November 27, 2002 Draft

Interim Guidance for Protecting and Restoring Bull Trout Habitat in Watershed-based Recovery Planning in the Coastal-Puget Sound Distinct Population Segment:

Puget Sound Bull Trout Recovery Unit Team

Introduction

The Coastal-Puget Sound distinct population segment (DPS) of bull trout consists of the populations of bull trout west of the Cascade Crest and those north of the Columbia River basin. This DPS has been divided into two recovery units, the Puget Sound Recovery Unit (Puget Sound populations, including the Chilliwack River and upper Skagit River transboundary populations) and the Olympic Peninsula Recovery Unit (coastal Washington populations, including those in river systems draining into Hood Canal and Straits of Juan de Fuca). Within these recovery units, targets are being developed by the respective bull trout recovery unit teams (RUTs) to describe four population characteristics or attributes (distribution, abundance, trend, and connectivity) of each population in its recovered condition. These targets are intended to be the basis for developing site specific actions that are necessary to achieve recovery in the individual recovery units and ultimately recovery in the DPS.

Purpose

While not specifically part of the range-wide recovery plan for bull trout, the purpose of this interim guidance is to help watershed groups begin to develop or evaluate near and long-term habitat related recovery actions for bull trout as part of the Puget Sound Shared Strategy. The intent of this guidance is to help watershed groups understand what basic habitat needs are required by bull trout, so they can successfully integrate bull trout and salmon recovery. We believe that recovery actions directed towards salmon will have significant contributions to the recovery of bull trout. However, actions focused towards salmon, specifically chinook salmon, may overlook important habitat elements or features that are ultimately necessary for the recovery of bull trout. This guidance is the first step in helping watersheds to understand these important elements and to ensure they are addressed during the watershed based recovery planning process under the Puget Sound Shared Strategy.

There are notable differences between the specific recovery approaches being used for chinook salmon and bull trout. These are a reflection of the life history differences between the two species, dissimilarities in the level of information available for the two species, and differences in how U.S. Fish and Wildlife Service and NOAA Fisheries have structured broader geographic recovery efforts. Unlike for chinook salmon, our ability to develop abundance targets for bull trout in some areas is currently constrained by limited and incomplete information, but will be refined as additional information is gathered. In these cases, we have emphasized distribution and diversity targets, although all four population characteristics are critically important in recovery. For bull trout, a range-wide recovery plan covering multiple

regions is being developed under the direction of the U.S. Fish and Wildlife Service. The two recovery unit teams of the Coastal-Puget Sound DPS are currently developing chapters following a template developed for this larger plan. The information developed for these chapters will ultimately serve as more detailed guidance for watershed-based recovery planning in the Puget Sound region.

Approach to Developing Recovery Targets for Bull Trout

The recovery oversight team, which coordinates efforts across the species' range, drafted an overall goal and four objectives for bull trout recovery. The recovery goal is to "*ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across the species' native range*."

This goal recognizes the importance of population and habitat characteristics that allow bull trout to maintain viability and the opportunity for bull trout to migrate. The recovery oversight team determined four objectives are necessary to attain this goal: 1) maintain current distribution of bull trout and restore distribution in previously occupied areas where needed within the species native range; 2) maintain stable or increasing trends in abundance of bull trout in all recovery units; 3) restore and maintain suitable habitat conditions for all bull trout life stages and life histories; and 4) conserve genetic diversity and provide opportunity for genetic exchange.

Within each recovery unit, the recovery unit team has preliminarily identified core populations of bull trout. A core population is defined as a group of one or more local bull trout populations that exhibit a level of genetic or ecological similarity that suggests they share migrants. A local population is defined as a group of bull trout that spawns within a particular stream or portion of a stream system. Gene flow among core areas may occur, but is assumed to be infrequent compared to that occurring among local populations, and even more infrequent compared to within each local population. Ultimately, core areas (core populations and their associated spawning rearing, foraging, migrating, and overwintering habitat) were delineated. In the Puget Sound recovery unit, core areas generally equate to a major watershed with population continuity (e.g., Snohomish/Skykomish River system and Puyallup/White/Carbon River system). In addition, important foraging habitats used by multiple populations, but outside of currently delineated core areas were also identified. These are areas such as the lower Green/Duwamish River below Howard Hansen Dam and Lake Washington Watershed excluding the Chester Morse Drainage, which are utilized for foraging by migratory bull trout, but are not known and believed unlikely to support spawning or early (pre-dispersion) rearing.

