APPENDIX H
NOOKSACK CORE AREA

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Nooksack River Core Area

The Nooksack River core area comprises the Nooksack River and its tributaries, including the North, Middle, and South Fork Nooksack Rivers. Fluvial and anadromous are the most abundant life history forms in the Nooksack River core area. Presence of the resident life history form is unknown (USFWS 2008a, Nooksack River core area Chapter, p. 1). Bull trout spawning occurs in the North, Middle, and South Fork Nooksack Rivers and their tributaries. Post-dispersal rearing and subadult and adult foraging probably occur throughout most of the accessible reaches below barriers to anadromous fish. Overwintering likely occurs primarily in the lower mainstem reaches of the three forks and in the mainstem Nooksack River. Bull trout from the Nooksack River core area are known to utilize marine waters at least as far south as the Swinomish Channel in Puget Sound, based on limited acoustic tagging efforts (Goetz et al. 2007, p. 9).

Bull trout and Dolly Varden (*S. malma*) co-occur in the Nooksack River core area, but the level of interaction between the two species and degree of overlap in their distributions is unknown. Limited genetic analysis and observational data suggest Dolly Varden in this core area inhabit stream reaches above barriers to anadromous fish, while bull trout primarily occupy the accessible stream reaches below the barriers. Other salmonids that are present in this watershed include coho salmon (*Oncorhynchus kisutch*), steelhead/rainbow trout (*O. mykiss*), cutthroat trout (*Salmo clarki*), pink salmon (*O. gorbuscha*), chum salmon (*O. keta*) (Currence 2007, pp. 3, 6), Chinook salmon (*O. tshawytscha*) (USFWS 2008a, Nooksack River core area Chapter, p. 2), and sockeye salmon (*O. nerka*) (WSCC 2002, p. 50).

The Nooksack River core area population is considered at "potential risk" for extirpation (USFWS 2008b, p. 35; USFWS 2015b). The status of the bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, Vol. I, p. 215).

Number and Distribution of Local Populations

Ten local populations are recognized within the Nooksack River core area (USFWS 2004, pp. 56-74; USFWS 2015a, pp. A-10 to A-11): 1) Lower Canyon Creek, 2) Glacier Creek, 3) Lower Middle Fork Nooksack River, 4) Upper Middle Fork Nooksack River, 5) Lower North Fork Nooksack River, 6) Middle North Fork Nooksack River, 7) Upper North Fork Nooksack River, 8) Lower South Fork Nooksack River, 9) Upper South Fork Nooksack River, and 10) Wanlick Creek. Spawning areas used by the local populations are believed to be small and dispersed. Core areas with 5 to 10 interconnected local populations are at an intermediate risk of local extirpation and adverse effects from random naturally-occurring events (USFWS 2004, pp. 216-218). Most, but not all, Nooksack River core area local populations are interconnected (see Connectivity section below).

Adult Abundance

The Nooksack River core area adult abundance is estimated between 250 to 1,000 individuals based on limited spawn survey data. Eight of the local populations likely have fewer than 100 adults each, based on the relatively low number of migratory adults observed returning to the core area. The North Fork has more confirmed spawning areas than the Middle or South Forks (Currence 2007, p. 5). In the North Fork, Thompson Creek has the most consistent and highest numbers of bull trout redds recorded of any stream in the Nooksack River watershed (Currence 2007, p. 6). In the Middle Fork, the anadromous life history form is mostly or entirely blocked at the Bellingham Diversion Dam, and fluvial individuals are infrequently recorded in the upper portion of the system, although survey efforts are limited (USFWS 2008a, Nooksack River core area Chapter, p. 2). Incidental observations of South Fork Nooksack River bull trout redds are occasionally noted during Chinook surveys in the upper river. More often though, incidental observations of staging anadromous adults are recorded during the Chinook surveys, usually between river miles 21 and 30. Although not complete counts, recorded numbers of adults are consistently in the single digits, suggesting a small population size (USFWS 2008a, Nooksack River core area Chapter, p. 2). The Glacier Creek local population has approximately 100 adults, based on incidental redd counts and available spawning habitat. The Upper North Fork Nooksack River local population may support 100 adults, based on the persistent, small numbers of spawning adults observed in tributaries and available side channel habitat.

The Nooksack River core area is at risk from genetic drift because it likely contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 218-224). Eight local populations are at risk from inbreeding depression because they are believed to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 218-224). Only two local populations – the Glacier Creek and the Upper North Fork Nooksack River populations – are not at risk from inbreeding depression.

Productivity

Currently, there is insufficient information to determine a trend in the size of the core area population (USFWS 2008a, Nooksack River core area Chapter, p. 4). Estimates of population growth rate that indicate a population is consistently failing to replace itself are at increased risk of extirpation. The Nooksack River core area is considered at increased risk of extirpation until sufficient information is available to assess productivity.

Connectivity

There is connectivity among most of the local populations, except for the Middle Fork Nooksack River. The Bellingham Diversion Dam on the Middle Fork Nooksack River obstructs fish movement into and out from the reach occupied by the Upper Middle Fork Nooksack River local population (USFWS 2004, p. 190). High seasonal temperatures on reaches of the South Fork Nooksack River limit migratory movements into and out of this area, temporarily isolating the three local populations found here (Lower South Fork Nooksack River, Upper South Fork Nooksack River, and Wanlick Creek) (USFWS 2004, p. 160). There is a partial barrier limiting movement into and out of the Lower Canyon Creek local population due to previous Whatcom County flood control work (Nooksack Natural Resources et al. 2005, pp. 88-89), although

Whatcom County may improve passage as part of a restoration effort proposed in 2013. There are road culvert barriers in several local populations. For these reasons, the Nooksack River core area is considered at intermediate risk of extirpation from habitat isolation and fragmentation.

Acoustic tagging studies have shown that anadromous bull trout have extensive and complex migrations throughout the nearshore areas of Puget Sound (Goetz et al. 2004; Goetz et al. 2007). These study results strongly indicate that connectivity within nearshore habitats and among major river basins within Puget Sound are necessary for the anadromous form to complete its life history.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, federal actions occurring in the Nooksack River core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Nooksack River core area.

The number of non-federal actions occurring in the Nooksack River core area since the bull trout listing is unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout. Additionally, a significant number of mass wasting events have been associated with timber management and associated road construction in the Nooksack basin (WSCC 2002, pp. 91, 93, 117, 130).

