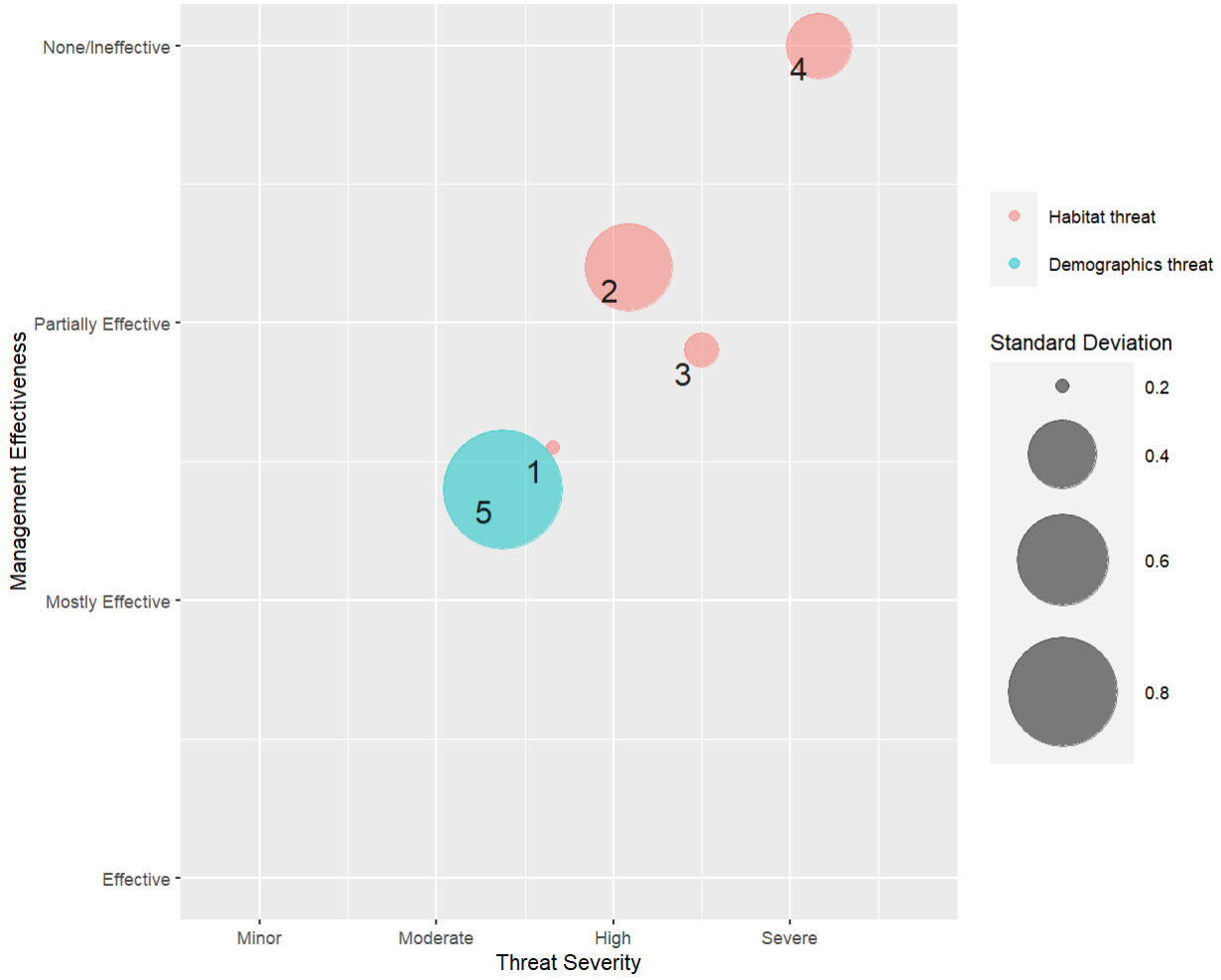
- (3) Genetic and demographic stochasticity in Warm Spring River population.

Nonnatives
Nonnative Fishes

- (4) Hybridization and competition with brook trout.

CO11 – Lower Skagit River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Legacy Forest Management – associated sediment impacts, particularly from forest roads, have led to habitat degradation within key SR basins (i.e., Sauk and Suiattle Rivers) in the core area.

Instream Impacts

- (2) Flood Control – flood and erosion control associated with agricultural practices, transportation corridors, residential development, and urbanization continue to result in poor structural complexity within lower river FMO habitats (e.g., Skagit and lower Sauk Rivers) key to the persistence of the anadromous life history form.

Water Quality

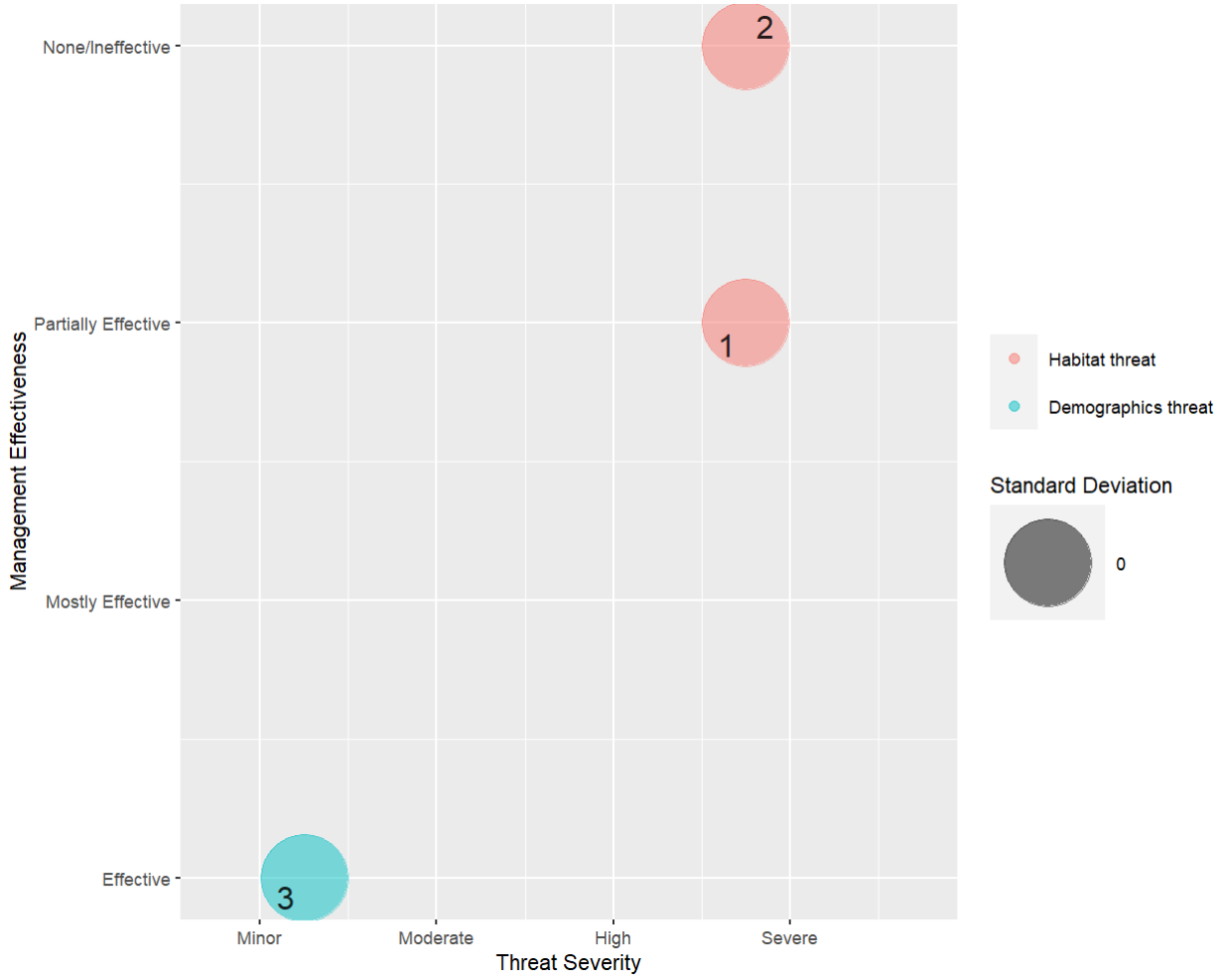
- (3) Agriculture Practices and Residential Development and Urbanization – related activities have resulted in sediment and temperature impairment in major tributaries to the lower Skagit River and possibly the upper Sauk River.
- (4) Climate Change – increasing variability in flows (higher peak and lower base flows) are anticipated to significantly impact both spatial and life history diversity of bull trout within the core area.

Demographic
Connectivity Impairment

- (5) Fish Passage Issues – upstream and downstream connectivity at hydropower facilities (Baker River Hydropower Project) is directly tied to active fish passage measures under FERC agreements.

CO12 – Nooksack River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Legacy Forest Management and Agriculture Practices – impacts associated with past forest management plus past and ongoing agricultural practices have led to channelization and habitat degradation within lower river FMO habitats key to the persistence of the anadromous life history form.

Water Quality

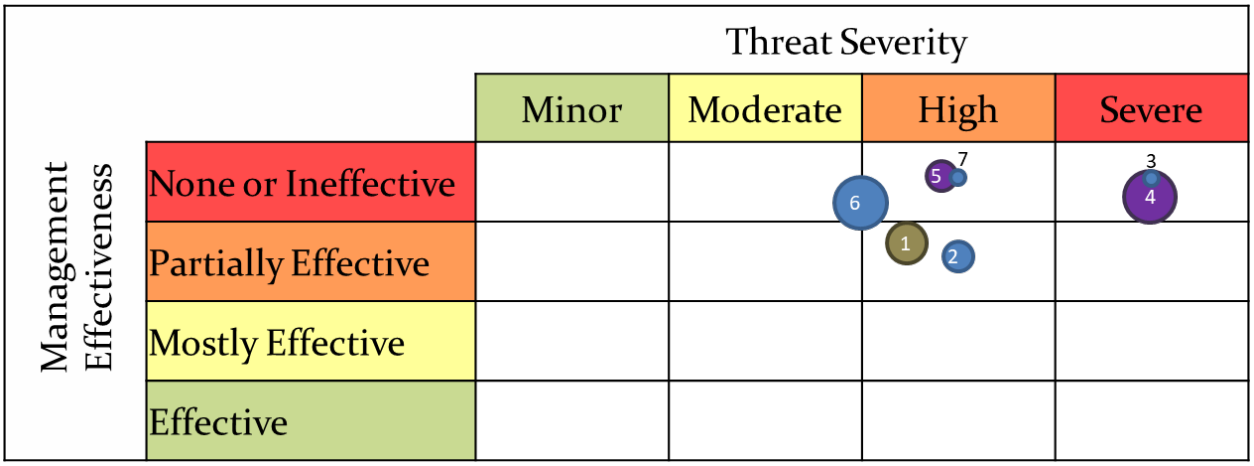
- (2) Climate Change – seasonal high water temperatures in the South Fork Nooksack River are expected to be exacerbated, likely impairing migration, especially of the anadromous life history form, and reducing available SR habitat for the South Fork Nooksack River local populations.

Demographic
Connectivity Impairment

- (3) Fish Passage Issues – the Bellingham Water Diversion on the Middle Fork Nooksack River continues to limit access by the migratory life history form to habitats above the diversion and impairs connectivity between the lower and upper Middle Fork River local populations.

CO13 – Odell Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Instream Impacts

- (1) Transportation Networks – legacy effects related to transportation networks (railroad and road crossings and Hwy 58) degraded and limited spawning habitat in Odell Lake tributaries.

Demographic
Connectivity Impairment

- (6) Odell Lake Outlet Dam – The dam at the outlet of Odell Lake impedes bull trout movement in and out of Odell Creek.

Fisheries Management

- (2) Angling – a portion of the estimated bull trout population is handled through incidental catch in the kokanee and lake trout fisheries.

Small Population Size

- (3) Genetic and Demographic Stochasticity – available spawner abundance data indicates Odell Lake bull trout are at risk of genetic and demographic stochasticity. Redd counts over the last generation average less than 12 redds.

Predation

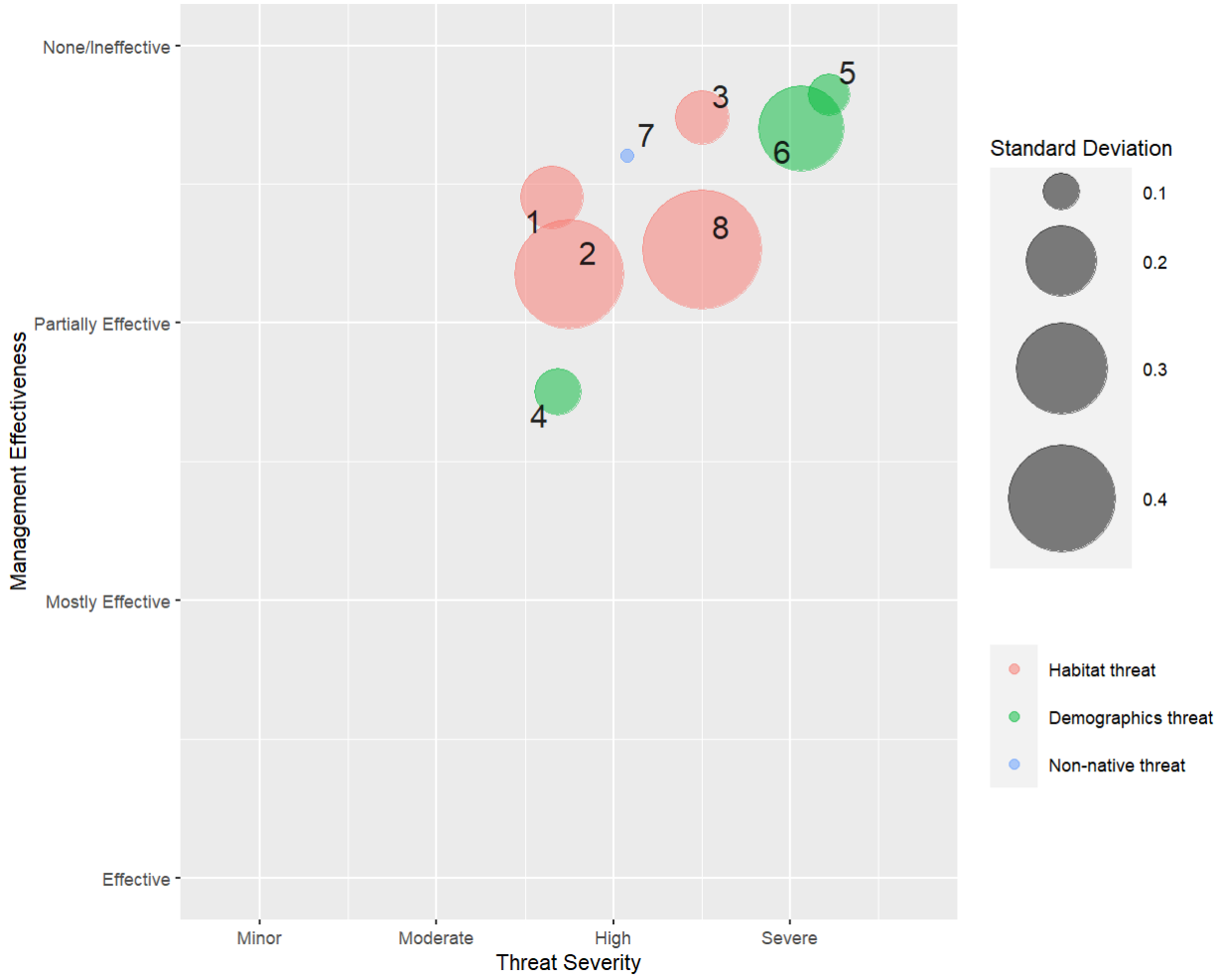
- (7) Otters – otter predation at the mouth of Trapper Creek could decimate the few bull trout moving into Trapper Creek to spawn.

Nonnatives
Nonnative Fishes

- (4) Predation/Species Competition – nonnative lake trout likely negatively impact bull trout
- (5) Hybridization/Species Competition – nonnative brook trout hybridize with bull trout and compete for food and space.

CO14 – Puyallup River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Legacy Forest Management Practices – significant impacts in mid-elevation areas outside of Mount Rainier National Park, especially within the Upper Puyallup and Mowich Rivers local population.

Instream Impacts

- (2) Flood Control – flood and erosion control associated with residential development and urbanization continue to result in poor structural complexity within lower river FMO habitats key to the persistence of the anadromous life history form.

- (3) Climate Change – increases in glacial outbursts and channel widening are reducing access to available spawning tributaries and negatively impacting spawning habitats.

Water Quality (*Emerging threat*)

- (8) Water Quality – biological, chemical, and physical impairments exist throughout the watershed. Bull trout are subjected to bacteria, toxins, and water temperatures exceeding thermal tolerances and lower levels of dissolved oxygen.

Demographic

Connectivity Impairment

- (4) Fish Passage Issues – Buckley Diversion/Mud Mountain Dam isolate local populations and/or delay migrations; low flows in bypass reaches can limit habitat availability and migration.
- (5) Entrainment – Electron Dam isolates local populations, delays migrations, and/or entrains individuals; low flows in bypass reaches can limit habitat availability and migration.

Small Population Size

- (6) Genetic and Demographic Stochasticity – available spawner abundance data indicates the low number of adults results in increased genetic and demographic stochasticity in the Upper Puyallup and Mowich Rivers local population.

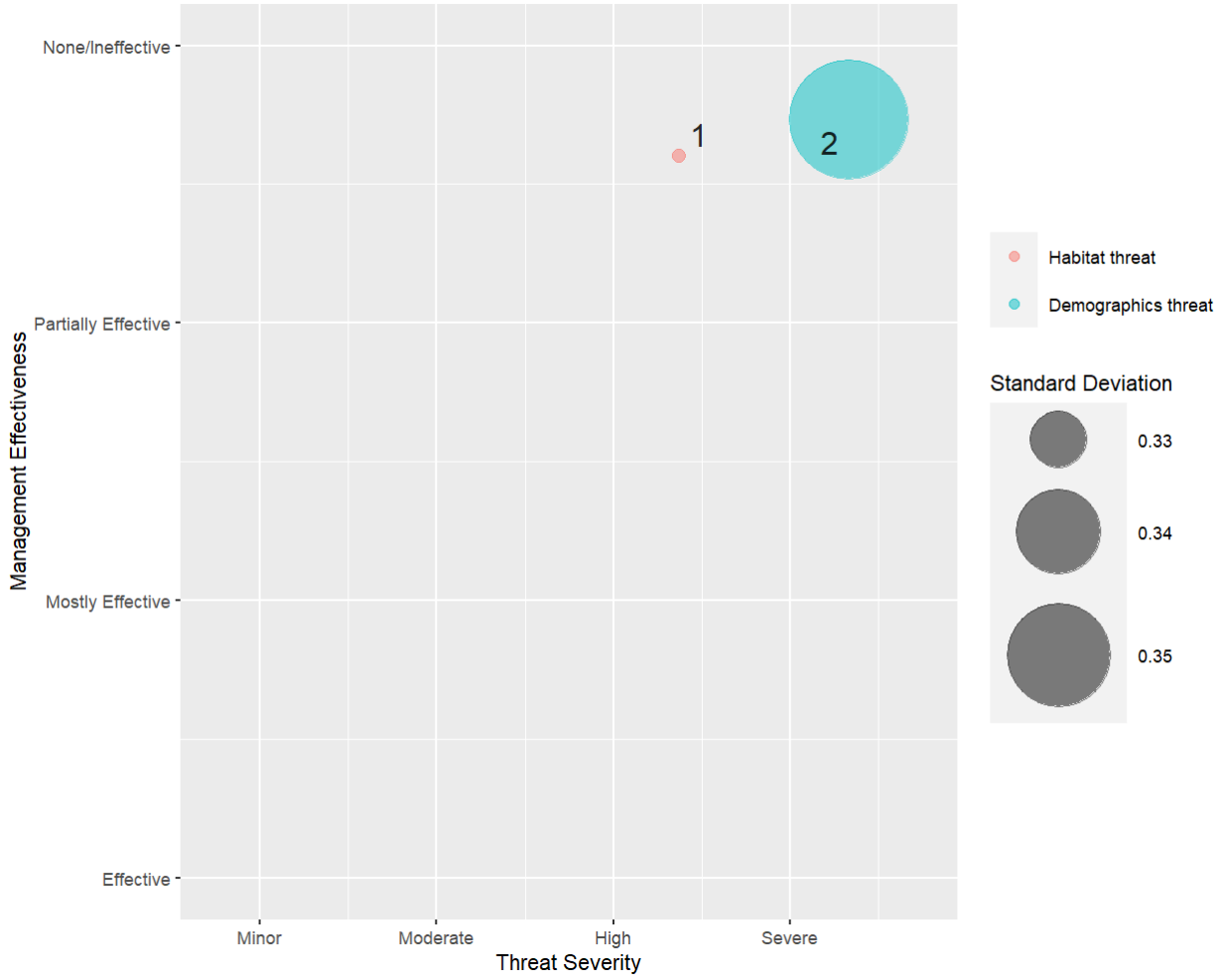
Nonnatives

Nonnative Fishes

- (7) Hybridization – presence of brook trout poses significant risk of hybridization in the Carbon River local population, which is largely composed of the resident life history; brook trout also detected in SR areas within other parts of the core area, which may pose hybridization risk, although to a lesser extent, in other local populations.

CO15 – Queets River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

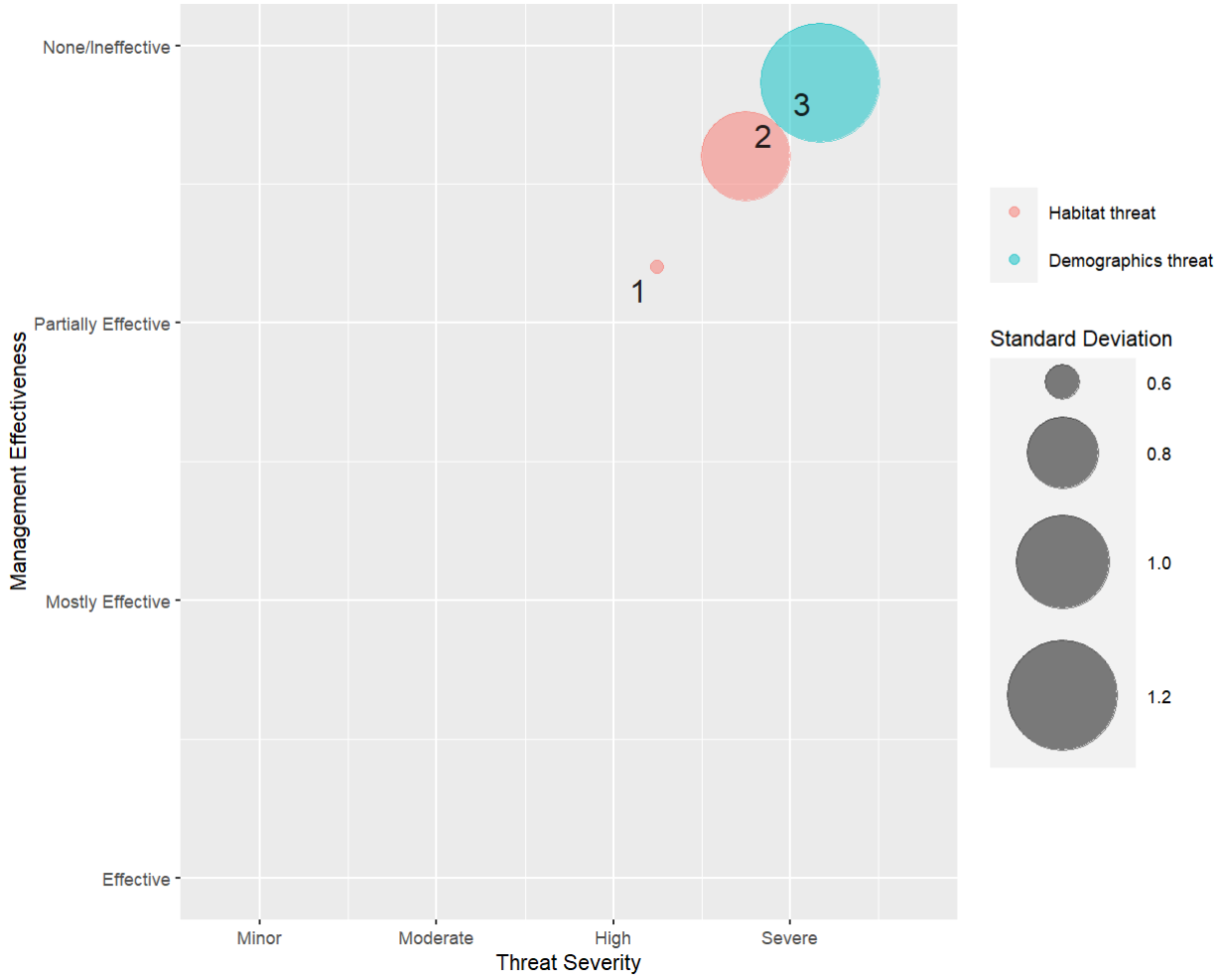
- (1) Forest Road System – the system in parts of the watershed requires ongoing maintenance and stabilization to limit stream associated impacts.

Demographic
Fisheries Management

- (2) Angling or Harvest – incidental catch has been amplified by regional salmon and steelhead ESA-listings that have shifted regional recreational angling effort to coastal streams, and it has been demonstrated to be significant in some Tribal fisheries.

CO16 – Quinault River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

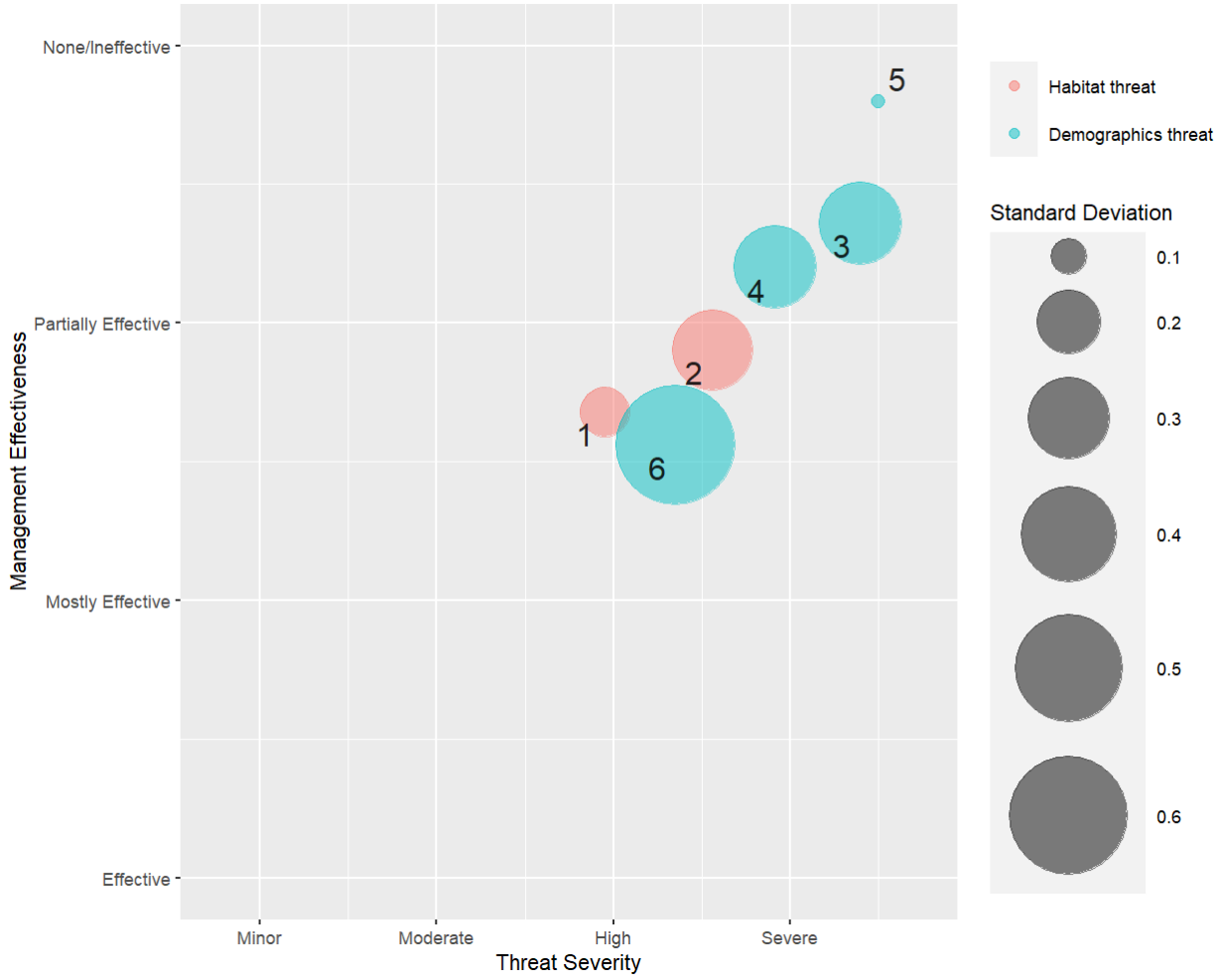
- (1) Transportation Networks – improved roads paralleling the river continue to impact habitat within stream corridors through loss of riparian areas, bank stability efforts, channel simplification of FMO habitat, and altered tributary connectivity.
- (2) Loss of Channel Complexity – land management impacts have altered Middle Reach, which was historically a key spawning area for sockeye salmon and migratory reach for adfluvial bull trout. This reach is growing highly unstable due to land management impacts.

Demographic
Fisheries Management

- (3) Angling or Harvest – incidental catch has been amplified by regional salmon and steelhead ESA-listings that have shifted regional recreational angling effort to coastal streams, and it has been demonstrated to be significant in some Tribal fisheries.

CO17 – Skokomish River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Legacy Forest Management and Roads – the South Fork Skokomish River system is still undergoing recovery with additional restoration efforts required to address further contribution to habitat degradation and channel aggradation (*Note*; assess the basin as one core area rather than separate North and South Fork Skokomish River).

Instream Impacts

- (2) Flood Control – the South Fork Skokomish River continues to aggrade due to past removal of LWD and bank protection measures. This has resulted in a highly simplified stream channel lacking habitat complexity critical for supporting fish.

Demographic

Connectivity Impairment

- (3) Fish Passage Issues – incomplete passage efforts at Cushman Dams on the North Fork Skokomish River currently constrain migration and limit connectivity of local populations, while aggraded reaches in the mainstem and South Fork Skokomish Rivers and canyon reaches in the upper South Fork Skokomish River can seasonally impair migration of fluvial and anadromous life history forms. The South Fork Skokomish River conditions are likely to be further exacerbated by climate change.

Fisheries Management

- (4) Angling or Harvest – incidental catch from other fisheries in mainstem and South Fork Skokomish River puts the South Fork Skokomish local population at increased risk due to its small population size and the timing of fisheries.

Small Population Size

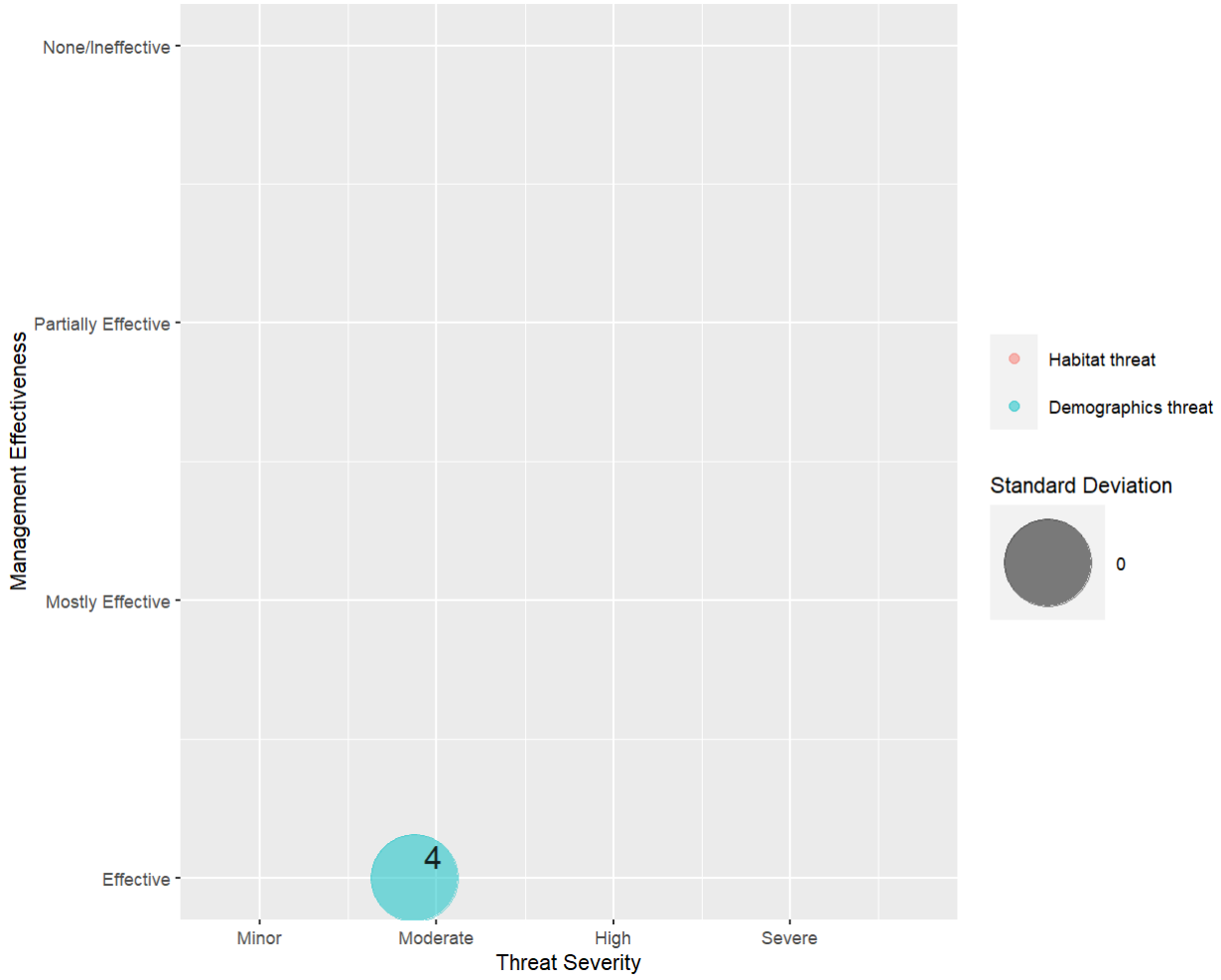
- (5) Genetic and Demographic Stochasticity – available spawner abundance data indicates the low number of adults results in increased genetic and demographic stochasticity in the South Fork Skokomish local population.

Forage Fish Availability

- (6) Preybase – depressed populations of salmon/steelhead primarily in the South Fork Skokomish River limit productivity within this local population (*Note*; assess the entire one core area rather than separate North and South Fork Skokomish River).

CO18 – Snohomish and Skykomish River Core Area

Threats Assessment Results



Threats Summary

Habitat

Instream Impacts

- (*Not scored/plotted*) Flood Control – flood and erosion control associated with agricultural practices, residential development, and urbanization continue to result in poor structural complexity within lower river FMO habitats key to the persistence of the anadromous life history form.
- (*Not scored/plotted*) Recreational Mining – activities impact SR tributary habitats.

Water Quality

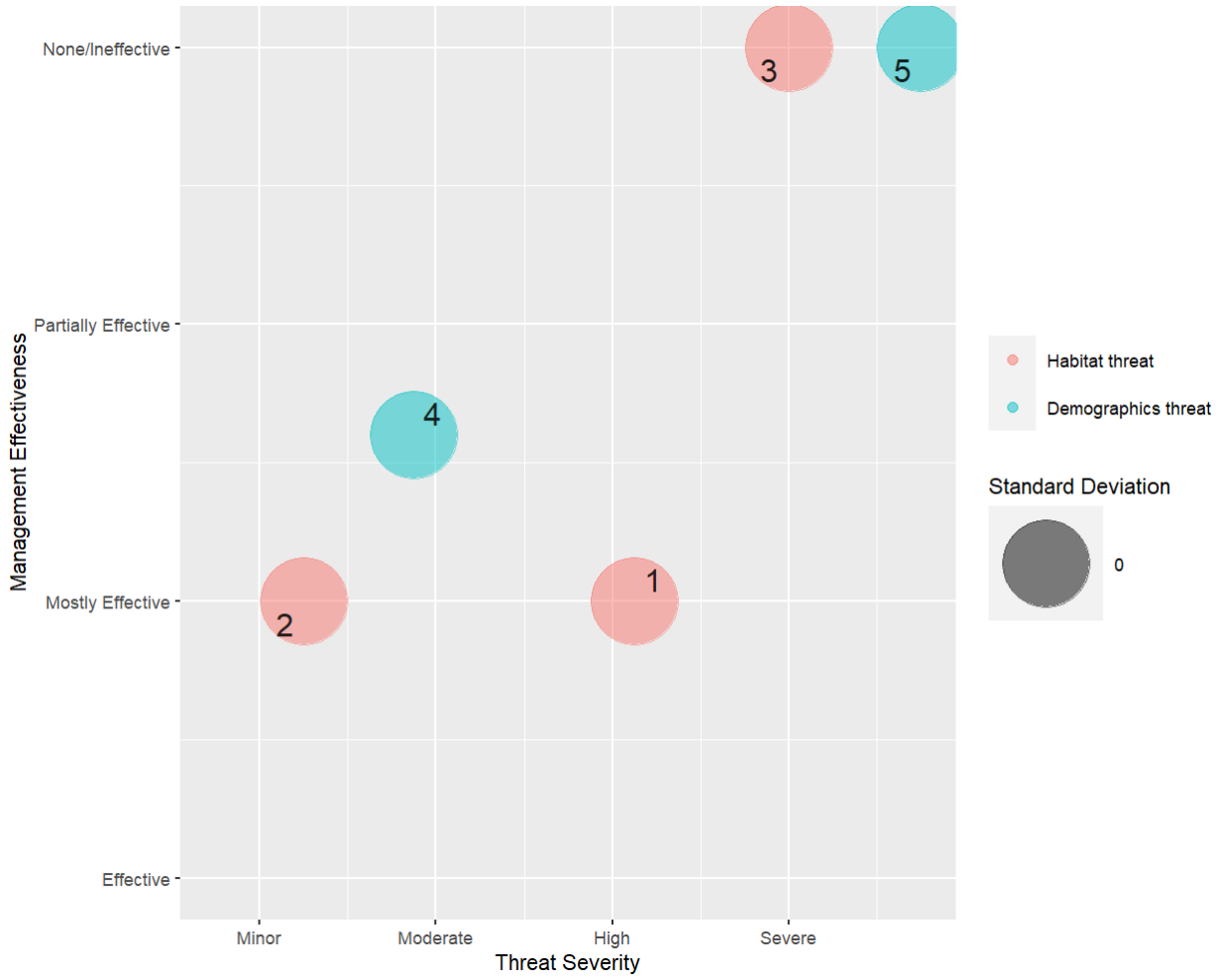
- (*Not scored/plotted*) Residential Development and Urbanization – associated impacts increase seasonal high water temperature in the lower mainstem river, a migration corridor key to the persistence of the anadromous life history form.

Demographic
Connectivity Impairment

- (4) Fish Passage Issues – persistence of the South Fork Skykomish River local population is reliant upon ongoing operation of the trap and haul facility at Sunset Falls.

CO19 – Stillaguamish River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Forest Management – legacy and ongoing impacts have exacerbated landslide activity in the watershed, degrading salmonid habitat and water quality.

Instream Impacts

- (2) Recreational Mining – activities impact SR tributary habitats.

Water Quality

- (3) Forest Management, Residential Development, and Urbanization – legacy impacts result in seasonal high-water temperatures in mainstem river, North and South Forks,

and some local population tributaries; anticipated to be further exacerbated by climate change.

Demographic
Connectivity Impairment

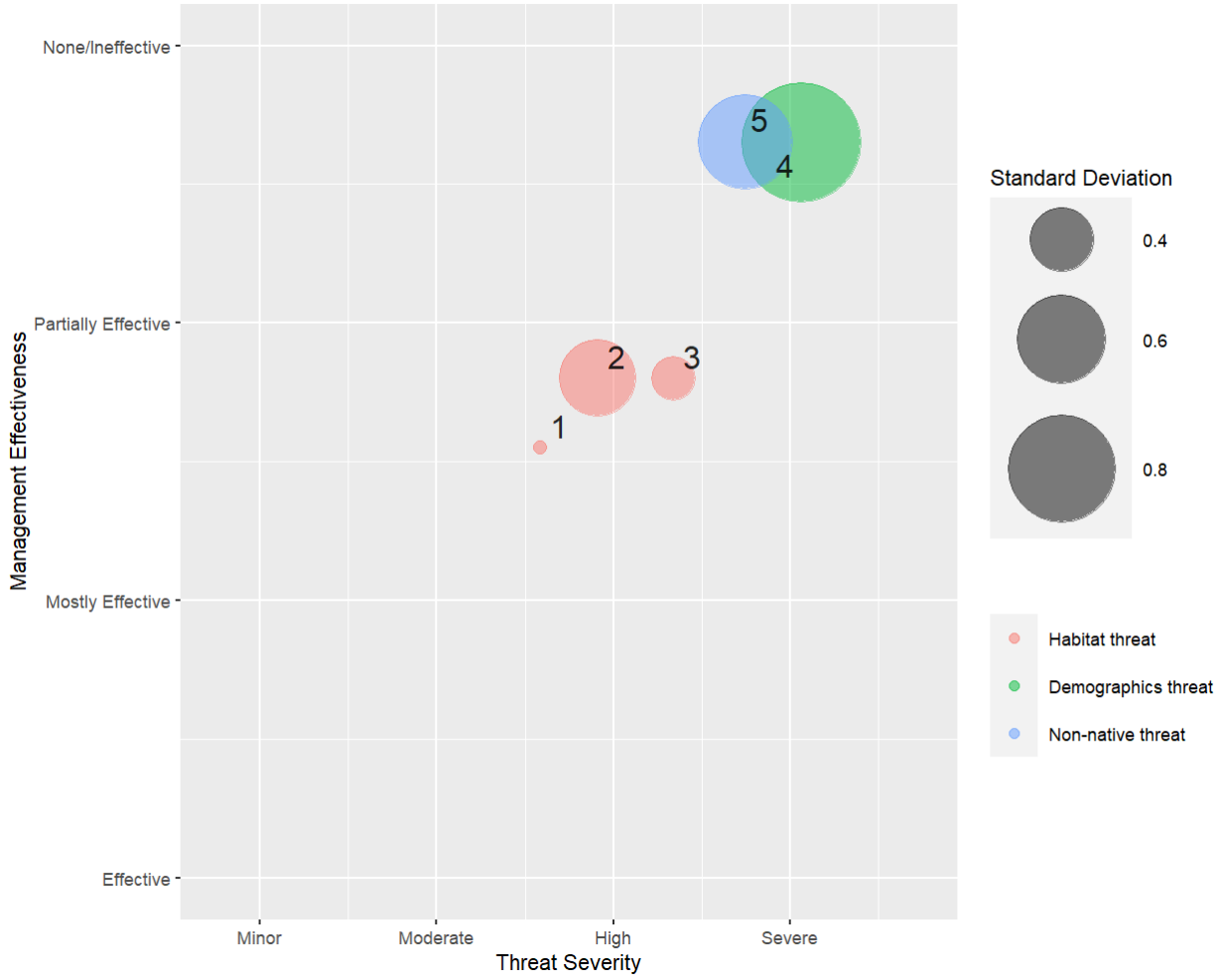
- (4) Fish Passage Issues – the Stillaguamish weir on Cook Slough impedes upstream fish passage and/or traps migratory spawners. Persistence of the migratory life history form in the South Fork Stillaguamish River local population is reliant upon continued functionality of the fishway at Granite Falls (*Note*; these were separate in the Plan but are considered the same threat).