Although core areas have been defined for the two recovery units, not all local populations have been identified due to limited information on current and historic bull trout spawning distribution. For many bull trout populations, spawning areas are geographically difficult to reach, spawning distribution is patchy, spawner abundance usually low, and detection of redds often difficult. Further, for impacted populations specific spawning reaches may have

contracted from their historic size or have shifted location with in a reach, or habitat conditions may have degraded, thus adding to the difficulty in identifying local populations. Generally, only the most apparent local spawning groups have been identified.

For each core population, the RUT determines a population's characteristics for both its current condition as well as its potential recovered condition. These characteristics include distribution (measured by the number of local populations and their spatial structure), abundance (the number of adult spawners), trend (productivity or the reproductive rate of the population as measured by population trend and variability), and connectivity (the diversity of the population as measured by the persistence of the migratory life history forms and of the supporting functional habitat**)** within the core area. How these characteristics are measured in bull trout recovery may differ slightly from how they are measured under salmon recovery. For distribution, local populations identified by the RUT (those that currently exist and those that may need to be reestablished in each core area) are intended to support the desired spatial structure within the recovery unit. For abundance, it is not just the number of adult spawners that make up the target, but also the composition of those spawners (i.e., the percentage and age structure of repeat spawners). The age structure of repeat spawners can be as important as the number of spawners for population stability. For trend, we are typically measuring changes in abundance from year to year through annual spawner returns as opposed to the actual productivity of the population (i.e., recruits per spawner). For connectivity, the persistence of migratory forms of bull trout within core areas and among local populations is intended to support the desired diversity within the recovery unit.

Because population characteristic data for bull trout is limited or incomplete for many of the areas within the Coastal-Puget Sound DPS, defaults are being developed as interim targets for some of the core populations. These reflect the best available science and knowledge at this time, and are a combination of principles from conservation biology, recently published literature on bull trout in other parts of their range, inferences drawn from the available information about core populations within the recovery unit, and local bull trout and watershed expertise. These defaults will likely require modification over time as new information is gathered.

Because the recovered condition of a core area may vary with the size and complexity of the watershed, the recovered condition of an individual core area was based on its own attributes, and not necessarily on a certain predetermined standard. Some core areas may not be able to achieve "ideal conditions" because they are limited by natural attributes and may always remain at a higher risk of extirpation.

Risk associated with three of the population characteristics was divided into three broad categories (i.e., low, medium, and high) and based on the following values for each characteristic. **Distribution (number of local populations)**: core areas that contain more than ten local populations have the lowest risk of extirpation, while core areas containing one to four local populations have the highest risk; **trend (productivity)**: core areas with a stable or

increasing abundance with low annual variability have the lowest risk of extirpation, while core areas with declining and or highly variable abundance year to year have the highest risk; **connectivity (diversity)**: core areas with migratory life forms present in all or nearly all local populations have the lowest risk of extirpation, while core areas with migratory life forms absent (comprised of only resident fish) have the highest risk. Moderate risk is a value intermediate between the low and high risk categories.

For **abundance**, risk was assessed at two levels, the core population level and the local population level. At the core population level, the risk from genetic drift was evaluated, while at the local population level, the risk from inbreeding depression was evaluated. Generally core areas with an annual abundance of 1,000 or more adult spawners were considered not at risk from genetic drift. Local populations with an annual abundance of 100 or more adult spawners were considered not at risk from inbreeding depression. Core areas having less than ten local populations could conceivably have low genetic risks as long as the aggregate number of annual adult spawners is at least 1,000 individuals. We realize, however, that natural habitat conditions and other constraints may effectively limit the numbers of spawners such that achieving these thresholds to minimize negative genetic consequences may not be realistically possible for some core areas.