Salmon recovery efforts are improving conditions for bull trout. Although directed toward salmonids other than bull trout, the regional salmon recovery plan under the Shared Strategy for Puget Sound (SSPS 2007) and watershed-scale implementation under the Puget Sound Partnership have resulted in general aquatic habitat improvements that are likely benefitting bull trout. Also, the Critical Areas Ordinance and Shoreline Management Plan were updated for Whatcom County, which may benefit bull trout. However, there are concerns with implementation of the ordinance, particularly with variances and enforcement of buffers within riparian areas (Currence, in litt. 2008).

Climate change is expected to have substantial adverse effects to bull trout in the Nooksack River core area. The Nooksack River core area is a glacier fed system except for the South Fork Nooksack River, which does not receive glacial melt (USFS 2006, p. 35). The North and Middle Forks are somewhat buffered against increases in high temperatures due to glacial melt. However, as glaciers continue to contract and recede with climate change, summer discharges are expected to decrease and temperatures increase (Snover et al. 2005). Glacier recession is also expected to increase the incidence of debris flows (Seattle Post Intelligencer 2008; Chiarle et al. 2007), negatively impacting spawning and rearing areas. Several debris flows from the

Deming Glacier were documented in 2013. Such debris flows may occur in more Mount Baker drainages due to increased glacial contraction and exposure of the glacial moraines (MBVRC 2013a; MBVRC 2013b).

The South Fork Nooksack River is seasonally acutely temperature impaired, with peak temperatures in the 20 °C to 24 °C range (Smith 2002, pp. 172-173). Some impairment of water temperatures have also been observed within the North and Middle Forks. The mainstem Nooksack River is generally temperature-impaired throughout the summer months. The temperature criterion in this reach of the river is 16 °C. The annual 7-day average maximum water temperatures measured at the long-term monitoring station at Cedarville (WDOE station 01A120) between 2001and 2010 rarely exceeded 18 °C (19 °C in 2005 and 2009).

Climate change is expected to result in less annual snow pack and earlier loss of snow pack, which is likely to reduce summer low flow migration and rearing habitats. Climate change is also expected to increase fall and winter storm intensities and increase the amount of precipitation that is delivered as rain instead of snow. Thus, redd scour is likely to increase.

Additionally, as summer migrants, adults and sub-adults are exposed to annual minimum flows and maximum temperatures, and thus will likely be more prone to disease. In several recent years, pre-spawn mortalities of adult Chinook salmon have been determined to have *Columnaris* as the primary cause of death (Nooksack Natural Resources et al. 2005, p. 80). This disease becomes progressively more lethal with increased temperatures and has even been an issue in the North Fork, though less commonly than in the South Fork. The effects of this disease on bull trout are not currently known.

Threats

There are three primary threats to bull trout in the Nooksack River core area (USFWS 2015a, p. A-10 to A-11):

Upland/Riparian Land Management: Legacy Forest Management and Agricultural Practices. Impacts associated with legacy forest management and agricultural practices have led to channelization and habitat degradation within lower river foraging, migration and overwintering habitats, which are key to the persistence of the anadromous life history form.

Water Quality: Climate Change. Seasonal high water temperatures in the South Fork Nooksack River are expected to be exacerbated, likely impairing migration, especially for the anadromous life history form, and reducing available spawning and rearing habitat for South Fork Nooksack local populations.

Connectivity Impairment: Fish Passage Issues. Bellingham Water Diversion on Middle Fork Nooksack 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 local populations.

Additional threats to the Nooksack River core area bull trout population include the following:

- Depressed abundances of naturally-reproducing salmon and steelhead populations in the Nooksack River system likely limit important bull trout forage resources and bull trout abundance. Abundance of spawning anadromous salmonids has been found to influence abundance, growth rates, and size of bull trout (Kraemer 2003, pp. 5, 9-10; Zimmerman and Kinsel 2010, pp. 26, 30; Copeland and Meyer 2011, pp. 937-938), as well as other species (Bentley et al. 2012; Nelson and Reynolds 2014). Anadromous salmonids provide a forage resource in the form of eggs and freshwater-rearing juveniles, which can make up a substantial proportion of the bull trout diet in freshwater habitats (Lowery and Beauchamp 2015). Spawning fish and carcasses also increase ecosystem productivity, thereby increasing the abundance of aquatic invertebrates and resident fishes (e.g., Cederholm et al. 1999; Moore et al. 2008; Copeland and Meyer 2011; Rinella et al. 2012), which may also provide important components of the bull trout diet (Lowery and Beauchamp 2015). Recovering naturally-reproducing salmon and steelhead populations is an important component of bull trout recovery in the Puget Sound region.

- Past timber harvest and harvest-related activities, such as roads, have caused the loss or degradation of a number of spawning and rearing areas. State forest practice regulations were significantly revised following the Forest and Fish Agreement (FFR 1999; WFPB 2001). These regulations are expected to significantly reduce the level of future timber harvest impacts to bull trout streams on private lands; however, most legacy threats from past forest practices will continue to be a threat for decades.

- Residential development, road networks, agricultural practices, and related stream channel and bank modifications have caused the loss and degradation of foraging, migration, and overwintering habitat in mainstem reaches of the major forks and in a number of tributaries. Stormwater runoff from residential development and urbanization continues to be a significant contributor of non-point source water pollution (WSCC 2002). Recent work by the National Oceanic and Atmospheric Administration suggests that the synergistic effects of pesticides found in the waters of the region may pose a greater risk to salmonids than previously estimated (Scholz et al. 2006). Impacts to marine foraging habitats have been, and continue to be, greatly affected by urbanization along nearshore areas in Bellingham Bay and the Strait of Georgia. For example, the Cherry Point herring stock was once a substantial prey resource, and its current diminished condition may appreciably affect bull trout.

- Fisheries pose a general threat to bull trout. There are currently no fisheries for bull trout in the Nooksack River watershed or nearby marine waters. However, bull trout are highly susceptible to incidental capture in fisheries targeting other species when those fisheries overlap in time and space with bull trout. Various commercial, Tribal, and recreational fisheries in the Nooksack River watershed and nearby marine waters are open annually. Incidentally-captured bull trout are exposed to inadvertent injury and immediate and delayed mortality associated with hooking, suffocation (e.g., from gill nets), handling, stress and physical exhaustion, and predation (e.g., Arlinghaus et al.

2007, pp. 105-134). Poaching and intentional killing (i.e., from anglers that believe bull trout are a threat to their preferred target species or confuse them with other species) are also a concern in some areas.

- In addition to the climate change-related temperature threats to the South Fork Nooksack River described above, climate change is expected to negatively affect bull trout throughout the Nooksack River watershed via elevated water temperatures during migration, spawning, and rearing periods; redd scour due to increased peak flows; and decreased habitat quantity as a result of lower summer flows. Climate change will exacerbate the low flow issues and elevated water temperature problems currently existing in the watershed.