Small Population Size

- (5) Genetic and Demographic Stochasticity – available spawner abundance data indicates the low number of adults results in increased genetic and demographic stochasticity in the South Fork Stillaguamish River and Upper Deer Creek local populations; in fact, the Upper Deer Creek local population may be extirpated.

CO20 – Upper Skagit River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Forest Management – legacy and ongoing degradation of habitat and water quality in SR tributaries outside of designated protected areas; coordinate with British Columbia.

Instream Impacts

- (2) Recreational Mining – activities impact SR tributary habitats.

Water Quality

- (3) Mining – legacy impacts from Silver Daisy Mine in upper Skagit River, potential contaminants, and downstream impacts associated with proposed Imperial Metals Giant Copper Mine in the upper Skagit River and Ross Lake, legacy and current impacts from mining in Ruby Creek watershed; coordinate with British Columbia.

Demographic
Connectivity Impairment

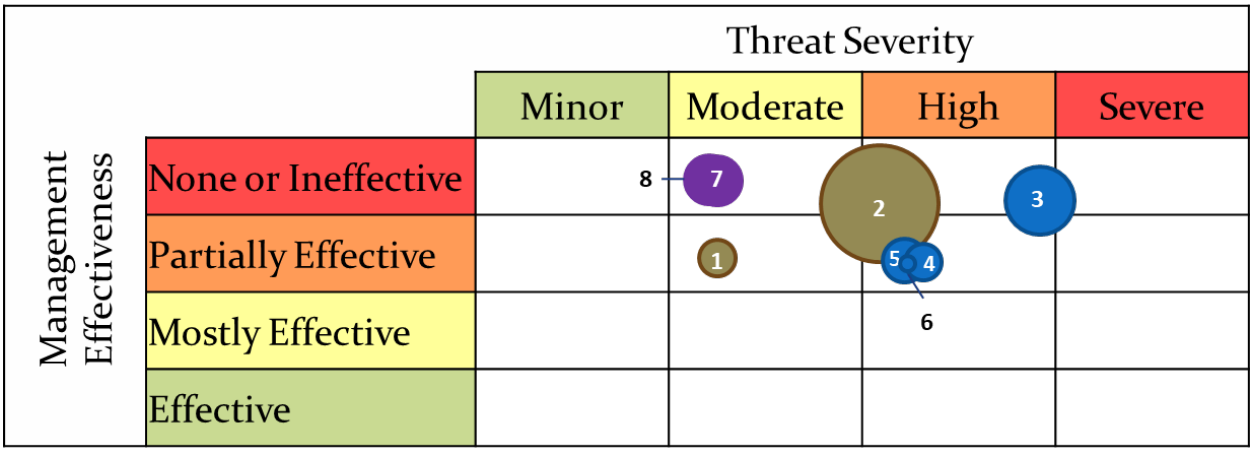
- (4) Fish Passage Issues – upstream and downstream connectivity at hydropower facilities (Skagit River projects) is currently not tied to any measures under the current FERC agreement. Recent genetic analyses indicate the isolated local populations in both Gorge and Diablo Reservoirs should be grouped with the Upper Skagit River local populations (Ross Reservoir populations).

Nonnatives
Nonnative Fishes

- (5) Hybridization – increasing risk of brook trout hybridization due to population expansion and increase in fish size as a result of redside shiner introduction; coordinate with British Columbia.

CO21 – Upper Willamette River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Forest Management Practices – legacy forest management practices have degraded instream and riparian habitats.

Instream Impacts

- (2) Altered Flows and Geomorphic Processes – operation of the major dams alters the natural flow regime and geomorphic processes, eliminating pools and complex habitat suitable for juvenile and adult rearing.

Demographic
Connectivity Impairment

- (3) Entrainment and Fish Passage Issues – dams entrain fish, impede passage, cause passage-related mortality, and affects connectivity within and among populations.

Fisheries Management

- (4) Illegal Harvest – illegal harvest and incidental angling-related mortality are significant sources of take in the McKenzie River and Middle Fork Willamette River (Hills Creek Reservoir).

Forage Fish Availability

- (5) Preybase – loss of native fish due to fish passage issues at dams impact forage base and productivity of bull trout above the dams.
- (6) Preybase – decline in native fish populations in reaches below the dams impacts forage base and productivity of bull trout.

Nonnatives
Nonnative Fishes

- (7) Hybridization and Competition – Brook trout are present in SR habitats.
- (8) Predation – Nonnative warm water species are abundant in the Middle Fork Willamette Basin and are beginning to show up in the McKenzie River and Cougar Reservoir.

CO22H – Clackamas River Core Area (Historical)

Threats Assessment Results

NA

Threats Summary

NA

CO23H – North Santiam River Core Area (Historical)

Threats Assessment Results

NA

Threats Summary

NA

CO24H – South Santiam River Core Area (Historical)

Threats Assessment Results

NA

Threats Summary

NA

CO25H – Upper Deschutes River Core Area (Historical)

Threats Assessment Results

NA

Threats Summary

NA

CO26H – White Salmon River Core Area (Historical)

Threats Assessment Results

NA

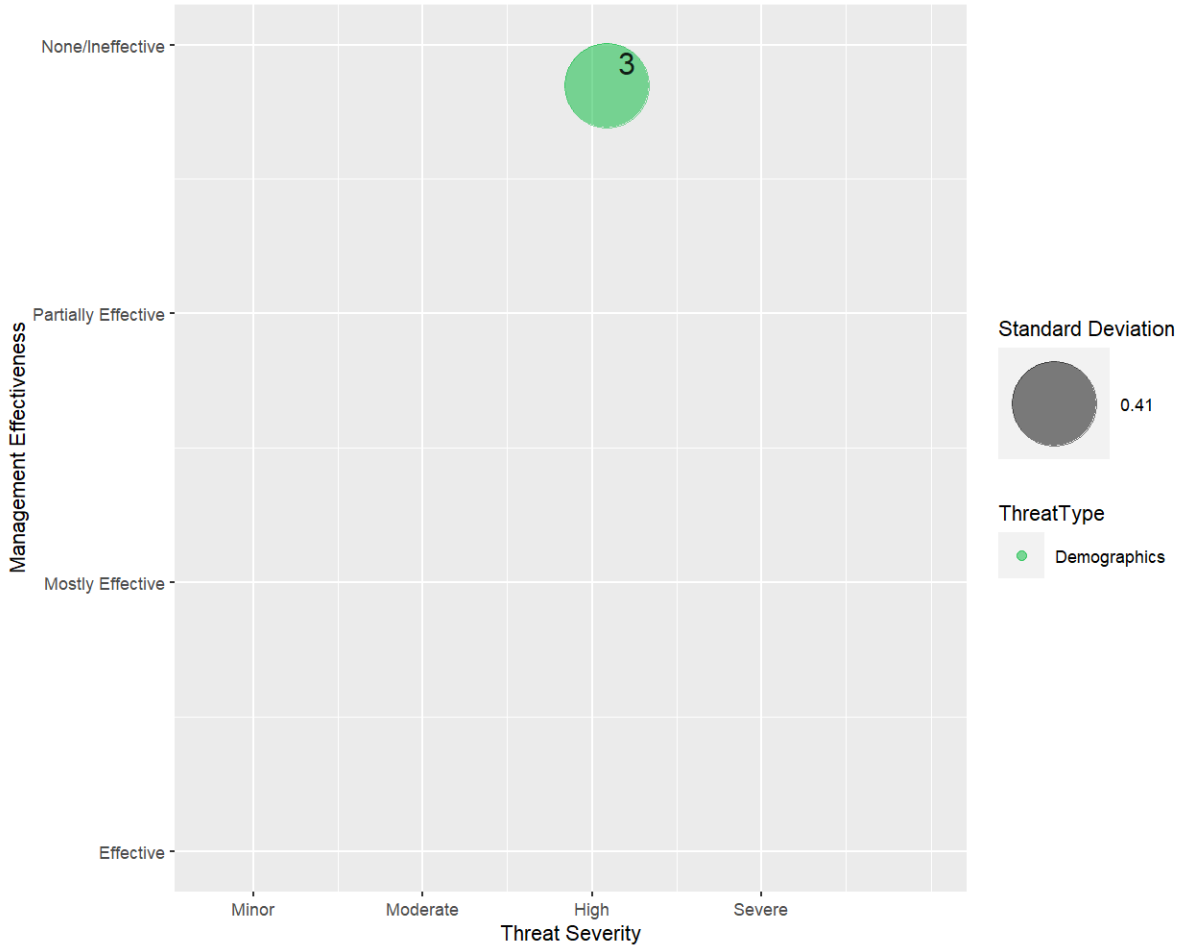
Threats Summary

NA

Columbia Headwaters Representative Unit

CH01 – Akokala Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Small Population Size

- (3) Single local population is remnant; may be smaller than what is sustainable/viable (i.e., low single digit redd counts may be aggravated by barrier construction for protection from nonnatives. Small perturbations to access of suitable SR habitat is a concern (beavers).

CH02 – Big Salmon Lake Core Area

Threats Assessment Results

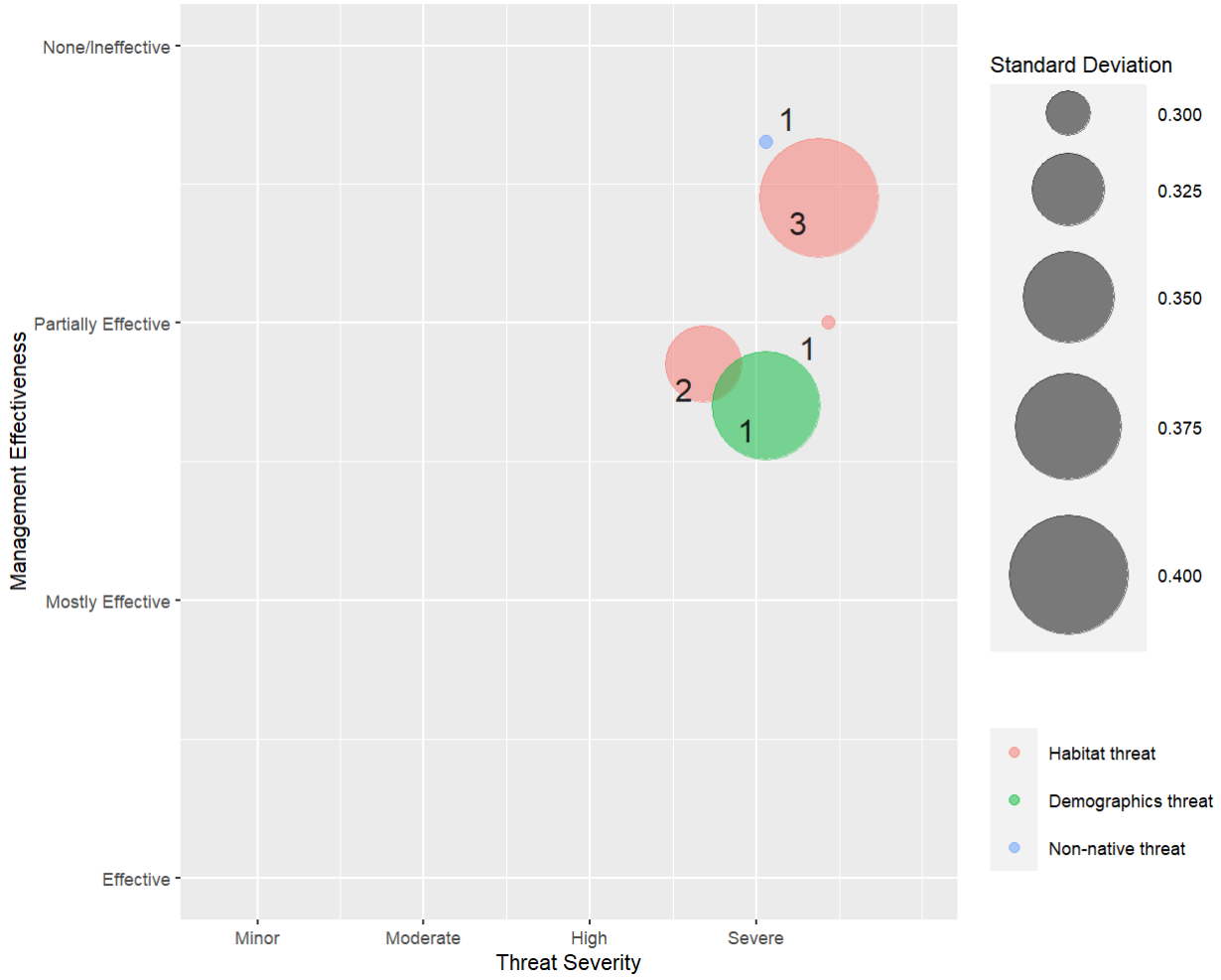
NA

Threats Summary

NA

CH03 – Bitterroot River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Sediment from forest roads, logging practices, livestock grazing, and agricultural practices (irrigation impacts and dewatering) are causing riparian and instream degradation, loss of LWD, and pool reduction in FMO habitat and some SR tributaries. This is especially acute on private lands mostly downstream of National Forest SR habitat.

  Extensive residential development of riparian and uplands, especially in the lower (valley) reaches of many tributaries, is exacerbating the effects of dewatering, entrainment, and blockage of upstream fish passage due to irrigation, roads, overgrazing and a myriad of other human activities.

Increased intensity of recreational use throughout the Bitterroot and in many of the headwater SR reaches is negatively impacting SR and FMO.

Instream Impacts

- (2) Transportation corridors along riparian areas contribute to instream habitat degradation through the loss of LWD, pool reduction, increased sedimentation, and loss of structure due to streambank stabilization in some SR tributaries (e.g., Lolo Creek).

Water Quality

- (3) Dewatering of the Bitterroot River mainstem FMO habitat and lower portions of most SR tributaries contributes to seasonally critical high temperatures in the mainstem downstream of Hamilton. There are few remaining bull trout in the mainstem and those that are become isolated in pockets of thermal refugia where they are very vulnerable to anglers and predators.

Demographic

Connectivity Impairment

- (1) Fragmentation of SR habitat is extreme, and connectivity with FMO habitat is poor. Migratory life forms are being lost due primarily to irrigation diversions. Further range reduction of bull trout in remaining patches of occupied SR habitat may limit recovery potential, even if other threats are resolved. Resident bull trout populations are doing relatively well on the east side of the Bitterroot (with the exception of Sleeping Child Creek), but most are isolated and are not contributing migratory individuals to the core area.

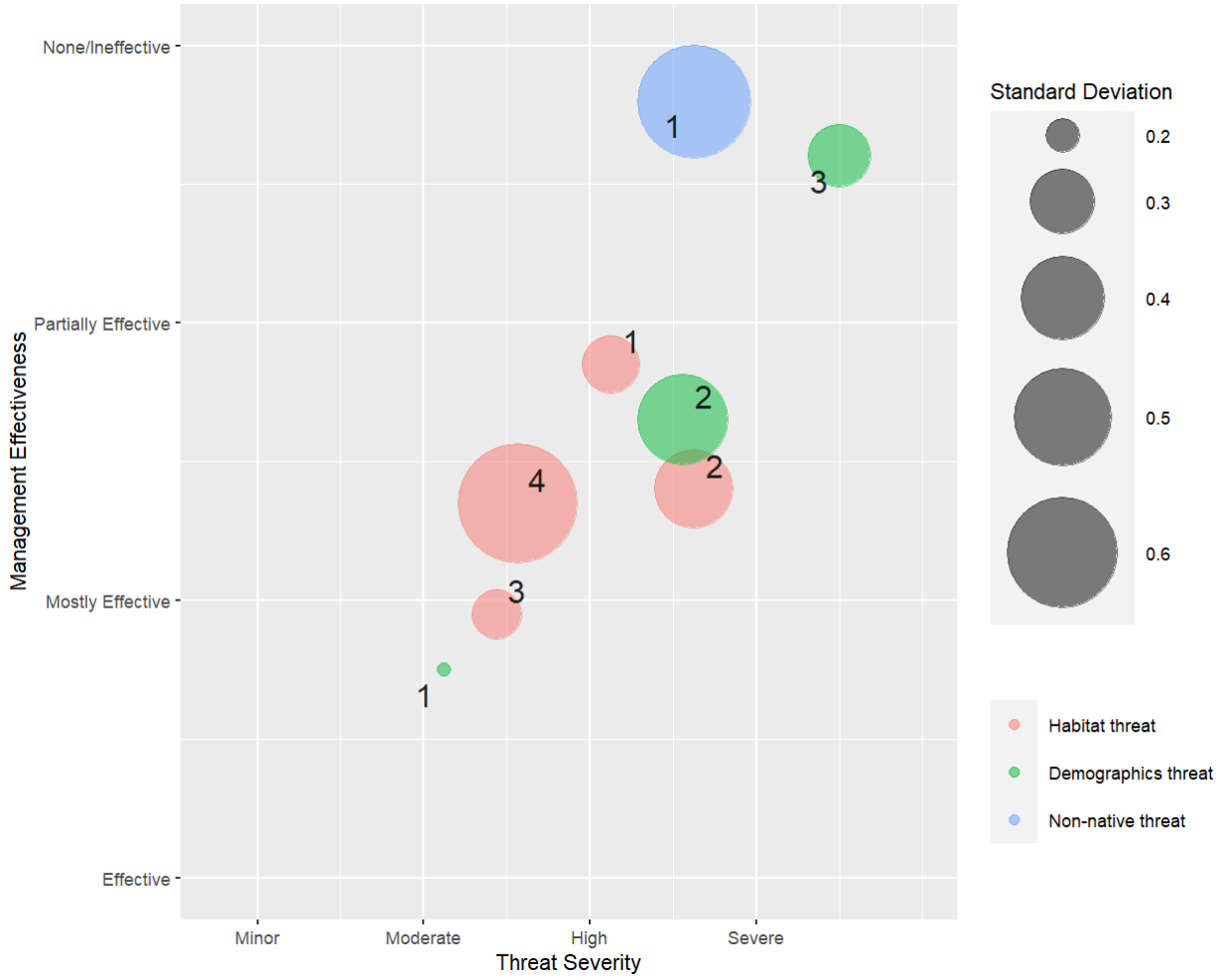
Nonnatives

Nonnative Fishes

(1) Brook trout are common on the west side of the drainage, and hybridization is well documented in some SR tributaries. Brown trout are common throughout the Bitterroot, including some of the SR reaches, and present a threat in the form of competition and possible predation. This is especially true on the east side in Sleeping Child. Northern pike pose a threat in the form of predation and, to a lesser extent, competition within the lower portions of the Bitterroot. Northern pike is present downstream of Stevensville, with more prevalence downstream of Florence.

CH04 – Blackfoot River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Agriculture/Transportation Infrastructure/Fire Suppression – legacy road systems and current land management practices (including fire suppression) have resulted in reduced habitat complexity (i.e., wood, primary pools, functioning floodplains). Legacy impacts of industrial forestry and extensive road networks on formerly private timber lands continue to affect bull trout in some FMO and SR streams.

Instream Impacts

- (2) Dewatering in the upper Blackfoot River mainstem FMO habitat and some tributaries contributes to seasonally high summer water temperatures, often aggravated by instream flow depletion. Dewatering of numerous reaches, collectively extending

over 100 miles of waterway, has been documented. Bull trout become isolated in pockets of thermal refugia at the confluence of a few cold-water tributaries, where they are very vulnerable to anglers and predators.

Water Quality

- (3) Contamination from mine runoff, from historical sources (e.g., Mike Horse Mine), is an ongoing threat to water quality, though water quality is slowly improving.

Recreation

- (4) Legacy and new recreational developments impact SR habitat (i.e., reduced riparian vegetation in sensitive area (spawning reaches) areas, and compacted stream banks).

Demographic

Connectivity Impairment

- (1) Entrainment (hydropower and diversions)/Fish Passage – entrainment occurs at all dams on the Clark Fork River, impeding migration, and causing altered movement from FMO areas to the SR tributaries in the Blackfoot River Core Area.

Fisheries Management

- (2) Angling/Targeting/Poaching – angling, intentional targeting, and perhaps poaching at well-known cold-water refugia and staging locations occur throughout the core area.

Small Population Size

- (3) Genetic/Demographic Stochasticity – many of the local populations in the core area are small and unstable or stable at very low numbers, some are functionally extirpated. Although all local populations were once supported by the migratory life history forms, the fluvial life history form has been greatly reduced and/or replaced with less resilient resident populations. Fire Suppression and Retardant Misapplications – due to the small size and isolated nature of the remaining populations, fire suppression and retardant misapplication strikes on SR tributaries have the potential to irreparably harm local populations.

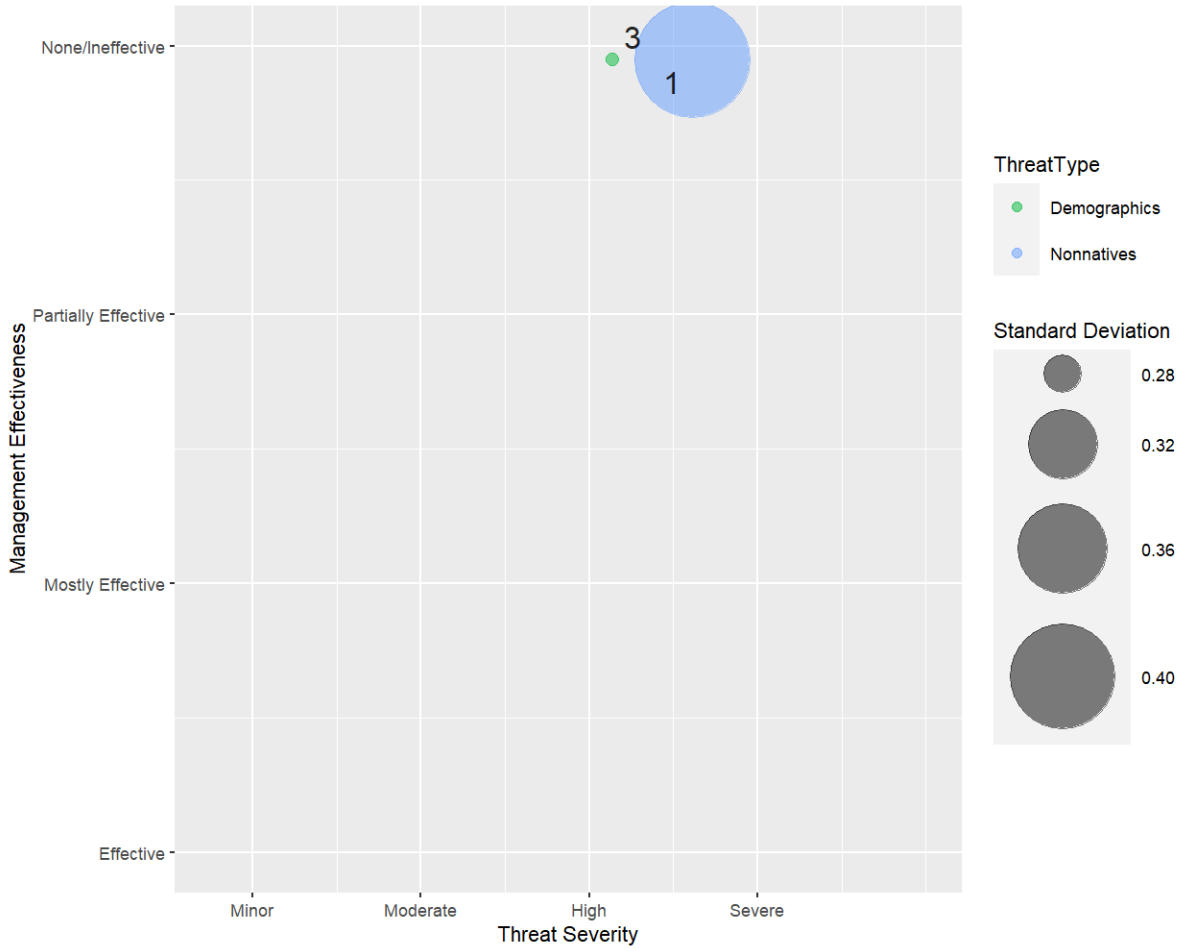
Nonnatives

Nonnative Fishes

- (1) Brook trout are ubiquitous in some SR tributaries and are especially problematic in those occupied by resident bull trout. Bull trout brook hybridization is well documented and may impact recovery. Brown trout populations are expanding. The expansion is likely the result of warming water temperatures making SR and FMO less suitable for bull trout. There is overlap with bull trout in FMO habitat throughout the core area. Brown trout are nonnative predators and, at times, competitors that may impact recovery. The long-term compatibility of brown trout and bull trout is not well understood.

CH05 – Bowman Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Small Population Size

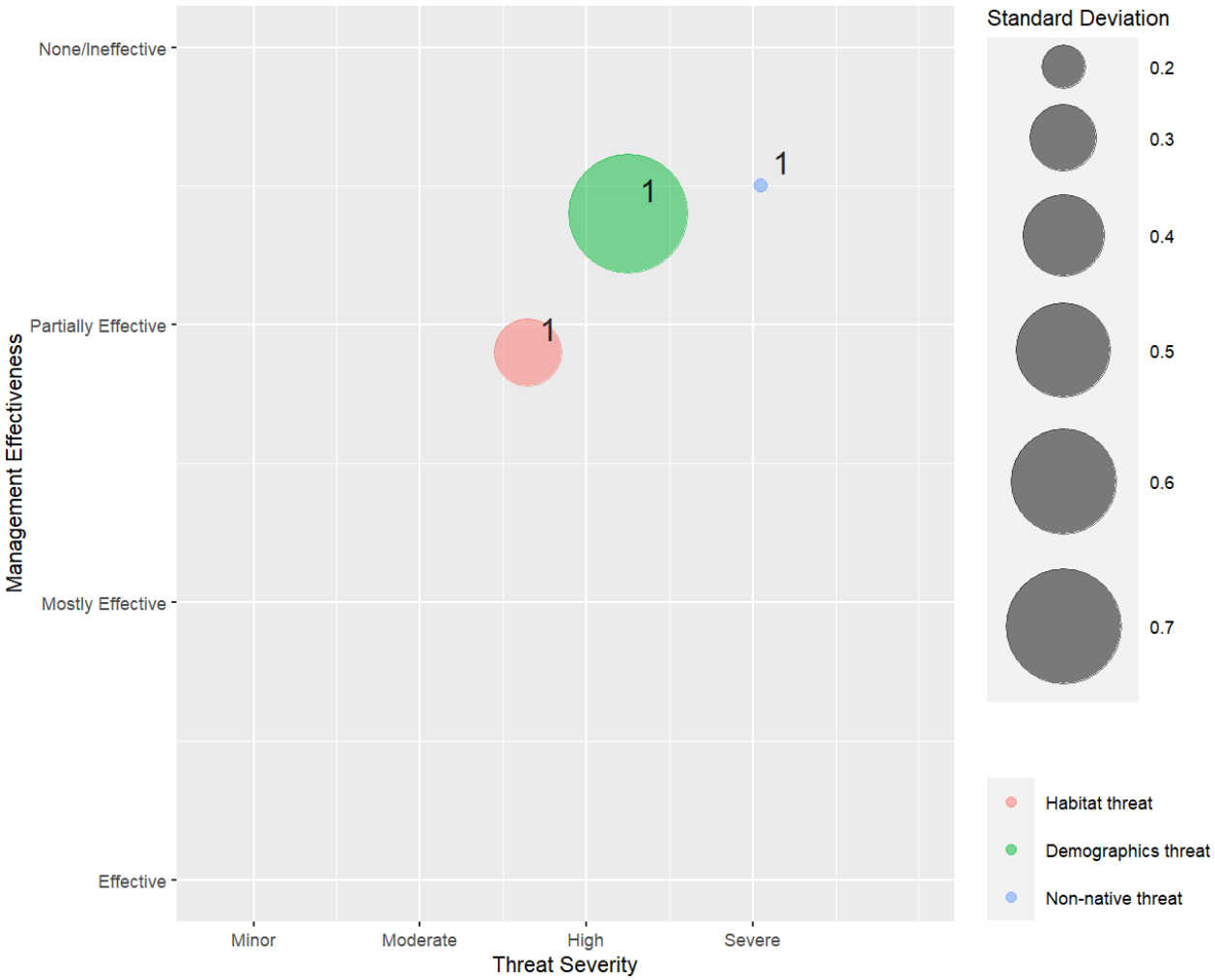
- (3) Single local population is remnant; may be smaller than what is sustainable/viable (i.e., low single digit redd count consecutively for over a decade). Spawning and rearing habitat is naturally unstable, and loss of individuals can be aggravated by increased angling facilitated by road and boating access.

Nonnatives
Nonnative Fishes

- (1) Lake trout invasion, within the past ~50 years, has led to seriously reduced bull trout population through unknown mechanisms of competition and/or predation.

CH06 – Bull Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Accessible high quality SR habitat is limited (in part naturally) and appears to be of declining quality in Keeler Creek due to limited gravel recruitment past management and beaver activity. The riparian zone has been impacted by forest practices and ongoing use and management of roads. Past land management in the Keeler Creek riparian area has led to an artificial increase in beaver activity, potentially resulting in upstream and downstream barriers.

Demographic
Connectivity Impairment

- (1) Single local population size lower than what may be sustainable or viable (i.e., formerly robust population is now reduced to low single digit redd, maintaining connectivity to SR is essential.

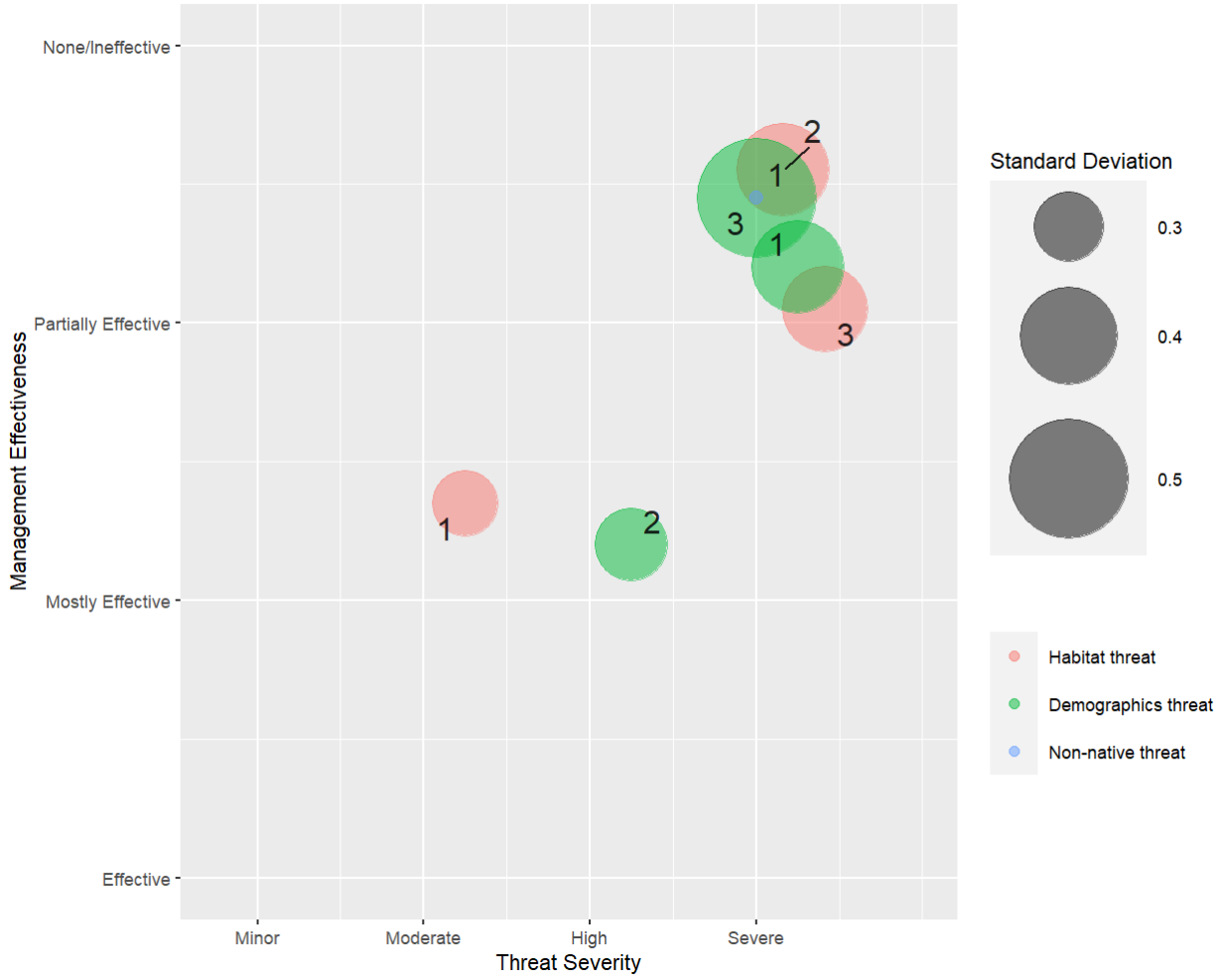
Nonnatives

Nonnative Fishes

- (1) FMO habitat (Bull Lake) is increasingly compromised by expanding populations of Northern pike. Other nonnatives including smallmouth bass and black crappie remain a concern. Brook trout are proliferating with some evidence of hybridization in the single SR tributary (Keeler Creek).

CH07 – Clark Fork River (Section 1, Upper) Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Forest practices (roads, sediment) and livestock grazing are causing riparian and instream degradation, loss of LWD, and pool reduction in FMO habitat and some SR habitat in tributaries. Transportation system impacting FMO habitat.

  Fire suppression activities – stream clearing, fire retardant drops, road recommissioning, fire break construction.

Instream Impacts

- (2) Transportation networks (e.g., I-90) have channelized and oversimplified the river channel, eliminating important wetlands and floodplain interaction, increasing water temperatures, and decreasing FMO complexity.

Water Quality

- (3) Agricultural practices (including irrigation) and residential developments reduce and fragment suitable habitat and migration corridors. Irrigation, industrial, and municipal uses result in further dewatering of some habitat. Runoff from mining in the early 20th century resulted in toxic conditions for aquatic species in large portions of the mainstem FMO habitat and some headwater tributaries due to concentrations of heavy metals and other contaminants. Low water quality is still affecting bull trout in some areas, though it is slowly improving. Water temperature in the mainstem FMO habitat and lower reaches of most tributaries is unsuitable for bull trout survival in the summer. The elevated water temperatures are often exacerbated by instream flow depletion for human uses. Temperatures are marginal in upper portions of tributaries, and seasonally unsuitable in mainstem Clark Fork River and lower ends of tributaries, including lower Warm Springs Creek. Warm Springs ponds operations impact water quality (i.e., pH, water quantity, water temperature, ammonia and COCs). Evaporative loss affects water quantity.

Demographic
Connectivity Impairment

- (1) Fragmentation of tributary SR habitat, as well as mainstem Clark Fork River FMO habitat, by dams and diversions combined with major loss of bull trout distribution in occupied tributaries, are limiting recovery potential, even if other threats are resolved. This threat is aggravated by dewatering and entrainment in irrigation systems, especially in lower reaches of tributaries.

Fisheries Management

- (2) Barrier Maintenance – maintained to be beneficial to bull trout and detrimental to lake trout, brown trout, and brook trout.

Small Population Size

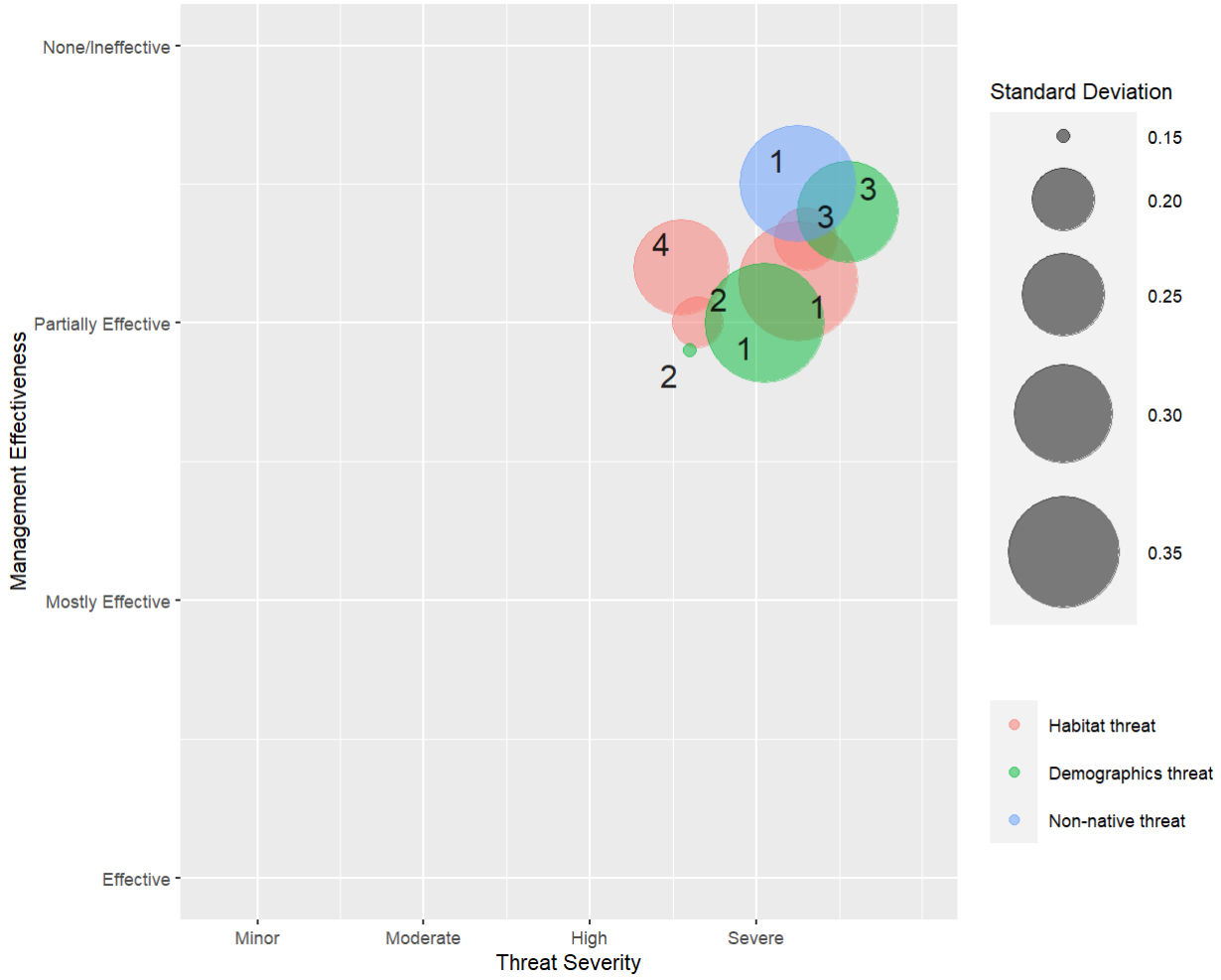
- (3) Few populations and few individuals; most robust populations face threats from isolation. Enhance migratory populations for conservation.

Nonnatives
Nonnative Fishes

- (1) Brook trout are abundant, and high rates of hybridization with bull trout have been documented in some SR tributaries (e.g., Warm Springs Creek). Brown trout populations are expanding. The expansion is likely the result of warming water temperatures making SR and FMO less suitable for bull trout. There is overlap with bull trout in FMO habitat throughout the core area. Brown trout are nonnative predators and at times competitors that may impact recovery. The long-term compatibility of brown trout and bull trout is not well understood.

CH08 – Clark Fork River (Section 2, Middle) Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Agriculture/Transportation Infrastructure/Fire Suppression – legacy road systems and current land management practices have resulted in reduced habitat complexity (i.e., wood, primary pools, functioning floodplains). Legacy impacts of industrial forestry and extensive road networks on formerly private timber lands continue to affect bull trout. Legacy and current fire suppression activities have resulted in damage to riparian area habitat in some FMO and SR streams.

Instream Impacts

- (2) Historic placer mining significantly changed stream hydrology, created sediment sources and caused passage issues in some SR tributaries (e.g., Cedar Creek) and the effects are still felt today.

Water Quality

- (3) Dewatering – water temperatures in mainstem FMO habitat and lower reaches of most tributaries are marginally high for bull trout survival in the summer, and conditions are worsening. This concentrates bull trout in isolated pockets at the mouths of cold-water tributaries where they are highly vulnerable to anglers and predators. Fire suppression/retardant misapplications. Retardant misapplication strikes SR tributaries have resulted in impairment of water quality. Fire suppression activities are reasonably certain to increase in scale and frequency in a warming climate.

Recreation

- (4) Legacy and new recreational developments impact SR habitat (i.e., rock dam building, reduced riparian areas, and compacted stream banks) and reduce habitat complexity.

Demographic
Connectivity Impairment

- (1) Entrainment (hydropower and diversions)/Fish Passage – entrainment occurs at all dams on the Clark Fork River, fish passage is impeded, causing altered movement from FMO areas to SR tributaries.

Fisheries Management

- (2) Angling/Targeting/Poaching – angling, intentional targeting, and perhaps poaching at well-known cold-water refugia, and staging locations occurs throughout the core area.

Small Population Size

- (3) Genetic/Demographic Stochasticity – all of the local populations in the core area are small and unstable or stable at very low numbers, some are functionally extirpated. Although all local populations were once supported by the migratory life history forms, the fluvial life history form been greatly reduced and/or replaced with less resilient resident populations in all but two populations (Fish and Rattlesnake Creeks).

  Fire Suppression and Retardant Misapplications – due to the small size and isolated nature of the remaining populations, fire suppression and retardant misapplication strikes on SR tributaries have the potential to irreparably harm local populations.

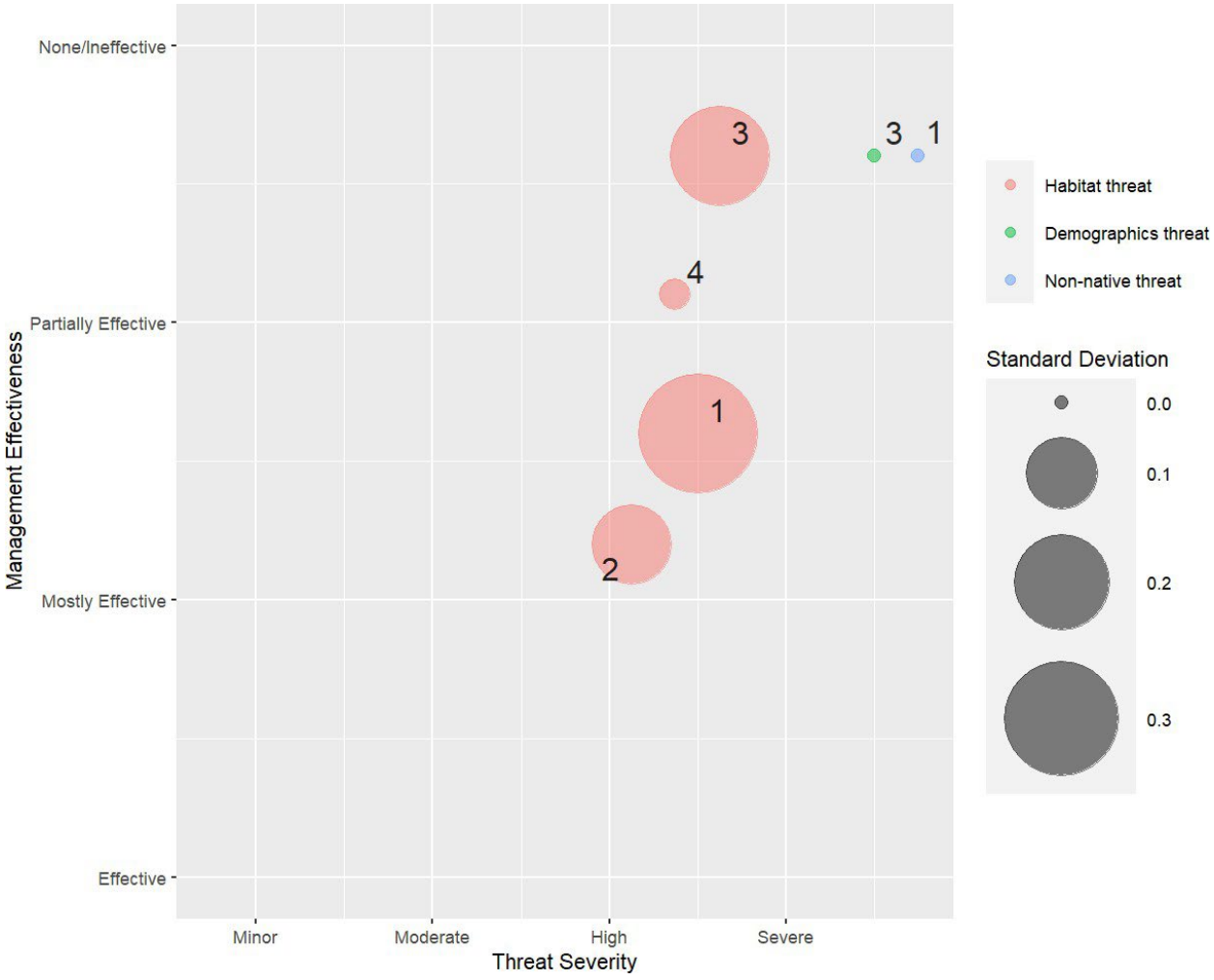
Nonnatives
Nonnative Fishes

- (1) Brook trout are ubiquitous in some SR tributaries and are especially problematic in those occupied by resident bull trout. Bull trout brook hybridization is well documented and may impact recovery.