Characteristics of Self-Sustaining Core Populations

The recovery unit team believes a key to supporting self-sustaining core populations of bull trout within the Coastal-Puget Sound DPS, is to ensure the long-term persistence of all extant populations and especially those exhibiting the anadromous life history. In the coterminous United States, anadromous bull trout are found only within the Coastal-Puget Sound DPS. In addition to their unique life history, anadromous forms are key to providing an opportunity for core populations to exchange genetic material and hence increase the diversity and stability of the overall DPS. Presumably, this diversity reduces the risk of extinction of the DPS. Anadromous bull trout are typically larger at a given age, so they have higher fecundity (reproductive capacity) than the resident and fluvial forms and use a greater diversity of spawning and foraging habitats. This also contributes to population diversity and lowers the risk of extinction. All migratory life history forms require spawning and rearing habitat well connected to adequate foraging, overwintering, and migratory habitat. All bull trout require very cold water to initiate spawning and successfully incubate their eggs. In addition, clean substrates and complex habitats are critical to juvenile survival.

For anadromous bull trout, these necessary habitats span the whole watershed, from headwater tributaries to the estuary and adjacent nearshore habitat. Bull trout typically spawn in headwater streams, which maybe tributaries or side channels to larger mainstem river reaches. Early juvenile rearing occurs in and around these natal areas. As juveniles grow, they begin to disperse to other parts of their natal watershed. Juveniles generally rear for one to three years in the upper reaches of a watershed before migrating downstream in spring months, where they eventually enter a larger body of water (fluvial life history-large mainstem river, adfluvial life

history-lake or reservoir, anadromous life history-estuary and nearshore) as subadults. Anadromous bull trout can migrate extensively while in marine waters, however, there is currently no evidence to indicate that they make long offshore migrations similar to salmon or steelhead. Anadromous subadults and adults utilize estuaries and nearshore waters of Puget Sound, Straits of Juan de Fuca, and the Pacific Ocean for foraging and migration between watersheds. Although there is extensive use of the estuarine and nearshore areas of eastern Puget Sound by anadromous bull trout, the level of use in other areas of Puget Sound is currently unknown. It has also not been determined whether anadromous bull trout in Puget Sound migrate to and from watersheds along the Straits of Juan de Fuca or coastal Washington. Anadromous subadults reenter freshwater between later summer and early fall to overwinter in lower portions of river systems, that may or may not be there natal watershed, and return to estuarine and nearshore waters each spring to forage, reaching adult maturity at about 4 to 5 years of age. Mature adults typically leave marine waters to begin their migration to spawning grounds in late spring and early summer and then spawn in the fall. Migratory bull trout are repeat spawners, and may live 12 years or more, annually repeating this cycle of spawning in headwater areas, and depending on their life history returning to either larger rivers, lakes/reservoirs, or estuarine and nearshore marine waters to forage. Given the demands of their life history, the anadromous form currently migrates through, and forages in, some of the most degraded areas of watersheds.

Unlike salmon, adult bull trout can spawn multiple times over their lifetime. Repeat spawners are extremely important to the long-term persistence of bull trout populations. Not only do repeat spawners typically have greater fecundity, they provide population stability over time, and allow individuals multiple opportunities to contribute to the gene pool under variable survival and habitat conditions. Maintaining and restoring appropriate habitat conditions in migratory and foraging corridors that support multiple years of use by subadults and repeat spawners is extremely important for bull trout recovery.

Overlaps with Salmon Habitat

Although bull trout coexist with many anadromous salmon species, differences exist in the period of time and types of habitat they use to complete their life history. Bull trout typically use salmon and steelhead freshwater habitats for subadult and adult foraging, overwintering, and migration. Bull trout juvenile rearing often occurs in the upper extent of these habitats, especially where cold water reaches are present. Bull trout spawning distribution may overlap with other salmon spawning habitats, although the very cold water habitats required by bull trout are often outside of the areas typically used by salmon and steelhead. Because of their smaller size and ability to inhabit colder waters, bull trout can use tributary habitats that are not typically used by chinook salmon. Bull trout also have the ability to migrate past typical anadromous barriers, so they may access freshwater habitats that can not be reached or are only occasionally reached by salmon.

Near-Term Recovery Strategies for Bull Trout

Many federal, state, tribal and local government and non-governmental groups are engaging in salmon and bull trout recovery planning at both jurisdictional and watershed scales. It is crucial that recovery actions begin as soon as possible, even without a completed recovery plan. Bull trout recovery strategies for any particular watershed should focus on actions that protect, enhance, and or restore habitats and processes necessary for bull trout to complete all facets of their life history (i.e., egg incubation, fry emergence, juvenile rearing, juvenile outmigration, subadult maturation, and spawning).