- The potential for brook trout and brook trout/Dolly Varden hybrids, detected in many parts of the Nooksack River core area, to increase their distributions is a significant concern. Brook trout are likely more widespread within the system than first suspected (USFWS 2008a, Nooksack River core area Chapter, p. 6). The magnitude of this threat is expected to increase over time if habitat continues to be degraded in the system, and migratory life history forms of bull trout remain in low abundance. Brook trout appear to adapt better to degraded habitats than bull trout (Clancy 1993; MBTSG 1996). Because elevated water temperatures and sediments are often indicative of degraded habitat conditions, bull trout may be subject to stresses from both interactions with brook trout and degraded habitat (MBTSG 1996). The low numbers of adult bull trout observed at known spawning sites may further allow brook trout to become more dominate within the core area.

- There is a potential for impact to subadult and adult bull trout from *Columnaris* outbreaks due to elevated water temperatures in the South Fork Nooksack River. *Columnaris* has been detected in upstream migrating and holding adult salmon (Nooksack Natural Resources et al. 2005, p. 80).

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APPENDIX I
LOWER SKAGIT CORE AREA

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Lower Skagit Core Area

The Lower Skagit core area comprises the Skagit basin downstream of Seattle City Light's Gorge Dam, including the mainstem Skagit River and the Cascade, Sauk, Suiattle, White Chuck, and Baker Rivers, including the reservoirs (Baker Lake, Lake Shannon) upstream of upper and lower Baker Dams.

Bull trout occur throughout the Lower Skagit core and express fluvial, adfluvial, resident, and anadromous life history forms. Adfluvial bull trout occur in Baker Lake and Lake Shannon. Fluvial bull trout forage and overwinter in the larger pools of the upper portion of the mainstem Skagit River and, to a lesser degree, in the Sauk River (Kraemer 2001, p. 2). Populations expressing the resident life history form are found throughout the basin and often co-occur with migratory life history forms. Life history expression of bull trout is highly plastic. Individual fish may change life histories during their lifetime (USFWS 2008a, p. 2). Also, life history of progeny may vary from that of the parents (Brenkman et al. 2007, pp. 8-9; Rieman and McIntyre 1993, pp. 2-3).

Many subadult and adult bull trout use the lower river, estuary, and nearshore marine areas extensively for rearing and foraging. Key spawning and early rearing habitat, found in the upper portions of much of the basin, is generally on federally protected lands, including the North Cascades National Park, North Cascades National Recreation Area, Glacier Peak Wilderness, and Henry M. Jackson Wilderness Area.

The Lower Skagit core area population is considered at "low risk" for extirpation (USFWS 2008b, p. 35). This core area is one of four population strongholds in the Coastal Recovery Unit (USFWS 2015a, p. 79). The status of the bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity (i.e., trend in adult abundance), and 4) connectivity (USFWS 2004, p. 215).

Number and Distribution of Local Populations

Twenty local populations are recognized within the Lower Skagit core area (USFWS 2004, p. 76; USFWS 2015b, p. A-148): 1) Bacon Creek, 2) Baker Lake, 3) Buck Creek, 4) Cascade River, 5) Downey Creek, 6) Forks of Sauk River, 7) Goodell Creek, 8) Illabot Creek, 9) Lime Creek, 10) Lower White Chuck River, 11) Milk Creek, 12) Newhalem Creek, 13) South Fork Cascade River, 14) Straight Creek, 15) Sulphur Creek, 16) Sulphur Creek (Lake Shannon), 17) Tenas Creek, 18) Upper South Fork Sauk River, 19) Upper Suiattle River, and 20) Upper White Chuck River. Core areas with more than 10 interconnected local populations are at a diminished risk of local extirpation and adverse effects from random naturally-occurring events (USFWS 2004, pp. 216-218). Eighteen local populations within the Lower Skagit core area are interconnected. Connectivity of two local populations with the rest of the core area is partially obstructed (see Connectivity section below).

Adult Abundance

The Lower Skagit core area is believed to contain the largest spawning population of bull trout in Washington. Adult abundance is estimated to be between 5,000 and 10,000 individuals based on partial spawner survey data from less than half of the core area (USFWS 2008a, p. 3). This core area is not considered at risk from genetic drift because it supports more than 1,000 adults (USFWS 2004, pp. 218-224). However, some local populations may be at risk from inbreeding depression because they appear to contain fewer than 100 adults (USFWS 2004, pp. 218-224). At least half of the local populations are believed to have 100 or more adults, and thus are not at risk from inbreeding depression. Abundance data for most local populations are limited and/or outdated. These data are described below. More recent and/or higher quality survey data for most local populations are needed to reach more confident conclusions.

The WDFW conducted surveys in index reaches of six local populations from 2001 to 2011 (Downen 2009; Fowler 2012), although not every local population was surveyed in every year. It is uncertain what proportion of available habitat was represented by the surveyed index reaches. Therefore, survey results represent minimum abundances. Unless otherwise noted, the following adult abundances are based on redd survey results. Survey years are noted in parentheses.

Bacon Creek: 42 to 134 adults (2009 to 2011); 118 to 300 adults (2001 to 2008).

Cascade River: 182 to 414 adults (2009 to 2011); 666 to 868 adults (2006 to 2008).

Downey Creek: 190 to 282 adults (2009 to 2011); 316 to 394 adults (2005 to 2008).

Forks of Sauk River: 154 to 416 adults (2005 to 2011); 350 to 740 adults (2001 to 2004); 10 to 104 adults (1988 to 1996).

Goodell Creek: 25 to 63 adults (2004 to 2008); 150 to 175 adults (2002 to 2003). Abundances are peak live counts of individual fish.

Illabot Creek: 100 to 260 adults (2005 to 2008); 600 to 660 adults (2002 to 2004).

Puget Sound Energy has performed limited bull trout surveys annually in the Baker Lake and Sulphur Creek (Lake Shannon) local populations since 2009. Similar surveys were performed by the National Park Service and/or R2 Consulting from 2000 to 2006. Surveys have been intended to provide indicators of relative, not absolute, abundance. Nonetheless, surveys suggest the following:

Baker Lake: May contain at least 100 adults, but likely fewer than 500.

Sulphur Creek (Lake Shannon): Less than 100 adults.

For all other local populations, there are no recent adult abundance data. In 2001, the WDFW provided abundance estimates for many core areas (Kraemer 2001). However, the methods and assumptions used to derive these estimates were not described; therefore, the quality and accuracy of these estimates is uncertain.

Buck Creek: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Lime Creek: Less than 100 migratory adults. "Abundant" residents.

Lower White Chuck River: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Newhalem Creek: Unknown abundance.