  Brown trout populations are expanding. The expansion is likely the result of warming water temperatures making SR and FMO less suitable for bull trout. There is overlap with bull trout in FMO habitat throughout the core area. Brown trout are nonnative predators and at times competitors that may impact recovery. The long-term compatibility of brown trout and bull trout is not well understood. Northern pike are nonnative predators, and competitors in the core area and may impact recovery. Northern pike overlap bull trout in limited areas within the core area (e.g., backwater areas).

CH09 – Clearwater River & Lakes Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Agriculture/Transportation Infrastructure/Fire Suppression – legacy road systems and current land management practices (including fire suppression) have resulted in reduced habitat complexity (i.e., wood, primary pools, functioning floodplains). Legacy impacts of industrial forestry and extensive road networks on formerly private timber lands continue to affect bull trout in some FMO and SR streams.

Instream Impacts

- (2) Connectivity Impairments – dewatering mainstem FMO habitats as a result of residential development affects water levels in the lakes and connectivity between lakes. User-built dams are impacting connectivity in FMO.

Water Quality

- (3) Residential development is impacting overall water quality and quantity. Increased nutrification and algal blooms are a growing concern in Salomon, Seeley, and Placid Lakes. Changes in water quantity are affecting connectivity between FMO and SR.

Recreation

- (4) Legacy and new recreational developments reduce or limit habitat complexity, increase water temperatures and sediment loading, and reduce wood recruitment in some important SR reaches. Impacts may also include increased angling pressure.

Demographic

Small Population Size

- (3) Genetic/Demographic Stochasticity – many of the local populations in the core area are small and unstable or stable at very low numbers, some are functionally extirpated. Although all local populations were once supported by the migratory life history forms, the adfluvial life history form has been greatly reduced and/or replaced with less resilient resident populations. Fire Suppression and Retardant Misapplications – due to the small size and isolated nature of the remaining populations, fire suppression and retardant misapplication strikes on SR tributaries have the potential to irreparably harm local populations.

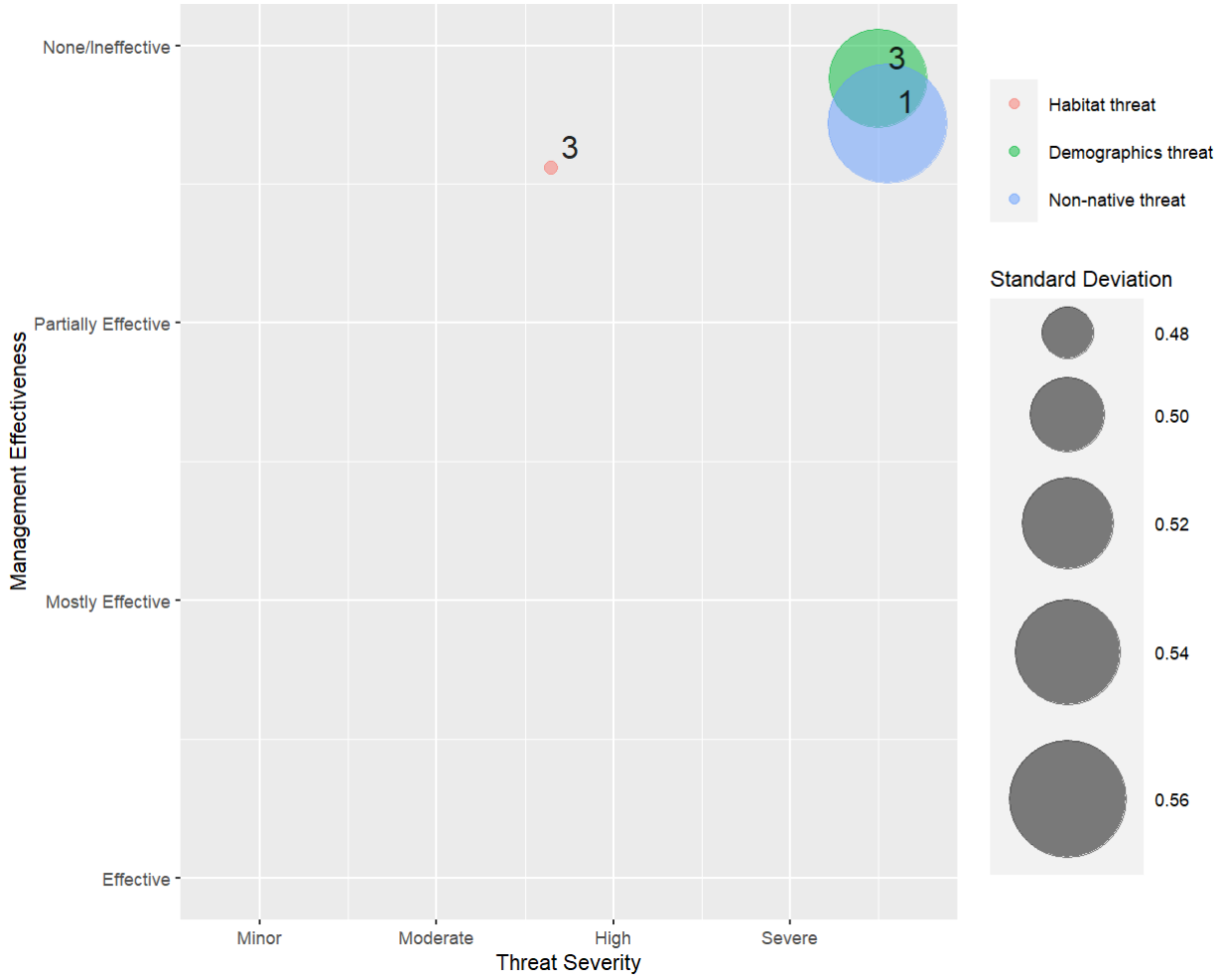
Nonnatives

Nonnative Fishes

- (1) Brook trout are ubiquitous in all but the coldest SR tributaries. Bull trout brook hybridization is well documented and may impact recovery. Brown trout populations are expanding. The expansion is likely the result of warming water temperatures making SR and FMO less suitable for bull trout. There is overlap with bull trout in FMO habitat throughout the core area. Brown trout are nonnative predators and, at times, competitors that may impact recovery. The long-term compatibility of brown trout and bull trout is not well understood. Northern pike are nonnative predators and competitors in the core area and may impact recovery. Northern pike overlap bull trout in FMO habitats. Other nonnatives including smallmouth bass, mussels, and aquatic plants are a concern.

CH10 – Coeur d'Alene Lake A Core Area

Threats Assessment Results



Threats Summary

Habitat
Water Quality

- (3) Poor water quality in the mainstem Coeur d'Alene River FMO habitat (temperature, metals, oxygen) and in the St. Joe River FMO habitat (temperature and low levels of DO) impacts migratory capability. This combines with some habitat limitations (loss of pools and instream cover) to create relatively hostile conditions in the migratory corridor.

Demographic
Small Population Size

- (3) Low population size and lack of replication of stable populations in the St. Joe River (no bull trout remain in the Coeur d'Alene River system) limit recovery potential, despite a relatively expansive FMO habitat in Coeur D'Alene Lake.

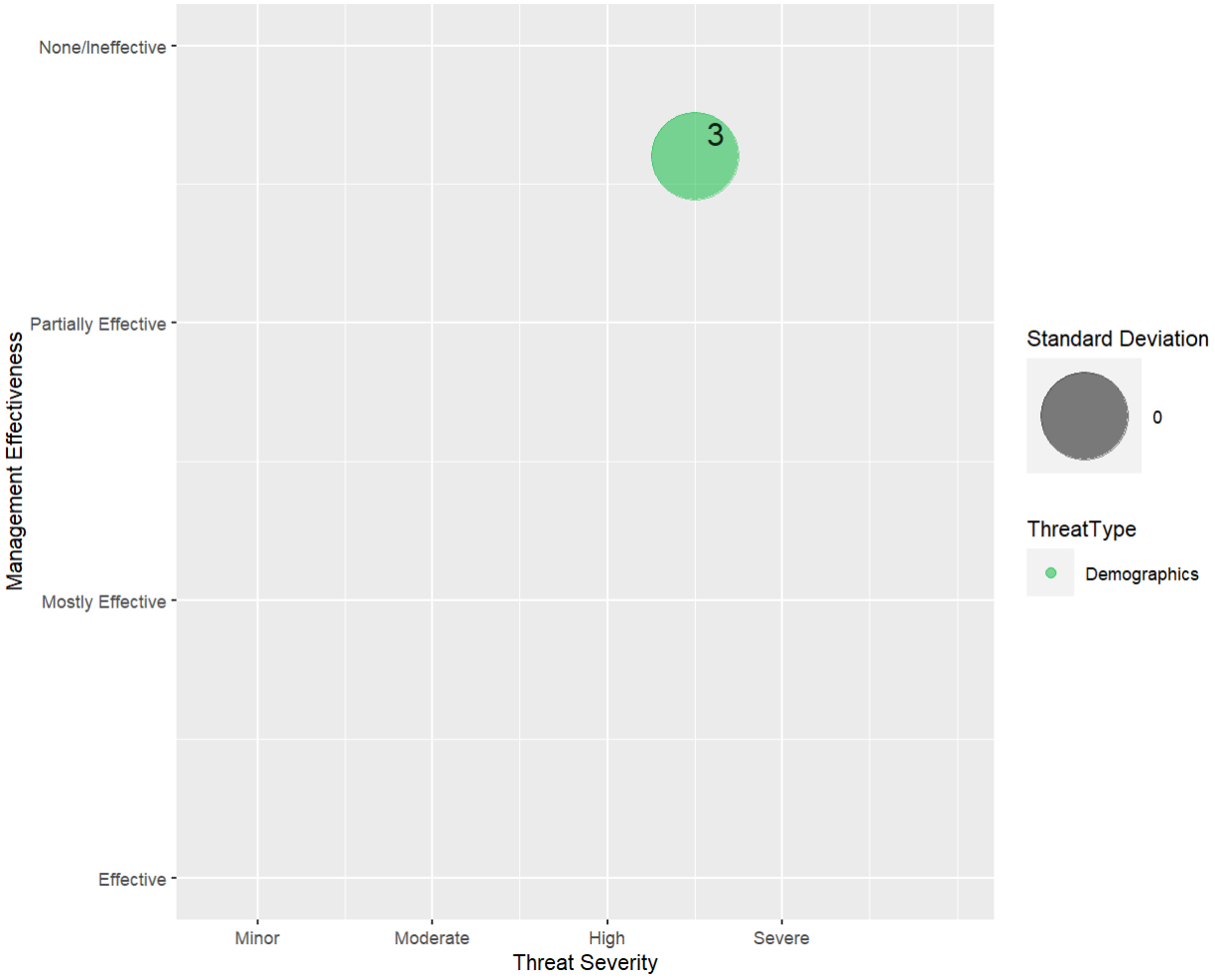
Nonnatives

Nonnative Fishes

- (1) Northern pike, smallmouth bass, and possibly Chinook salmon in FMO habitat (lake and mainstem migratory corridor) are relatively certain to be limiting survival of juvenile/subadult migratory bull trout.

CH12 – Cyclone Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Small Population Size

- (3) Population size is naturally limited due to size of core area, relatively warm and shallow FMO habitat in the lake, and limited SR habitat, but lower than what may be sustainable or viable. May be aggravated by direct take from angling, facilitated by road accessibility.

CH13 – Doctor Lake Core Area

Threats Assessment Results

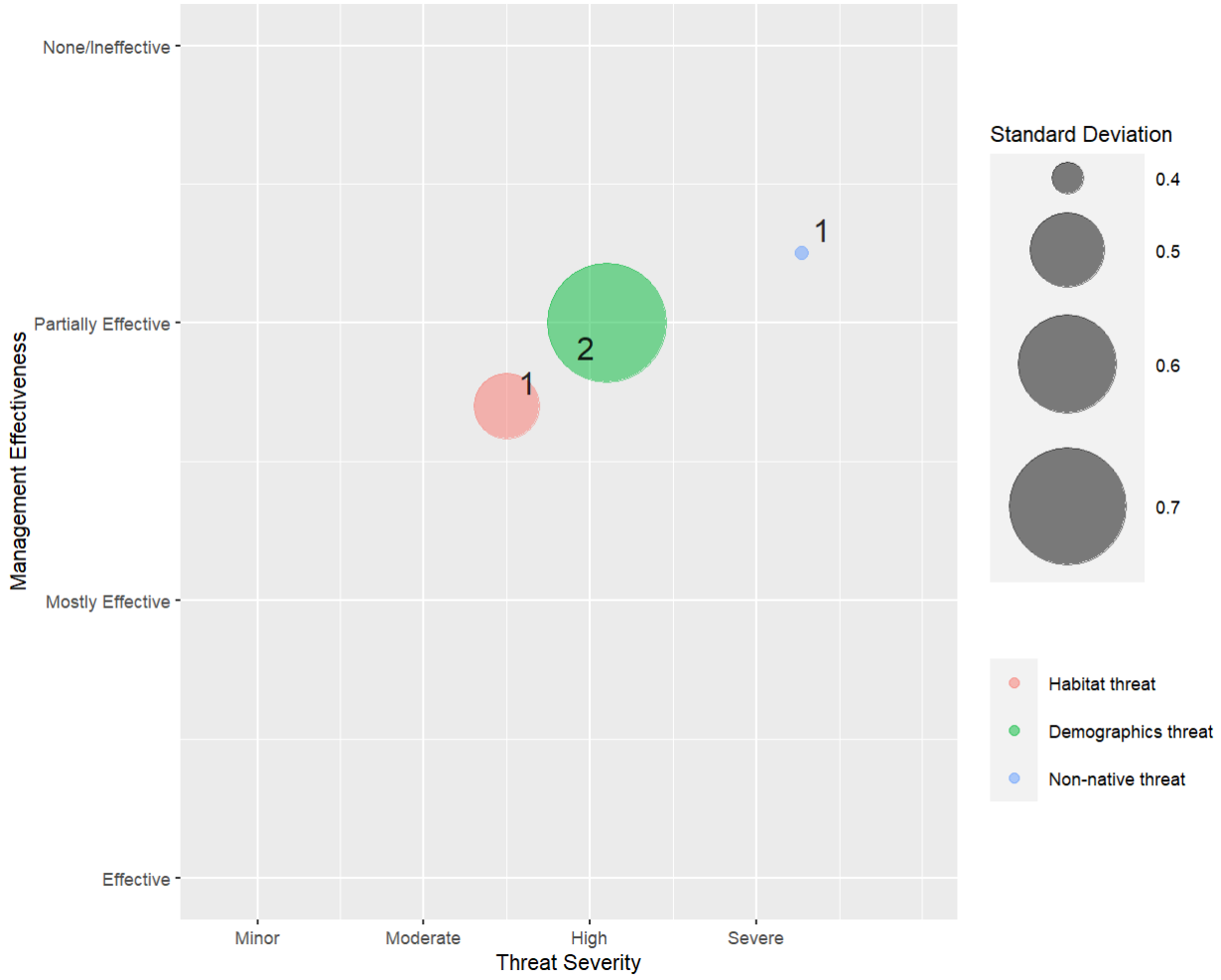
NA

Threats Summary

NA

CH14 – Flathead Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Rural and urban development, roads, and other land management actions have reduced riparian habitats and floodplains. Urban development in FMO habitat and watershed resilience supporting SR habitat are of particular concern. Water quality is still a concern in listed water bodies.

Demographic
Fisheries Management

- (2) Loss of bull trout from angling bycatch mortality (combined Flathead Lake and River system) and occasional poaching contributes to the low populations in this system. Low population size (single digit redd counts) is a concern in some SR

tributaries, especially in recent years in the North Fork Flathead SR streams. Sampling mortality of bull trout due to gillnetting for lake trout suppression in Flathead Lake may directly impact potential recruitment and reduce local populations.

Nonnatives
Nonnative Fishes

(3.1. Nonnative: Nonnative Fishes

(1) In the 1980's, the nonnative lake trout expanded in the Flathead Lake and mainstem Flathead River FMO habitat, triggered by the *Mysis* introduction (now estimated 1+ million lake trout population). Concurrently, the complete collapse of the formerly abundant kokanee forage base for lake trout resulted in a substantial increase in predation of bull trout and competition for other foods. This combination of effects likely caused the subsequent rapid decline in bull trout, demonstrated by a 75 percent decline in redd counts from the 1980's levels. Partial recovery of bull trout occurred in the 2000s (to approximately one half of the 1980's levels) but gains have stagnated and are fluctuating below conservation objectives. Nonnative lake trout predation and competition remains a substantial threat to bull trout in this system. Predation from nonnative Northern pike (possibly smallmouth bass) in the mainstem Flathead River is a documented threat.

CH15 – Frozen Lake Core Area

Threats Assessment Results

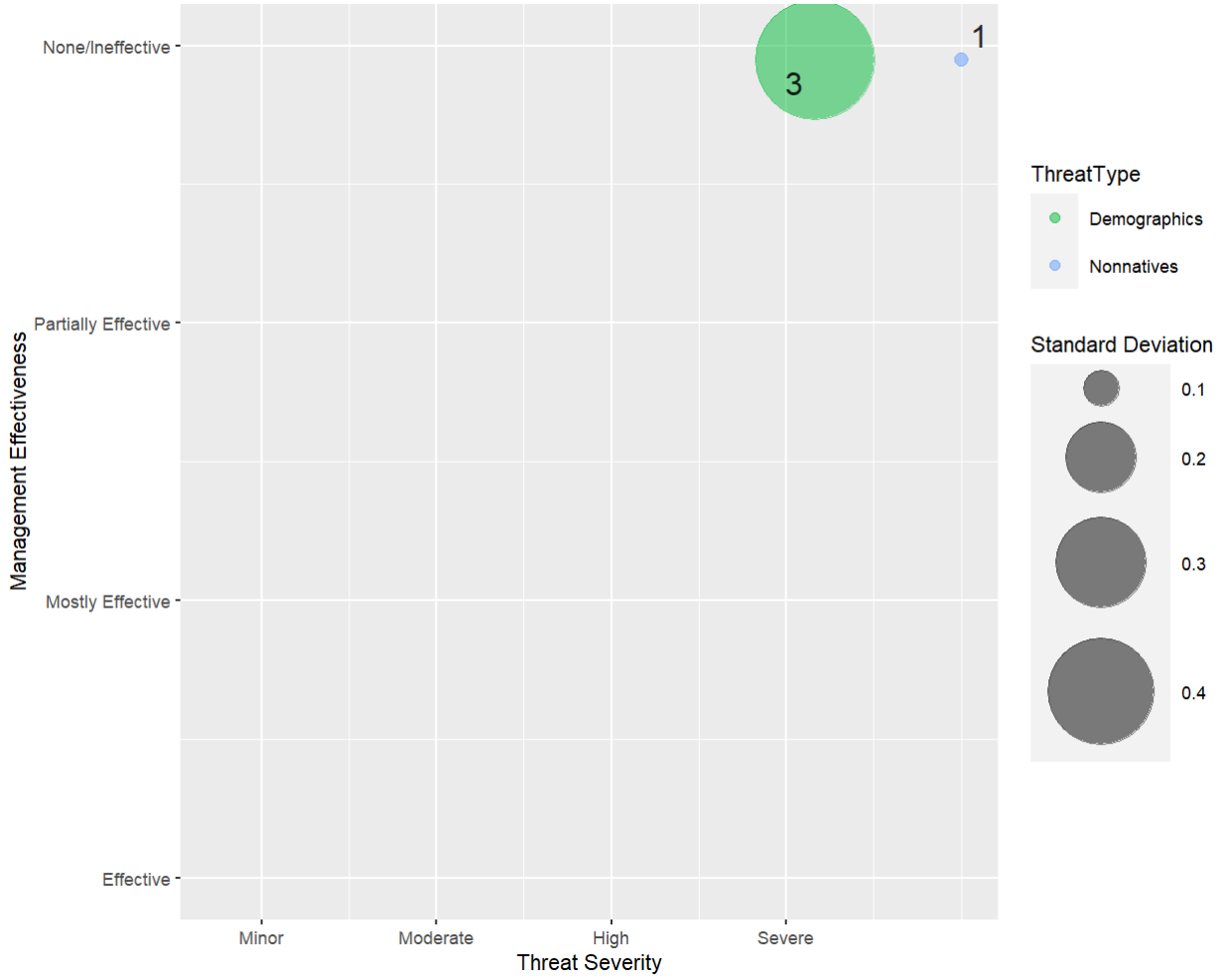
NA

Threats Summary

NA

CH16 – Harrison Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Small Population Size

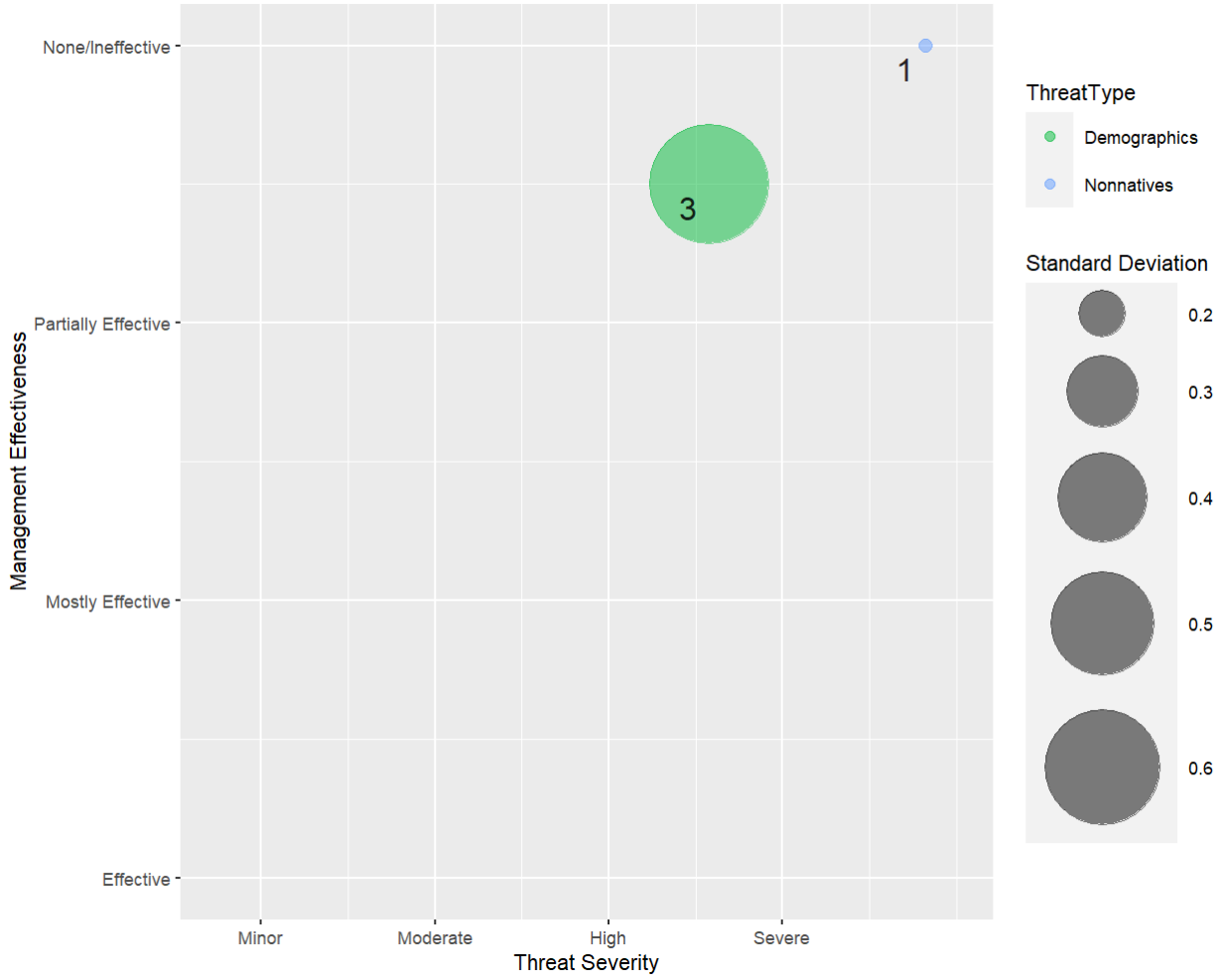
- (3) Genetic and Demographic Stochasticity – single local population size lower than what may be sustainable or viable (i.e., formerly robust population is now zero to single digit redd counts, possibly extirpated). Nonnative fish species are the primary driver for low population size.

Nonnatives
Nonnative Fishes

- (1) Hybridization – lake trout invasion within the past ~30 years has seriously reduced bull trout population through unknown mechanisms of competition and/or predation. Documented hybridization with brook trout continues to reduce bull trout fitness.

CH17 – Holland Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Small Population Size

- (1) Genetic and Demographic Stochasticity – Population size is naturally limited due to size of core area and extremely limited and unstable SR habitat. Redd counts averaged in the teens to low 20s prior to 2000, typically in single digits since. May not remain sustainable or viable in face of nonnative lake trout pressure. Low numbers aggravated by bycatch mortality due to high angler use.

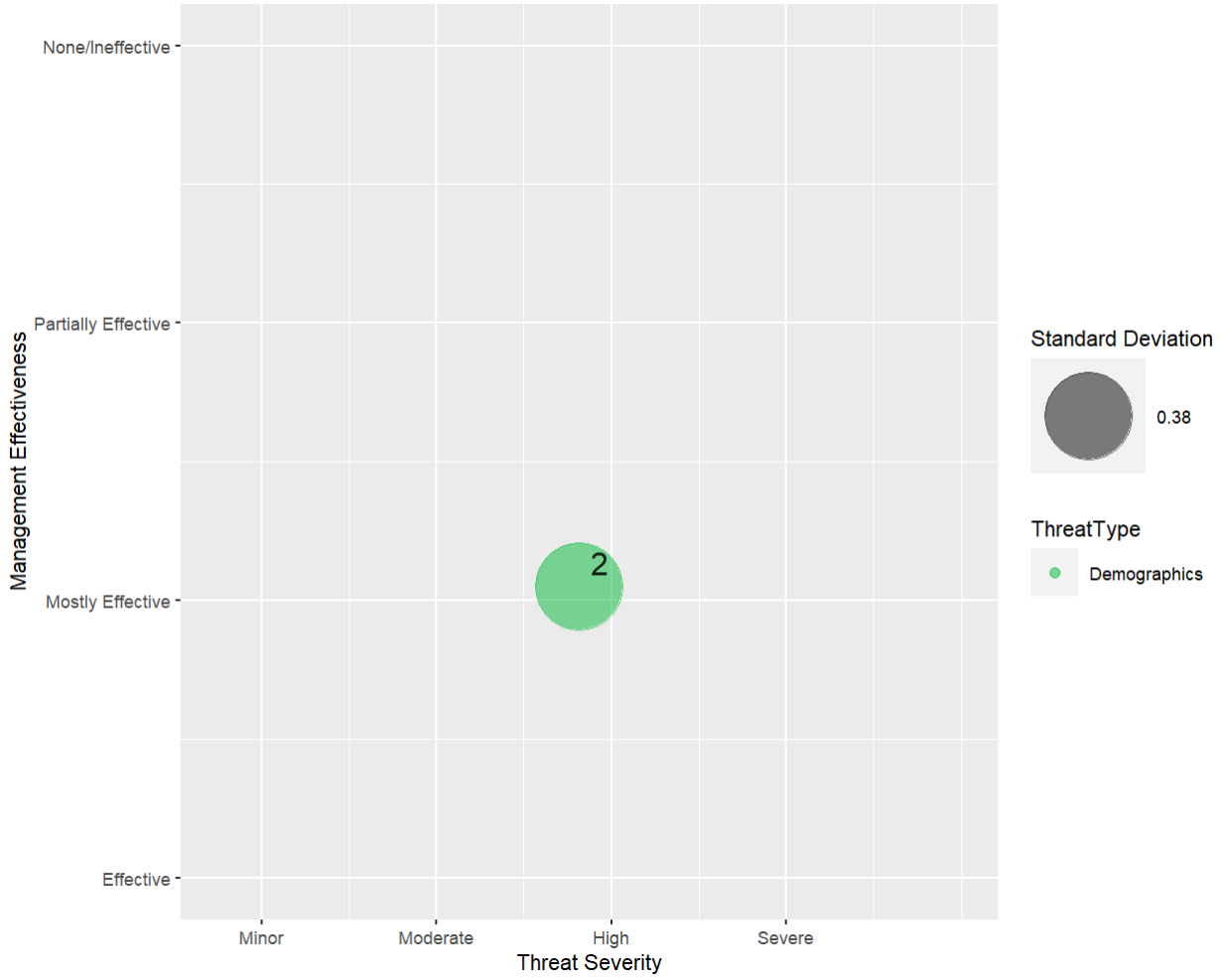
Nonnatives
Nonnative Fishes

- (3) Hybridization/Predation/Competition – lake trout are established in FMO habitat, ostensibly through upstream migration from Swan Lake, with rising predation and competition anticipated.

  Brook trout population is well established in most of SR habitat.

CH18 – Hungry Horse Reservoir Core Area

Threats Assessment Results



Threats Summary

Demographic
Fisheries Management

- (2) Increased recreational pressure is increasing the number of bull trout being handled and possibly handling-related mortality.

CH19 – Isabel Lakes Core Area

Threats Assessment Results

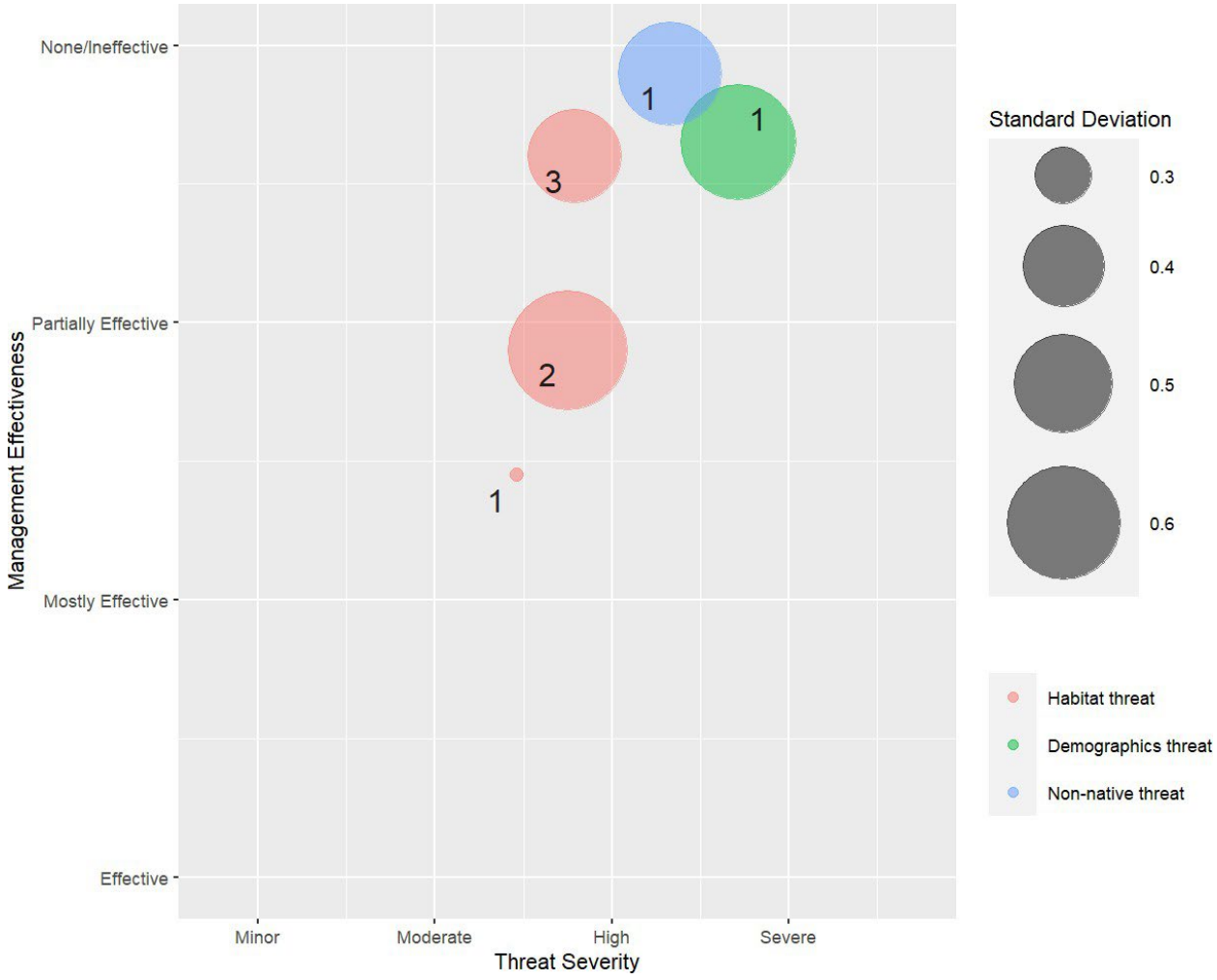
NA

Threats Summary

NA

CH20 – Kootenai River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Forest practices and the ongoing use and management of roads and transportation corridors are impacting most SR tributaries by causing riparian and instream degradation, loss of LWD, and pool reduction.

Instream Impacts

- (2) Mainstem habitat (FMO in a regulated river) downstream of Libby Dam is affected by lack of flushing flows, gas supersaturation (seasonally and sporadically), erratic instream flow patterns and recent *Didymo* blooms.

Water Quality

- (3) Recent changes in selenium and nitrate from mines in Canada have the potential to impact food webs and bull trout reproduction. Reservoir acts as a phosphorous sink limiting productivity in the Kootenai River.

Demographic
Connectivity Impairment

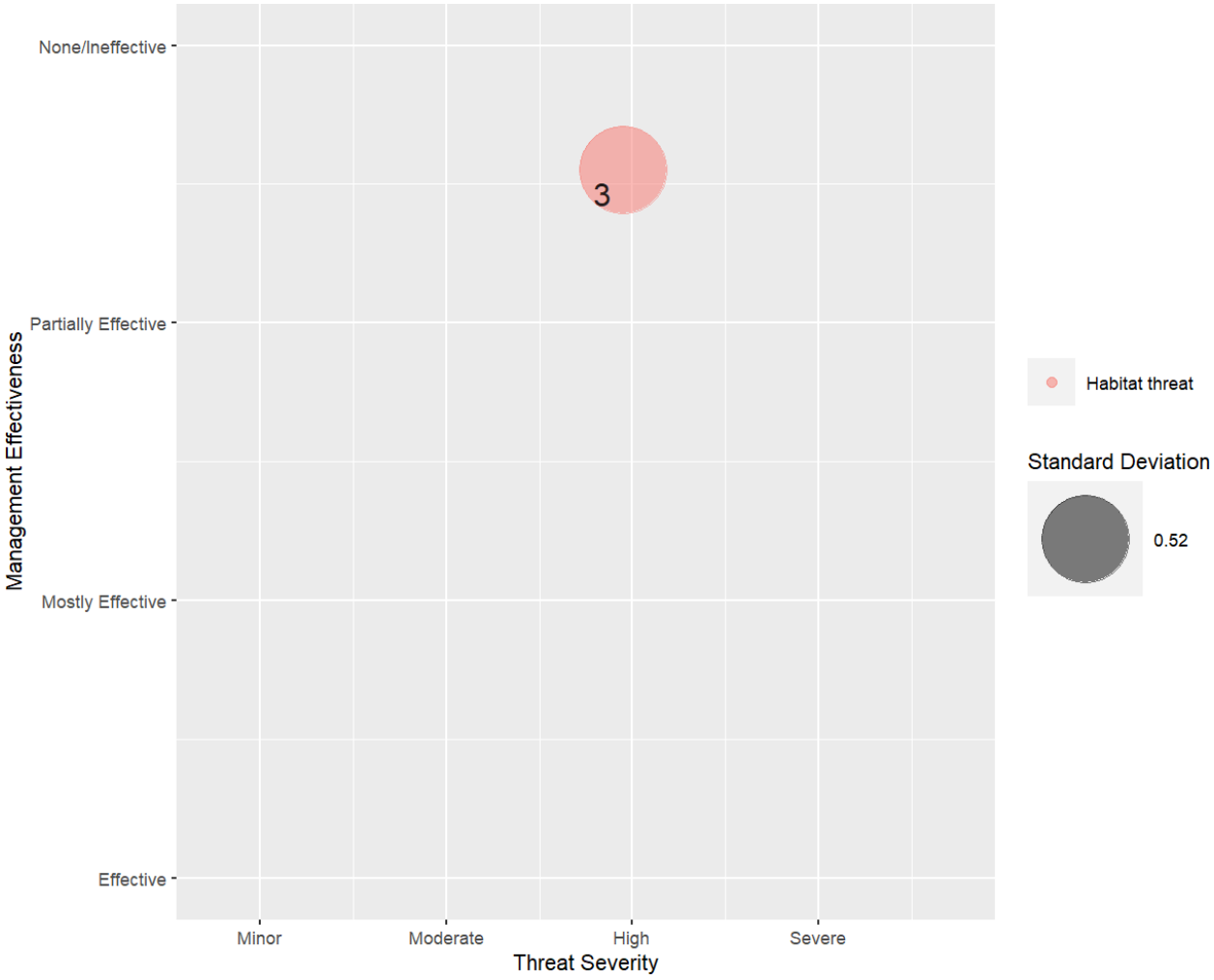
- (1) Genetic/Demographic Stochasticity – all of the local populations in the core area are small and unstable or functionally extirpated. Although all local populations were once supported by the migratory life history forms, the fluvial life history form been greatly reduced. Increased angling pressure immediately below dam is a concern.

Nonnatives
Nonnative Fishes

- (1) Brook trout proliferate with high rates of hybridization in some SR tributaries (e.g., O'Brien Creek, Pipe, and West Fisher).

CH21 – Lake Koocanusa Core Area

Threats Assessment Results



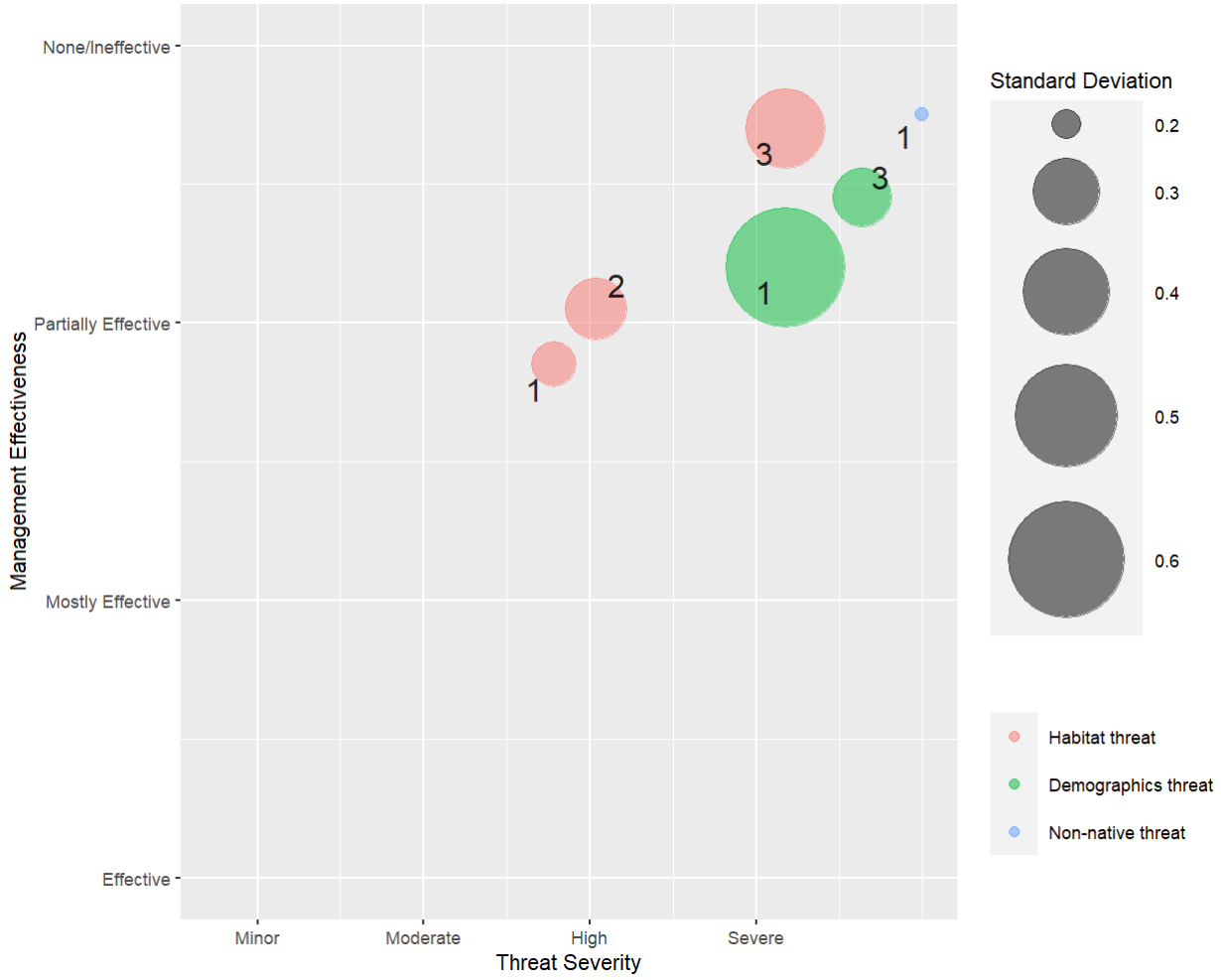
Threats Summary

Habitat
Water Quality

- (3) Recent changes in selenium and nitrate from mining operations in Canada have the potential to impact food webs in FMO habitat.

CH22 – Lake Pend Oreille A Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Forest Management/Transportation Infrastructure/Fire Suppression – legacy road systems and current land management practices (including fire suppression activities/salvage) have resulted in reduced habitat complexity (i.e., wood recruitment, functioning floodplains). Legacy impacts of industrial forestry and extensive road networks on formerly private timber lands continue to affect bull trout. Fire suppression activities have resulted in damage to riparian area habitat in some FMO and SR streams.