Considerable planning is underway for Puget Sound chinook recovery. Many of these efforts have already identified suites of near-term protection and recovery actions and some watersheds have begun implementation. It is anticipated that these efforts will generally address the needs of bull trout throughout their migratory and foraging corridors, but may not address bull trout use in higher elevation portions of the basin. There are also significant species differences so additional planning for bull trout requirements should be conducted. For example, given bull trout proclivity for cold water it will be important to identify and protect or restore unique cold water features (e.g., springs, cold water tributaries, hyporheic upwelling zones). Even relatively low elevation areas tend to have streams with cold water usually caused by springs emanating from glacial outwash deposits. Other tributaries may be colder due to localized cool air masses caused by northerly aspect, topography, and mature forest that limits air circulation, slows snow melt, and provides for high levels of groundwater inputs into summer low-flow periods, thus creating relatively cold valleys and streams. Also cool air masses and subsequent cool water are typical in glacial-fed watersheds.

First and foremost, recovery efforts must focus on the identification and protection of the cold water producing areas at high, mid, and low elevations such as described above and on existing bull trout spawning habitats. For some populations spawning and early rearing habitat is limited, restricted to a very small fraction of the watershed, usually the coldest, highest elevation salmonid bearing streams where there is also clean gravel substrate and low or no competition from other salmonid species. Given its specificity and location, bull trout spawning habitat is fragile, extremely sensitive to habitat degradation caused by forest practices, other land and water management activities (e.g., mining, water diversions, road building and maintenance, recreation), and development. In some (perhaps most) cases, additional spawning habitat will need to be reestablished or enhanced through restoration. The most intact bull trout spawning habitat is generally within US Forest Service lands and National Parks; however, historic, lesser used, or currently more marginal spawning habitat is located outside these areas.

Recovery efforts must also focus on the protection and restoration of early juvenile rearing habitats. Bull trout early juvenile rearing (i.e., that which occurs immediately after emergence until dispersion from the natal area) is typically concentrated in or near the same sensitive habitats as spawning. As juveniles develop, they begin to disperse and rear in other areas of the watershed. Cold water, clean substrate, complex habitat and connectivity with subadult rearing areas is critical to their survival.

As they grow, bull trout become opportunistic, apex predators, feeding on a variety of prey (predominately fish) in both fresh and salt waters. Thus an adequate forage base is critical to sustaining migratory bull trout. Bull trout recovery actions should include efforts to ensure adequate forage for bull trout within freshwater systems, this includes those tributaries too small for chinook, but used by other species such as coho salmon. By protecting and restoring watershed processes that provide for a wide diversity of salmon species, watershed productivity and available forage should increase to levels that help ensure self-sustaining populations of bull trout.

Anadromous bull trout also target a variety of estuarine and near-shore marine forage fish such as sandlance, surf smelt, and herring when foraging outside of freshwater systems. Thus, recovery efforts for bull trout must focus on the protection, enhancement, and restoration of areas productive for these species, including marine forage fish spawning beaches and vegetated intertidal habitats, such as eel grass beds. Persistence of these areas will likely require additional analysis to ensure water quality and basic processes such as bluff and beach erosion, onshore drift, and recruitment of woody debris and other natural organic matter are adequately protected or restored.

Hatchery and Harvest Strategies for Bull Trout

Bull trout have not been extensively cultured in hatcheries in any part of the species' range. The absence of bull trout hatcheries within Washington State has limited the potential biological risks associated with hatcheries (e.g., loss of genetic diversity within and among stocks, interbreeding between hatchery and wild fish, competition with or predation by hatchery fish, disruptive behavior, effects on non-target species, disease, depletion of wild stocks for broodstock, and escapement from hatcheries). For the Puget Sound Recovery Unit, the use of hatcheries in bull trout recovery is believed to be unneeded and is currently not being considered in planning. The potential use of hatcheries in bull trout recovery across their range has generally been limited to genetic reserves and restoration stocking in watersheds where a population has been extirpated.

How salmon hatchery operations and the interactions between hatchery-origin salmon may affect bull trout have not been closely examined, however, the risks to bull trout are likely limited given their life history. It is anticipated that potential risks to bull trout will be assessed during the ongoing process of integrating hatcheries in salmon recovery.