Milk Creek: Limited migratory use presumably due to natural factors. "Abundant" residents believed to be near historical numbers.

South Fork Cascade River: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Straight Creek: Less than 100 migratory adults. "Unknown" resident component.

Sulphur Creek: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Tenas Creek: Less than 100 migratory adults. "Limited" resident component.

Upper South Fork Sauk River: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Upper Suiattle River: "Unknown" abundance of migratory and resident forms.

Upper White Chuck River: "Unknown" abundance of migratory and resident forms, but believed to be one of the larger local populations, presumably due to the quantity and quality of habitat.

Productivity

Most local populations are not consistently monitored; therefore, trends in abundance are unknown. Data from the six local populations monitored by the WDFW (Downen 2009; Fowler 2012) suggest that a basin-wide decline in productivity occurred in the mid-2000's (see Adult Abundance section above). Unusually low summer flows and record flood events in the mid-2000 may have been primary contributors to this decline. It is unknown if productivity is continuing to decline or has stabilized. This uncertainty is due to the following: 1) the relatively recent timing of the decline; 2) lack of any abundance data more recent than 2011; and, 3) inherent inter-annual variability in bull trout abundance surveys. Any persistent and widespread decline in productivity across the core area would increase the risk of extirpation (USFWS 2004, pp. 224-225). More recent and/or higher quality survey data for most local populations are needed to reach more confident conclusions.

Long-term monitoring data from the Forks of Sauk River local population suggests that this local population remains at abundances greater than pre-listing levels despite the apparent recent decline in productivity. The extent to which this is true for other local populations is unknown.

Monitoring data from 2009 to 2014 for the Baker Lake and Sulphur Creek (Lake Shannon) local populations suggest stable or increasing trends in productivity, likely due to recent intensive sockeye salmon hatchery production and fry releases into the lakes.

Connectivity

There are no connectivity barriers between 18 of the 20 local populations, and most, if not all, of these local populations contain migratory life history forms. Thus, there are no extirpation risks associated with connectivity among these local populations. Connectivity within the Baker River system, and between the Baker River system and other local populations, is partially obstructed by two hydropower dams owned and operated by Puget Sound Energy. Bull trout passage across the dams has improved with the construction of new passage infrastructure (floating surface collectors for downstream migrants; adult trap-and-haul facility for upstream migrants) and implementation of improved passage protocols. These were negotiated as part of the 2004 Settlement Agreement and 2008 Federal Energy Regulatory Commission license renewal. The overarching bull trout passage strategy is the most effective one that can be achieved with the dams in place. However, there are limitations that prevent the passage measures from being fully effective, which places the two local populations above the dams - Baker Lake and Sulphur Creek (Lake Shannon) - at increased risk of extirpation. The Service works closely with Puget Sound Energy to monitor passage effectiveness and make improvements where possible.

Currently, bull trout in the Lower Skagit core area can migrate upstream only as far as Gorge Dam. Historically, bull trout may have been able to migrate as far as the current site of Diablo Dam (USFWS 2004, p. 77), approximately 4 miles upstream from Gorge Dam.

Changes in Environmental Conditions

Since the bull trout listing, federal actions occurring in the Lower Skagit core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; federally authorized repair and maintenance of levees and emergency bank protection actions; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have negatively directly affected bull trout in the Lower Skagit core area.

Carpenter, Turner, Otter Pond, Red, Fisher, Hansen, Lake, Nookachamps, and East Fork Nookachamps Creeks are all temperature-impaired tributaries to the Skagit River within the Lower Skagit core area. These creeks are addressed in a TMDL study of the lower Skagit basin (WDOE 2008, p. 18).

The number of non-federal actions occurring in the Lower Skagit core area since the bull trout listing is unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably have negatively affected bull trout and parts of their forage base. State fishing regulations allow a daily limit of two fish within the Lower Skagit core area. Emergency regulations were implemented in 2007 within sections of the Skagit River to prohibit the retention of bull trout to address the decline in bull trout spawners that had been observed. These declines may have been the result of drought and flood events. Changes in fishing regulations were implemented in 2008 by WDFW within portions of the Skagit, Sauk, and Cascade Rivers, including new selective gear rules and catch and release requirements (USFWS 2008a, p. 12)

A number of major restoration and conservation land protection projects have been completed in the Skagit River watershed that improve and protect bull trout habitat. Many of these projects were implemented as the result of project prioritization processes and state and federal funding coordinated by the Skagit Watershed Council (E. Connor, Seattle City Light, pers. comm. 2008 in USFWS 2008a, p. 12). Major restoration projects that have been implemented or completed since 2004 include the Milltown Island and Wiley Slough Estuary Restoration Project sponsored by the Skagit River System Cooperative (SRSC) and WDFW, and the sediment reduction projects in the middle Skagit and Suiattle River watersheds sponsored by the U.S. Forest Service. Over 1,100 acres of habitat in the Cascade River was put into permanent conservation protection through the partnership of Seattle City Light, Washington Department of Natural Resources, and USFWS (USFWS 2008a, p. 12). Several miles of foraging, migration, and overwintering habitat along the middle Skagit River have been protected since 2004 by the Skagit Land Trust and The Nature Conservancy, and major areas along the middle Skagit are being restored by the Skagit Fisheries Enhancement Group and SRSC. The SRSC has been reducing the impacts of bank armoring on foraging, migration, and overwintering habitats in the Sauk River by acquiring lands and subsequently removing riprap (USFWS 2008a, p. 12). Additionally, the severity of downstream fish passage impacts at Upper Baker Dam have been reduced (USFWS 2008a, p. 9) and work to upgrade the upstream adult trap and haul facility at the Lower Baker Dam has been completed.

Climate change is expected to negatively affect the Lower Skagit core area (USFWS 2008a, p. 19). Climate change is expected to result in higher water temperatures, lower spawning flows, and increased magnitude of winter peak flows (Battin et al. 2007 in USFWS 2008a, p. 19; Lee and Hamlet 2011). Glacial retreat, snowpack reduction, bluff erosion, landslides, and increased peak flows, are expected to result in increased rates of aggradation downstream (Lee and Hamlet 2011, p. 128-131). Higher peak flows and increased aggradation may increase redd scour and smothering, resulting in mortality to eggs, incubating embryos, and pre-emergent juveniles. The unusually low summer flows and record flood events in the mid-2000's, which are believed to be a primary contributor to basin-wide declines in bull trout abundance, may be an indicator of how climate change may affect bull trout in the Lower Skagit core area (USFWS 2008a, p. 19).