Instream Impacts

- (2) Transportation and utility corridors along riparian areas contribute to degradation through the loss of LWD, pool reduction, and increased sedimentation in some SR tributaries (e.g., Thompson River and Prospect Creek). Past placer mining, as well as active and proposed mines (e.g., East Fork Bull River, Vermilion River, Rock Creek) affect hydrology, increase sediment, and cause passage issues for bull trout.

Water Quality

(3) Water temperatures in mainstem FMO habitat in Cabinet Gorge, Noxon Rapids, Thompson Falls Reservoirs and lower reaches of most tributaries are marginally high for bull trout survival in the summer, and conditions are worsening. This concentrates bull trout in isolated pockets of cold water at the mouths of cold-water tributaries where they are highly vulnerable to anglers and predators. Flow modification affects water temperatures and sedimentation due to stream flow management and return flows from irrigation (Flathead River/Jocko River).

Demographic

Connectivity Impairment

- (1) The FMO and SR habitat is fragmented by large mainstem dams and small tributary barriers leading to low population size and risk of extirpation on now SR habitat. Bull trout are currently trucked and transported upstream at Cabinet Gorge and Noxon Rapids Dams on the Clark Fork River. Improved connectivity is necessary to remediate the effects of this fragmentation and enhance persistence of bull trout in isolated upstream SR habitat in Montana. A reduction in connectivity and increased competition with nonnatives may also occur from beaver dam construction (East Fork Bull River, Fishtrap Creek).

Small Population Size

- (3) Genetic/Demographic Stochasticity – many of the local populations in the core area are small and unstable or stable at very low numbers; some are functionally extirpated. Although all local populations were once supported by the migratory life history forms, the fluvial life history form has been greatly reduced.

Nonnatives

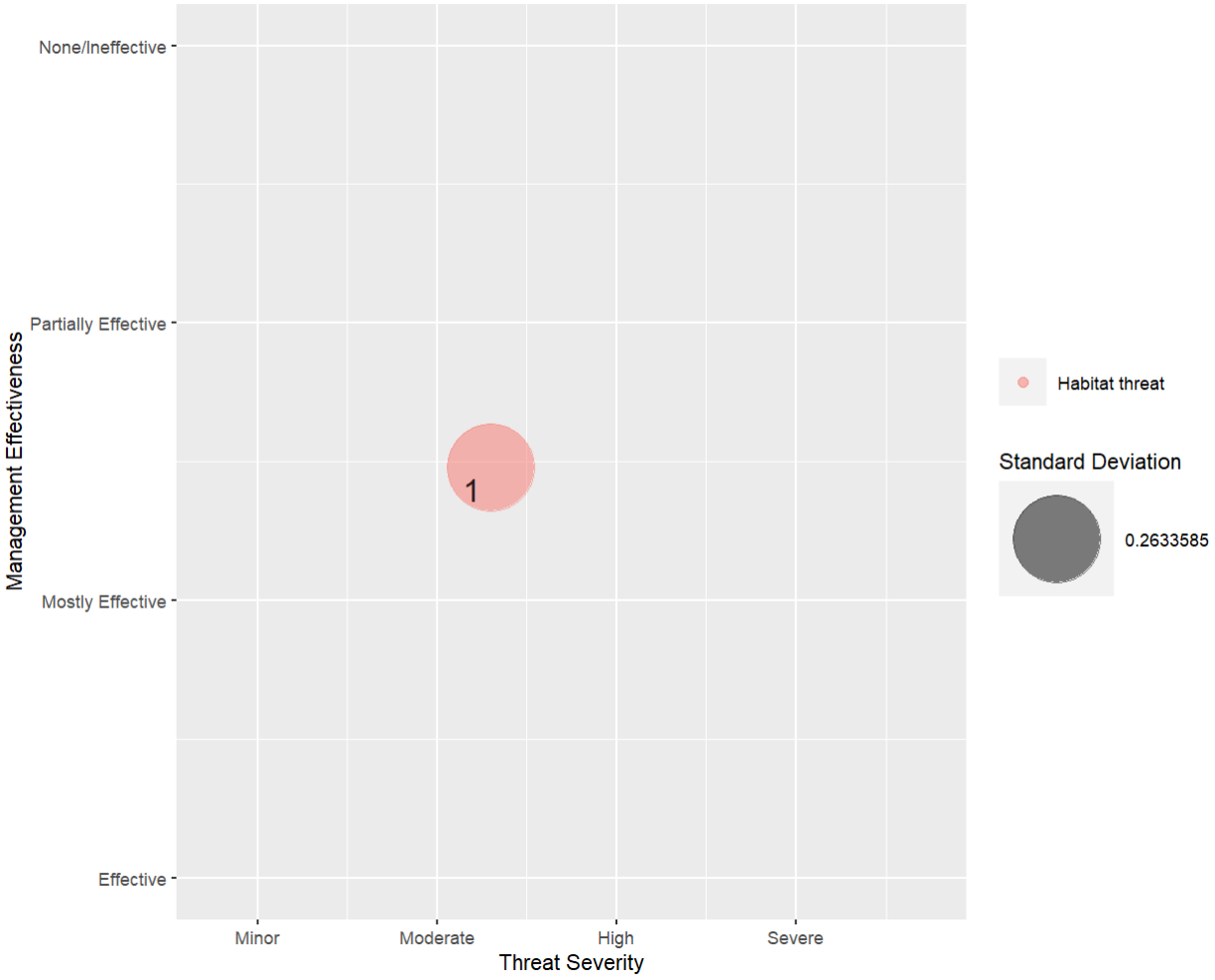
Nonnative Fishes

(1) Brook trout are ubiquitous in some SR tributaries (e.g., St. Regis River drainage, Rattlesnake Creek), and are especially problematic in those occupied by resident bull trout. Hybridization is well documented. Brown trout populations are expanding and overlap bull trout in both SR and FMO habitat throughout the core area. The expansion is likely exacerbated by warming water temperatures. Brown trout are nonnative predators and, at times, competitors in the core area and will likely impact recovery. The long-term compatibility of brown trout and bull trout is not well understood. Nonnative lake trout, smallmouth and largemouth bass, walleye (recent), Northern pike, and brown trout occupy the artificial reservoir habitat (FMO) in Cabinet Gorge, Noxon Rapids, and Thompson Falls Reservoirs. All are highly

piscivorous species. They may prey on bull trout to varying degrees (especially migrating juveniles).

CH23 – Lake Pend Oreille B Core Area

Threats Assessment Results



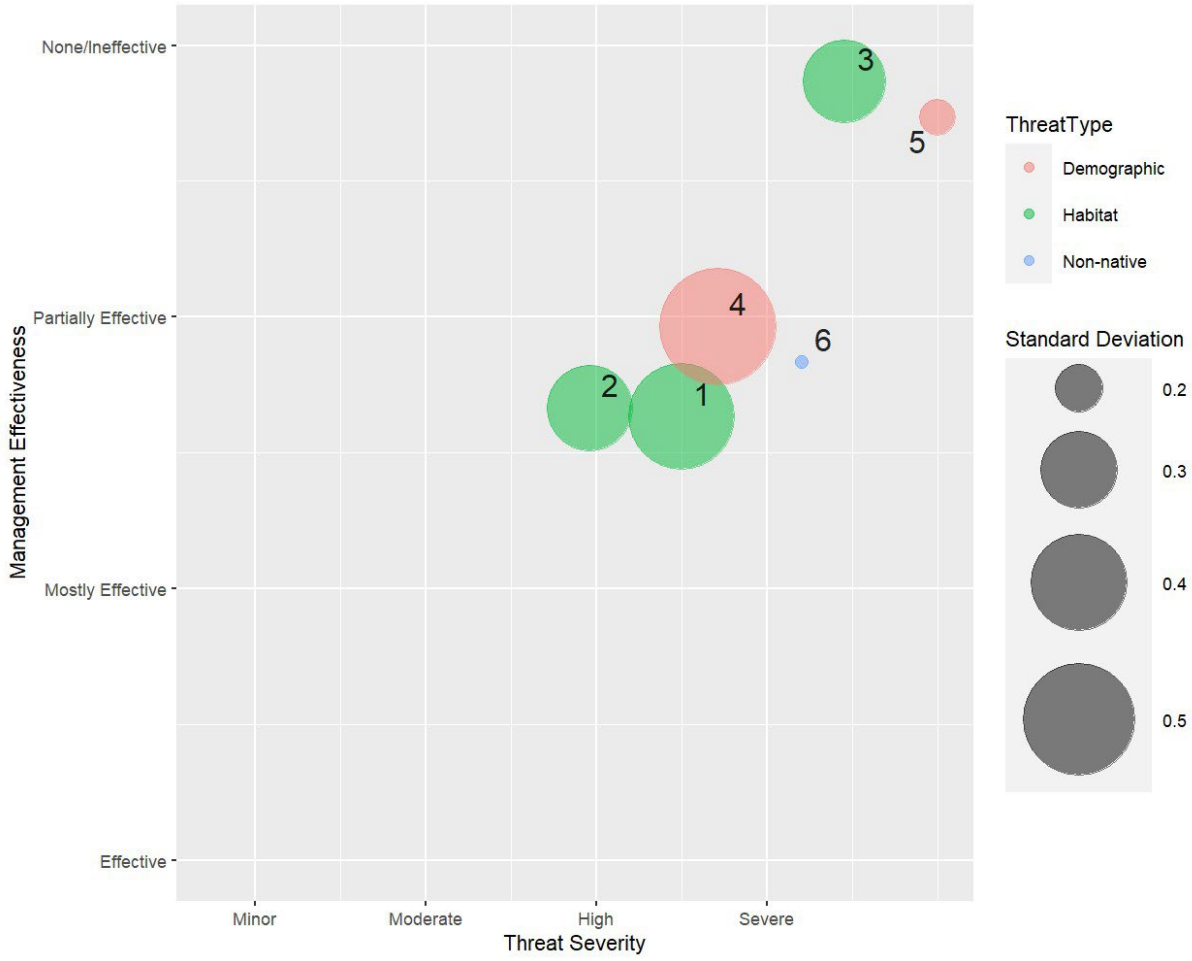
Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy impacts from forest roads, logging, and fires increase sediment and cause riparian and instream degradation, loss of LWD, and pool reduction in FMO habitat and some SR tributaries (e.g., Lightning and Grouse Creeks and Pack River).

CH24 – Lake Pend Oreille C Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Sediment from forest roads, logging, and livestock grazing cause riparian and instream degradation, loss of LWD, and pool reduction in FMO habitat and most SR tributaries downstream of Albeni Falls Dam (e.g., LeClerc, Calispell, and Tacoma Creeks).

Instream Impacts

- (2) Transportation, flood control, and utility corridors along riparian areas contribute to degradation through the loss of LWD, pool reduction, and increased sedimentation in some SR tributaries (e.g., Sullivan, Creek, Calispell, and Tacoma Creeks).

  Historic placer mining significantly changed the hydrology, created sediment sources, and caused passage issues (e.g., Sullivan Creek), and the effects are still felt today.

Water Quality

- (3) Water temperatures in mainstem FMO habitat (lower Pend Oreille River and run-of-the-river reservoirs), and lower reaches of most tributaries are marginally high for bull trout survival in the summer, and conditions are worsening. Artificial pools created by operation of Albeni Falls, Box Canyon, and Boundary Dams warm and perpetuate high water temperatures in summer, delaying or hindering movement of bull trout to spawning tributaries.

Demographic

Connectivity Impairment

- (4) FMO habitat is fragmented by Albeni Falls and Box Canyon Dams leading to low population size and risk of extirpation on now isolated SR habitat. Bull trout are currently, though sporadically, tucked and transported over Albeni Falls Dam. Safe, timely, and effective upstream and downstream passage is necessary to fully remediate effects of fragmentation and to enhance persistence of bull trout in isolated downstream SR habitat in Idaho and Northeast Washington. Lack of upstream and downstream passage at Box Canyon Dam increases the risk to the persistence of bull trout in isolated systems downstream.

Small Population Size

- (5) Small population size and fragmentation are severely limiting bull trout survival and recovery in key SR tributaries in the lower drainage (e.g., LeClerc and Sullivan Creeks). Survival of bull trout in this portion of the lower Clark Fork is at risk.

Nonnatives

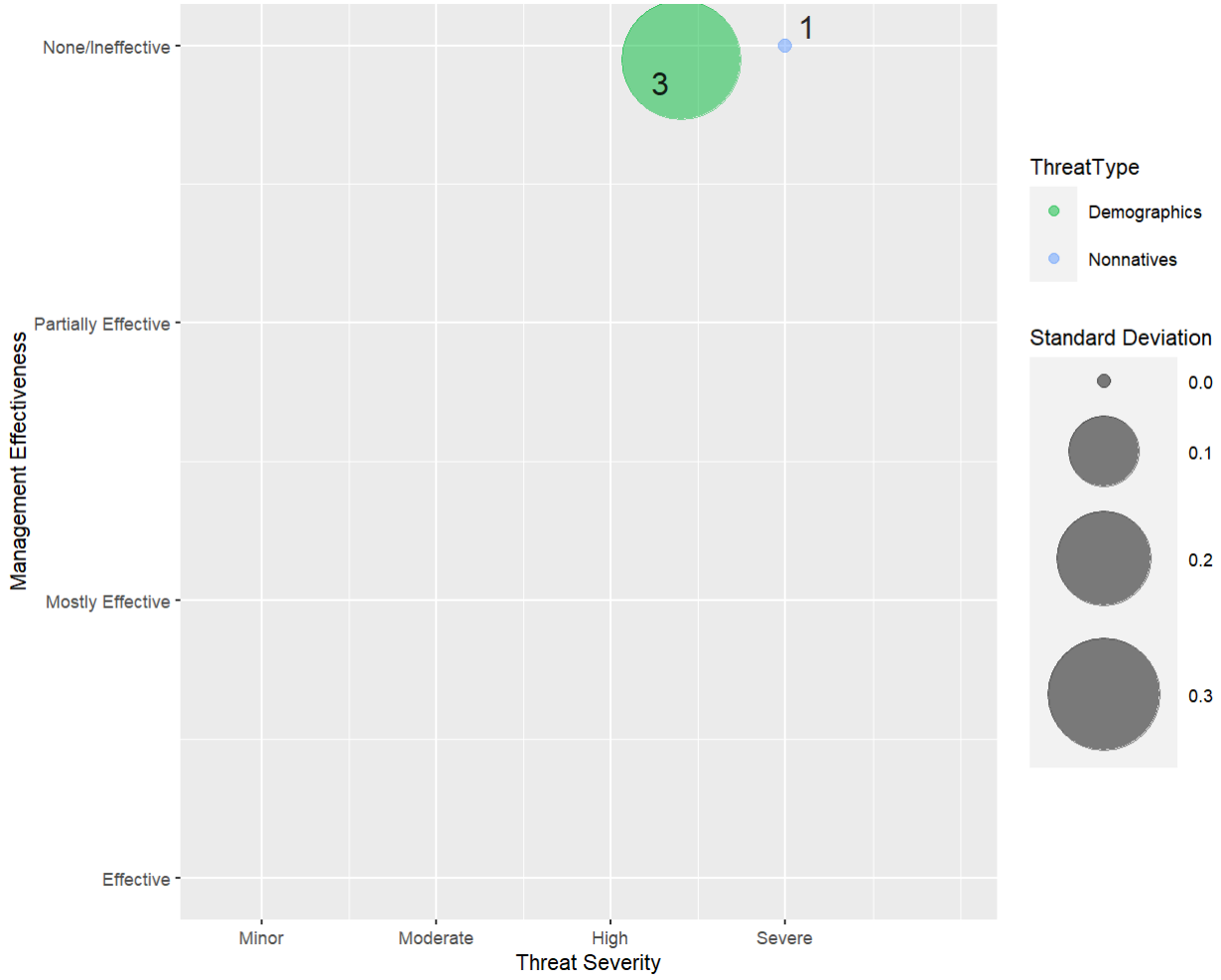
Nonnative Fishes

- (6) Nonnative Northern pike, smallmouth bass, walleye (recent), and, to a lesser extent, brown trout and occasional lake trout occupy the artificially created habitat (FMO) downstream of Albeni Falls Dam. All are and highly piscivorous species. Situationally (temporally and spatially), these species may prey on bull trout (especially migrating juveniles) to varying degrees. Given the low abundance in this area, any loss is significant.

  In SR habitat, brook trout occur in high numbers in some streams, especially in lower elevations. Hybridization is observed frequently due to low bull trout population (e.g., LeClerc Creek).

CH25 – Lincoln Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Small Population Size

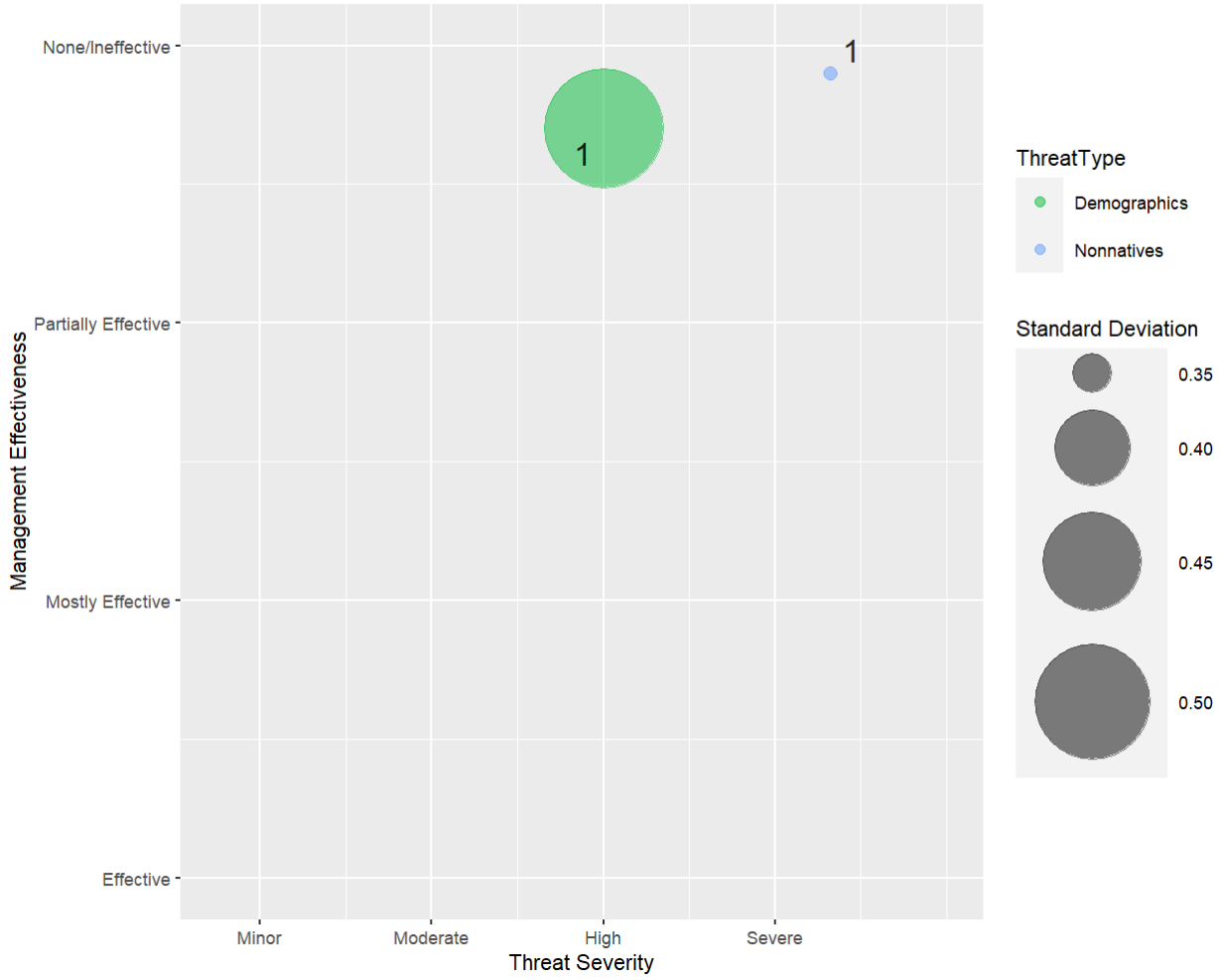
- (3) Single local population size is lower than what may be sustainable or viable (i.e., formerly robust population is now zero to single digit redd counts over recent decade, possibly extirpated). Brook trout is a primary driver for low population size.

Nonnatives
Nonnative Fishes

- (1) Abundant brook trout leading to hybridization and competition, well documented.

CH26 – Lindbergh Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Connectivity Impairment

- (1) Critically low abundance and an apparent reduction in the resident life history type put the core area at high risk of genetic and demographic stochasticity. Low numbers aggravated by bycatch mortality due to high angler use.

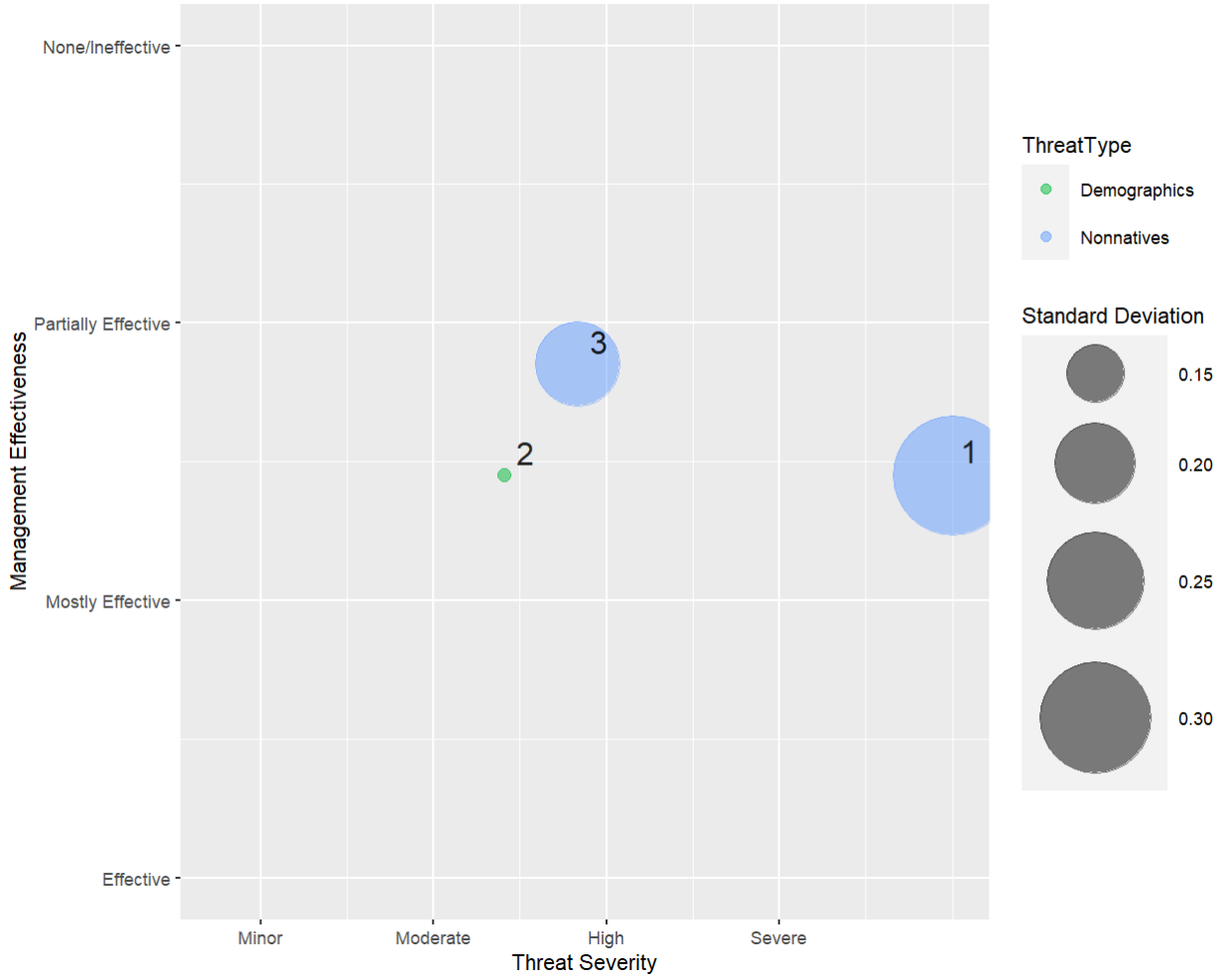
Nonnatives
Nonnative Fishes

- (1) Lake trout are established in FMO habitat, ostensibly through upstream migration from Swan Lake, with rising predation and competition anticipated.

  Brook trout population is well established in most of SR habitat.

CH27 – Logging Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Fisheries Management

- (1) Lake trout suppression actions (gillnetting) may cause some additional bull trout bycatch loss.

Small Population Size

- (3) Single local population size lower than what may be sustainable or viable (i.e., formerly robust population is now reduced to low single digit redd count over recent decade).

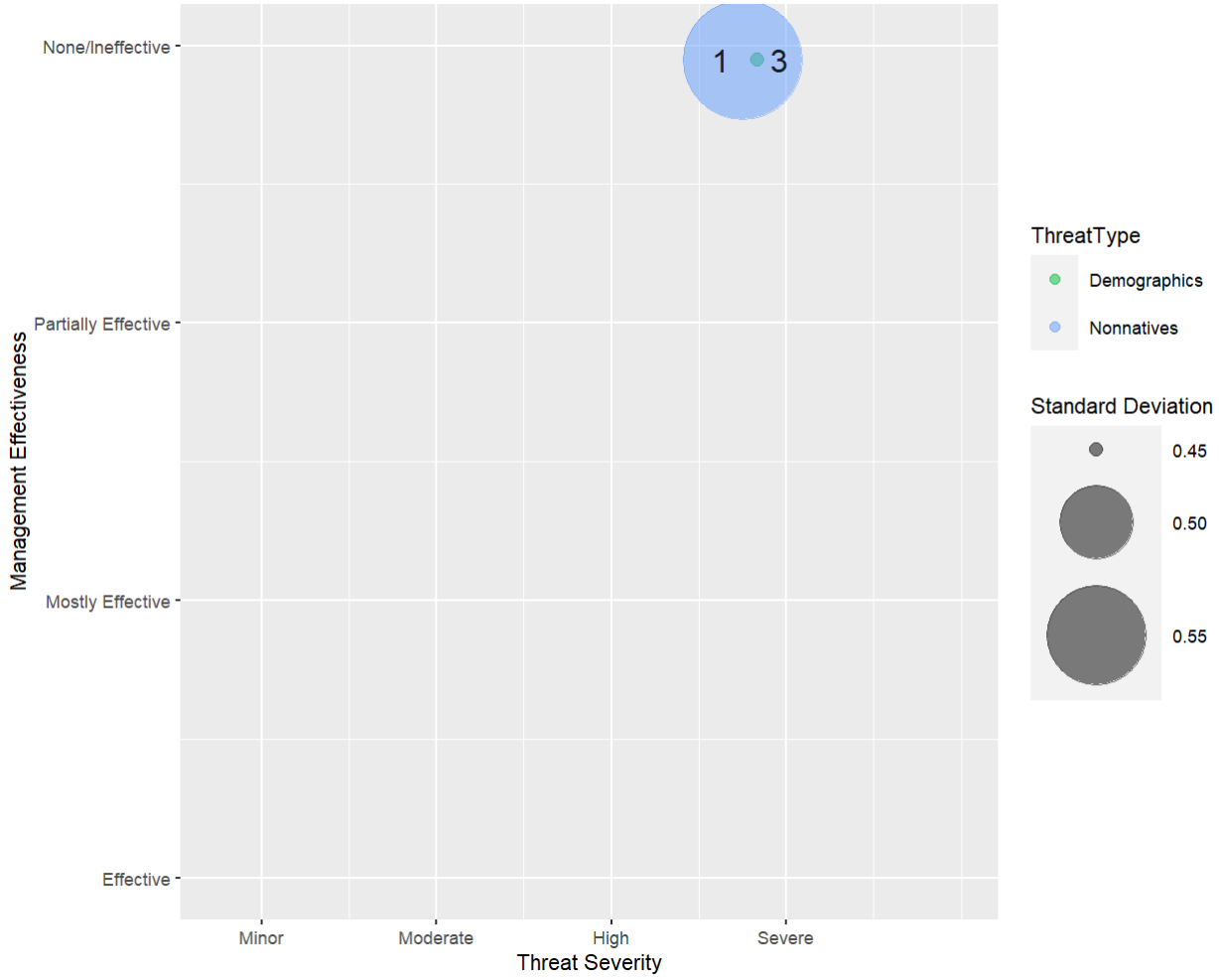
Nonnatives

Nonnative Fishes

- (2) Lake trout invasion within the past ~30 years has seriously reduced bull trout population through unknown mechanisms of competition and/or predation.

CH28 – Lower Quartz Lake Core Area

Threats Assessment Results



Threats Summary

Demographic
Small Population Size

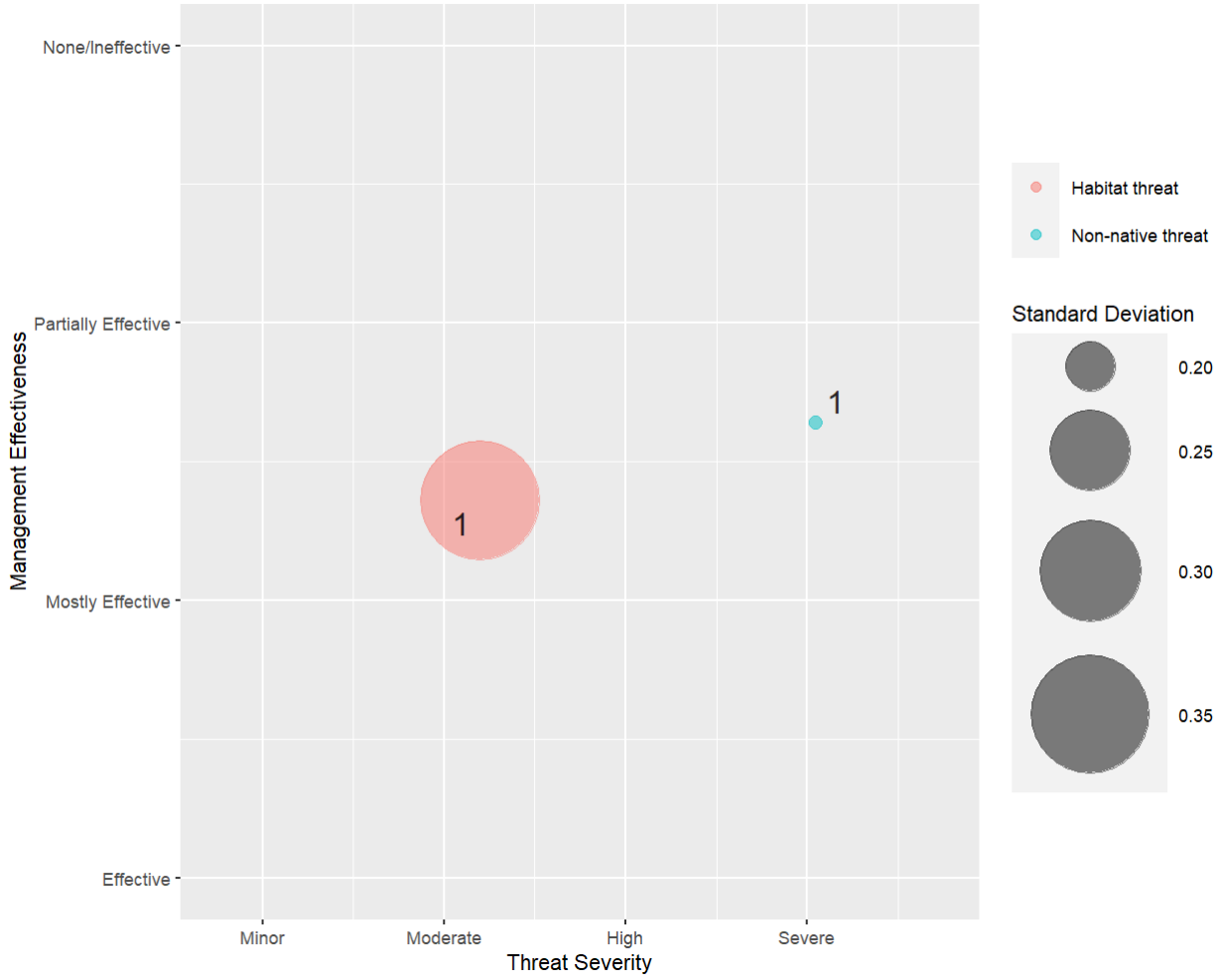
- (3) Single local population is likely a remnant of what was once a connected population between Upper Quartz and Lower Quartz; may be smaller than what is sustainable/viable (i.e., low single digit redd count consecutively for over a decade).

Nonnatives
Nonnative Fishes

- (1) Lake trout invasion within the past ~20 years, bull trout population impact unknown.

CH31 – Priest Lakes Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Legacy forest practices (roads, sediment) cause riparian and instream degradation, loss of LWD, and pool reduction in FMO habitat and some SR tributaries (e.g., Gold Creek, Hughes Fork, Granite Creek).

Nonnatives

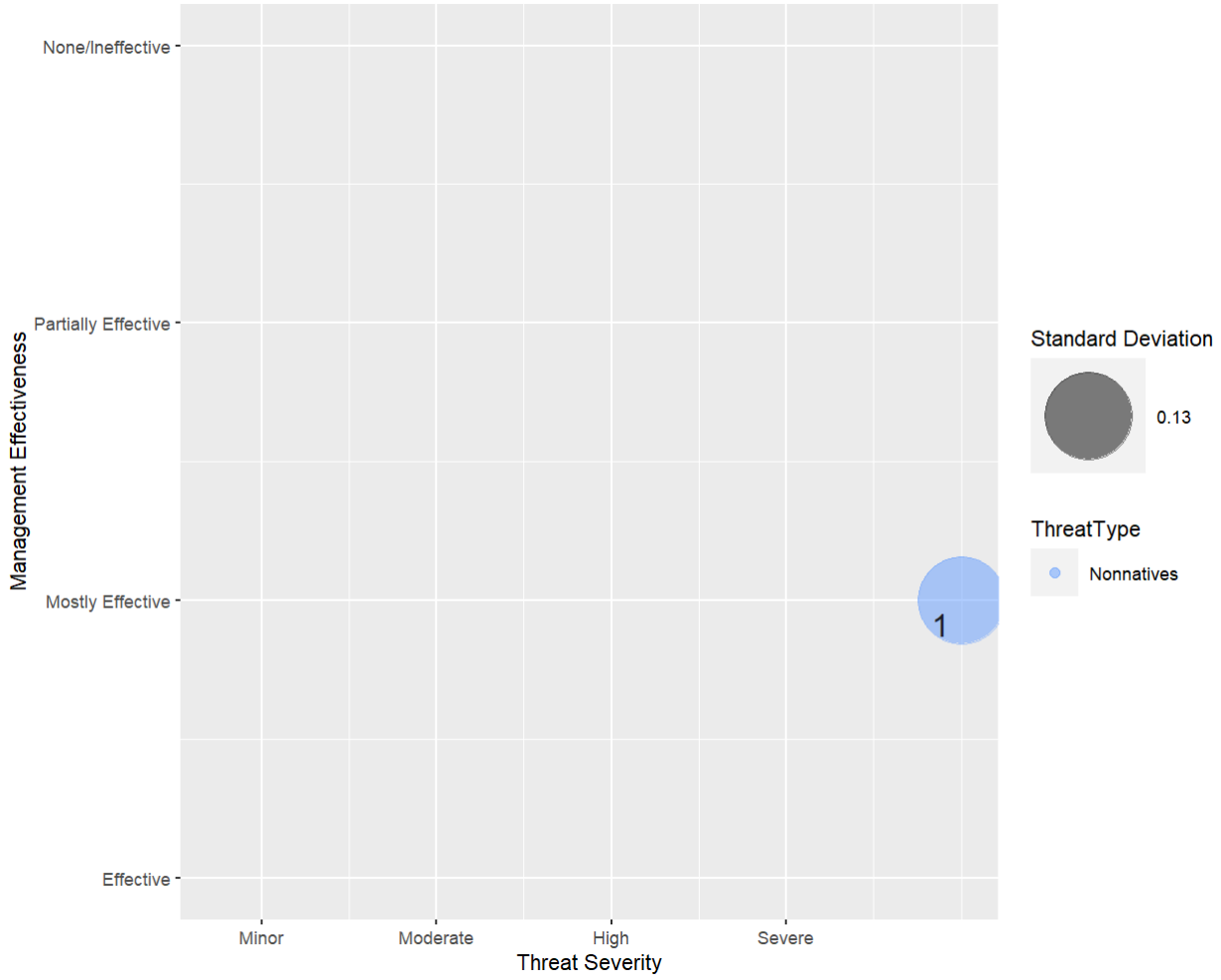
Nonnative Fishes

- (1) Lake trout in Priest Lake have severely reduced bull trout survival through predation and/or competition and have contributed to near collapse of several local populations. Despite suppression actions for lake trout, their continual reinvasion of

Upper Priest Lake through the Thorofare is difficult to manage and places at risk the relatively more secure headwaters as well. Brook trout are common in SR in Priest and Upper Priest local populations. Hybridization reduces bull trout resiliency and replication in the face of lake trout and habitat pressures as well.

CH32 – Quartz Lakes Core Area

Threats Assessment Results



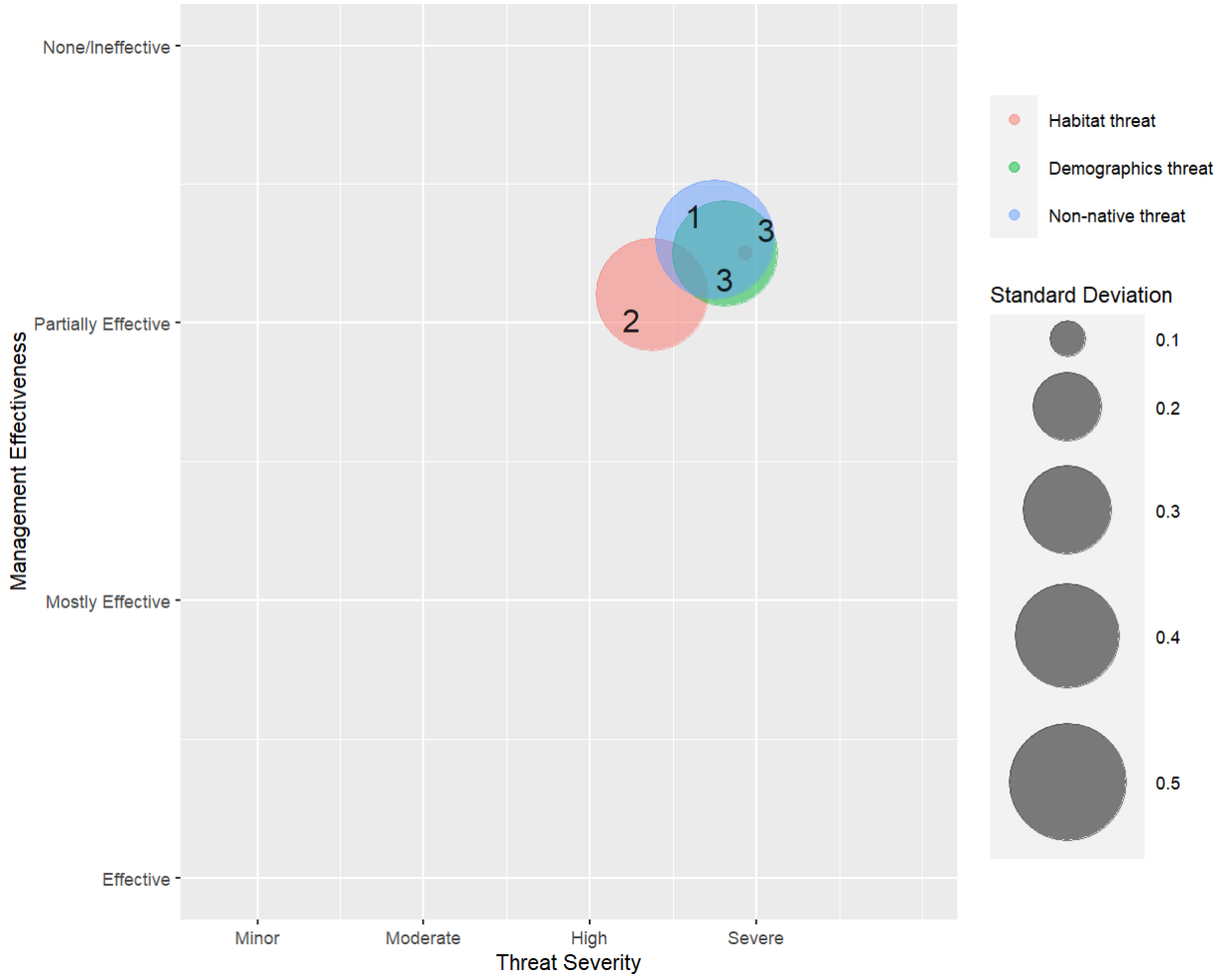
Threats Summary

Nonnatives
Nonnative Fishes

- (1) Lake trout invasion within the past ~20 years is being aggressively deterred by suppression actions (targeted gillnetting). Bull trout population is currently stable.

CH33 – Rock Creek Core Area

Threats Assessment Results



Threats Summary

Habitat

Instream Impacts

- (2) Removal of wood (LWD) by floaters/recreational users and mainstem road system. Habitat degradation by dispersed campers and recreational users.

Water Quality

- (3) Water temperature in mainstem FMO habitat and lower reaches of tributaries in the downstream portions of the core area are marginally high for bull trout survival in the summer. The elevated water temperatures are often exacerbated by instream flow depletion for human uses and the road system.

Demographic
Small Population Size

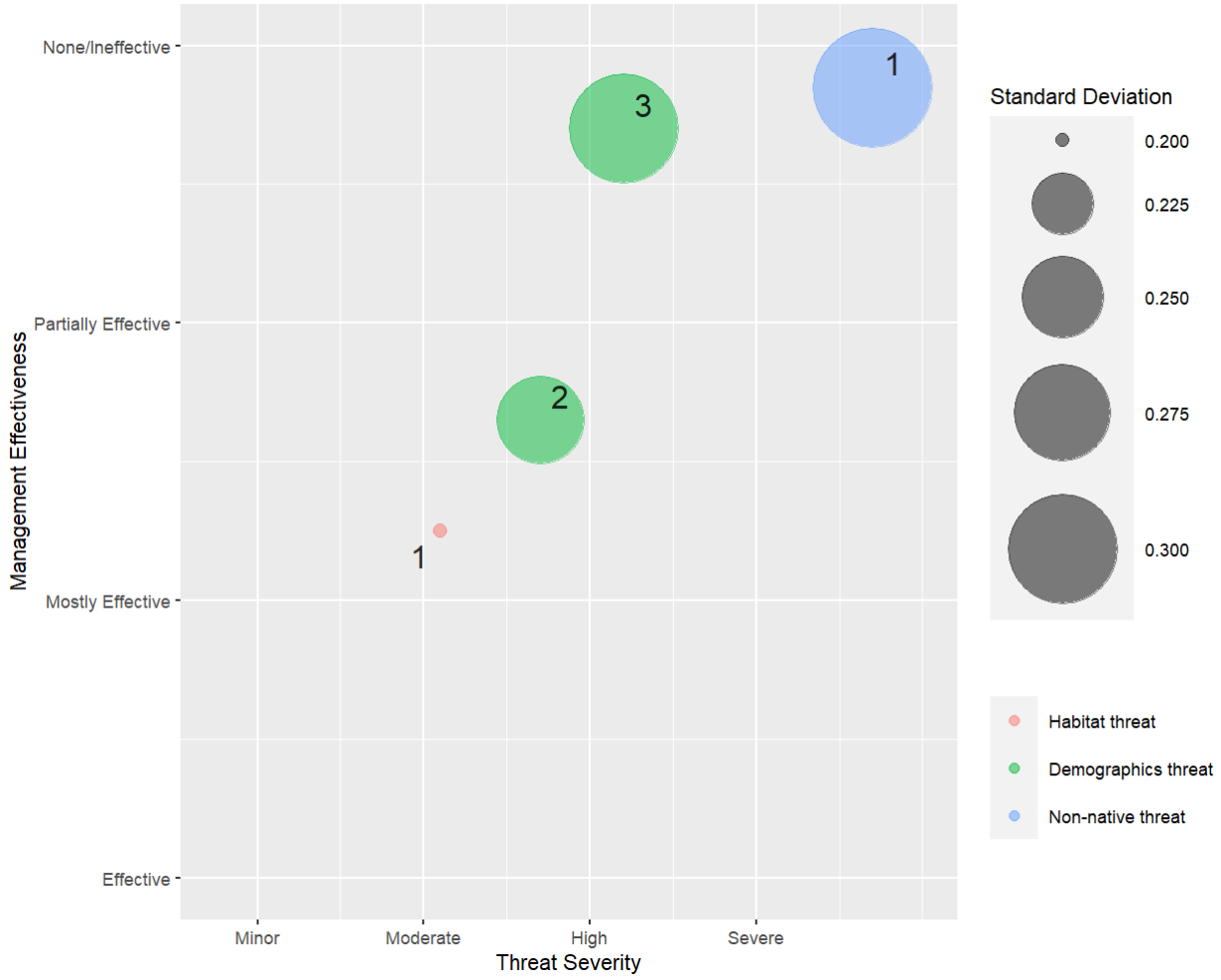
- (3) Genetic/demographic stochasticity, populations are small and unstable or stable at very low numbers. Recent downward trend is a concern. Irrigation ditches entrain juveniles on mainstem and spawning tributaries.