Harvest for bull trout has been significantly reduced across the species range. Most recreational fisheries for bull trout in fresh and marine waters in the Coastal-Puget Sound DPS have been closed since 1994. There are only two river systems where directed recreational harvest of bull trout is currently allowed by Washington Department of Fish and Wildlife, the Skagit and Skykomish Rivers. In these two systems, a minimum harvest size was established in 1990 to allow all migratory individuals the opportunity to spawn at least once to increase

spawner abundance levels. To date, this management action has succeeded in increasing spawner abundance levels in these two systems. As the Coastal-Puget Sound DPS begins to achieve its recovery goal, the Washington Department of Fish and Wildlife and Tribes in coordination with the U.S. Fish and Wildlife Service will determine the location and level of bull trout harvest that continues to support the population characteristics consistent with bull trout recovery.

The level of incidental bull trout harvest in other fisheries is not broadly monitored at this time. Additional monitoring is needed to determine the level of incidental harvest in other fisheries and ultimately where and when this incidental harvest may significantly impact progress towards bull trout recovery. As additional information is gathered, it is anticipated that harvest management actions developed for other fisheries will integrate measures that minimize negative impacts to bull trout where incidental harvest significant impedes recovery.

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and stability of the overall DPS. Presumably, this diversity reduces the risk of extinction of the DPS. Anadromous bull trout are typically larger at a given age, so they have higher fecundity (reproductive capacity) than the resident and fluvial forms and use a greater diversity of spawning and foraging habitats. This also contributes to population diversity and lowers the risk of extinction. All migratory life history forms require spawning and rearing habitat well connected to adequate foraging, overwintering, and migratory habitat. All bull trout require very cold water to initiate spawning and successfully incubate their eggs. In addition, clean substrates and complex habitats are critical to juvenile survival.

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Overlaps with Salmon Habitat

Although bull trout coexist with many anadromous salmon species, differences exist in the period of time and types of habitat they use to complete their life history. Bull trout typically use salmon and steelhead freshwater habitats for subadult and adult foraging, overwintering, and migration. Bull trout juvenile rearing often occurs in the upper extent of these habitats, especially where cold water reaches are present. Bull trout spawning distribution may overlap with other salmon spawning habitats, although the very cold water habitats required by bull trout are often outside of the areas typically used by salmon and steelhead. Because of their smaller size and ability to inhabit colder waters, bull trout can use tributary habitats that are not typically used by chinook salmon. Bull trout also have the ability to migrate past typical anadromous barriers, so they may access freshwater habitats that can not be reached or are only occasionally reached by salmon.

Near-Term Recovery Strategies for Bull Trout

Many federal, state, tribal and local government and non-governmental groups are engaging in salmon and bull trout recovery planning at both jurisdictional and watershed scales. It is crucial that recovery actions begin as soon as possible, even without a completed recovery plan. Bull trout recovery strategies for any particular watershed should focus on actions that protect, enhance, and or restore habitats and processes necessary for bull trout to complete all facets of their life history (i.e., egg incubation, fry emergence, juvenile rearing, juvenile outmigration, subadult maturation, and spawning).

Considerable planning is underway for Puget Sound chinook recovery. Many of these efforts have already identified suites of near-term protection and recovery actions and some watersheds have begun implementation. It is anticipated that these efforts will generally address the needs of bull trout throughout their migratory and foraging corridors, but may not address bull trout use in higher elevation portions of the basin. There are also significant species differences so additional planning for bull trout requirements should be conducted. For example, given bull trout proclivity for cold water it will be important to identify and protect or restore unique cold water features (e.g., springs, cold water tributaries, hyporheic upwelling zones). Even relatively low elevation areas tend to have streams with cold water usually caused by springs emanating from glacial outwash deposits. Other tributaries may be colder due to localized cool air masses caused by northerly aspect, topography, and mature forest that limits air circulation, slows snow melt, and provides for high levels of groundwater inputs into summer low-flow periods, thus creating relatively cold valleys and streams. Also cool air masses and subsequent cool water are typical in glacial-fed watersheds.