Threats

There are five primary threats to bull trout in the Lower Skagit core area (USFWS 2015b, pp. A-11 to A-12):

Upland/Riparian Land Management: Legacy Forest Management. Associated sediment impacts, particularly from forest roads, have led to habitat degradation within key spawning and rearing basins (i.e., Sauk and Suiattle Rivers) in the core area.

Instream Impacts: 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 (e.g., Skagit and lower Sauk Rivers) key to the persistence of the anadromous life history form.

*Water Quality: Agriculture Practices and Residential Development and Urbaniza*tion. Related activities have resulted in sediment and temperature impairment in major tributaries to the lower Skagit River and possibly upper Sauk River

Water Quality: 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.

Connectivity Impairment: Fish Passage Issues. Upstream and downstream connectivity at hydropower facilities (i.e., Baker River hydropower project) is directly tied to active fish passage measures under the 2004 Settlement Agreement and 2008 Federal Energy Regulatory Commission license renewal.

Additional threats to the Lower Skagit core area bull trout population include the following:

- Operations of the Lower Baker Dam occasionally have significantly affected water quantity in the lower Baker and Skagit Rivers.

- Estuarine nearshore foraging habitats have been, and continue to be, negatively affected by agricultural practices and development activities. In addition, declines in forage fish species, particularly surf smelt and Pacific herring, in the marine nearshore areas of the Salish Sea (Therriault et al. 2009; Greene et al. 2015) have resulted in part from degradation of habitats including natural beaches and eel-grass beds, and from water pollution impacts. Anadromous bull trout feed heavily on these species in nearshore areas (Goetz et al. 2004, pp. 109-112). Declines in marine nearshore habitat quality and prey resources may limit the abundance of the anadromous life history form.

- Declines in abundance of anadromous salmonids have reduced the bull trout forage base and may limit the abundance and productivity of the core area's bull trout populations (USFWS 2008a, p. 15). Anadromous salmonids are vital to Lower Skagit core area bull trout because they provide an abundant forage resource. However, the abundance of many species of anadromous salmonids in the Lower Skagit core area has been in decline

for a decade (chum salmon, *Oncorhynchus keta*) or more (Chinook salmon, *O. tshawytscha*, and steelhead trout, *O. mykiss*) (WDFW 2015). Bull trout abundance and growth rates are positively correlated with abundance of spawning anadromous salmonids in the Lower Skagit core area (Kraemer 2003, pp. 5, 9-10; Zimmerman and Kinsel 2010, pp. 26, 30) and elsewhere (Copeland and Meyer 2011, pp. 937-938). Such correlations have been observed for other species as well (Bentley et al. 2012; Nelson and Reynolds 2014). Anadromous salmonids provide a direct forage resource via eggs and juveniles, which make up a substantial proportion of the bull trout diet (Lowery and Beauchamp 2015). Spawning fish and carcasses also stimulate ecosystem productivity, thereby increasing abundance of aquatic invertebrates and resident fishes (e.g., Cederholm et al. 1999; Moore et al. 2008; Copeland and Meyer 2011; Rinella et al. 2012). Aquatic invertebrates and resident fishes are also important components of the Lower Skagit core area bull trout diet (Lowery and Beauchamp 2015).

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APPENDIX J
STILLAGUAMISH CORE AREA

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Stillaguamish Core Area

The Stillaguamish core area is comprised of the Stillaguamish River basin, including the North Fork and South Fork Stillaguamish Rivers and their tributaries. Major tributaries to the North Fork Stillaguamish River include the Boulder River and Deer, Little Deer, and Higgins Creeks. Canyon Creek, the only major tributary to the South Fork Stillaguamish River, has minor tributaries including Millardy, Deer, Coal, Palmer, Perry, and Beaver Creeks.

Bull trout in the Stillaguamish core area primarily consist of the anadromous and fluvial life-history forms (USFWS 2004, p. 96). Resident bull trout occur in the upper South Fork Stillaguamish River (USFWS 2004, p. 98; USFWS 2008a, p. 1) and possibly also upstream of the anadromous barrier on Higgins Creek (USFWS 2008a, p. 3). There are no known populations in the North Fork Stillaguamish River above a natural anadromous barrier at river mile 37.5 (Kraemer, in litt. 1999).

The South Fork Stillaguamish River upstream of Granite Falls has supported anadromous bull trout since the construction of a fishway in the 1950s (USFWS 2004, pp. 97-98). Previously, the falls were impassable to anadromous fish. Anecdotal information from fish surveys in the 1920s and 1930ssuggest that native char likely were present above Granite Falls prior to construction of the fishway (USFWS 2004, pp. 97-98).

Spawning habitat is generally limited in the Stillaguamish core area due to two primary factors: 1) there is a relatively small amount of high elevation areas, which often provide the best thermal regimes for spawning, egg incubation, and early juvenile rearing; and, 2) historical land management practices, particularly related to timber harvesting, have degraded much of the available spawning and rearing habitat. In the North Fork Stillaguamish River basin, migratory bull trout spawn in the upper reaches of the Deer Creek subbasin, including Upper Deer, Little Deer, and Higgins Creeks. There is also a spawning population of resident char (bull trout or Dolly Varden) above the anadromous barrier on Higgins Creek (USFWS 2008a, p. 3). In the Boulder River subbasin, bull trout spawn below the impassible falls at river mile 3. Adult bull trout have been observed in the North Fork Stillaguamish River above the Boulder River confluence, including in the Squire Creek subbasin (USFWS 2004, p. 97). However, these fish are suspected to be strays, colonizers (USFWS 2015, p. A-149), and/or fish foraging from other core areas (USFWS 2004, pp. 3-4), although there has been no extensive juvenile sampling or evaluation of spawning success.

In the South Fork Stillaguamish River basin, bull trout are known to spawn and rear in Canyon, Palmer, Perry, and Buck Creeks and the upper South Fork mainstem above Palmer Creek (USFWS 2004, pp. 94-99). Primary spawning grounds have been identified in the South Fork Stillaguamish River above the Palmer Creek confluence. Spawning and early rearing habitat in the South Fork Stillaguamish River is considered to be in fair condition. Although bull trout spawn in the upper South Fork Stillaguamish River and other tributaries, available habitat is partially limited by gradient and competition with coho (*Oncorhynchus kisutch*) salmon. Migratory and resident fish coexist on the spawning grounds.

In Canyon Creek, bull trout use the upper south fork of the creek for spawning and rearing (USFWS 2004, p. 98). Although there have been isolated and incidental observations of spawning by migratory-size bull trout, electrofishing surveys in the early 2000s were unable to locate any juvenile or resident fish. Spawning and early rearing habitat is believed to be in poor condition due to the relatively low elevation and persistent effects of historical land management activities, including logging.