Nonnatives
Nonnative Fishes

- (1) Brook trout occur in some tributaries with SR habitat, and hybridization has been documented. Brown trout populations are expanding. The expansion is likely the result of warming water temperatures making SR and FMO less suitable for bull trout. There is overlap with bull trout in FMO habitat throughout the core area and in many of the SR. Brown trout are nonnative predators and at times competitors that may impact recovery. The long-term compatibility of brown trout and bull trout is not well understood.

CH34 – Swan Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Rural and urban development, roads, and other land management actions have reduced riparian habitats and floodplains. Urban development in FMO habitat and watershed resilience supporting SR habitat are of particular concern. Water quality is still a concern in listed water bodies.

Demographic
Fisheries Management

- (2) Sampling mortality of bull trout due to gillnetting for lake trout suppression in Swan Lake may directly impact potential recruitment and reduce local populations.

Small Population Size

- (3) Small Population Size in key SR tributaries where redd counts were routinely double digits are now in the single digits.

Nonnatives
Nonnative Fishes

- (1) Lake trout and Northern pike represent the largest primary threat to bull trout, overwhelming the FMO habitat in Swan Lake. Lake trout invasion and expansion in the past 20 years, coupled with a robust *Mysis* population from a 1970s introduction, has compromised bull trout survival (predation) and introduced competition for a limited preybase (primarily kokanee) available to piscivores. Brook trout have been present in most SR tributaries for a half century or longer, with no documented recent change in status, but in some important SR tributaries (e.g., Lion, Goat) resulting in high-documented rates of hybridization. Hybrids are abundant throughout SR and FMO habitat (observed hybrids from 8 lbs to 10 lbs in Swan Lake), further reducing potential bull trout recruitment. Due to the proximity and relative ease of access, increased introductions of walleye, smallmouth, and other nonnative species continue to be a concern.

CH35 – Trout/Arrow Lakes Core Area

Threats Assessment Results

NA

Threats Summary

NA

CH36 – Upper Kintla Lake Core Area

Threats Assessment Results

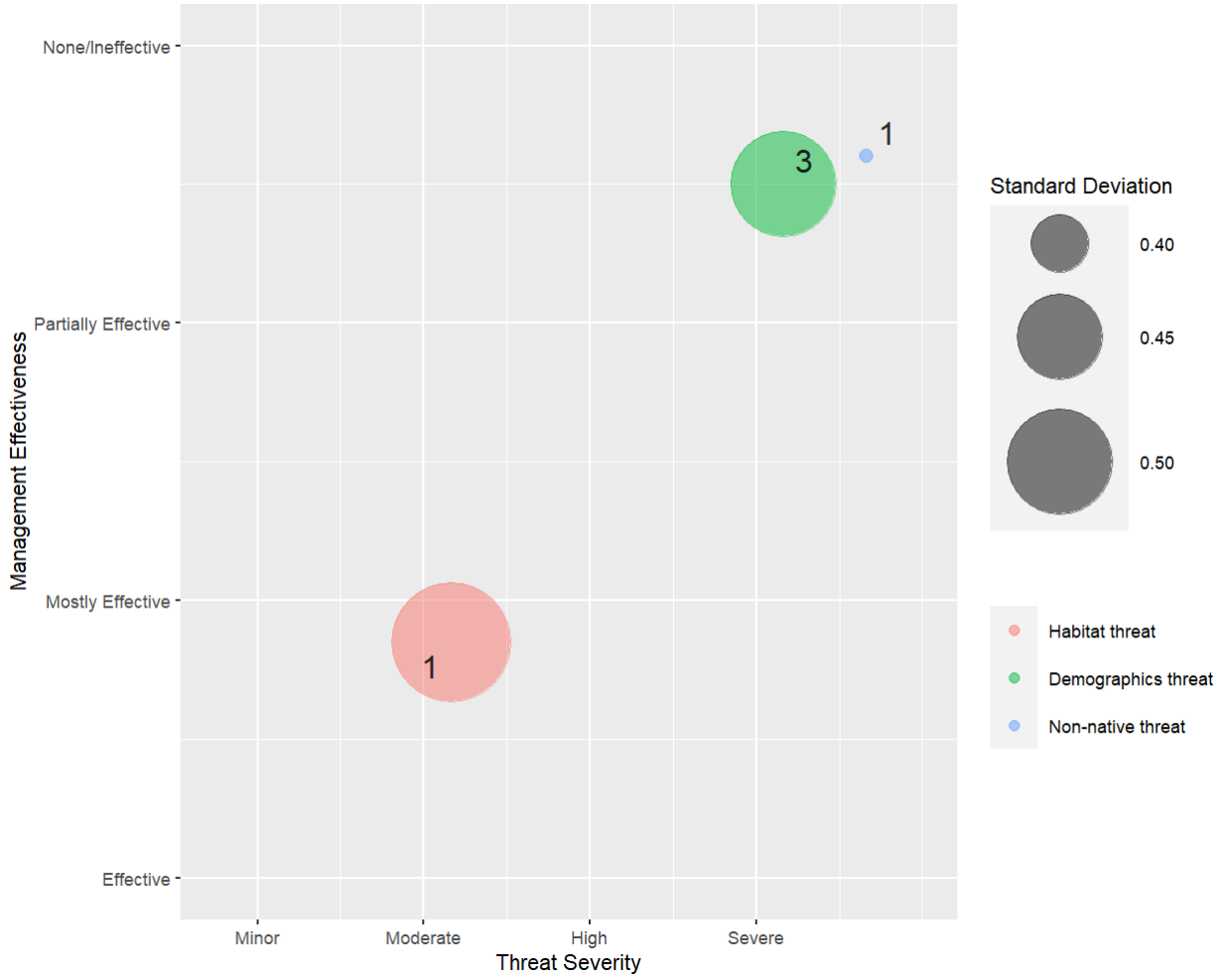
NA

Threats Summary

NA

CH37 – Upper Stillwater Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Rural and urban development, roads (including forestry activities in SR), and other land management actions have reduced riparian habitats and floodplains. Urban development in FMO habitat and watershed resilience supporting SR habitat are of particular concern. Water quality is still a concern in listed water bodies.

Demographic
Small Population Size

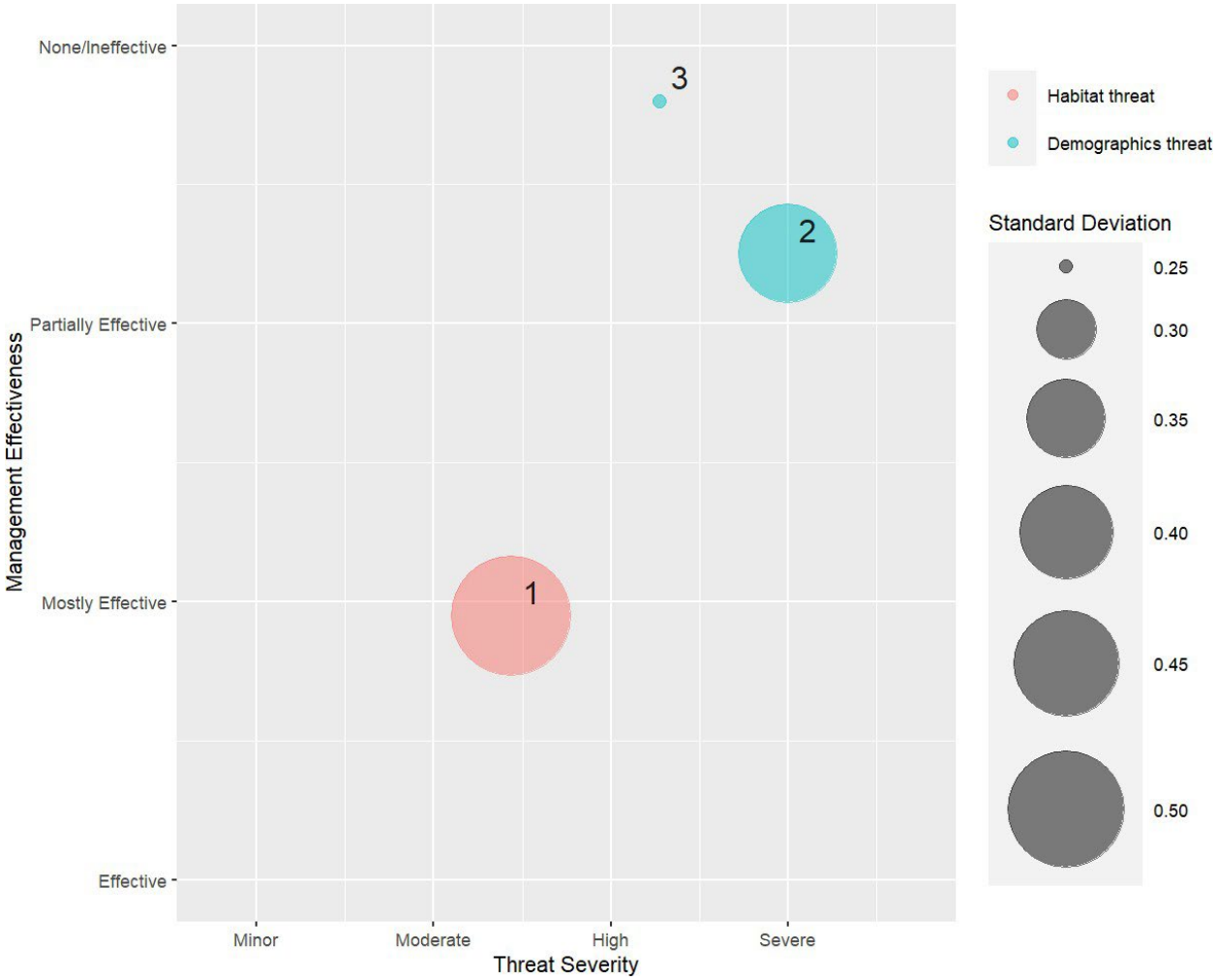
- (3) Critically low abundance and an apparent reduction in the migratory life history type put the core area at high risk of genetic and demographic stochasticity. High densities of juveniles documented in tributary to the lake.

Nonnatives
Nonnative Fishes

- (1) Hybridization/Predation/Species Competition – Brook trout are abundant in most of the SR habitat. Competing/predating lake trout and Northern pike dominate FMO habitat.

CH38 – Upper Whitefish Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

(1) Developed State campground on the lakeshore and outlet; associated multiple user activities affect habitat quality through riparian degradation and sedimentation. Roads (including forestry activities in SR) and other land management actions have reduced riparian habitats and floodplains. Watershed resilience supporting SR habitat is of particular concern. Water quality is still a concern in listed water bodies.

Demographic
Fisheries Management

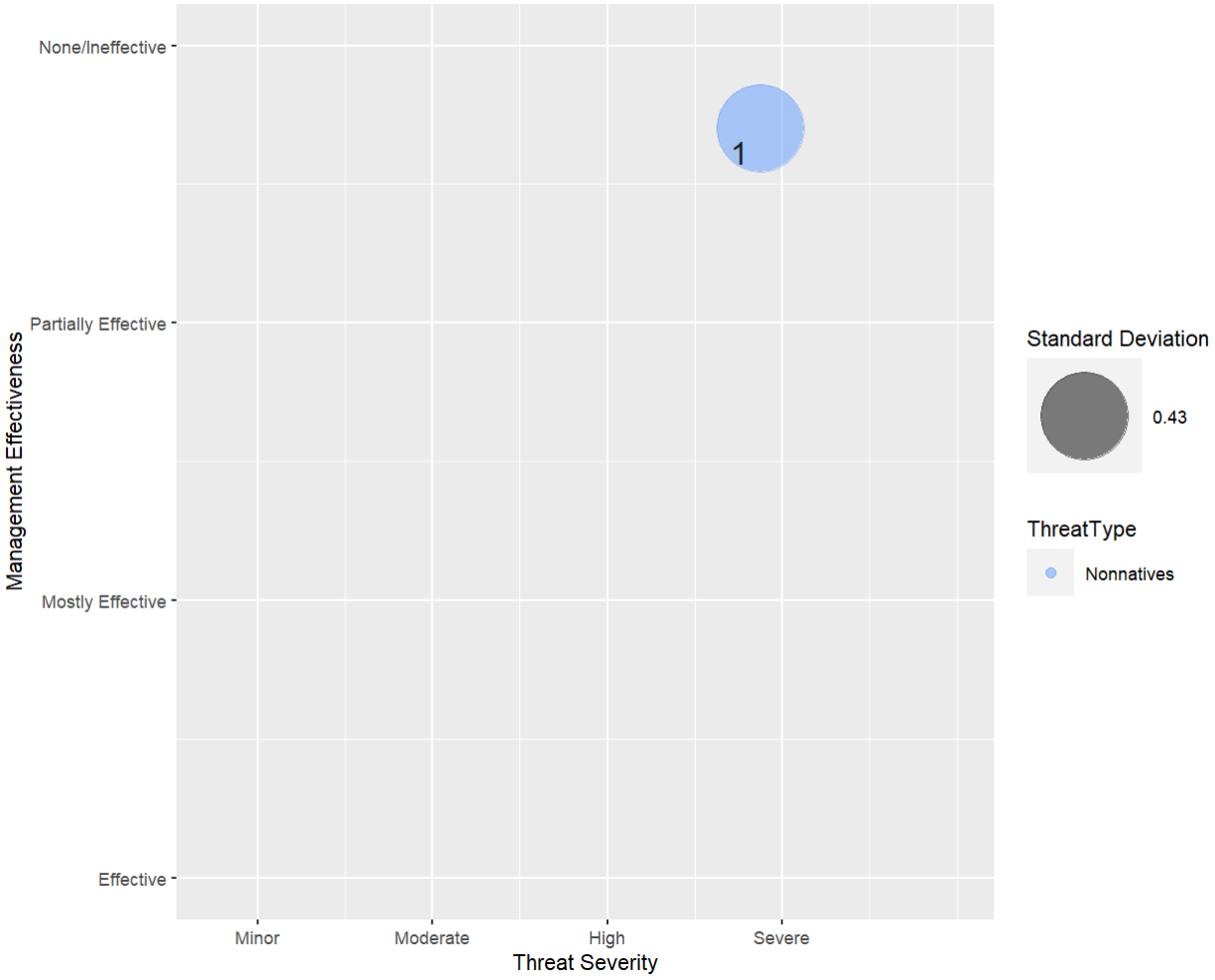
- (2) Low population numbers are further aggravated by bycatch mortality due to high angler use. High angler use is likely the result of fish stocking (cutthroat stocking).

Small Population Size

- (3) Low population (mid-single digit redd count over recent decade) is partially natural due to size of core area but lower than what may be sustainable/viable.

CH39 – West Fork Bitterroot River Core Area

Threats Assessment Results



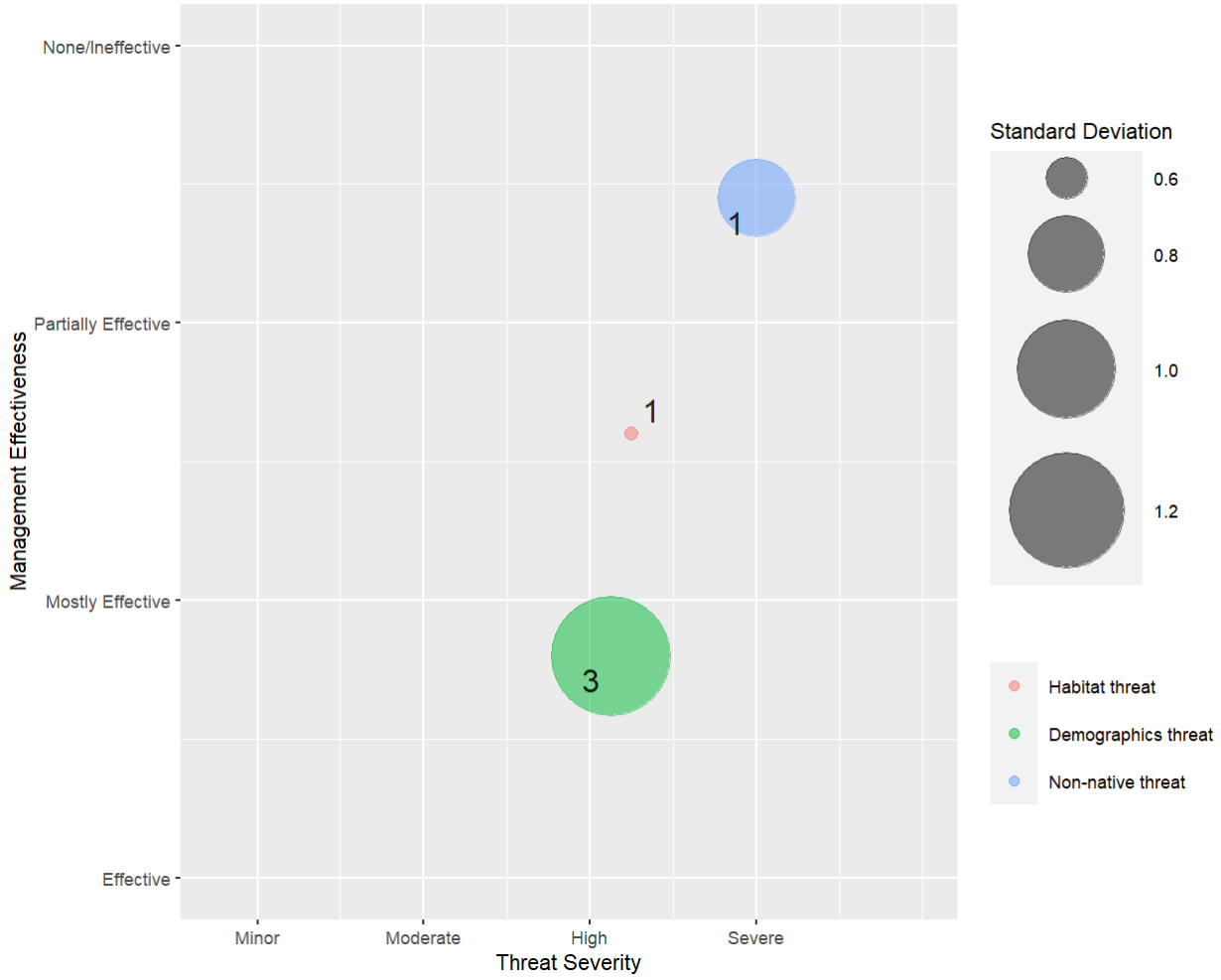
Threats Summary

Nonnatives
Nonnative Fishes

- (1) Brook trout occur in high numbers in some SR habitat. The extent of hybridization or other impacts is not well documented.

CH40 – Whitefish Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Residential development (including municipality of Whitefish), roads, railroad, and forest management continue to affect habitat quality through riparian degradation, sedimentation, and nutrient enrichment on the lakeshore.

Demographic
Connectivity Impairment

- (3) Critically low abundance and an apparent reduction in the resident life history type put the core area at high risk of genetic and demographic stochasticity. Low numbers aggravated by bycatch mortality due to high angler use.

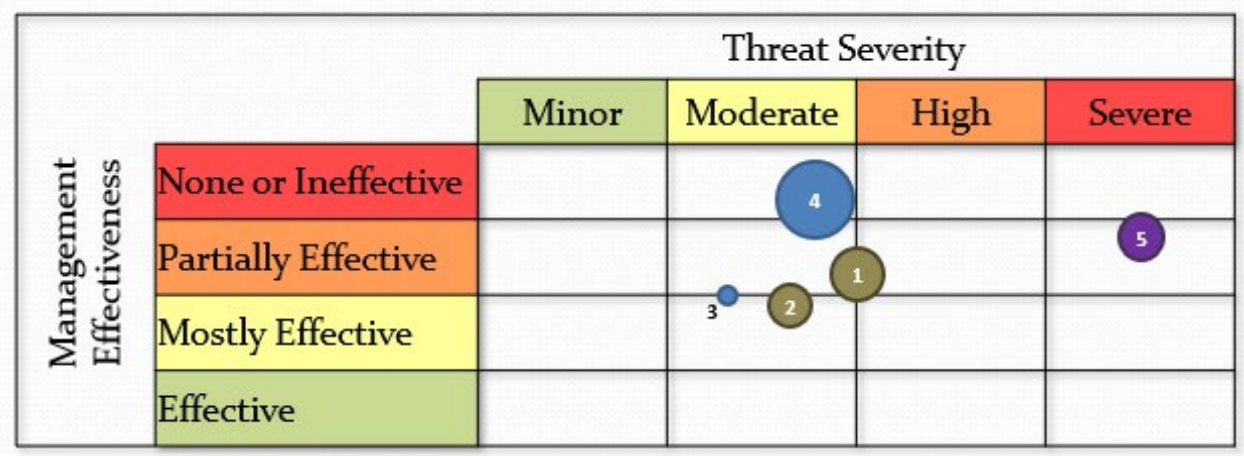
Nonnatives
Nonnative Fishes

- (1) Abundant brook trout populations in SR likely leading to hybridization and competition, but poorly documented. Competing/predating lake trout and Northern pike dominate FMO habitat.

Klamath River Representative Unit

KL01 – Sycan River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy Forest Management and Agricultural Practices – channelization and habitat degradation.

Instream Impacts

- (2) Long Creek has been diverted, channelized, and lost riparian habitat near the Sycan Marsh.

Demographic
Connectivity Impairment

- (3) Lack of connectivity from Long Creek to FMO habitat in Sycan Marsh (mainstem Sycan River) due to road crossing, unscreened irrigation diversions (entrainment, dewatering), and fish passage issues.

Small Population Size

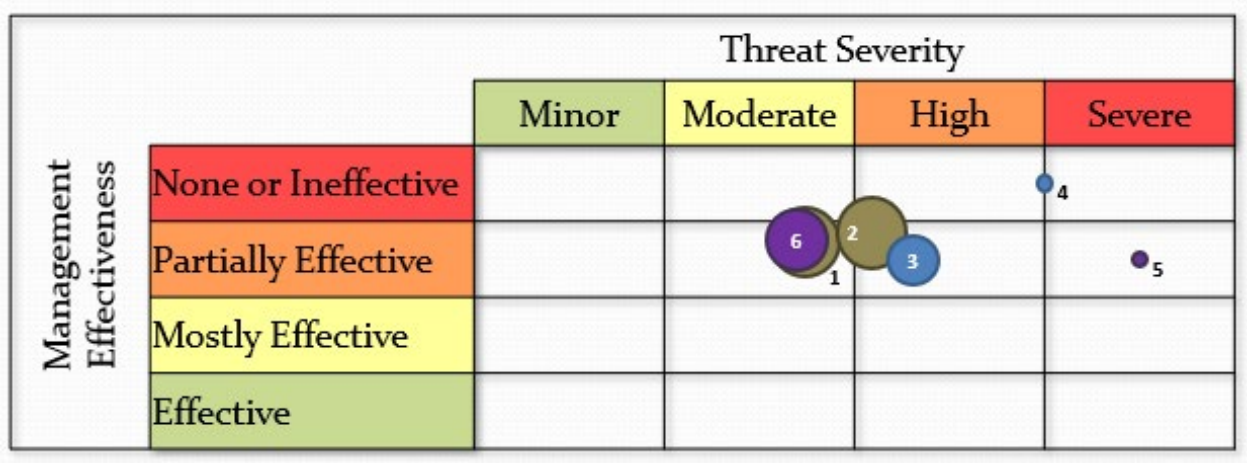
- (4) The only population in this core area, Long Creek, has a small population size.

Nonnatives
Nonnative Fishes

- (5) Brook trout are numerous in all historically occupied and suitable SR and FMO habitat. Hybridization and competition presently occur in Long Creek.

KL02 – Upper Klamath Lake Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy Forest Management and Agricultural Practices – channelization and habitat degradation.

Instream Impacts

- (2) The lower reaches of many creeks have been altered where they meet the floor of the Wood River Valley due to agricultural practices. At these locations, streams have been diverted, channelized, and lost riparian habitat.

Demographic
Connectivity Impairment

- (3) Entrainment and Dewatering – unscreened irrigation diversions exist within the Annie Creek, Sun Creek, Sevenmile Creek, Cherry Creek, and the Wood River that result in fish entrainment and lack of connectivity to FMO habitat.

Small Population Size

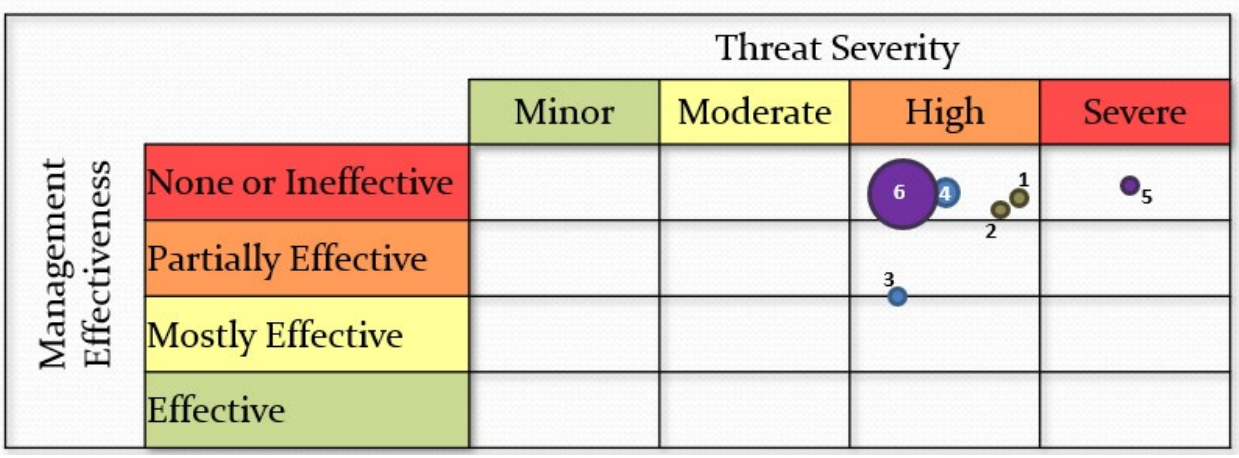
- (4) Both local populations have small population sizes, particularly Threemile Creek.

Nonnatives
Nonnative Fishes

- (5) Brook trout are numerous in all historically occupied and suitable SR and FMO habitat, impacting bull trout through hybridization and competition.
- (6) Brown trout are overlapping in some occupied and suitable SR and FMO habitat.

KL03 – Upper Sycan River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy Forest Management and Agricultural Practices – channelization and habitat degradation.

Instream Impacts

- (2) Low gradient reaches have been diverted, channelized, or feature degraded riparian areas due to agricultural practices and the Bootleg Fire in 2021.

Demographic
Connectivity Impairment

- (3) Lack of connectivity to FMO habitat (between North Fork and South Fork Sprague River), unscreened irrigation diversions (entrainment, dewatering), and fish passage issues.

Small Population Size

- (4) The local populations have small population sizes, particularly Boulder, Dixon, and Leonard Creeks, and nearly all are isolated from one another, which may confer genetic risks and reduce the likelihood of population persistence over time; lack of migratory life history.

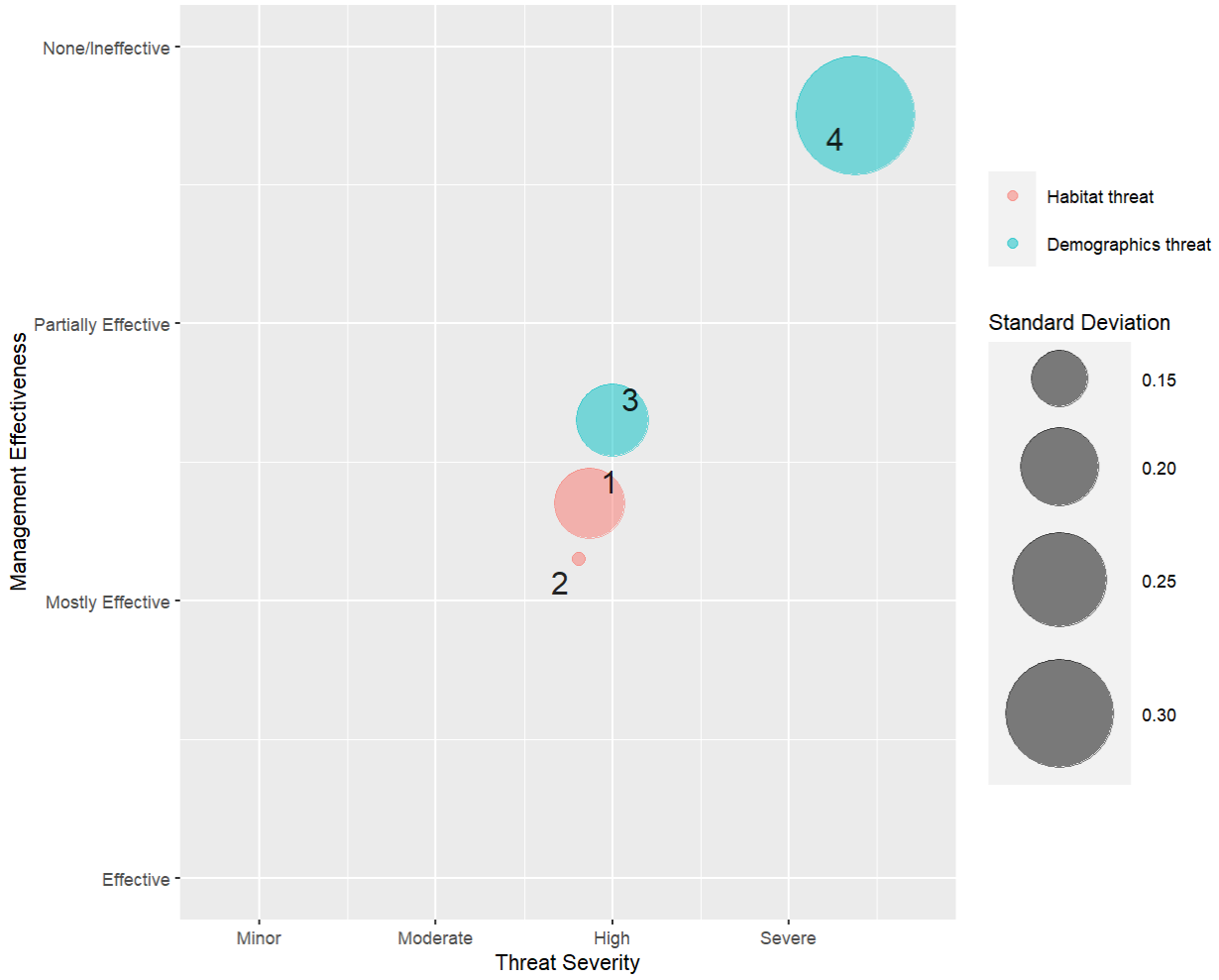
Nonnatives
Nonnative Fishes

- (5) Brook trout are numerous in all historically occupied and suitable SR and FMO habitat, impacting bull trout through hybridization and competition.
- (6) Brown trout are overlapping in some occupied and suitable SR and FMO habitat. Brown trout presently occur with bull trout in Boulder, Dixon, Leonard, and Brownsworth Creeks.

Mid-Columbia Representative Unit

MC01 – Asotin Creek Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Legacy impacts from residential development, agricultural practices, grazing, and recreation that reduce or limit habitat complexity, increase water temperatures and sediment loading, and reduce wood recruitment.

Instream Impacts

- (2) Impacts from flood control and repairs, especially in lower stream reaches. Intermittent flows and dewatering throughout the basin in tributaries impacting

migration. Naturally low instream flows and high temperatures accentuated by climate change.

Catastrophic Fire

- (*Not scored/plotted*) Altered fire regimes, including recent higher intensity and severity fires, resulting in loss of riparian vegetation, increased sedimentation, and increased water temperatures.

Demographic
Connectivity Impairment

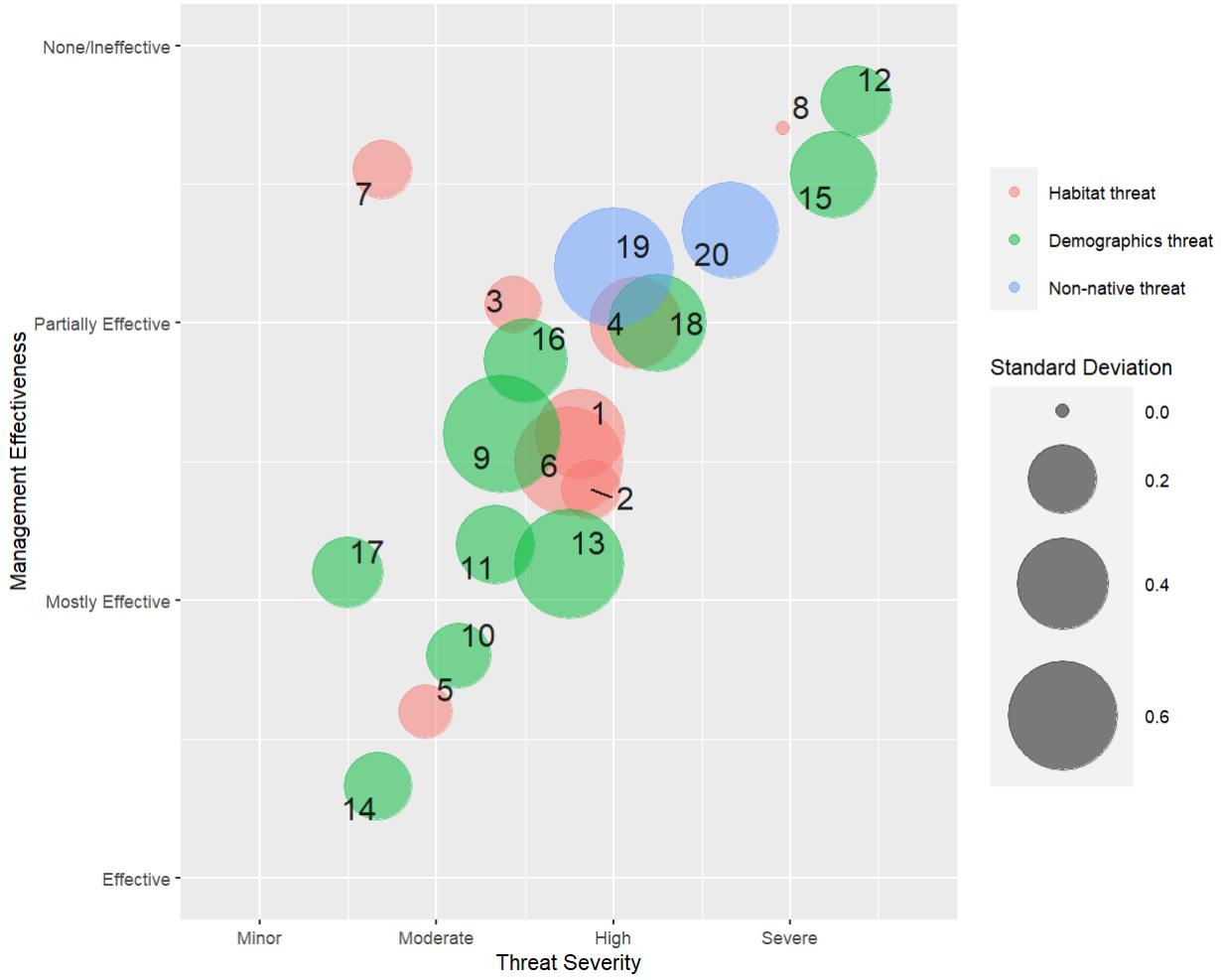
- (3) Seasonal manmade and temperature barriers to migration in Snake River and lower Asotin Creek prevent or hinder migratory life history.

Small Population Size

- (4) Low population size and loss of fluvial migratory life history form have reduced genetic diversity and demographic stability.

MC02 – Entiat River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Agriculture/Livestock Grazing/Forest Management Practices – legacy and current practices, including forest roads, have resulted in a lack of habitat complexity (i.e., wood, primary pools, functioning floodplains). Agriculture practices have channelized and reduced riparian vegetation and floodplain functions.
- (2) Development/Transportation Networks – legacy and current facilities impact both SR and FMO habitat.
- (3) Recreation – legacy and new recreational developments impact SR habitat (i.e., rock dam building, reduced riparian areas, and compacted stream banks) and reduce habitat complexity.

Instream Impacts

- (4) Agriculture/Forest Management Practices/Development/Transportation Networks – legacy and current management actions have degraded habitat. Past timber, fire, recreation, and grazing management are compounded and have impacted stream reaches and stream temperatures, increased sediments, and reduced riparian areas. Current grazing management plans need to be maintained and improved in spawning areas. Highways and county roads along FMO and development in floodplains reduce complexity, create passage issues, and degrade water quality.
- (5) Altered Flows – there are streams with naturally dewatering reaches impacted during low flow years. Mainstem diversion dams have altered instream flows and water quality.
- (6) Entrainment and Connectivity/Fish Passage – hydropower dams on the mainstem Columbia River, irrigation dams, and historic splash dams altered channel structure.

Water Quality

- (7) Water Quality Impairment – legacy and current management have led to 303(d) listed reaches with water quality degradation. Standards are frequently not met in FMO areas. Irrigation returns, runoff, application of pesticides/herbicides/deicer impact FMO and SR areas.
- (8) Climate Change – current science predicts temperature changes will impact stream flow/temperature patterns. Quality of the lower elevation SR habitat and FMO will be further degraded (stream temperatures, turbidity, sediments, dissolved oxygen levels).

Demographic
Connectivity Impairment

- (9) Agriculture – irrigation diversions block fish passage and cause entrainment. Some reaches within SR and FMO have 303(d) listed reaches. Stream temperature and agricultural chemicals have legacy and current impacts and reduce habitat complexity and connectivity of bull trout habitat.
- (10) Forest Management/Transportation Networks – legacy and current forest roads/highways/county roads continue to impair connectivity for migration. Forest Management and Transportation Networks have impeded passage and contributed to a lack of habitat.
- (11) Entrainment (hydropower and diversions)/Fish Passage – entrainment occurs at all hydropower dams on the Columbia River and at other diversions/dams in the Entiat Core Area where fish passage is impeded, causing altered movement from SR to migration areas. Climate change has or will have caused reduced or limited use of migratory corridors.
- (12) Climate Change – climate change is predicted to impact stream flows and temperatures that will cause barriers for passage and reduced refuge.

Fisheries Management

- (13) Angling/Harvest/Poaching – fishing regulations and harvest rules need to continue to be improved to reduce incidental catch of bull trout. Illegal poaching occurring in several basins.
- (14) Fisheries Management – increased fish management and need for fish monitoring cause increased handling impacts. Species interactions from hatchery fish are likely, degree of impacts is unknown.

Small Population Size

- (15) Genetic/Demographic Stochasticity – both populations in the basin are very small and unstable or stable at very low numbers. Recent downward trends are a concern.
- (16) Loss/Altered Migratory Life History – life histories have been altered due to long-term impediment of fish passage at long-time diversions, large hydropower Columbia River dams, and splash dams. Almost all migratory fish use the Columbia River for FMO habitat.
- (17) Fisheries Management – species interactions from hatchery-released smolts/fishes may be greatest on low abundance populations.

Forage Fish Availability

- (18) Fish Passage/Introduced Species/Fish Management – Columbia River dams, irrigation diversions, and legacy splash dams or other culverts currently or historically impede passage for potential native prey species. Hatchery releases may both impact and benefit bull trout. Brook trout outcompete bull trout for habitat and food.

Nonnatives

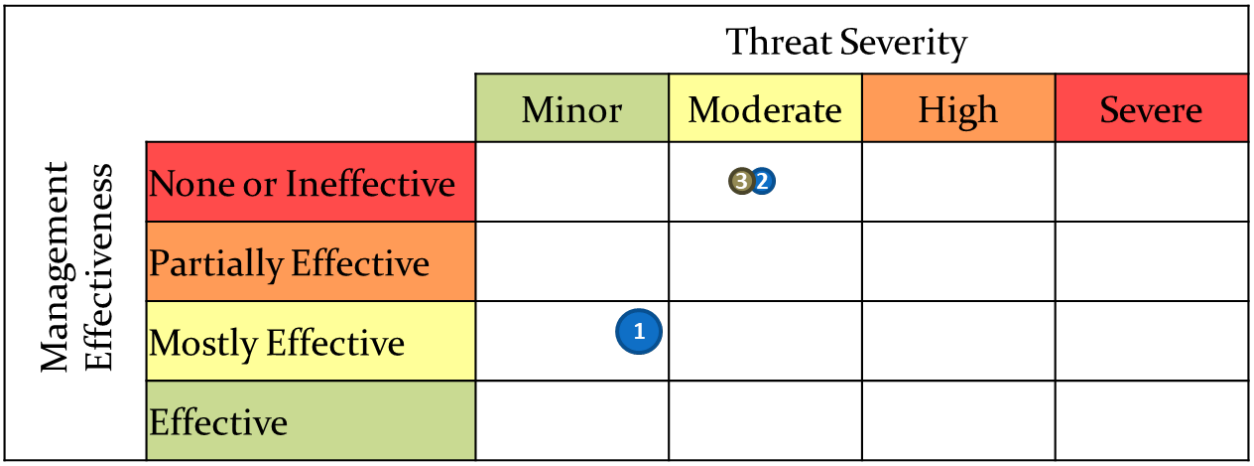
Nonnative Fishes

- (19) Introduced Species/Fish Management – Brook trout are nonnative predators in the basin and will impact recovery. Brook trout overlap with bull trout in both SR and FMO habitat. Fisheries still occur for brook trout. Genetic analysis has identified Brook trout x bull trout hybrids within the basin.

  Salmon recovery involves output of high numbers of smolts, with some residualization and species competition, which may have impacts to preybase on small populations of bull trout.
- (20) Climate Change – predatory nonnative species occur within FMO habitats and risk potential spread especially as waters warm with climate change.

MC03 – Imnaha River Core Area

Threats Assessment Results



Threats Summary

Habitat
Instream Impacts

- (3) Altered Flows and Geomorphic Processes – WVIC alters the natural flow regime and geomorphic processes, affecting the temperature profile and retaining gravel substrates above the canal.

Demographic
Connectivity Impairment

- (1) Operation of the Imnaha Hatchery weir may impede upstream migration. A majority of the migratory bull trout in the core area are handled to pass upstream. Downstream passage is provided daily.
- (2) Wallowa Valley Improvement Canal – one way passage at diversions results in a loss of individuals, diminishing long-term persistence of affected populations.