First and foremost, recovery efforts must focus on the identification and protection of the cold water producing areas at high, mid, and low elevations such as described above and on existing bull trout spawning habitats. For some populations spawning and early rearing habitat

is limited, restricted to a very small fraction of the watershed, usually the coldest, highest elevation salmonid bearing streams where there is also clean gravel substrate and low or no competition from other salmonid species. Given its specificity and location, bull trout spawning habitat is fragile, extremely sensitive to habitat degradation caused by forest practices, other land and water management activities (e.g., mining, water diversions, road building and maintenance, recreation), and development. In some (perhaps most) cases, additional spawning habitat will need to be reestablished or enhanced through restoration. The most intact bull trout spawning habitat is generally within US Forest Service lands and National Parks; however, historic, lesser used, or currently more marginal spawning habitat is located outside these areas.

Recovery efforts must also focus on the protection and restoration of early juvenile rearing habitats. Bull trout early juvenile rearing (i.e., that which occurs immediately after emergence until dispersion from the natal area) is typically concentrated in or near the same sensitive habitats as spawning. As juveniles develop, they begin to disperse and rear in other areas of the watershed. Cold water, clean substrate, complex habitat and connectivity with subadult rearing areas is critical to their survival.

As they grow, bull trout become opportunistic, apex predators, feeding on a variety of prey (predominately fish) in both fresh and salt waters. Thus an adequate forage base is critical to sustaining migratory bull trout. Bull trout recovery actions should include efforts to ensure adequate forage for bull trout within freshwater systems, this includes those tributaries too small for chinook, but used by other species such as coho salmon. By protecting and restoring watershed processes that provide for a wide diversity of salmon species, watershed productivity and available forage should increase to levels that help ensure self-sustaining populations of bull trout.

Anadromous bull trout also target a variety of estuarine and near-shore marine forage fish such as sandlance, surf smelt, and herring when foraging outside of freshwater systems. Thus, recovery efforts for bull trout must focus on the protection, enhancement, and restoration of areas productive for these species, including marine forage fish spawning beaches and vegetated intertidal habitats, such as eel grass beds. Persistence of these areas will likely require additional analysis to ensure water quality and basic processes such as bluff and beach erosion, onshore drift, and recruitment of woody debris and other natural organic matter are adequately protected or restored.

Hatchery and Harvest Strategies for Bull Trout

Bull trout have not been extensively cultured in hatcheries in any part of the species' range. The absence of bull trout hatcheries within Washington State has limited the potential biological risks associated with hatcheries (e.g., loss of genetic diversity within and among stocks, interbreeding between hatchery and wild fish, competition with or predation by hatchery fish, disruptive behavior, effects on non-target species, disease, depletion of wild stocks for broodstock, and escapement from hatcheries). For the Puget Sound Recovery Unit, the use of

hatcheries in bull trout recovery is believed to be unneeded and is currently not being considered in planning. The potential use of hatcheries in bull trout recovery across their range has generally been limited to genetic reserves and restoration stocking in watersheds where a population has been extirpated.

How salmon hatchery operations and the interactions between hatchery-origin salmon may affect bull trout have not been closely examined, however, the risks to bull trout are likely limited given their life history. It is anticipated that potential risks to bull trout will be assessed during the ongoing process of integrating hatcheries in salmon recovery.

Harvest for bull trout has been significantly reduced across the species range. Most recreational fisheries for bull trout in fresh and marine waters in the Coastal-Puget Sound DPS have been closed since 1994. There are only two river systems where directed recreational harvest of bull trout is currently allowed by Washington Department of Fish and Wildlife, the Skagit and Skykomish Rivers. In these two systems, a minimum harvest size was established in 1990 to allow all migratory individuals the opportunity to spawn at least once to increase spawner abundance levels. To date, this management action has succeeded in increasing spawner abundance levels in these two systems. As the Coastal-Puget Sound DPS begins to achieve its recovery goal, the Washington Department of Fish and Wildlife and Tribes in coordination with the U.S. Fish and Wildlife Service will determine the location and level of bull trout harvest that continues to support the population characteristics consistent with bull trout recovery.

The level of incidental bull trout harvest in other fisheries is not broadly monitored at this time. Additional monitoring is needed to determine the level of incidental harvest in other fisheries and ultimately where and when this incidental harvest may significantly impact progress towards bull trout recovery. As additional information is gathered, it is anticipated that harvest management actions developed for other fisheries will integrate measures that minimize negative impacts to bull trout where incidental harvest significant impedes recovery.