The Stillaguamish core area population was considered "at risk" for extirpation in 2008 (USFWS 2008b, p. 35). Extirpation risk may be greater now due to lower abundance and declining productivity. The status of the bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, p. 215).

Number and Distribution of Local Populations

Three local populations are recognized within the Stillaguamish core area: 1) Upper Deer Creek, 2) South Fork Stillaguamish River, and 3) Canyon Creek. These local populations are relatively well-distributed throughout the core area. The Upper Deer Creek local population may be extirpated (USFWS 2015, p. A-13), based on the paucity of historical observations of bull trout and more recent failures to detect bull trout. Core areas with fewer than 5 interconnected local populations are at increased risk of local extirpation and adverse effects from random naturally-occurring events (USFWS 2004, pp. 216-218).

A fourth local population - North Fork Stillaguamish River - was recognized from the early 2000s (USFWS 2004, p. 94-99) until 2015, when it was no longer considered a local population (USFWS 2015, p. A-149). Numerous adult bull trout have been observed in this part of the Stillaguamish River system during staging and spawning periods. However, these are now thought to have been anadromous individuals from outside the basin (USFWS 2015, p. A-149). Bull trout redds, possibly from colonizing individuals from outside the basin, were observed in the 1980s (USFWS 2015, p. A-149). No bull trout redds have been detected since then, though redd surveys have been limited. Because of the past adult detections in this area, the North Fork Stillaguamish River is considered a potential local population only.

Adult Abundance

The Stillaguamish core area likely contains fewer than 250 adults, however survey data is limited and origin of fish observed in the former North Fork Stillaguamish River local population is uncertain. This core area is at risk from genetic drift because it contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 218-224).

The South Fork Stillaguamish River local population may be the only functional population in the core area (USFWS 2008a, p. 2). Average adult abundance in this local population, estimated from redd counts, was approximately 40 fish from 2009 to 2011, a decline from approximately 125 fish from 2005 to 2008 (Fowler 2012).

The Upper Deer Creek and Canyon Creek local populations are believed to be very low, although systematic surveys are not performed here. Past observations of redds and adults suggest that each of these populations number well below 100 adults (USFWS 2004, p. 96). Surveys in 2002 and 2003 did not detect any native char in either area (USFWS 2008a, p. 3). The Upper Deer Creek local population may be extirpated (USFWS 2015, p. A-13).

The North Fork Stillaguamish River is not currently believed to support a spawning local population, although there is insufficient information to rule out the possibility of one in existence (USFWS 2015, p. A-149). It is believed that upwards of 100 adult bull trout utilize this area (USFWS 2004, pp. 96-97), presumably as strays, colonizers (USFWS 2015, p. A-149), and/or fish foraging from other core areas (USFWS 2004, pp. 3-4).

All Stillaguamish core area local populations are at risk from inbreeding depression because they appear to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 218-224).

Productivity

Productivity of the Stillaguamish River core area may be in decline based on trends in redd counts observed in the South Fork Stillaguamish River, the primary local population. Average adult abundance estimated from redd counts was approximately 40 fish from 2009 to 2011, a decline from approximately 125 fish from 2005 to 2008 (Fowler 2012). In addition, the three-year running average of redd counts declined every year from 2007 (53 redds per year) to 2011 (18 redds per year). More recent survey data is needed to confirm whether this apparent trend is continuing. Declining productivity places the core area at increased risk of extirpation (USFWS 2004, p. 224-225).

Connectivity

The presence of migratory bull trout in the primary local population (South Fork Stillaguamish River) and likely other local populations diminishes the risk of local extirpation from connectivity issues. However, persistence of migratory life history forms in the South Fork Stillaguamish River depends upon continued operation of the Granite Fall fishway, which may not be fully functional (USFWS 2008a, p. 5). In addition, a weir on Cook Slough impedes upstream fish passage and/or traps migratory spawners (USFWS 2015, p. A-13).

Bull trout habitat within the Stillaguamish core area generally has good connectivity. However, because the local populations are somewhat isolated from one another, maintaining connectivity among them will be critical to support life-history diversity, refounding, and genetic exchange.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, federal actions occurring in the Snohomish-Skykomish core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, restoration of fish passage at barriers, and habitat-improvement projects. In addition, federally funded transportation projects involving repair and

protection of roads and bridges have been completed. Finally, section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans that address bull trout in this core area. For example, in 2000, State forest practice regulations were significantly revised following the Forest and Fish agreement. These regulations increased riparian protection, unstable slope protection, recruitment of large wood, and improved road standards significantly. Because there is biological uncertainty associated with some of the prescriptions, the Forest and Fish agreement relies on an adaptive management program for assurance that the new rules will meet the conservation needs of bull trout. The updated regulations are expected to significantly reduce the level of future timber harvest impacts to bull trout streams on private lands, however, most legacy threats from past forest practices will likely continue to be a threat for decades.

The number of non-federal actions occurring in the Stillaguamish core area since the bull trout listing is unknown. Beneficial actions include Snohomish County revised Critical Area Regulations, effective October 1, 2007. The revised regulations included consideration for anadromous fish intended to preserve the critical area functions beneficial to these species. In addition, recent salmon recovery efforts are improving conditions for bull trout. Although directed toward salmonids other than bull trout, the regional salmon recovery plan under the Shared Strategy for Puget Sound and watershed-scale implementation under the Puget Sound Partnership have resulted in general aquatic habitat improvements that benefit many target and non-target species, including bull trout. Other non-federal activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout.

Climate change is expected to negatively affect the Stillaguamish core area (USFWS 2008a, pp. 14-15). Climate change projections for the Puget Sound region suggest the following impacts to occur in river systems across the region, including the Stillaguamish (Battin et al. 2007; Beechie et al. 2013; Hall et al. 2014; Tohver et al. 2014): greater proportion of rain during the winter and less snowpack in the late spring and early summer; higher water temperatures, especially during the summer; lower flows during the summer and early fall; and, increased magnitude of winter peak flows Snowpack reduction, increased peak flows, and associated bluff erosion and landslides may result in increased rates of sediment aggradation downstream (Lee and Hamlet 2011, p. 128-131). Higher peak flows and increased aggradation may increase redd scour and smothering, resulting in mortality to eggs, incubating embryos, and pre-emergent juveniles. In addition, the Stillaguamish River basin already suffers from temperature exceedances within its mainstem and two forks (WDOE 2007), making it particularly vulnerable to climate change impacts. There are no glaciers or protected areas in the Stillaguamish River basin that could help to buffer the impacts of climate change (USFWS 2008a, p. 14-15).