MC05 – Little Minam River Core Area

Threats Assessment Results

NA

Threats Summary

NA

MC06 – Lochsa River Core Area

Threats Assessment Results

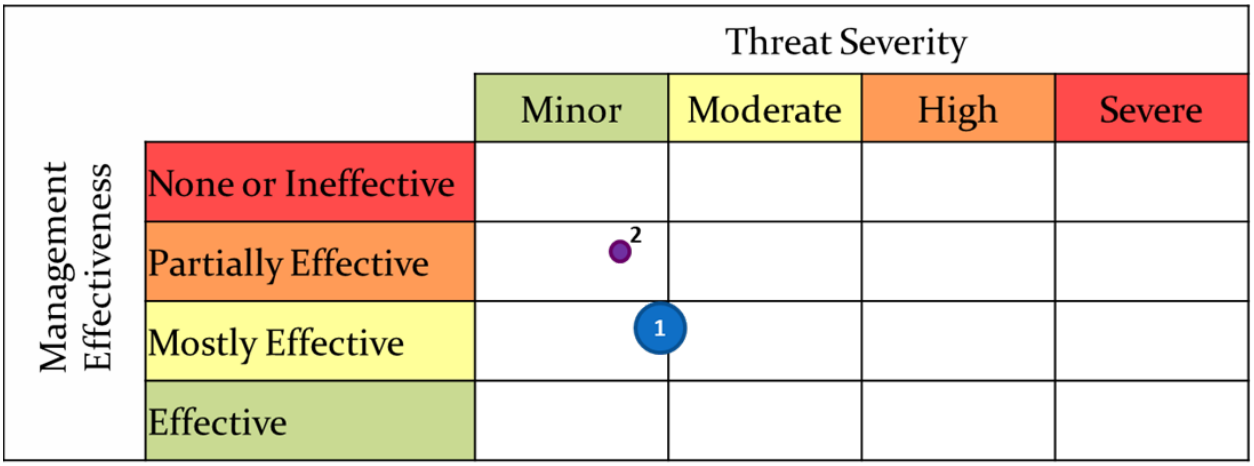
NA

Threats Summary

NA

MC07 – Lookingglass/Wenaha Core Area

Threats Assessment Results



Threats Summary

Demographic
Connectivity Impairment

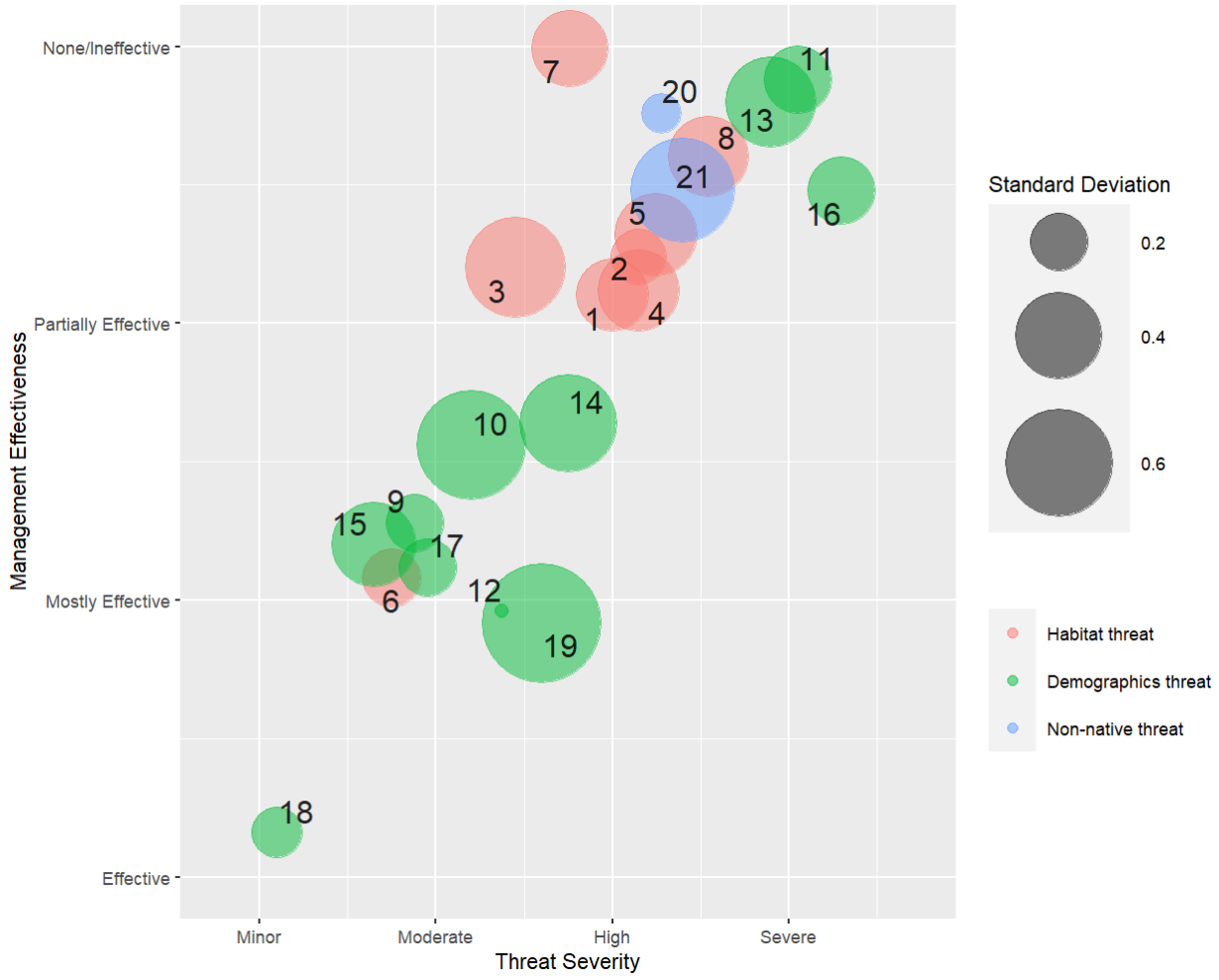
- (1) Operation of the Lookingglass Hatchery Weir (handling fish, intake screens) may adversely impact bull trout and impede passage preventing connectivity between spawning and FMO habitat.

Nonnatives
Nonnative Fishes

- (2) Brook trout are present in a headwater lake (Langdon Lake) from which Lookingglass Creek originates and two ponds adjacent to Lookingglass Creek and pose a potential threat to bull trout through competition and hybridization.

MC08 – Methow River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Agriculture/Livestock Grazing/Forest Management Practices – legacy and current practices including forest roads, have resulted in a lack of habitat complexity (i.e., wood, primary pools, functioning floodplains). Agriculture practices have channelized streams, altered floodplains, and reduced riparian vegetation.
- (2) Development/Transportation Networks – legacy and current structures and features impact both SR and FMO habitat.
- (3) Recreation – legacy and new recreational developments impact SR habitat (i.e., rock dam building, reduced riparian areas, and compacted stream banks) and reduce habitat complexity.

Instream Impacts

- (4) Agriculture/Forest Management Practices/Grazing/Development/Transportation Networks/Recreation (legacy and current) – actions have degraded habitat. Past timber, fire, recreation, and grazing management have compounded impacts in stream reaches (i.e., sediments, reduced riparian areas, and high stream temperatures). Current grazing management plans need to be maintained and improved in spawning areas and FMO areas. Highways and county roads along FMO and development in floodplains reduce complexity, create passage issues, and degrade water quality.
- (5) Dewatering and Altered Flows – streams with natural dewatering are further impacted during low flow years. Mainstem diversion dams have altered instream flows and water quality.
- (6) Entrainment and Connectivity/Fish Passage – hydropower dams on the mainstem Columbia River, Methow River mainstem and tributary irrigation dams, and historic splash dams altered channel structure, floodplains, and impede fish passage.

Water Quality

- (7) Water Quality Impairment (legacy and current) – management has led to 303(d) listed reaches with water quality degradation. Standards are frequently not met in FMO areas. Irrigation returns, runoff, application of pesticides/herbicides/deicer impacts occur in adjacent FMO and several SR areas.
- (8) Climate Change – current science predicts temperature changes will impact stream flow and temperature patterns. Quality of the lower elevation SR habitat and FMO will be further degraded (stream temperatures, turbidity, sediments, dissolved oxygen levels).

Demographic

Connectivity Impairment

- (9) Agriculture – irrigation diversions cause impacts to fish passage entrainment. Some reaches within SR and FMO have listed 303(d) reaches. Stream temperature and agriculture chemicals have legacy and current impacts that reduce habitat complexity and degrade connectivity of bull trout habitat.
- (10) Forest Management/Transportation Networks (legacy and current) – forest roads/highways/county roads continue to impair connectivity for migration. Forest Management and Transportation Networks have impeded passage and contributed to a lack of complex habitat.
- (11) Dewatering – several streams natural dewater during times of low snowpack/rain and may be further impacted with climate change and management impacting these populations.
- (12) Entrainment (hydropower and diversions)/Fish Passage/Altered Flows – entrainment and altered flows occur at all PUD and Federal hydropower dams on the Columbia River and at other diversions/dams in the Methow Core Area where, fish passage is impeded, causing altered movement from SR and migration areas. Altered flows and climate change have caused reduced or limited use of migratory corridors.

- (13) Climate Change – climate change is predicted to impact stream flows and temperatures that will cause barriers for passage and reduced refuge.

Fisheries Management

- (14) Angling/Harvest/Poaching – fishing regulations and harvest rules need to continue to protect bull trout. Illegal poaching occurring in several basins.
- (15) Fisheries Management – increased fish management and need for fish monitoring cause increased handling impacts. Species interactions from hatchery fish are likely; degree of impacts is unknown.

Small Population Size

- (16) Genetic/Demographic Stochasticity – half of the local populations in the basin are small and unstable or stable at very low numbers. Several populations are at the lowest they have been in years.
- (17) Loss/Altered Migratory Life History – life histories have been altered due to long-term impediment of fish passage at long-time PUD dams and irrigation diversions.
- (18) Fisheries Management – species interactions from hatchery-released smolts/fishes and overlapping adult spawners may be greatest on low abundance populations.

Forage Fish Availability

- (19) Fish Passage/Introduced Species/Fish Management – Columbia River dams, irrigation diversions, and legacy splash dams or other culverts currently or historically impeded passage for potential native prey species (i.e., other salmonids). Hatchery releases may both impact and benefit bull trout especially where low numbers of bull trout exist. Brook trout outcompete bull trout for habitat and food.

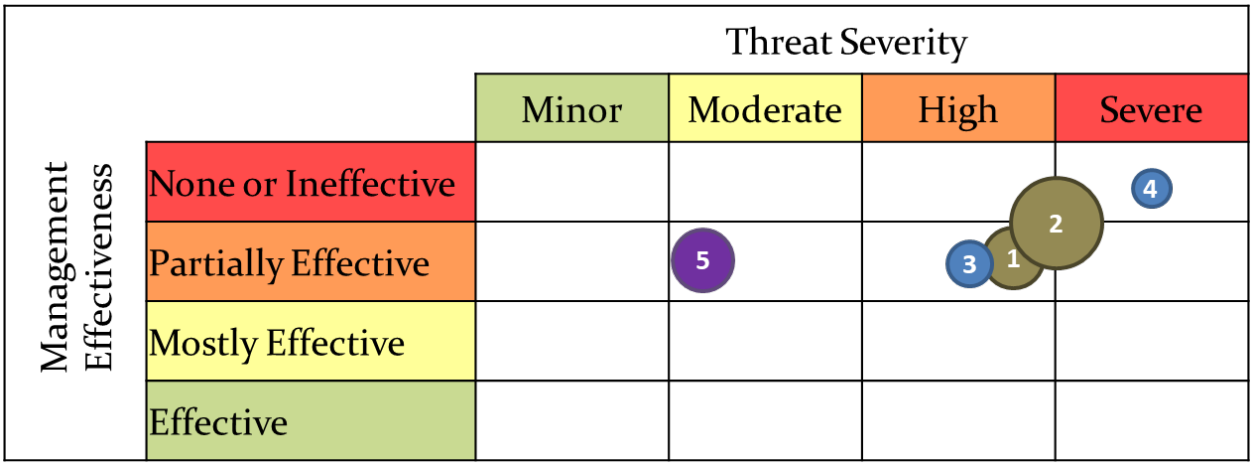
Nonnatives

Nonnative Fishes

- (20) Introduced Species/Fish Management – brook trout are nonnative predators in the basin and will impact recovery. Brook trout overlap with bull trout in both SR and FMO habitat. Distribution is unknown. Fisheries for brook trout continue to occur. Salmon recovery involves output of high numbers of smolts, with some residualization and species competition, which may have impacts to preybase and small populations of bull trout. Genetic analysis has identified brook trout x bull trout hybrids within the basin.
- (21) Climate Change – predatory nonnative species occur within FMO habitats and risk potential spread especially as waters warm with climate change.

MC09 – Middle Fork John Day Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy timber harvest, mining, livestock grazing, and loss of beaver have resulted in warm water temperatures, loss of cold water storage, degraded channel networks, and a lack of structural integrity.

Water Quality

- (2) Forest management practices, livestock grazing, mining, and loss of beaver have resulted in warm water temperatures and low flows in rearing areas and FMO habitat limiting movement and distribution.

Demographic
Connectivity Impairment

- (3) Temperature barriers in the Middle Fork John Day River, as well as passage issues at diversions, old log weirs, and road culverts in the tributaries impair connectivity between populations.

Small Population Size

- (4) Putative declines in recent years have put populations in the core area at higher risk of genetic and demographic stochasticity.

Nonnatives
Warm Water Fish

- (5) Smallmouth bass are present in the core area (lower river) and could reduce bull trout survival through predation and competition for prey.

MC10 – North Fork Clearwater River Core Area

Threats Assessment Results

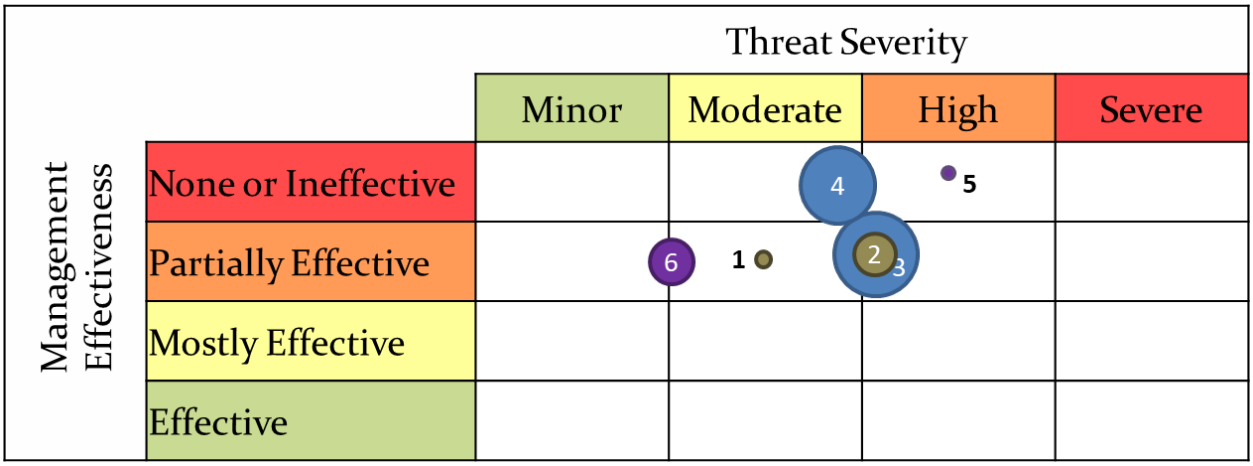
NA

Threats Summary

NA

MC11 – North Fork John Day Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy and current mining activities, livestock grazing, forest management, and agricultural impacts have resulted in high water temperatures, sedimentation, degraded channel networks and loss of instream complexity.

Instream Impacts

- (2) Current and legacy mining activity has disconnected streams from floodplain and interrupted natural hydrology, impacting water quality and stream temperature in FMO habitats.

Demographic
Connectivity Impairment

- (3) Fish passage issues at culverts, temperature barriers, and entrainment impact bull trout migratory behavior.

Small Population Size

- (4) Putative declines in recent years have put populations in the core area at higher risk of genetic and demographic stochasticity.

Nonnatives
Nonnative Fishes

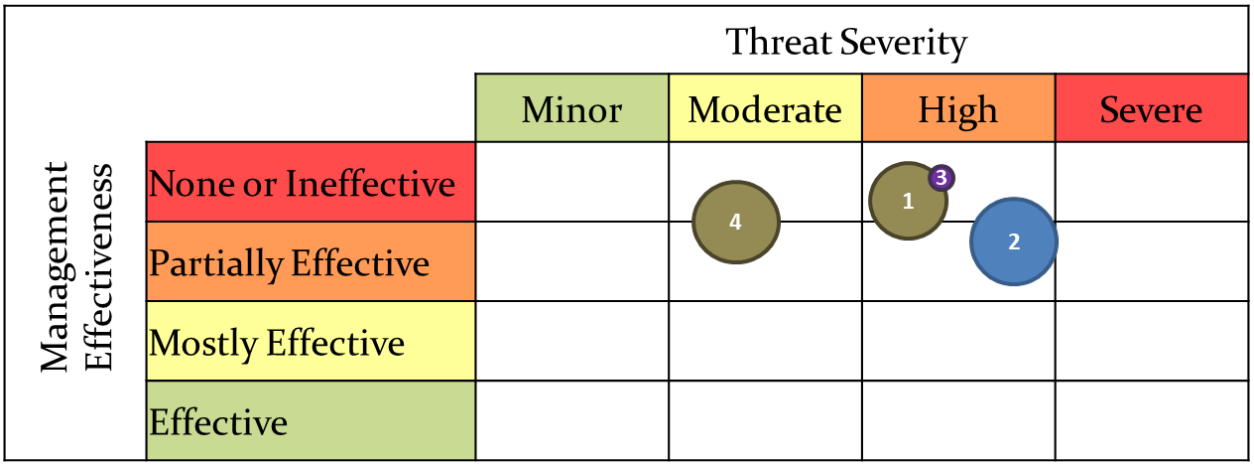
- (5) Hybridization and competition with Brook trout pose a serious risk to bull trout. Brook trout are widespread.

Warm Water Fish

- (6) Smallmouth bass are present in the core area (lower river) and could reduce bull trout survival through predation and competition for prey.

MC12 – Pine/Indian/Wildhorse Core Area

Threats Assessment Results



Threat Summary

Habitat
Upland/Riparian Land Management

- (4) Current grazing regime in Pine Creek directly results in trampling of redds.

Instream Impacts

- (1) Dewatering caused by numerous diversions has resulted in significantly reduced stream flow and elevated stream temperatures directly impacting the migratory life history.

Demographic
Connectivity Impairment

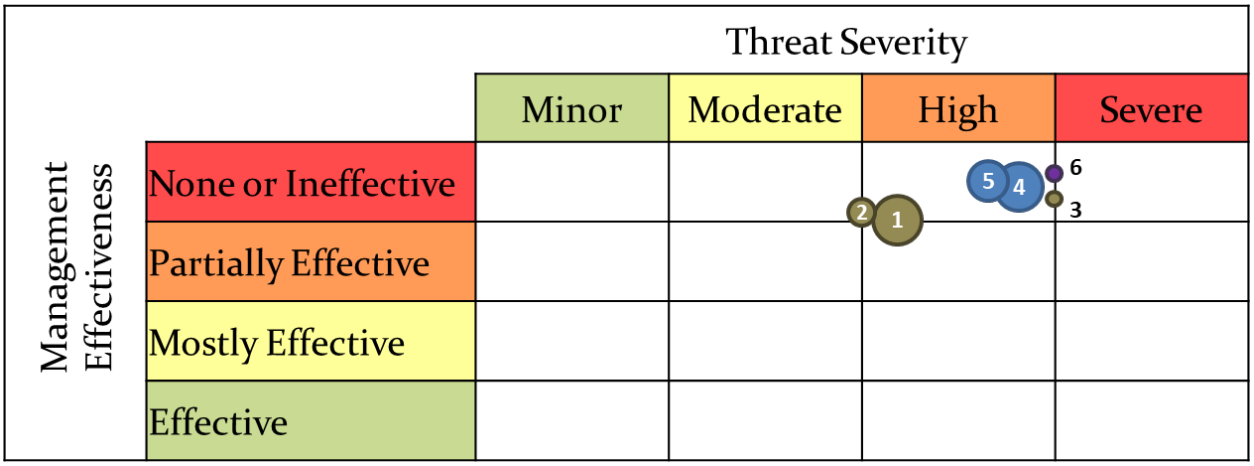
- (2) Dewatering, entrainment, and passage barriers caused by water diversions and impeded connectivity. Oxbow and Hells Canyon Dams isolate Wildhorse Creek from other populations in the core area and prevent connection to other core areas.

Nonnatives
Nonnative Fishes

- (3) Hybridization and competition with brook trout are serious threats to bull trout. Brook trout are widespread and abundant throughout the core area.

MC14 – Powder River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Agricultural practices, legacy forest management practices (including roads) and livestock grazing have resulted in high water temperatures, sedimentation, and loss of floodplain connection and instream complexity in bull trout habitats.

Instream Impacts

- (2) Agricultural practices and mining activities have degraded the stream channel and pose a risk of chemical contamination.

Water Quality

- (3) Dewatering and high water temperatures as a result of intense land use activities mentioned above create inhospitable conditions for bull trout in FMO habitats during summer months. Increased water temperatures and loss of available habitat due to climate change are predicted as a high risk to this core area.

Demographic
Connectivity Impairment

- (4) Fish passage issues and entrainment at dams, diversions, and culverts, as well as dewatering and temperature barriers impair connectivity between spawning populations and FMO habitats.

Small Population Size

- (5) Small populations isolated in headwater streams are at high risk of genetic and demographic stochasticity, and the loss of the migratory life history threatens persistence.

Nonnatives
Nonnative Fishes

- (6) Hybridization and competition with brook trout are serious threats to bull trout. Brook trout are widespread and abundant throughout the core area.

MC15 – Selway River Core Area

Threats Assessment Results

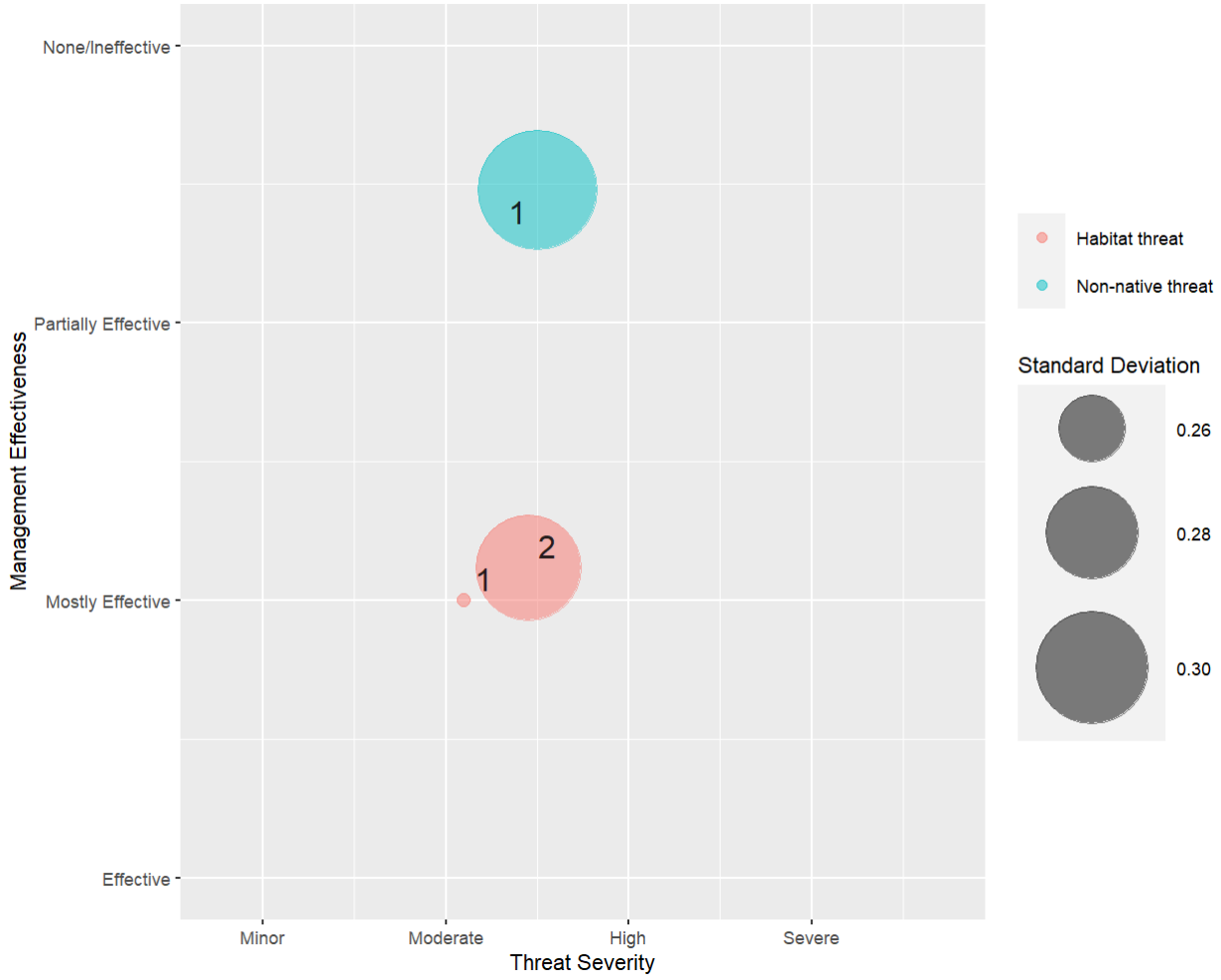
NA

Threats Summary

NA

MC16 – South Fork Clearwater River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Legacy impacts from forest practices, roads, and mining, as well as transportation corridors (historical and current) contribute to degradation in some SR tributaries and mainstem FMO habitat. Agricultural practices and improper grazing degrade habitat primarily in lower mainstem FMO habitat.

Instream Impacts

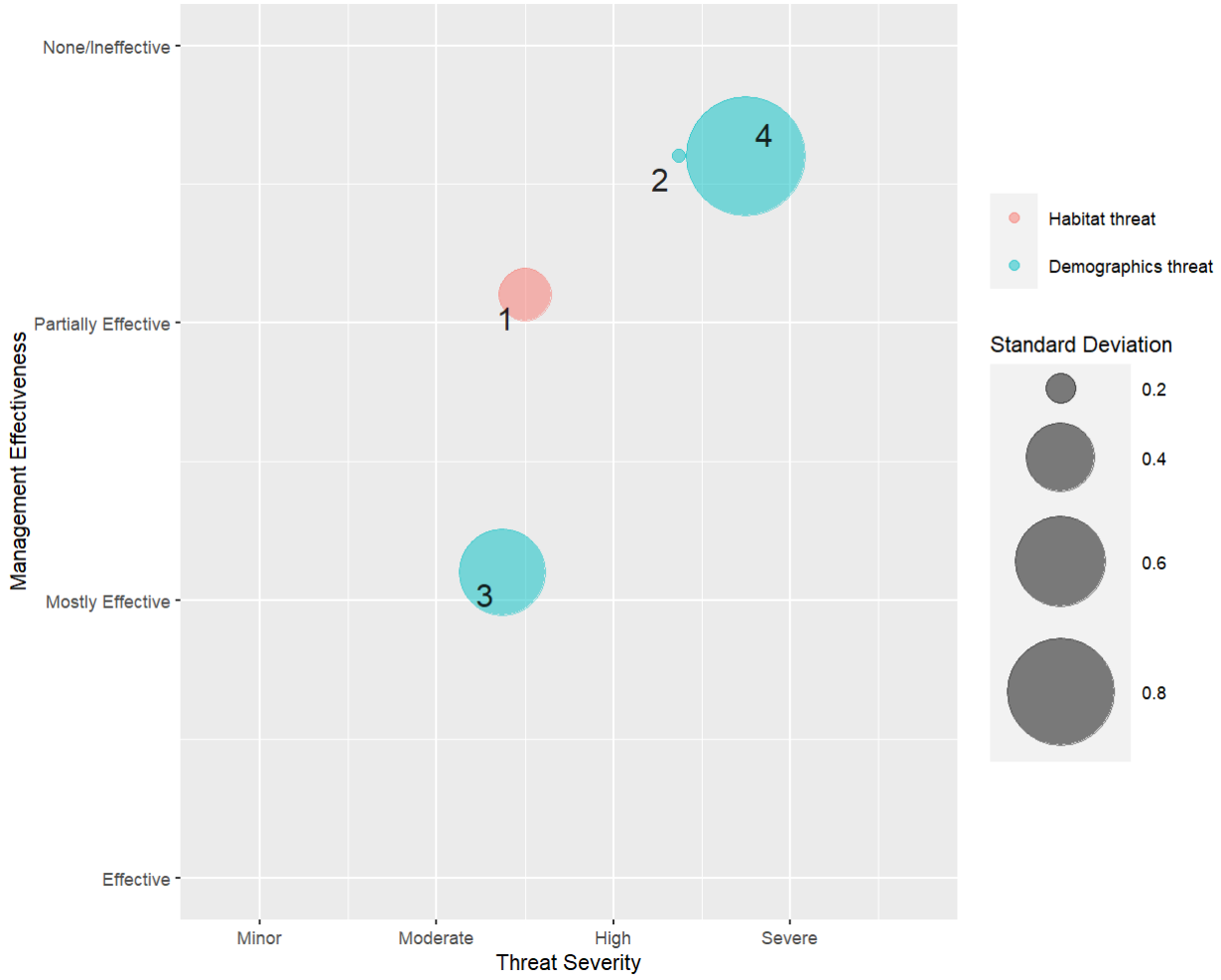
- (2) Activities such as forest practices, mining, roads, and grazing in upland and riparian areas have contributed to instream degradation, loss of LWD, pool reduction, and sedimentation.

Nonnatives
Nonnative Fish

- (1) Brook trout in some SR tributaries (e.g., upper Crooked and Red Rivers), and mainstem FMO habitats contributing to competition, predation, range reduction, and possible hybridization.

MC17 – South Salmo River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy and ongoing forestry and mining practices (roads, sediment) and development causing loss of wood, pool reduction, potential contaminants, and instream degradation within the Canadian portions; coordinate with British Columbia.

Demographic
Connectivity Impairment

- (2) Impacts to connectivity from artificial and natural barriers to historically connected wetlands and tributaries as a result of development, road systems, beaver activity, and subsurface flows; coordinate with Canada.

Fisheries Management

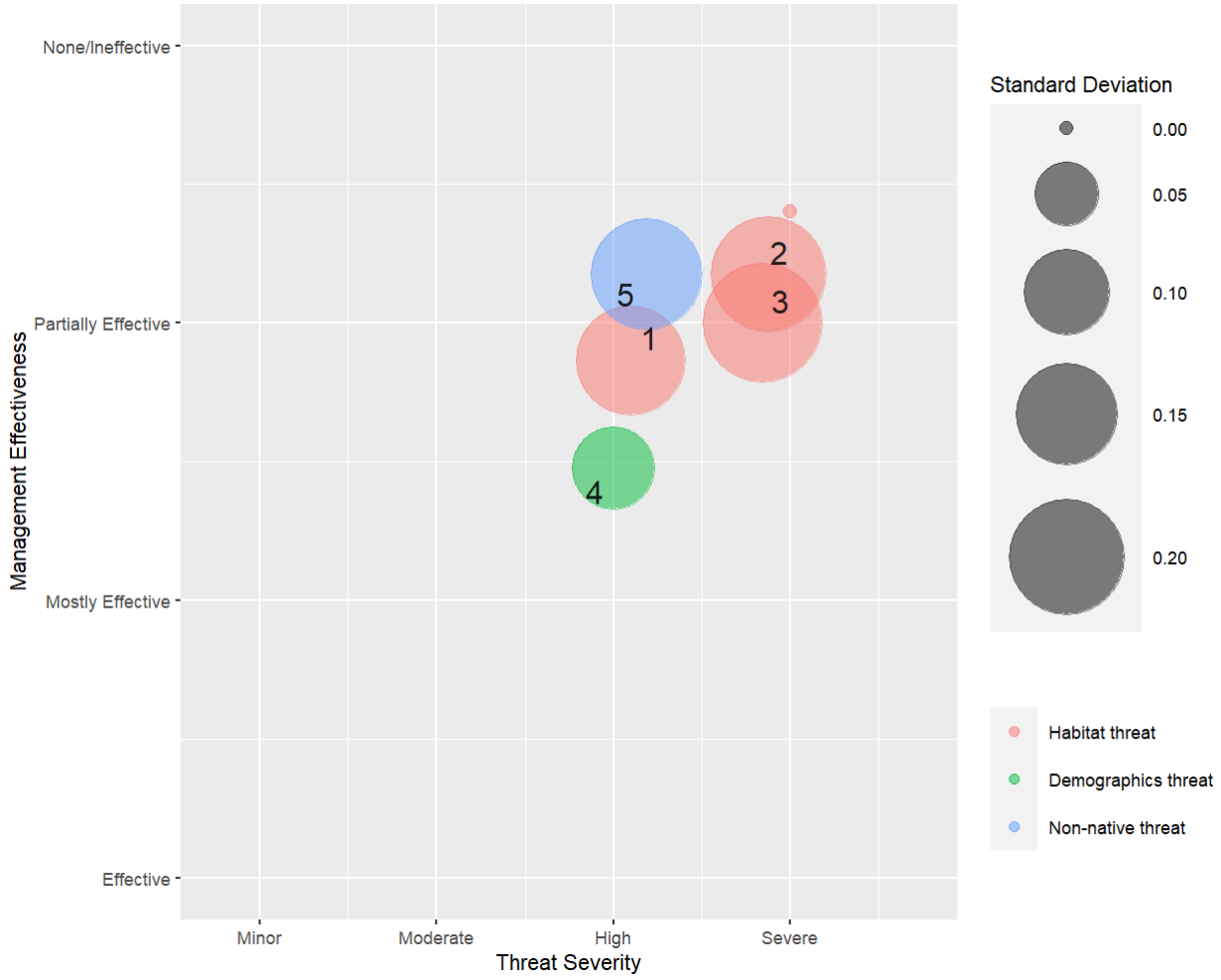
- (3) Legacy impacts of overharvest and current illegal harvest in Canada that may also occur at international border; coordinate with British Columbia.

Forage Fish Availability

- (4) Loss of and limited availability of preybase, nutrients, and native salmon due to downstream barriers on mainstem Pend Oreille and Columbia Rivers; coordinate with British Columbia.

MC18 – Touchet River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Transportation network, rural and urban development, agriculture, logging, and recreational (e.g., campground, ski resort) impact the riparian buffers, leading to reduced shade, increased runoff, sedimentation, and water temperatures, plus changes to water discharge levels. Legacy and new recreational development impacted SR habitat with recreational rock dam building, reduced riparian areas, and compacted stream banks, and reduced habitat complexity.

Instream Impacts

- (2) Flood control and transportation networks have led to channelization, loss of floodplain connectivity, levee installation, and loss of habitat complexity and diversity throughout the entire core area, especially in the lower Touchet River.

Water Quality

- (3) Contaminants, sedimentation, and temperature impairments both from current and legacy practices throughout the watershed have reduced habitat availability and suitability. Existing and predicted future elevated temperatures in the river create thermal barriers to migration and are anticipated to worsen based on forecasted climate modeling.

Catastrophic Fire

- (6) Altered fire regimes, including recent higher intensity and severity fires, resulting in loss of riparian vegetation, increased sedimentation, and increased water temperatures.

Demographic

Connectivity Impairment

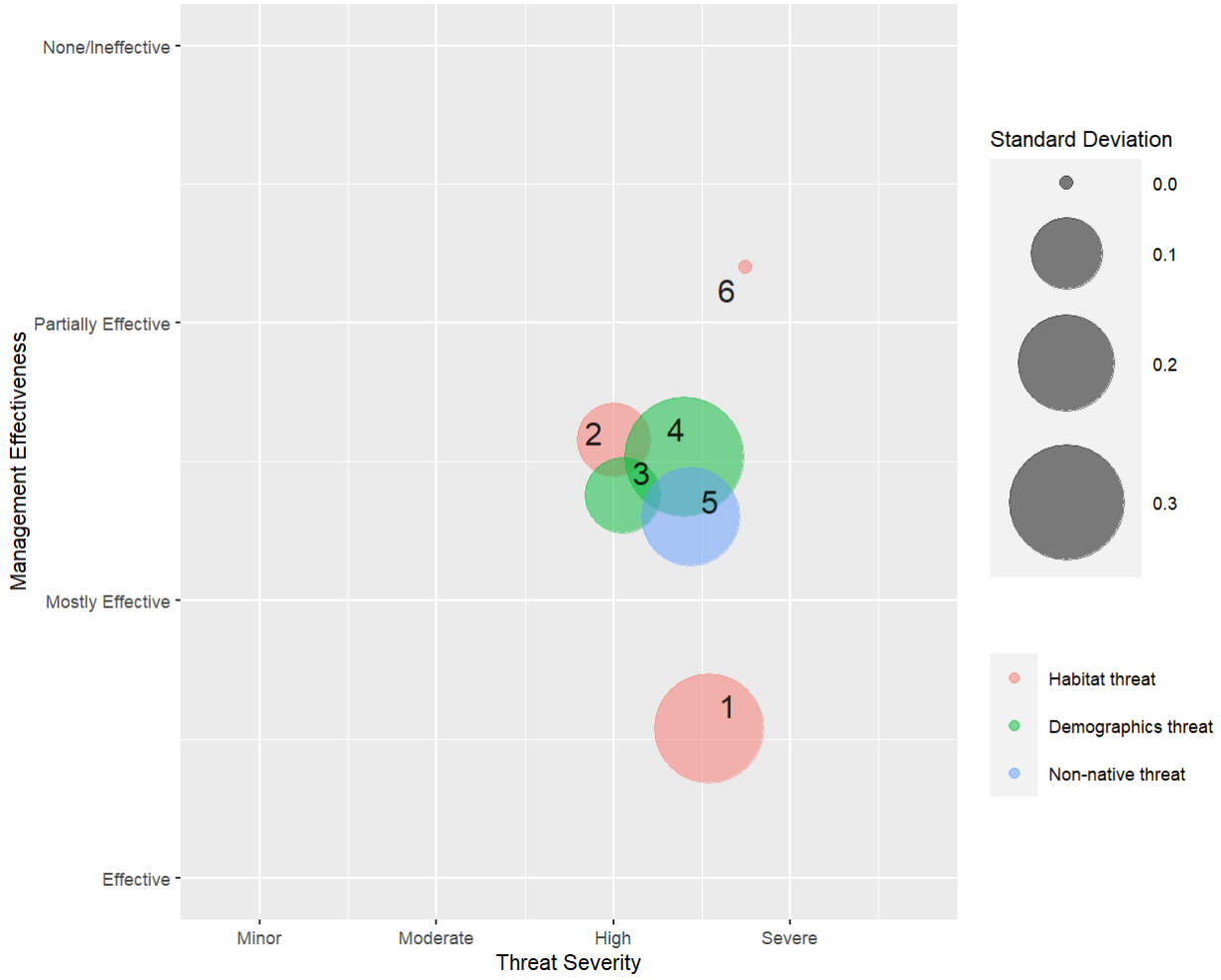
- (4) Barriers at the Dayton Steelhead Acclimation Pond Dam and on private property prevent or limit free movement and connectivity between FMO and SR areas, as well as movement between the Walla Walla and Touchet Core Areas.

Forage Fish Availability

- (5) Predatory species, such as smallmouth bass and walleye, in FMO areas of the lower Touchet River and mainstem Walla Walla River. Competing species, including hatchery origin rainbow trout and brown trout, in FMO and SR areas. As waters warm in climate change scenarios, conditions supporting nonnatives are likely to spread.

MC19 – Tucannon River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Agricultural and forest practices, transportation networks, and rural and urban development have eliminated or reduced riparian cover and protective buffers, resulting in the loss of habitat complexity, and increased water temperatures.

Instream Impacts

- (2) Flood control and transportation networks have led to channelization, loss of floodplain connectivity, levee installation, and loss of habitat complexity and diversity throughout the entire core area.

Water Quality

- (3) Contaminants, sedimentation, and temperature impairments both from current and legacy agricultural, recreational, forestry, and transportation practices in the watershed have reduced habitat availability and suitability. Reduction of habitat suitability due to climate change is predicted as high risk in the core area.

Catastrophic Fire

- (6) Altered fire regimes, including recent higher intensity and severity fires, resulting in loss of riparian vegetation, increased sedimentation, and increased water temperatures.

Demographic
Connectivity Impairment

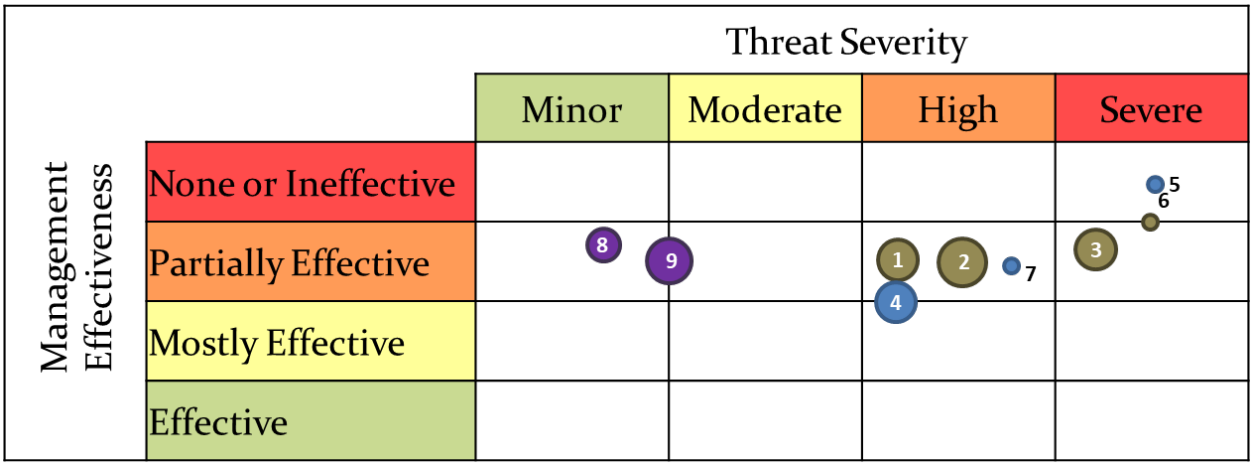
- (4) Thermal and manmade barriers prevent or limit free movement and connectivity between FMO and SR areas. Hydropower facilities on the mainstem Snake River delay migration or hinder free movement of bull trout among core areas.

Nonnatives
Nonnative Fishes

- (5) Predatory species such as smallmouth bass and walleye in FMO areas of the lower Tucannon River and mainstem Snake River. Competitive/interbreeding species including hatchery origin rainbow trout and Brook trout in FMO and SR areas. Changes in habitat and water temperatures as a result of climate change will likely exacerbate this threat in some areas.

MC20 – Umatilla River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Livestock grazing and agricultural practices, and transportation networks have eliminated or reduced riparian cover, resulting in a loss of habitat complexity and warm water temperatures.
- (6) Potential for catastrophic wildfire in the forested headwaters due to forest management practices. Impacts to bull trout habitat include increased stream temperature and sediment loading.

Instream Impacts

- (2) Transportation networks and agricultural practices have channelized and oversimplified the river channel, eliminating important wetlands and floodplain interaction, decreasing instream flows and increasing water temperatures.

Water Quality

- (3) High instream water temperatures as a result of intense land use activities mentioned above significantly limit summer rearing habitat for migratory fish, the predominant life history type. Increased water temperatures and loss of available habitat due to climate change are predicted as a high risk to this core area.