Threats

There are six primary threats to bull trout in the Stillaguamish core area (USFWS 2015, p. A-13):

Upland/Riparian Land Management: Forest Management. Legacy and ongoing impacts have exacerbated landslide activity in the watershed degrading salmonid habitat and water quality.

Instream Impacts: Recreational Mining. Activities impact spawning and rearing tributary habitats.

Water Quality: 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.

Connectivity Impairment: Fish Passage Issues. Stillaguamish weir on Cook Slough impedes upstream fish passage and/or traps migratory spawners.

Connectivity Impairment: Fish Passage Issues. Persistence of the migratory life history in the South Fork Stillaguamish River local population is reliant upon continued functionality of the fishway at Granite Falls.

Small Population Size: 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 and Upper Deer Creek local populations, in fact, the Upper Deer Creek local population may be extirpated.

Additional threats to the Stillaguamish core area bull trout population include the following:

- Estuarine nearshore foraging habitats have been severely diminished in quantity and quality (USFWS 2008a, pp. 8, 13). In addition, declines in forage fish species, particularly surf smelt and Pacific herring, in the marine nearshore areas of the Salish Sea (Therriault et al. 2009; Greene et al. 2015) have resulted in part from degradation of habitats including natural beaches and eel-grass beds, and from water pollution impacts. Anadromous bull trout feed heavily on these species in nearshore areas (Goetz et al. 2004, pp. 109-112). Declines in marine nearshore habitat quality and prey resources may limit the abundance of the anadromous life history form.

- The abundance of many species of anadromous salmonids in the Stillaguamish core area has been in decline for many years (WDFW 2015). Bull trout abundance and growth rates are positively correlated with abundance of live-spawning anadromous salmonids in the nearby Lower Skagit core area (Kraemer 2003, pp. 5, 9-10; Zimmerman and Kinsel 2010, pp. 26, 30) and elsewhere (Copeland and Meyer 2011, pp. 937-938). Such correlations have been observed for other species as well (Bentley et al. 2012; Nelson and Reynolds 2014). Anadromous salmonids provide a direct forage resource via eggs and juveniles, which can make up a substantial proportion of the bull trout diet (e.g., Lowery and Beauchamp 2015). Live spawners and carcasses also stimulate ecosystem productivity, thereby increasing abundance of aquatic invertebrates and resident fishes (e.g., Cederholm et al. 1999; Moore et al. 2008; Copeland and Meyer 2011; Rinella et al. 2012), which bull trout forage on (Lowery and Beauchamp 2015). The long-term decline in abundance of live-spawning anadromous salmonids and the related decline in the forage base may limit the long-term abundance and productivity of the core area's bull trout populations.

- Climate change is expected to negatively affect spawning and rearing bull trout via elevated water tempertures during migration, spawning, and rearing periods; redd scour due to increased peak flows; decreased habitat quantity as a result of lower summer flows.

- Historical planting of Westslope cutthroat trout in the North and South Forks of the Stillaguamish River in areas overlapping bull trout spawning and rearing is a concern (USFWS 2004; USFWS 2008a, p. 7).

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APPENDIX K
SNOHOMISH AND SKYKOMISH CORE AREA

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Snohomish-Skykomish Core Area

The Snohomish-Skykomish core area comprises the Snohomish, Skykomish, and Snoqualmie Rivers and their tributaries. Bull trout occur throughout the Snohomish River system downstream of barriers to anadromous fish. Bull trout are not known to occur upstream of Snoqualmie Falls, upstream of Spada Lake on the Sultan River, in the upper forks of the Tolt River, above Deer Falls on the North Fork Skykomish River, or above Alpine Falls on the Tye River. Bull trout did not occur above Sunset Falls on the South Fork Skykomish River prior to 1958, when the Washington Department of Fisheries (now Washington Department of Fish and Wildlife) implemented a trap-and-haul program for anadromous salmonids. This program is still operating.

Fluvial, resident, and anadromous life history forms of bull trout occur in the Snohomish-Skykomish core area. A large portion of the migratory segment of this population is anadromous. There are no lake systems within the basin that support typical adfluvial populations; however, anadromous and fluvial forma occasionally forage in a number of lowland lakes having connectivity to the mainstem rivers (USFWS 2004, p. 99).

The Snohomish, Snoqualmie, Skykomish, North Fork Skykomish, and South Fork Skykomish Rivers provide important foraging, migrating, and overwintering habitat for subadult and adult bull trout. The topography of the basin limits the amount of key spawning and early rearing habitat in comparison with many other core areas. Rearing bull trout occur throughout most of the accessible reaches of the basin and extensively use the lower estuary, nearshore marine areas, and Puget Sound for extended rearing.

In 2008, the Snohomish-Skykomish core area population was considered at "potential risk" for extirpation (USFWS 2008b, p. 35). Since 2008, some of the key status indicators have declined. The status of the bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, p. 215).

Number and Distribution of Local Populations

Four local populations are recognized within the Snohomish-Skykomish core area (USFWS 2004, pp. 99-105; USFWS 2015, p. A-14): 1) North Fork Skykomish River (including Goblin and West Cady Creeks), 2) Troublesome Creek (resident form only), 3) Salmon Creek, and 4) South Fork Skykomish River. Core areas with fewer than 5 interconnected local populations are at increased risk of local extirpation and adverse effects from random naturally-occurring events (USFWS 2004, pp. 216-218). Three of the four Snohomish-Skykomish core area local populations are interconnected (see Connectivity section below).

Adult Abundance

The Snohomish-Skykomish core area probably supports between 500 and 1,000 adults. In 2008, it was believed that this core area supported just over 1,000 adults (USFWS 2008a, p. 2; USFWS 2008b, p. 35). However, abundance indices in the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have substantially declined since then (WDFW 2015). From 2002 to 2007, North Fork redd counts averaged 305 redds, peaking at 538 redds in 2002. In contrast, from 2009 to 2014, counts averaged 90 redds, with a minimum of 17 redds observed in 2013, the lowest single-year count since surveys began in 1988. During the same time, spawner counts at the South Fork Skykomish River trap declined from a mean of 94 fish from 2002 to 2007, to a mean of 63 fish from 2009 to 2014. The Troublesome Creek local population is mainly a resident population upstream of a natural migration barrier. Adult abundance is unknown for this local population. The Salmon Creek local population likely has fewer than 100 adults.

The Snohomish-Skykomish core area is at risk from genetic drift because it likely contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 218-224). Two local populations (South Fork Skokomish River, Salmon Creek) are at risk from inbreeding depression because they are believed to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 218-224). The North Fork Skykomish River local population is not at risk from inbreeding depression. Risk from inbreeding depression to the Troublesome Creek local population is unknown.