Demographic
Connectivity Impairment

- (4) Passage barriers in the lower Umatilla River and warm water temperature barriers impede free movement of bull trout between SR areas and FMO habitat.

Small Population Size

- (5) Critically low abundance and an apparent reduction in the resident life history type put the core area at high risk of genetic and demographic stochasticity.

Fisheries Management

- (7) Angling– Incidental catch during steelhead, spring Chinook, and trout fishery and illegal angling.

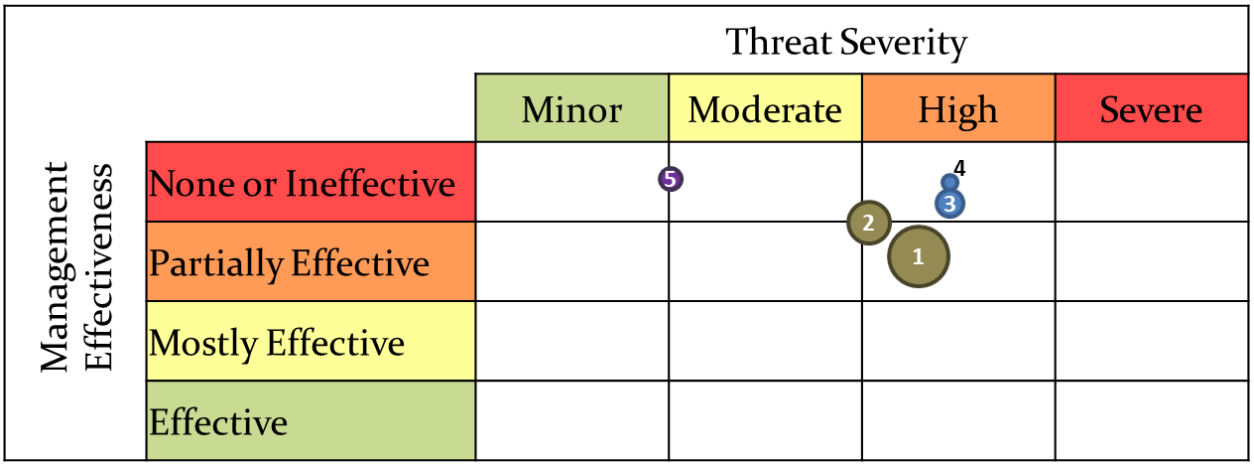
Nonnatives

Nonnative Fishes

- (8) Brook trout present in Meacham Creek, could potentially move into the North Fork Umatilla River.
- (9) Predatory species such as smallmouth bass and walleye in FMO areas of the mainstem Umatilla and Columbia Rivers.

MC21 – Upper Grande Ronde River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Livestock Grazing and Forest Management Practices, including forest roads, have resulted in a lack of large wood recruitment, loss of pools, sedimentation, warm water temperatures and low flows.

Instream Impacts

- (2) Legacy Forest Management Practices, including splash damming, and Agricultural Practices, construction of the State Ditch, have channelized the river channel, reduced instream complexity, and increased water temperature and sedimentation in FMO habitats.

Demographic
Connectivity Impairment

- (3) Temperature Barriers and Low Flows impede movement of bull trout between populations and in FMO habitats.

Small Population Size

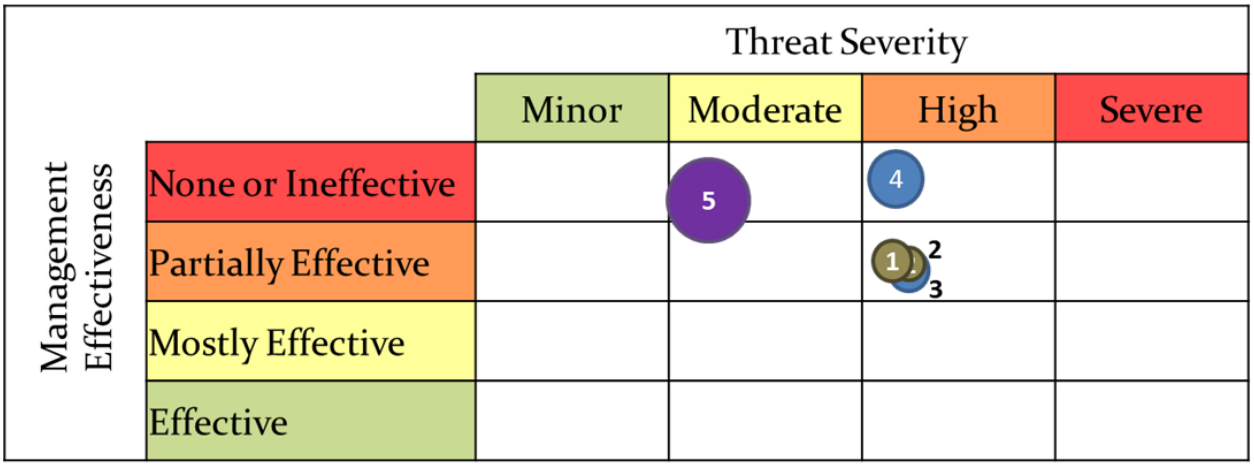
- (4) Populations in the upper basin (upstream of LaGrande) and Indian Creek are small and potentially isolated from other populations. Both are at high risk of genetic and demographic stochasticity, and the loss of the migratory life history further threatens their persistence.

Nonnatives
Nonnative Fishes

- (5) Hybridization and Competition – Brook trout are present in Upper Grande Ronde Lake and occupy streams close to bull trout strongholds in the core area.

MC22 – Upper Mainstem John Day Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy and current livestock grazing and agricultural practices have degraded riparian and instream habitat quality.

Water Quality

- (2) Agricultural practices and livestock grazing (current and legacy) have resulted in increases in instream water temperatures and low flows due to irrigation activities, altered channel conditions, and lack of shade.

Demographic
Connectivity Impairment

- (3) Fish Passage Issues – fish passage and entrainment at diversions and push up dams, as well as low flow conditions and temperature barriers created by irrigation activities, reduce connectivity within and among populations.

Small Population Size

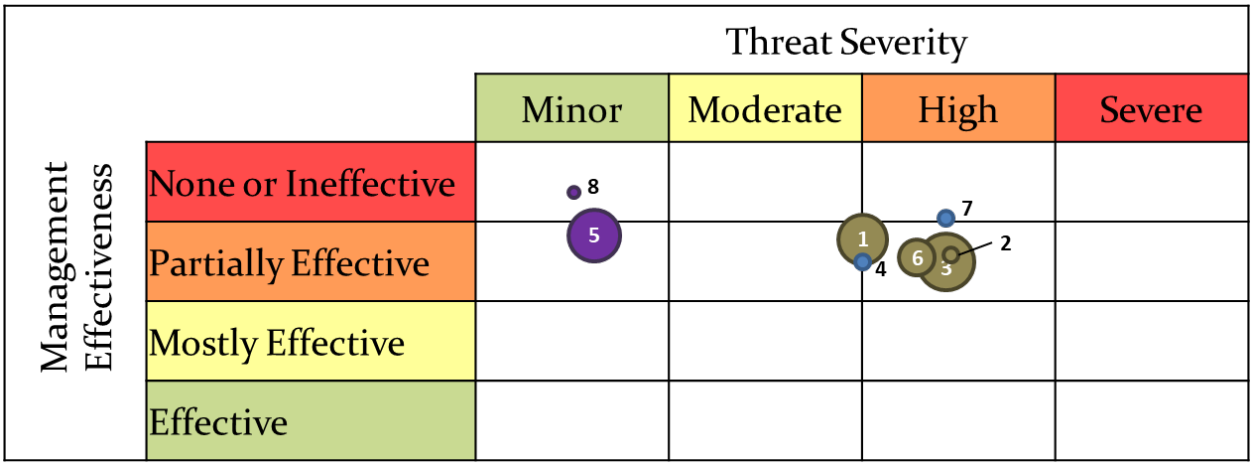
- (4) Critically low abundance and decline in fluvial life history component limit recovery potential and may have deleterious genetic effects.

Nonnatives
Nonnative Fishes

- (5) Hybridization and Competition – Brook trout are present in some streams (Little Meadow) in the core area.

MC23 – Walla Walla River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Agricultural practices, transportation networks, rural and urban developments, and other land management actions have eliminated or reduced riparian cover and protective buffers, resulting in the loss of habitat complexity, increased input of pollutants and storm-water runoff, and increased water temperatures.
- (6) Potential for catastrophic wildfire in Upper Mill Creek and South Fork Walla Walla due to forest management practices. Impacts to bull trout habitat include increased stream temperature and sediment loading.

Instream Impacts

- (2) Flood control and water management activities have eliminated complex channels and floodplain interaction, altered and reduced flows, and increased water temperatures particularly in FMO habitats.

Water Quality

- (3) High instream water temperatures as a result of intense land use activities mentioned above significantly limit FMO for migratory fish. Increased water temperatures and loss of available habitat due to climate change are predicted as a high risk to this core area.

Demographic
Connectivity Impairment

- (4) Entrainment at diversions and passage barriers, as well as temperature barriers and low flows, prevent bull trout from moving freely and easily between FMO and spawning habitats.

Fisheries Management

- (7) Angling – incidental catch and illegal harvest in the steelhead and Chinook fisheries are significant sources of mortality for bull trout in the mainstem and South Fork Walla Walla Rivers.

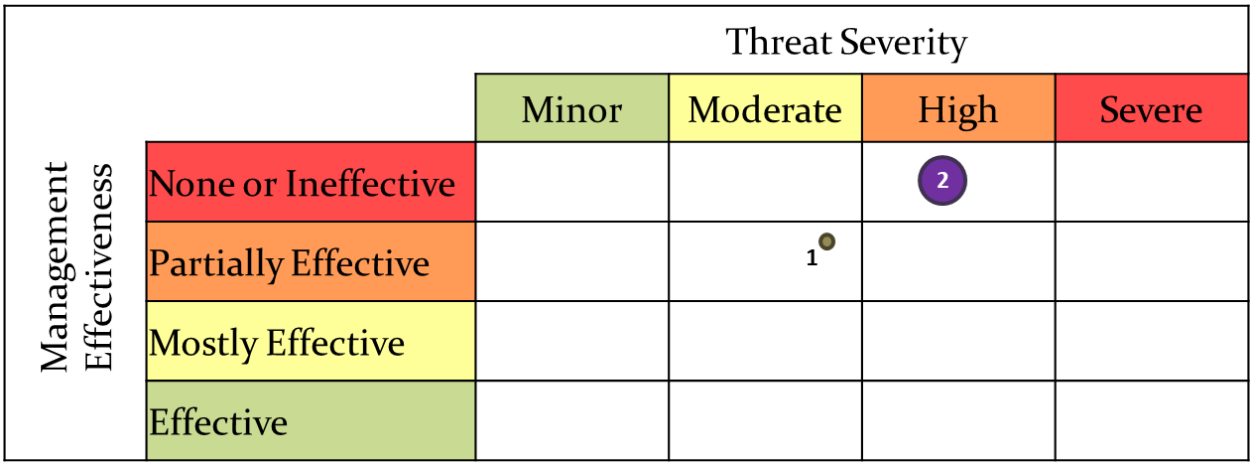
Nonnatives

Nonnative Fishes

- (5) Predatory and competing nonnative species in FMO areas of the mainstem Walla Walla and Columbia Rivers.
- (8) Brook trout were detected in East Big Spring Branch and West Big Spring Branch of the Walla Walla River. The threat is the eventual expansion of these populations into bull trout SR habitat.

MC24 – Wallowa/Minam Core Area

Threats Assessment Results



Threats Summary

Habitat
Water Quality

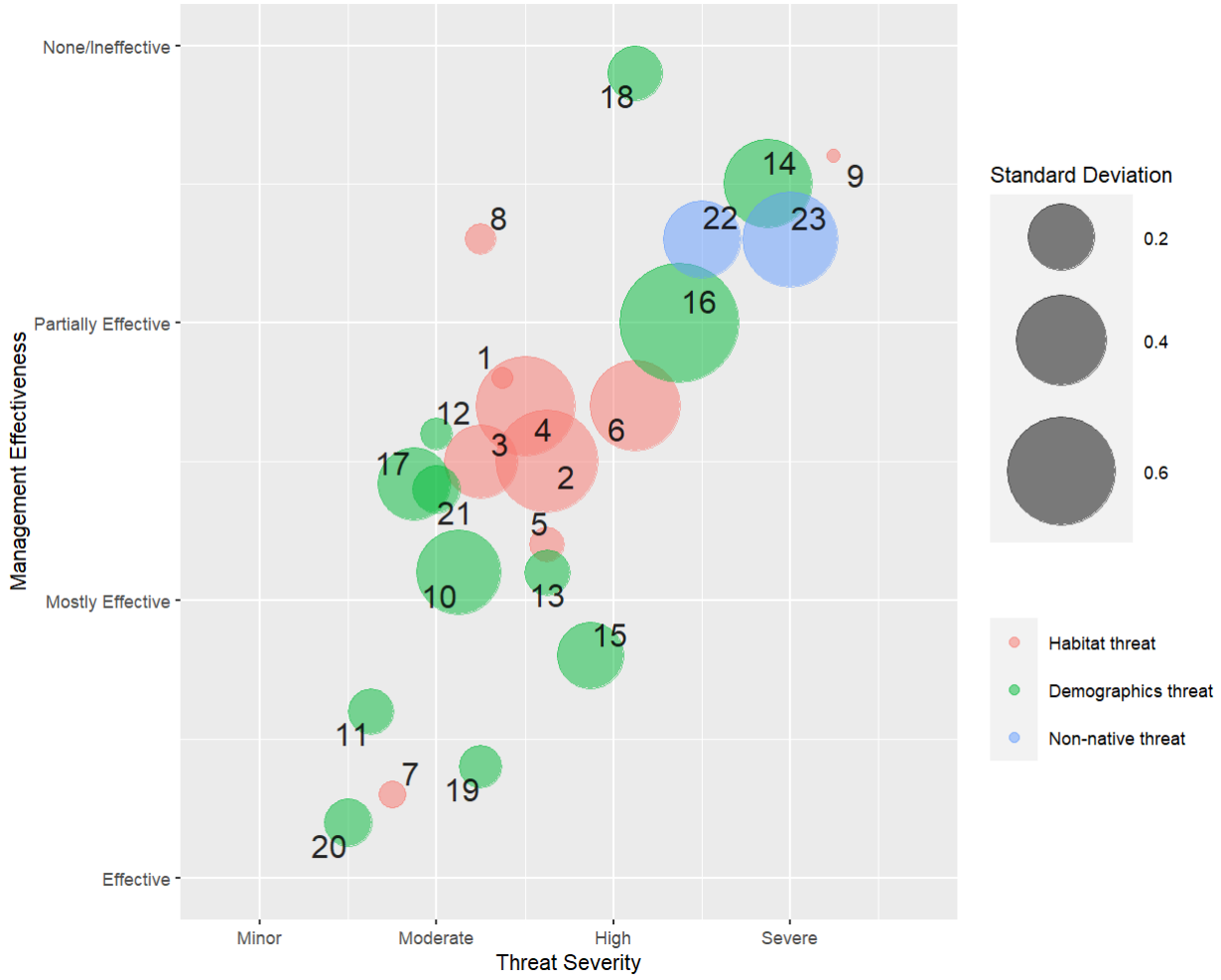
- (1) Agricultural Practices and other land use activities resulted in high water temperatures and low flows that degrade habitat quality and impede connectivity, particularly in FMO habitats.

Nonnatives
Nonnative Fishes

- (2) Brook trout are present in all populations except Deer Creek and negatively impact bull trout.

MC25 – Wenatchee River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Agriculture/Livestock Grazing/Forest Management Practices – legacy and current practices, including forest roads, have resulted in a lack of habitat complexity (i.e., wood, primary pools, functioning floodplains). Agriculture practices have channelized streams, altered floodplains, and reduced riparian vegetation.
- (2) Development/Transportation Networks – legacy and current roads and railroads impact both SR and FMO habitats.
- (3) Recreation – legacy and new recreational developments impact SR habitat (i.e., rock dam building, reduced riparian areas, and compacted stream banks) and reduce habitat complexity.

Instream Impacts

- (4) Agriculture/Forest Management Practices/Grazing/Development/Transportation Networks/Recreation – legacy and current management actions have degraded habitat, impacted stream channels, altered fish passage, reduced water flows, and constricted floodplains. Legacy timber, fire, recreation, and grazing management have added impacts to sediments, reduced riparian areas, and stream temperatures. Current grazing management plans need to be maintained and improved in spawning and FMO areas. Highways, county roads along FMO, and development reduce complexity, create passage issues, and degrade water quality.
- (5) Dewatering and Altered Flows – there are reaches of stream in FMO SR areas that naturally dewater and are further impacted during low flow years. Mainstem diversion dams have also altered instream flows and water quality.
- (6) Entrainment and Connectivity/Fish Passage – hydropower dams on the mainstem Columbia River, irrigation dams, historic dams (i.e., Tumwater Dam), and splash dams altered channel structure, cause harm, and impede fish passage.
- (7) Mining Impacts – legacy and current suction dredging practices lead to increased sediments and altered SR habitat.

Water Quality

- (8) Water Quality Impairment – both legacy and current management have led to 303(d) listed reaches with water quality degradation. Standards are frequently not met in FMO areas. Irrigation returns, runoff, application of pesticides/herbicides/deicer impacts occur in adjacent FMO and several SR areas.
- (9) Climate Change – current science predicts temperature changes will impact stream flow and stream temperature. Quality of the lower elevation SR habitat and FMO will be further degraded (i.e., stream temperatures, turbidity, sediments, dissolved oxygen levels).

Demographic

Connectivity Impairment

- (10) Agriculture – irrigation diversions cause fish passage barriers and entrainment. Some reaches within SR and FMO have listed 303(d) reaches. Stream temperature and agriculture chemicals have legacy and current impacts to FMO habitat and reduce complex habitat and impact connectivity of bull trout habitat.
- (11) Forest Management/Grazing/Recreation/Transportation Networks – legacy and current forest roads/highways/county roads continue to impair connectivity for migration. Forest Management and Transportation Networks have impeded passage and have reduced habitat complexity.
- (12) Dewatering – stream reaches naturally dewater during times of low snowpack/rain and may be further impacted with climate change.
- (13) Entrainment (hydropower and diversions)/Fish Passage/Altered Flows – entrainment and altered flows occur at all hydropower dams on the Columbia River

and at other diversions/dams in the Wenatchee Core Area where fish passage is impeded. Some passage barriers alter timing and migration from SR to migration areas. Altered flows and climate change have or will have caused reduced or limited use of some migratory corridors.

- (14) Climate Change – climate change is predicted to impact stream flows and temperatures that will cause barriers for passage and reduced refuge.

Fisheries Management

- (15) Angling/Harvest/Poaching – fishing regulations and harvest rules have improved but need to continue to protect bull trout. Illegal poaching occurring in several basins.
- (16) Introduced Species – brook trout overlap with bull trout in both SR and FMO habitat.
- (17) Fisheries Management – increased fish management and need for fish monitoring cause increased handling impacts. Species interactions from hatchery fish are likely, especially in areas of overlap with bull trout populations; the degree of impacts is unknown.

Small Population Size

- (18) Genetic/Demographic Stochasticity – half of the local populations in the basin are small and unstable or stable at very low numbers.
- (19) Loss/Altered Migratory Life History – life histories have been altered due to long-term impediment of fish passage at long-time diversion dams.
- (20) Fisheries Management – species interactions from hatchery-released smolts/fishes and may be greatest where they overlap with low abundance bull trout populations.

Forage Fish Availability

- (21) Fish Passage/Introduced Species/Fish Management – Columbia River dams, irrigation diversions, and legacy splash dams or road culverts currently or historically impede passage for potential prey species. Hatchery releases may both impact and benefit bull trout (especially where low numbers of bull trout exist). Lake trout, brown trout, and brook trout outcompete bull trout for habitat and food.

Nonnatives

Nonnative Fishes

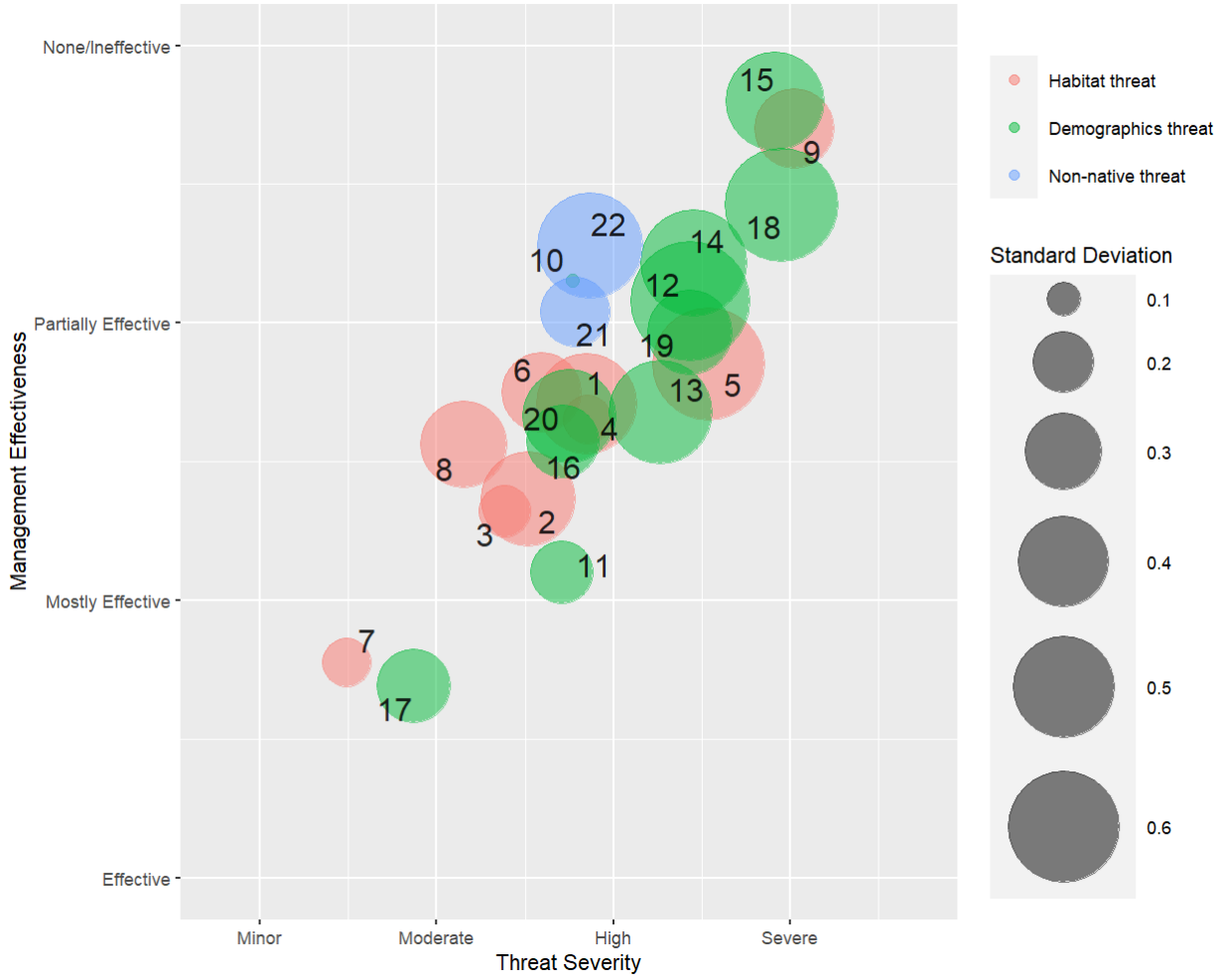
- (22) Introduced Species/Fish Management – lake trout, brown trout, and brook trout are nonnative predators in the basin and impact recovery. Brook trout overlap with bull trout in both SR and FMO habitat. The distribution of lake trout and brown trout is unknown and may alter with climate change. Fisheries still occur on lake trout, brown trout, and brook trout. Genetic analysis has identified brook trout x bull trout hybrids within the basin.

  Salmon recovery involves output of high numbers of smolts, with some residualization and species competition, which may have impacts to preybase and small populations of bull trout.

- (23) Climate Change – predatory nonnative species occur within FMO habitats and risk potential spread especially as waters warm with climate change.

MC26 – Yakima River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Agriculture/Livestock Grazing/Forest Management Practices – legacy and current practices, including forest roads, have resulted in a lack of habitat complexity (i.e., wood, primary pools, functioning floodplains). Agriculture practices have channelized streams, altered floodplains, and reduced riparian vegetation.
- (2) Development/Transportation Networks – legacy and current structures and features impact both SR and FMO habitat.
- (3) Recreation – legacy and new recreational developments impact SR habitat with rock dam building, reduced riparian areas, and compacted stream banks, and reduced habitat complexity.

Instream Impacts

- (4) Agriculture/Forest Management Practices/Grazing/Development/Transportation Networks/Recreation – legacy and current management actions have degraded habitat, impacted stream channels, altered fish passage, reduced water flows, and constricted floodplains. Legacy timber, fire, recreation, and grazing management have degraded stream reaches, contributed to sedimentation, recued riparian areas, and contributed to high stream temperatures. Current grazing management plans need to be maintained and improved in spawning areas. Highways, county roads along FMO, and development reduce habitat complexity and degrade water quality.
- (5) Dewatering and Altered Flows – some streams dewater and are impacted during low flow years. Current operation of large BOR reservoirs, mainstem diversion dams, and private irrigators have altered instream flows and contribute poor water quality. Water management and flood control have simplified river channels, eliminating important wetlands and floodplain connectivity in FMO habitat (*Note*; see above threats).
- (6) Entrainment and Connectivity/Fish Passage – irrigation dams and diversions have altered channel structure and complexity.
- (7) Mining Impacts – legacy and current suction dredging practices lead to increased sediments and reduced complexity.

Water Quality

- (8) Water Quality Impairment – both legacy and current management has led to 303(d) listed reaches with water quality degradation. Standards are frequently not met in FMO areas. Irrigation returns, runoff, application of pesticides/herbicides/deicer impacts occur adjacent to FMO and several rearing areas.
- (9) Climate Change – current science predicts temperature changes will greatly impact stream flow/temperature patterns in the Yakima basin. Quality of the lower elevation SR habitat and FMO are at risk and are predicted to be further degraded.

Demographic
Connectivity Impairment

- (10) Agriculture – the Yakima basin has impassable dams built as part of irrigation. Many 303(d) listed reaches occur across the basin. Stream temperature and agriculture chemicals have legacy and current impacts that reduce quality of FMO and degrade connectivity for bull trout populations.
- (11) Forest Management/Grazing/Recreation/Transportation Networks – legacy and current forest roads/highways/county roads continue to impair connectivity for migration. Grazing in spawning areas disrupts and causes trampling of redds. Recreation areas have user-built rock dams blocking passage. Forest Management and Transportation Networks have blocked and impeded passage.
- (12) Dewatering – stream reaches dewater in several SR and FMO areas during times of low snowpack/rain and may be further impacted with climate change or additional management impacts.

- (13) Entrainment (hydropower and diversions)/Fish Passage/Altered Flows – entrainment and altered flows from federal and private diversions/dams affect connectivity within FMO and SR areas. Within tributaries, water withdrawals can also affect connectivity. Altered flows and climate change have/will have caused reduced or limited use of migratory corridors in FMO habitats.
- (14) Limited Extent of Habitat – passage is impacted on streams that already have natural limitation(s) of amounts of habitat available.
- (15) Climate Change – climate change is predicted to impact stream flows and temperatures that will cause barriers for passage and reduced refuge.

Fisheries Management

- (16) Angling/Harvesting/Poaching – fishing regulations and harvest rules need to continue to protect bull trout. Illegal poaching occurring in several basins.
- (17) Fisheries Management – increased fish management and need for fish monitoring cause increased handling impacts.

Small Population Size

- (18) Genetic/Demographic Stochasticity – most populations in the basin are small and unstable or stable at very low numbers. Some are disconnected due to fish passage barriers at BOR's Yakima Irrigation Project dams and diversions, and road culverts that impede passage. Recent downward trends in several populations are a concern.
- (19) Loss/Altered Migratory Life History – life histories have been altered due to long-term passage impediment(s) and/or total obstruction of fish passage from large mainstem dams operated by BOR, forest practices, and other past actions.

Forage Fish Availability

- (20) Fish Passage/Introduced Species/Fish Management – BOR large dams, diversions, and forest/county/state highway road culverts block passage for potential native prey species. Salmon and steelhead hatchery releases may both impact and benefit bull trout (especially where low numbers of bull trout exist). Lake trout, brown trout, and brook trout outcompete bull trout for habitat and food.

Nonnatives

Nonnative Fishes

- (21) Introduced Species/Fish Management – lake trout, brown trout, and brook trout are nonnative predators in the basin and impact recovery. Salmon recovery involves output of high numbers of smolts, with some residualization and species competition, which may have impacts to preybase and small populations of bull trout. Genetic analysis has identified F2 (brook trout x bull trout) hybrids within the basin.
- (22) Climate Change – predatory nonnative species (lake trout, brown trout, spiny-ray fishes) occur within FMO habitats and risk potential spread especially as waters warm with climate change.

MC27H – Lake Chelan Core Area (Historical)

Threats Assessment Results

NA

Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Agriculture/Livestock Grazing/Forest Management Practices – legacy and current practices, including forest roads, have resulted in a lack of habitat complexity in larger tributaries in lower end of Lake Chelan (i.e., wood, primary pools, functioning floodplains). Agriculture practices have reduced riparian vegetation in lower reach of lake.
- (2) Development/Transportation Networks – legacy and current facilities and roads impact FMO and tributaries in lower end of Lake Basin, Railroad Creek, and Twenty-five mile, and Stehekin.
- (3) Recreation – legacy and current recreational developments impact habitat (i.e., riparian areas, compacted stream banks) and reduce habitat complexity.

Instream Impacts

- (4) Agriculture/Forest Management Practices/Development/Transportation Networks – legacy and current management actions have degraded habitat. Current grazing management plans need to be maintained. Highways, railroads, and county roads along FMO reduce complexity, create passage issues, and degrade water quality.
- (5) Altered Flows – mainstem Columbia River dams, the Chelan Dam and powerhouse, and diversion dams have altered lake levels, instream flows, and water quality.
- (6) Entrainment and Connectivity/Fish Passage – hydropower dams on the mainstem Columbia River, Lake Chelan, and irrigation dams entrained fish, altered habitat, and impacted passage.

Water Quality

- (7) Water Quality Impairment – both legacy and current management have led to 303(d) listed reaches with water quality degradation in Lake Chelan and fish consumption hazards issued. Irrigation returns, runoff, application of pesticides/herbicides affect adjacent fish habitat.
- (8) Climate Change – current science predicts temperature changes will impact stream flow/temperature. The Chelan basin provides for cool water refuge.

Demographic
Connectivity Impairment

- (9) Agriculture/Forest Management – irrigation diversions and dams cause impacts to fish passage and entrainment. Some areas have 303(d) listed reaches. Stream temperature and chemicals have legacy impacts. Legacy and current forest roads/highways/county roads continue to impair connectivity for migration. Forest Management and Transportation Networks have impeded passage and contributed to a lack of complex habitat.
- (10) Entrainment (hydropower and diversions)/Fish Passage – entrainment and altered flows occur at all hydropower dams on the Columbia River, Chelan dam, at the Chelan powerhouse, and at other diversions/dams where, fish passage is fully or partially blocked, causing altered movement patterns. Altered flows/climate change has/will have caused reduced or limited use of migratory corridors.
- (11) Climate Change – climate change is predicted to impact stream flows and temperatures that will cause barriers for passage and reduced refuge. The Chelan basin is predicted to remain a cool water refuge.

Fisheries Management

- (12) Angling/Harvest/Poaching – fishing regulations and harvest rules need to continue to be improved to reduce incidental catch of bull trout. Illegal poaching occurring in several basins, but it is unknown within the Chelan and Columbia Rivers in the vicinity of the Chelan River.
- (13) Fisheries Management – increased fish management and need for fish monitoring cause increased handling impacts. Species interactions from hatchery fish and other nonnative species are likely, degree of impacts is unknown.

Small Population Size

- (14) Loss/Altered Migratory Life History – life histories have been altered due to long-term impediment of fish passage at long-time dams and diversions. Bull trout have not been recently observed in Lake Chelan but use the Chelan River and FMO habitat. Telemetry detected most bull trout visiting the Chelan Hatchery near the mouth of the Chelan River.
- (15) Fisheries Management – species interactions from hatchery-released smolts/fishes may be greatest on low abundance populations and sub-adults. Need to understand food webs and predator-prey relationships.

Forest Fish Availability

- (16) Fish Passage/Introduced Species/Fish Management – Columbia River hydropower dams, irrigation diversions, and legacy splash dams or other culverts currently or historically blocked passage for potential native prey species. Hatchery releases may both impact and benefit bull trout. Lake trout and brook trout outcompete bull trout for habitat and food.

Nonnatives
Nonnative Fishes

- (17) Introduced Species/Fish Management – Lake trout and brook trout are nonnative predators in the basin and will impact recovery. Lake trout and brook trout overlap native/bull trout habitat. The distribution is unknown. Fisheries occur on both lake trout and bull trout.

  Salmon recovery involves output of high numbers of smolts in the Columbia River near the mouth of the Chelan River, with some residualization and species competition, which may have impacts to preybase and small populations of bull trout.
- (18) Climate Change – predatory nonnative species occur within FMO habitats and risk potential spread especially as waters warm with climate change.

MC28H – Eagle Creek (Historical)

Threats Assessment Results

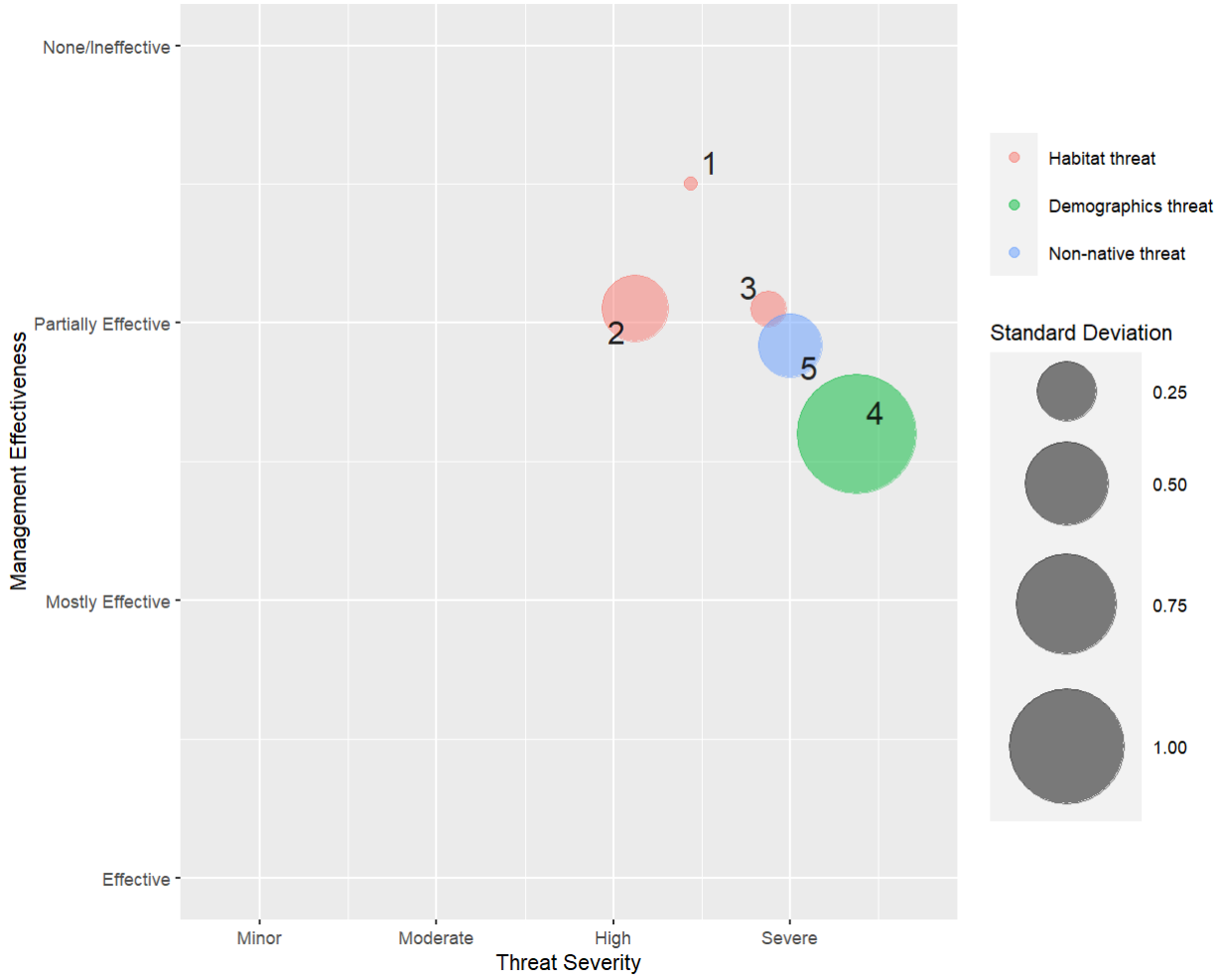
NA

Threats Summary

NA

MC29H – Northeast Washington RNA Core Area (Research Needs Area)

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (3) Historic or current water and land management activities resulting in the loss of riparian habitat sufficient to support wood recruitment, pool formation, and water temperatures needed for spawning, incubation, and rearing in historic tributaries (i.e., Kettle, San Poil, Spokane, Sherman, Sheep, Hawk, and Onion Rivers).

Instream Impacts

- (2) Historic or current water and land management activities resulting in altered flows, channelization, and reduced complexity in historic tributaries (i.e., Kettle, San Poil, Spokane, Sherman, Sheep, Hawk, and Onion Rivers) that support restoration of bull trout populations or forage species.

Water Quality

- (1) Historic water and land management activities resulting in elevated temperatures, sediment, and/or contaminants limiting spawning, incubation, and rearing in historic tributaries (i.e., Kettle, San Poil, Spokane, Sherman, Sheep, Hawk, and Onion Rivers) or mainstem connectivity.

Demographic

Connectivity Impairment

- (4) Manmade barriers within the mainstem Columbia River and its tributaries that prevent or limit free movement and connectivity between FMO and SR areas as well as hinder the historical free movement of bull trout between core areas in the Salmo, Pend Oreille, Methow, Entiat, Wenatchee and, to some extent, the Coeur d'Alene Rivers and suitable habitat and forage within the Northeast Washington Research Needs Area.

Nonnatives

Nonnative Fishes

- (5) Lake Roosevelt and its tributaries have numerous nonnative fish species, which compete with (e.g., coastal rainbow trout, brook trout, lake whitefish) and prey upon (e.g., northern pike, walleye, smallmouth bass) native fishes. Brook trout and other nonnative fish compete with native salmonids in tributaries and represent a hybridization risk for bull trout.

Saint Mary Representative Unit

SM01 – Cracker Lake Core Area

Threats Assessment Results

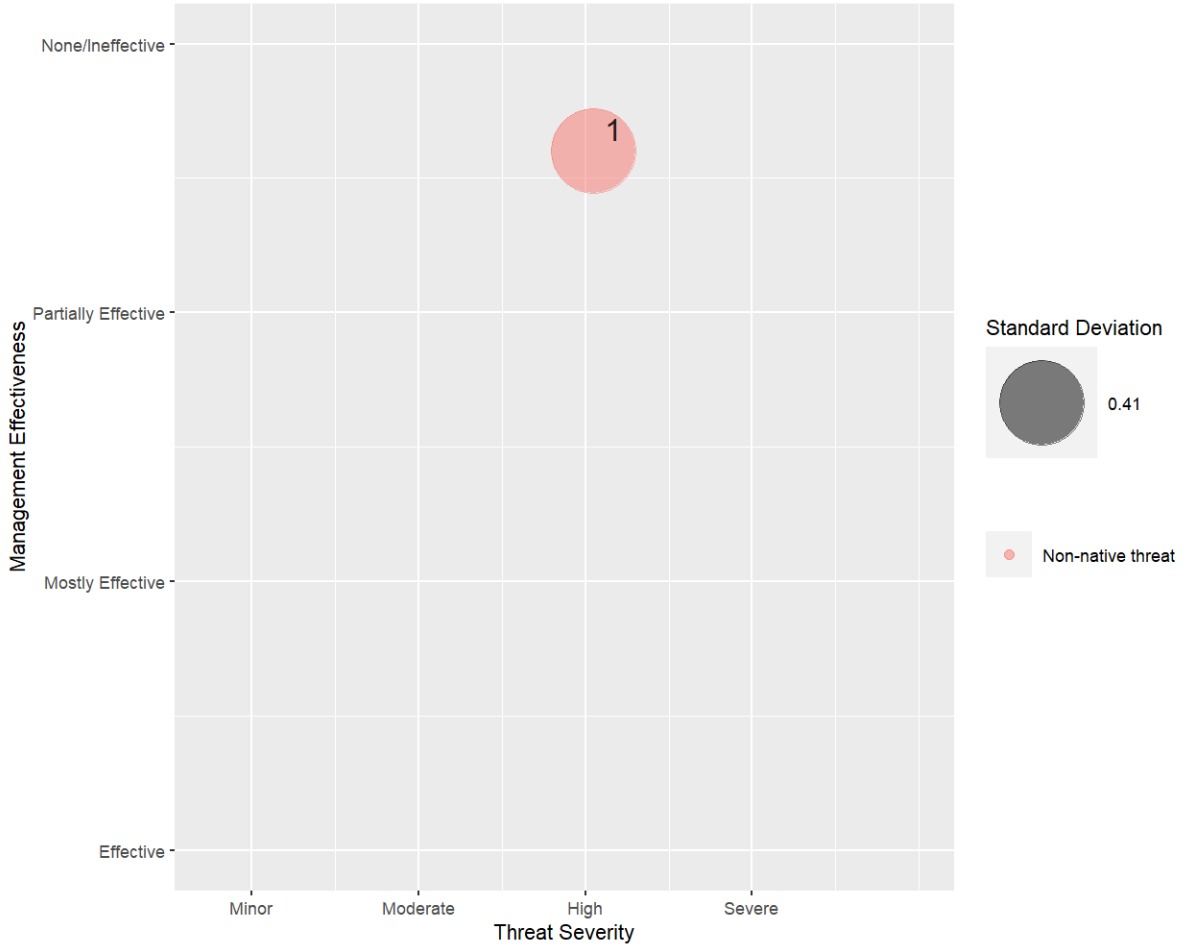
NA

Threats Summary

NA

SM02 – Red Eagle Lake Core Area

Threats Assessment Results



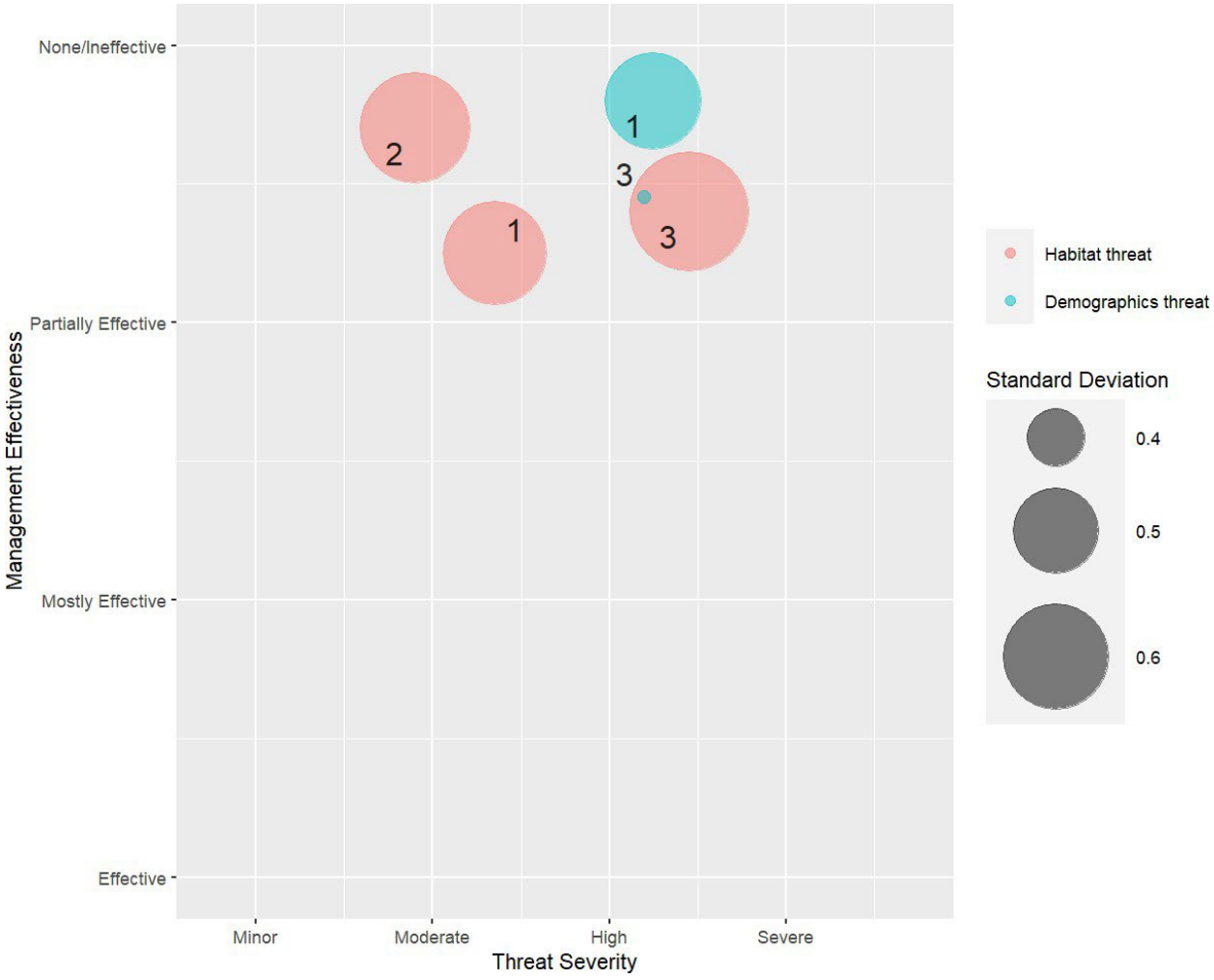
Threats Summary

Nonnatives
Nonnative Fishes

- (1) Hybridization and competition with brook trout are serious threats to bull trout. Brook trout are present in Red Eagle Creek downstream of Red Eagle Lake. A cascade on lower Red Eagle Creek is not likely acting as a year-round barrier, it is likely that brook trout in Red Eagle Creek could migrate to Red Eagle Lake. Red Eagle Lake is considered suitable brook trout habitat. Thus, brook trout migrating into Red Eagle Lake are likely to persist.

SM03 – Saint Mary River Core Area

Threats Assessment Results



Threats Summary

Habitat

Upland/Riparian Land Management

- (1) Trespass livestock grazing along lower reaches of SR tributaries (primarily Kennedy, Otatso, and Lee Creeks) causes riparian and instream degradation, leading to loss of LWD, potential pool reduction, and sedimentation. Redd trampling has been documented in Kennedy Creek and possibly also occurs in other SR tributaries.

  Periodic dredging and diking of the stream channel to reduce bedload along lower Divide Creek, associated with maintenance of residential development in Saint Mary and the NPS compound, along with historical rerouting of the lower channel, perpetually aggravates unstable alluvial deposits contributing to dewatering and potential blockage of upstream fish passage.

Instream Impacts

- (2) Ongoing management of roads and transportation corridors (Saint Mary River, Swiftcurrent Creek, and Divide Creek) impacts FMO habitat by contributing to destabilized stream channels.

Water Quality

- (3) Dewatering of the Saint Mary River mainstem (inter-basin transfer to the Milk River) reduces quality and quantity of FMO habitat and contributes to warmer summer water temperatures downstream of Saint Mary Diversion. Complete seasonal dewatering of Swiftcurrent Creek in winter (non-irrigation season) strands fish (up to 10 bull trout typically salvaged annually, but not all are captured) and reduces availability of FMO habitat, especially for subadult and adult bull trout in winter. Sherburne Reservoir discharges into Swiftcurrent Creek channel for conveyance downstream to Saint Mary Diversion, negatively affecting the thermal regime (warmer summer water temperature) in Swiftcurrent Creek as well as potentially downstream in the Saint Mary River.

Demographic

Connectivity Impairment

- (1) Entrainment of an estimated 470 juvenile bull trout (and a few subadults and adults) occurs annually at the unscreened Saint Mary Diversion, representing by far the most significant primary threat. Upstream passage of pre-spawning adult bull trout is partially blocked (some fish can jump the diversion under certain conditions) during irrigation season, disproportionately impacting Boulder and Divide Creek local populations. Passage improvement is necessary to fully remediate effects of fragmentation and to enhance persistence of bull trout in isolated local populations.

Small Population Size

- (3) Small population size and fragmentation limit annual recruitment and genetic diversity in key SR tributaries in the lower drainage (e.g., Divide Creek).

SM04 – Slide Lakes Core Area

Threats Assessment Results

NA

Threats Summary

NA

Upper Snake Representative Unit

US01 – Anderson Ranch Core Area

Threats Assessment Results

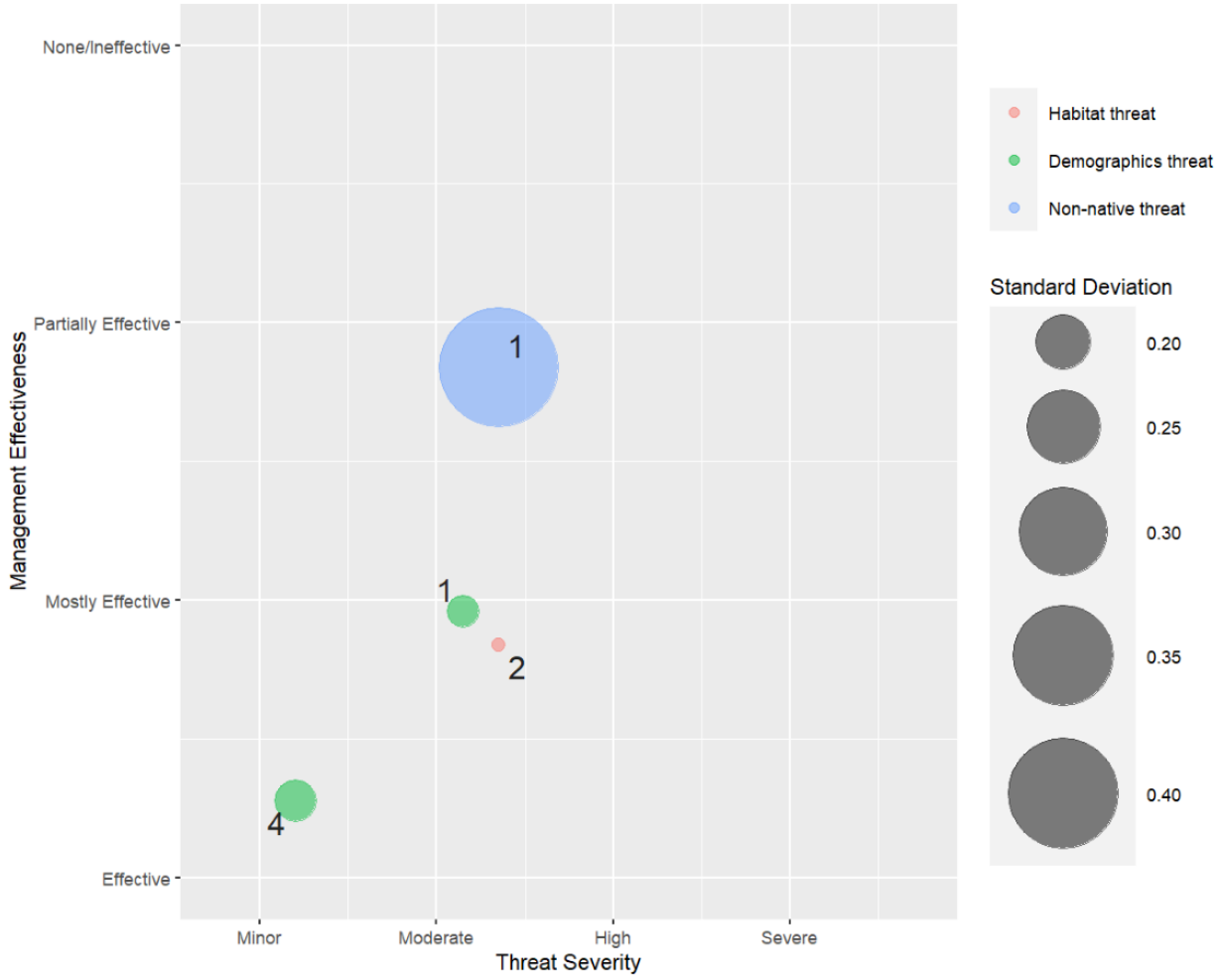
NA

Threats Summary

NA

US02 – Arrowrock Reservoir Core Area

Threats Assessment Results



Threats Summary

Habitat
Instream Impacts

- (2) Altered flows (water management).

Demographic
Connectivity Impairment

- (1) Fish Passage Issues.

Forage Fish Availability

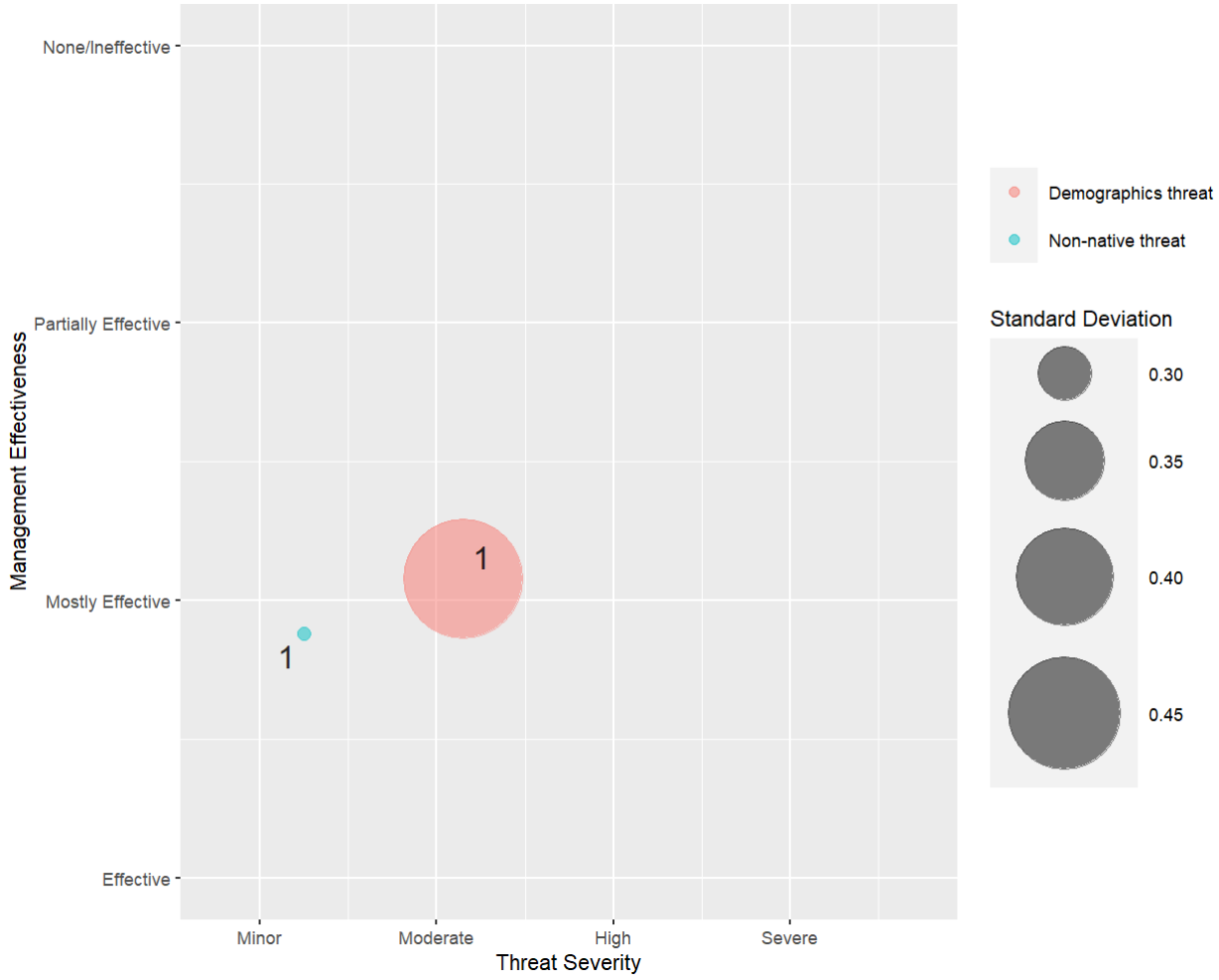
- (4) Water Management.

Nonnatives
Nonnative Fishes

- (1) Predation/Species Competition, Hybridization (brook trout).

US03 – Deadwood River Core Area

Threats Assessment Results



Threats Summary

Demographic

Connectivity Impairment

- (1) Fish Passage Issues.

Water Management

Nonnatives

Nonnative Fishes

- (1) Predation/Species Competition, Hybridization (brook trout).

US04 – Jarbidge River Core Area

Threats Assessment Results

NA

Threats Summary

NA

US05 – Lake Creek Core Area

Threats Assessment Results

NA

Threats Summary

NA

US06 – Lemhi River Core Area

Threats Assessment Results

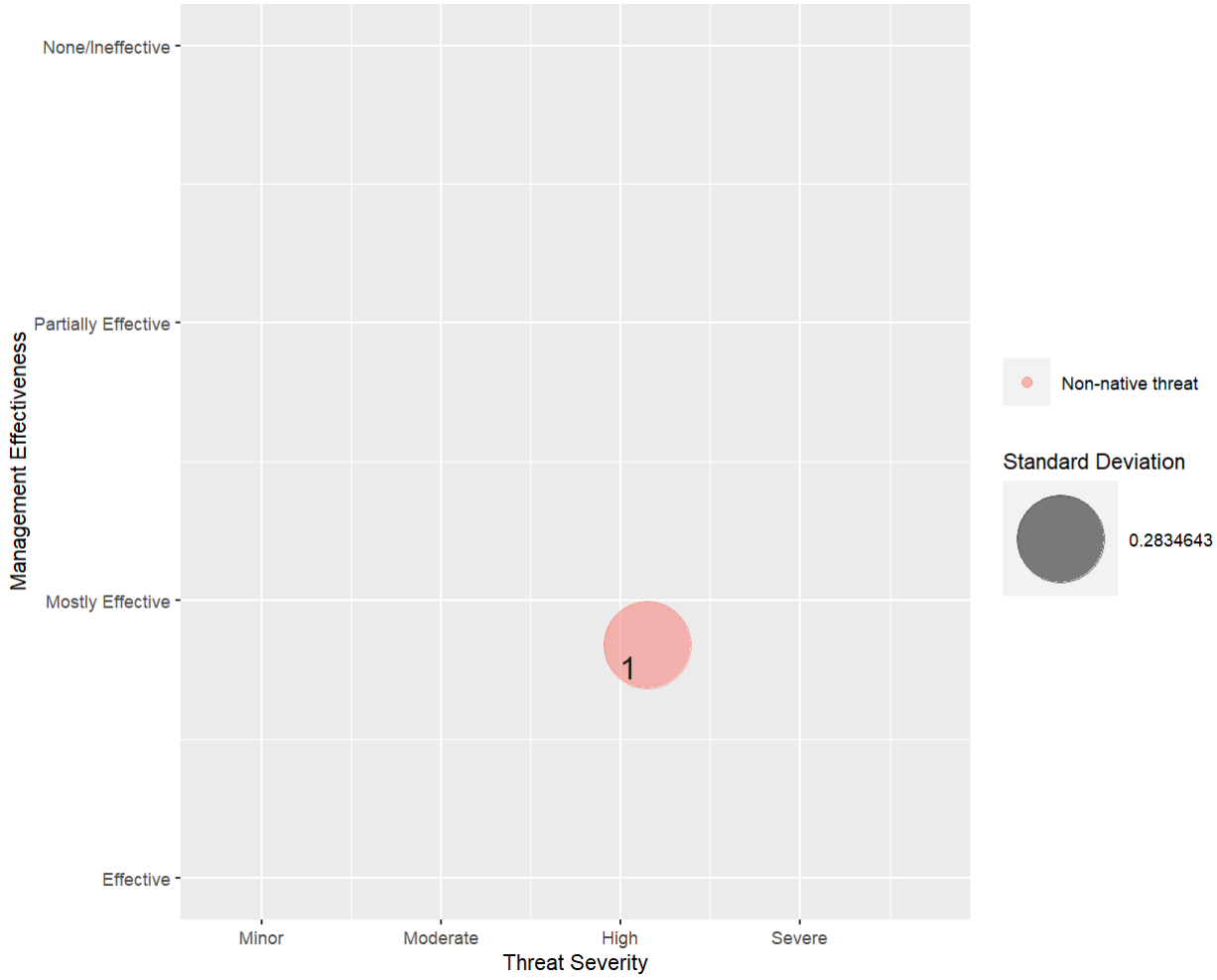
NA

Threats Summary

NA

US07 – Little Lost River Core Area

Threats Assessment Results



Threats Summary

Nonnatives
Nonnative Fishes

- (1) Added evaluation of brook trout found in SR habitat of core area. Competition, Predation, and Hybridization.

US08 – Little-Lower Salmon River Core Area

Threats Assessment Results

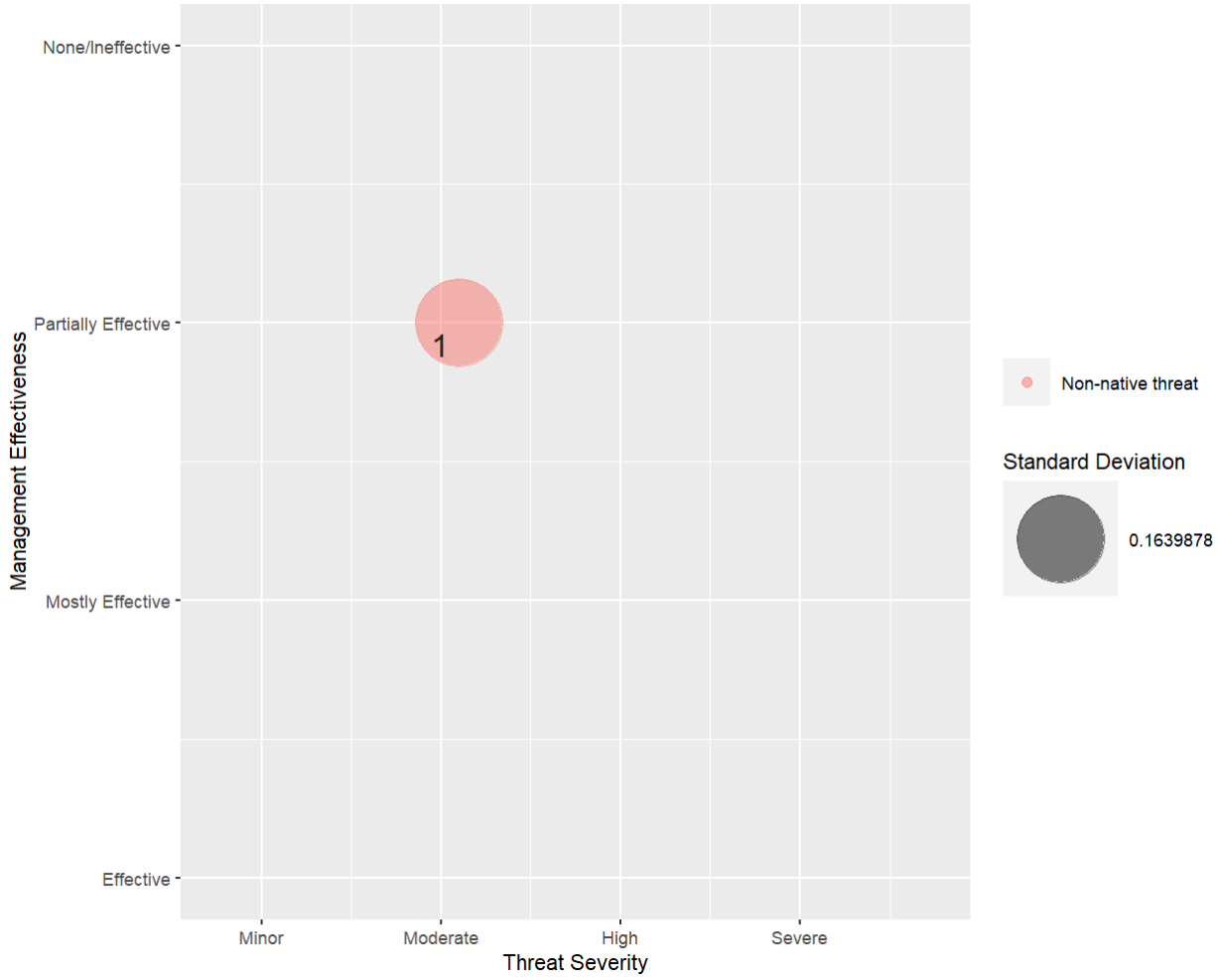
NA

Threats Summary

NA

US09 – Middle Fork Payette River Core Area

Threats Assessment Results



Threats Summary

Nonnatives
Nonnative Fishes

- (1) Predation/Species Competition, Hybridization (brook trout).

US10 – Middle Fork Salmon River Core Area

Threats Assessment Results

NA

Threats Summary

NA

US11 – Middle Salmon River-Chamberlin Core Area

Threats Assessment Results

NA

Threats Summary

NA

US12 – Middle Salmon River-Panther Core Area

Threats Assessment Results

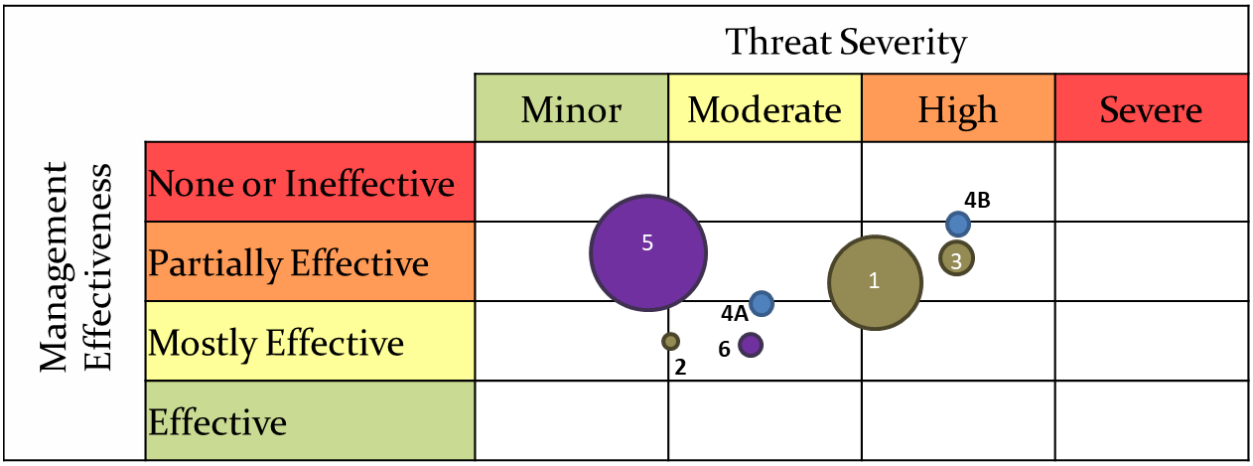
NA

Threats Summary

NA

US13 – North Fork Malheur River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Legacy Forest Management Practices, including timber harvest and forest roads, and current and legacy Livestock Grazing have degraded habitat quality and severely reduced suitable juvenile rearing areas.

Instream Impacts

- (2) Water Management – operations of Beulah Reservoir can reduce prey for overwintering, migratory bull trout.

Water Quality

- (3) Forest Management Practices and Livestock Grazing (on public/private land) – increases in instream water temperatures from altered channel conditions and lack of shade.

Demographic
Connectivity Impairment

- (4A) Entrainment at Agency Valley Dam and other diversions.
- (4B) Dewatering and Temperature Barriers in the mainstem North Fork Malheur River prevent bull trout from migrating between SR and overwintering areas.

Nonnatives
Nonnative Fishes

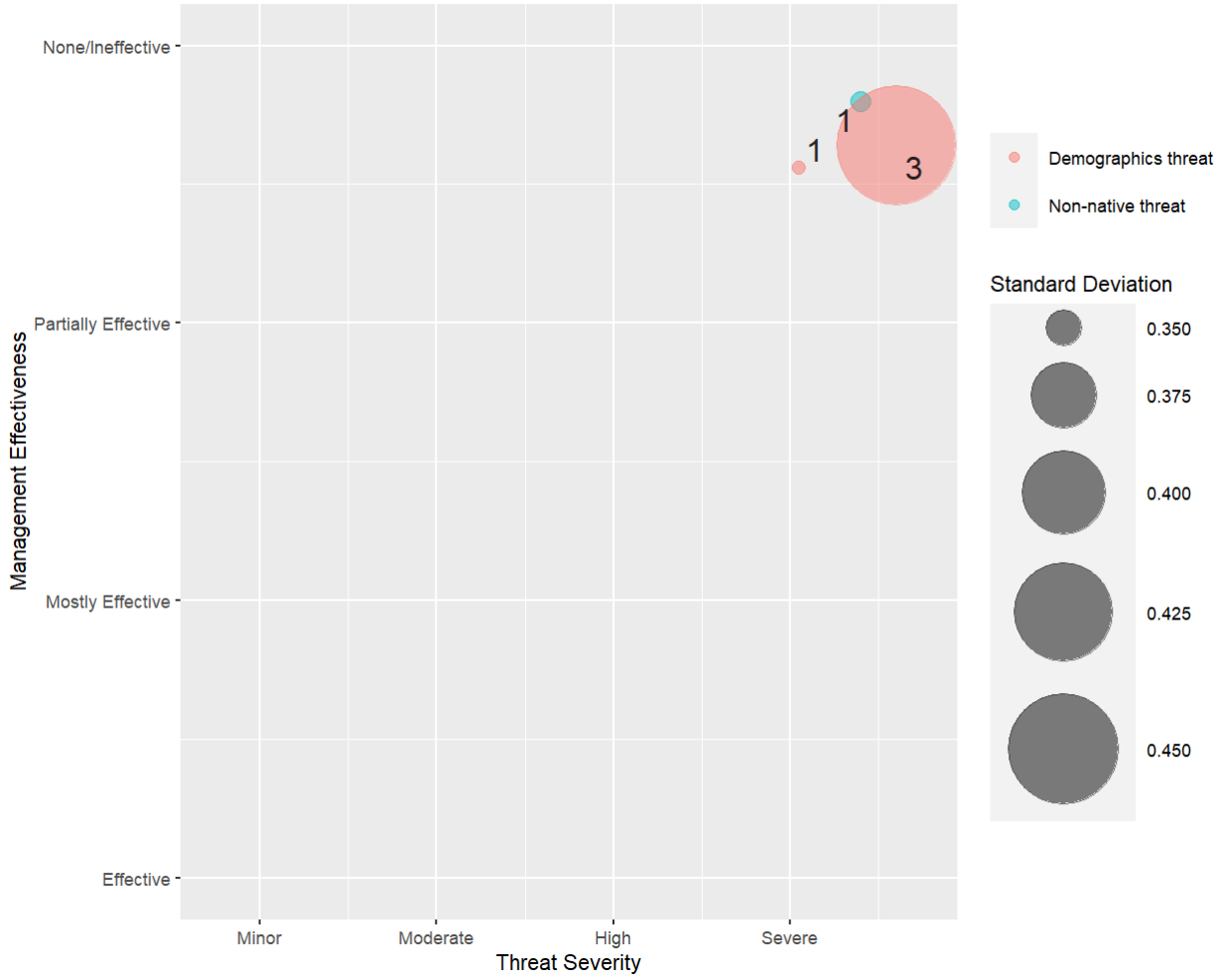
- (5) Potential for invasion by brook trout from Upper Malheur River tributaries.

Warm Water Fish

- (6) Warm water fish present in Buelah Reservoir could reduce bull trout survival through predation and competition for prey.

US14 – North Fork Payette River Core Area

Threats Assessment Results



Threats Summary

Demographic

Connectivity Impairment

- (1) Fish Passage Issues.

Small Population Size

- (3) Genetic, Demographic Stochasticity.

Nonnatives

Nonnative Fishes

- (1) Predation/Species Competition, Hybridization (brook trout).

US15 – Opal Lake Core Area

Threats Assessment Results

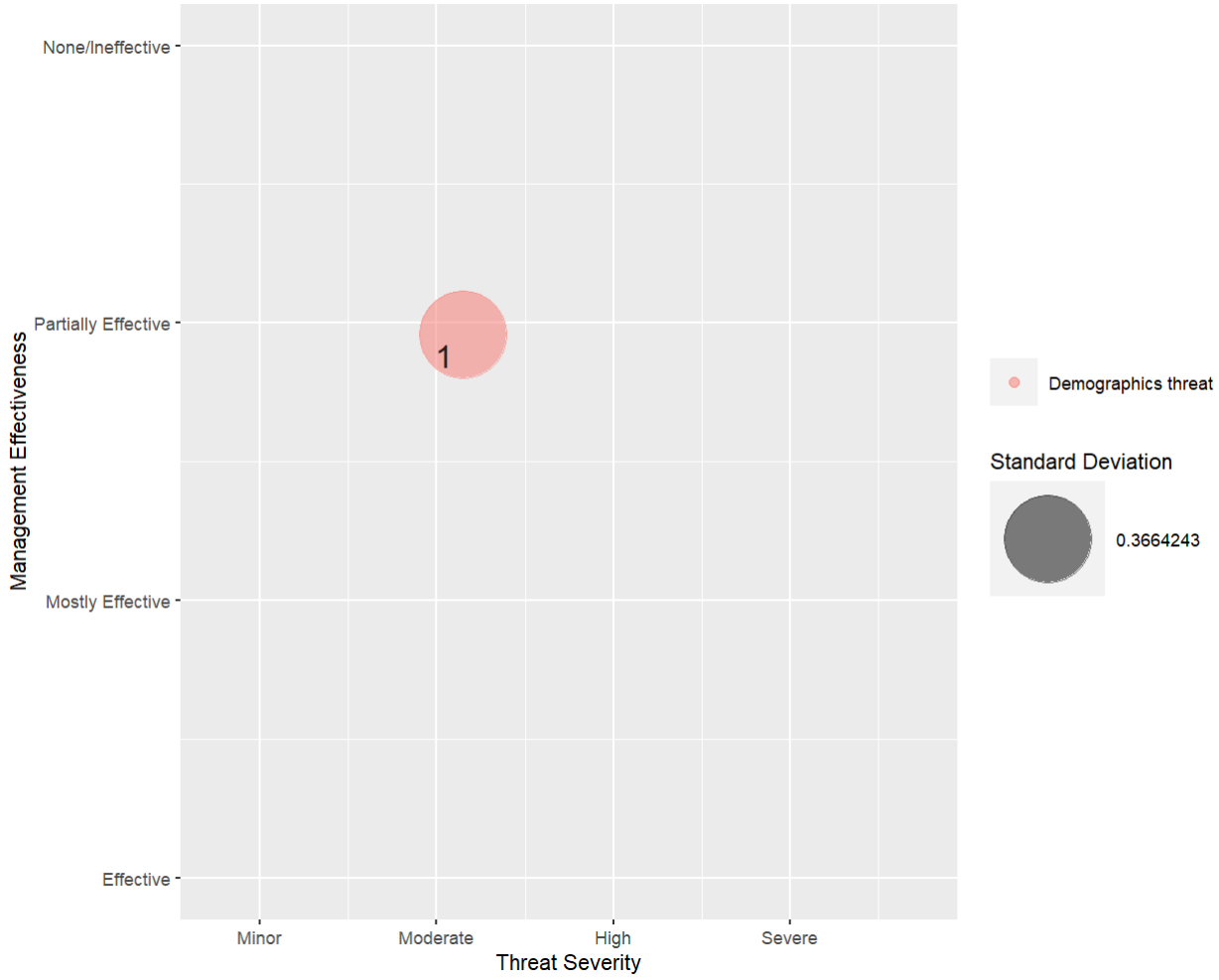
NA

Threats Summary

NA

US16 – Pahsimeroi River Core Area

Threats Assessment Results



Threats Summary

Demographic

Connectivity Impairment

- (1) Fish Passage Issues.

US17 – South Fork Salmon River Core Area

Threats Assessment Results

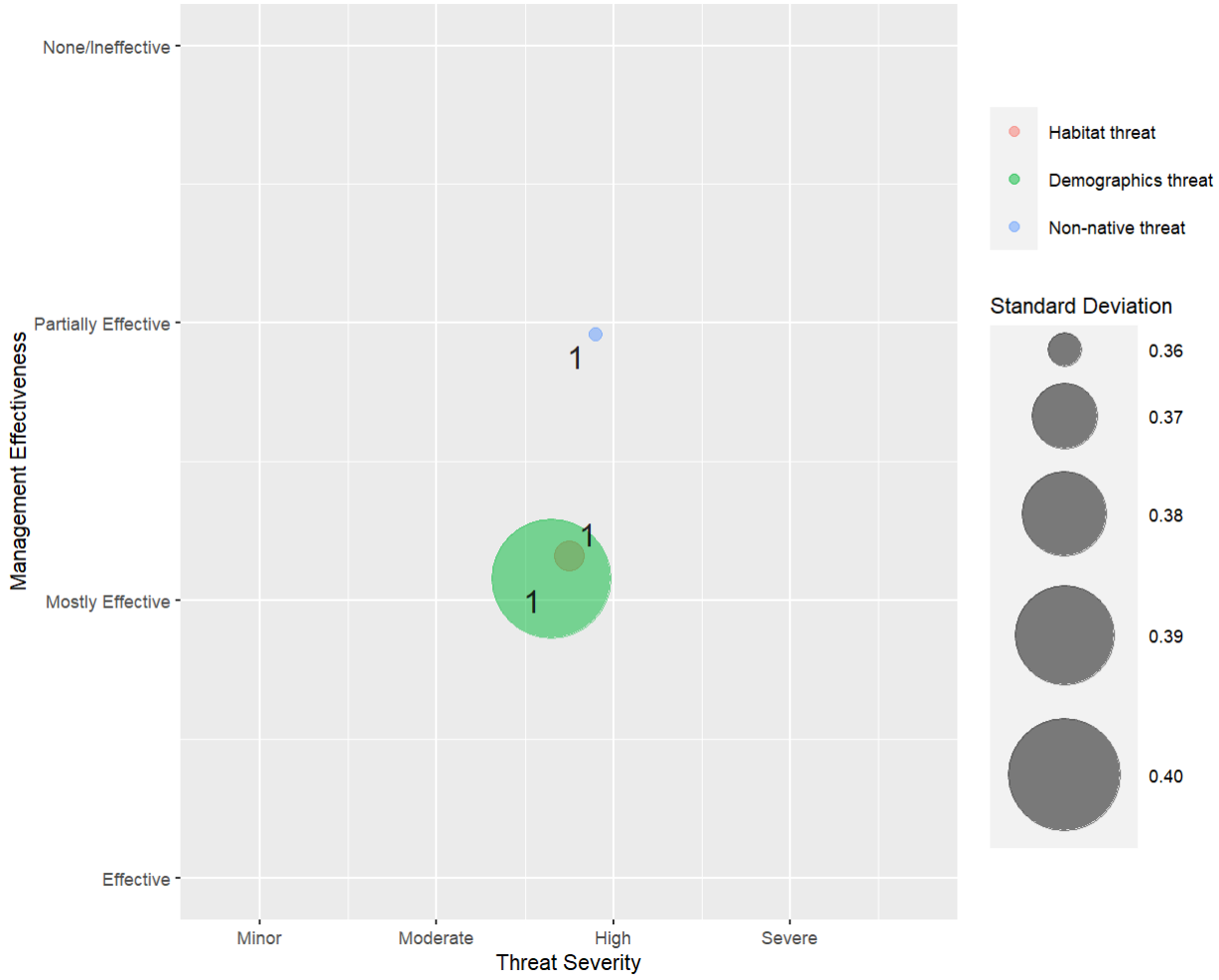
NA

Threats Summary

NA

US18 – Chief Eagle Eye Creek Core Area (*Renamed 2023*)

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Livestock Grazing

Demographic
Connectivity Impairment

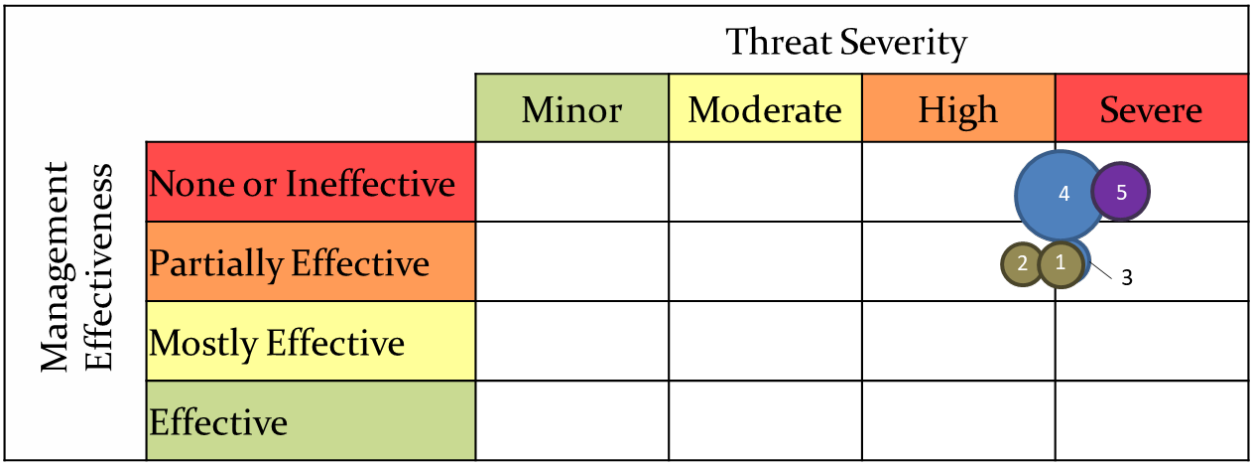
- (2) Fish Passage Issues

Nonnatives
Nonnative Fishes

- (3) Predation/Species Competition - hybridization (brook trout).

US19 – Upper Malheur River Core Area

Threats Assessment Results



Threats Summary

Habitat
Upland/Riparian Land Management

- (1) Forest Management Practices (legacy and current) and Livestock Grazing have degraded SR habitat quality.

Water Quality

- (2) Forest Management Practices (legacy and current) and Livestock Grazing on public and private land have degraded riparian areas and channel condition resulting in increases of instream temperatures.

Demographic
Connectivity Impairment

- (3) Entrainment and Fish Passage Issues at irrigation structures in the tributaries, and Dewatering and Temperature Barriers in Upper Mainstem Malheur River and the lower reaches of tributaries, impede movement between SR and overwintering areas.

Small Population Size

- (4) Genetic and Demographic Stochasticity threatens viability of all populations in the core area.

Nonnatives
Nonnative Fishes

- (5) Competition and Hybridization with brook trout in all populations.

(7) Warmwater fish present in Beulah Reservoir could reduce bull trout survival through predation and competition for prey.

US20 – Upper Salmon River Core Area

Threats Assessment Results

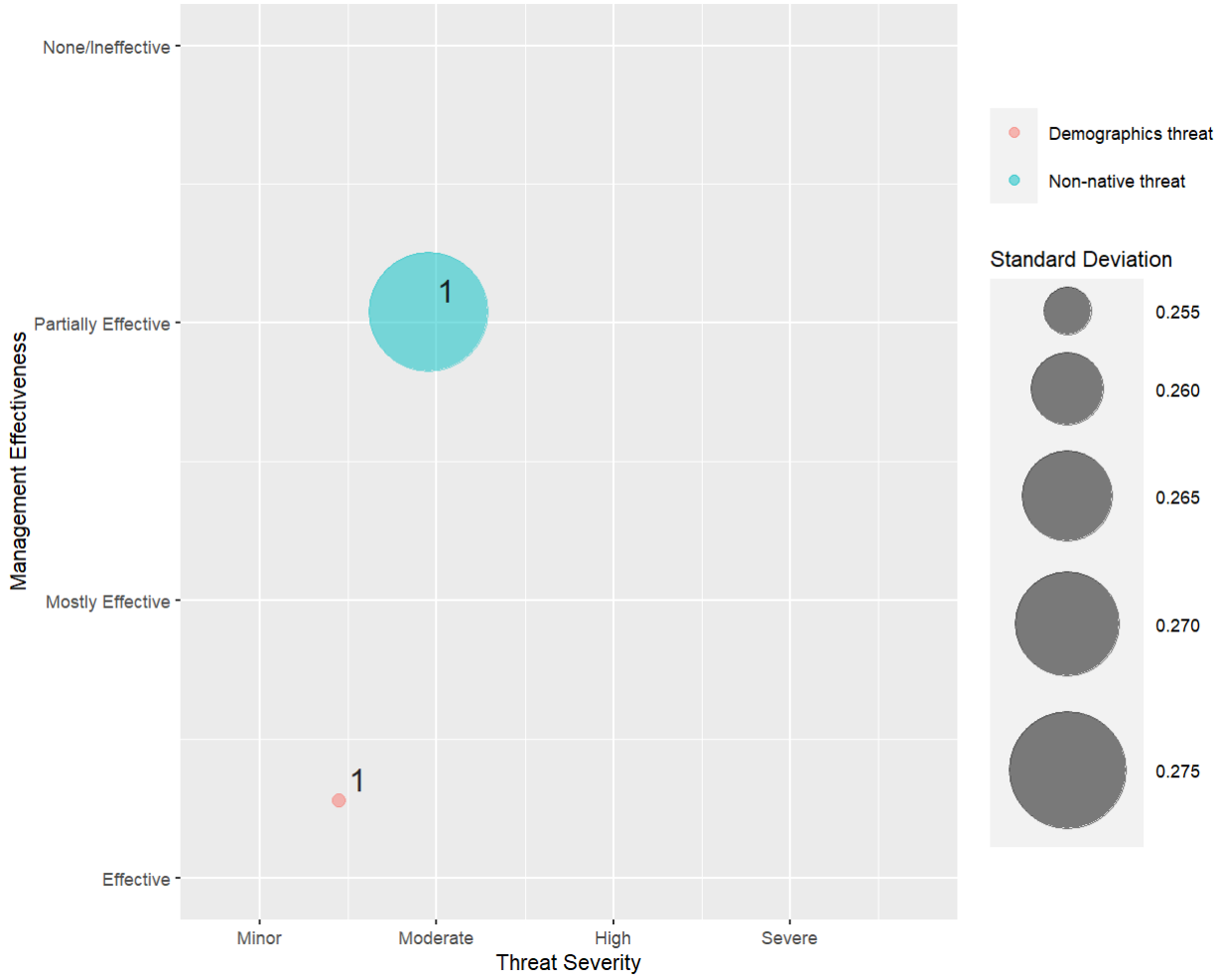
NA

Threats Summary

NA

US21 – Upper South Fork Payette River Core Area

Threats Assessment Results



Threats Summary

Demographic

Connectivity Impairment

- (1) Fish Passage Issues

Nonnatives

Nonnative Fishes

- (2) Predation/Species Competition – hybridization (brook trout).

US22 – Weiser River Core Area

Threats Assessment Results

NA

Threats Summary

NA