Productivity

Population trends for the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have been in decline since peaking in the early- to mid-2000's. Long-term redd counts for the North Fork Skykomish River local population increased from the time of listing, peaked between 2001 and 2004, and have generally been in decline since. The five-year running average from 2012 to 2014 varied between 83 and 118 redds, which is equivalent to pre-listing levels (75 to 118 redds) despite peaking at 348 to 366 redds between 2004 and 2006. A similar trend is evident in adult counts at the South Fork Skykomish River trap, although recent five-year running averages (62 to 66 adults) are still above pre-listing levels (38 to 44 adults). The five-year running average peaked between 2005 and 2007 at 95 to 102 adults. It is believed that the South Fork Skykomish River local population is continuing to colonize new spawning and rearing habitat, which may partially explain the less dramatic declining trend. Productivity of the Troublesome Creek and Salmon Creek local populations is unknown but presumed stable, as the available spawning and early rearing habitats are considered to be in good to excellent condition. The Snohomish-Skykomish core area is at increased risk of extirpation due to declining productivity (USFWS 2004, pp. 224-225).

Connectivity

Migratory bull trout occur in three of the four local populations in the Snohomish-Skykomish core area (North Fork Skykomish, Salmon Creek, and South Fork Skykomish). The lack of connectivity with the Troublesome Creek local population is a natural condition. The connectivity between the other three local populations reduces the risk of extirpation from habitat isolation and fragmentation. However, connectivity with the South Fork Skykomish local population is dependent upon the trap-and-haul facility at Sunset Falls.

Changes in Environmental Conditions

Since the bull trout listing, federal actions occurring in the Snohomish-Skykomish core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Snohomish-Skykomish core area.

The number of non-federal actions occurring in the Snohomish-Skykomish core area since the bull trout listing is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout.

Climate change is expected to negatively affect the Snohomish-Skykomish core area (USFWS 2008a, p. 14). Climate change is expected to result in higher water temperatures, lower spawning flows, and increased magnitude of winter peak flows (Battin et al. 2007 in USFWS 2008a, p. 14). Higher peak flows may increase redd scour and mortality to eggs, incubating embryos, and pre-emergent juveniles. Bull trout spawning and rearing areas are particularly vulnerable to future climate change impacts, especially due to the narrow distribution of spawning sites within this system (USFWS 2008a, p. 14).

Threats

There are four primary threats to bull trout in the Snohomish-Skykomish core area (USFWS 2015, p. A-14):

Instream Impacts: Flood Control. Flood and erosion control associated with agricultural practices, residential development, and urbanization continues to result in poor structural complexity within lower river FMO habitats key to the persistence of the anadromous life history form.

Instream Impacts: Recreational Mining. Recreational mining activities impact spawning and rearing tributary habitats.

Water Quality: Residential Development and Urbanization. Associated impacts increase seasonal high water temperature in lower mainstem rivers, migration corridors that are key to the persistence of the anadromous life history form.

Connectivity Impairment: Fish Passage Issues. Persistence of the South Fork Skykomish River local population is reliant upon continued funding and ongoing operation of the trap-and-haul facility at Sunset Falls.

Additional threats to the Snohomish-Skykomish core area bull trout population include the following:

- Degraded habitat conditions from effects associated with timber harvests, logging roads, and timber land fertilization, especially in the upper watershed, where spawning occurs.
- Blocked fish passage, altered stream morphology, and degraded water quality in the lower watershed resulting from agricultural and livestock management practices.
- Injury and/or mortality from illegal harvest or incidental hooking/netting, which may occur where recreational fishing is allowed by the Washington Department of Fish and Wildlife.
- Degraded water quality from municipal and industrial effluent discharges and development.
- Degradation of riparian areas due to residential development and urbanization, and associated loss of foraging habitat and prey.

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APPENDIX L
PUYALLUP CORE AREA

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Puyallup Core Area

The Puyallup core area comprises the Puyallup, Mowich, and Carbon Rivers; the White River system, which includes the Clearwater, Greenwater, and the West Fork White Rivers; and Huckleberry Creek. Glacial sources in several watersheds drain the north and west sides of Mount Rainier and significantly influence water, substrate, and channel conditions in the mainstem reaches. The location of many of the basin's headwater reaches within Mount Rainier National Park and designated wilderness areas (Clearwater Wilderness, Norse Peak Wilderness) provides relatively pristine habitat conditions in these portions of the watershed.

Anadromous, fluvial, and potentially resident bull trout occur within local populations in the Puyallup River system. Bull trout occur throughout most of the system although spawning occurs primarily in the headwater reaches. Anadromous and fluvial bull trout use the mainstem reaches of the Puyallup, Carbon, and White Rivers to forage and overwinter, while the anadromous form also uses Commencement Bay and likely other nearshore areas within Puget Sound. Habitat conditions within the lower mainstem Puyallup and White Rivers have been highly degraded, retaining minimal instream habitat complexity. In addition, habitat conditions within Commencement Bay and adjoining nearshore areas have been severely degraded as well, with very little intact intertidal habitat remaining.

The Puyallup core area has the southernmost, anadromous bull trout population in the Puget Sound Management Unit (USFWS 2004, Vol. 2 p. 19). Consequently, maintaining the bull trout population in this core area is critical to maintaining the overall distribution of migratory bull trout in the management unit.

The status of the bull trout core area population is based on four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, Vol. II p. 215).

Number and Distribution of Local Populations

Five local populations occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River. The Clearwater River is identified as a potential local population, as bull trout are known to use this river and it appears to provide suitable spawning habitat, but the occurrence of reproduction there is unknown (USFWS 2004, Vol 2 pp. 119-121).

Information about the distribution and abundance of bull trout in this core area is limited because observations have generally been incidental to other fish species survey work. Spawning occurs in the upper reaches of this basin where higher elevations produce the cold water temperatures required by bull trout egg and juvenile survival. Based on current survey data, bull trout spawning in this core area occurs earlier in the year (i.e., September) than typically observed in other Puget Sound core areas (Marks et al. 2002). The known spawning areas in local populations are few in number and not widespread. The majority of spawning sites are located in streams within Mount Rainier National Park, with two exceptions, Silver Creek and Silver Springs (Ladley, in litt. 2006; Marks et al. 2002).

Rearing likely occurs throughout the Upper Puyallup, Mowich, Carbon, Upper White, West Fork White, and Greenwater Rivers. However, sampling indicates most rearing is confined to the upper reaches of the basin. The mainstem reaches of the White, Carbon, and Puyallup Rivers probably provide the primary freshwater foraging, migration, and overwintering habitat for migratory bull trout within this core area.

With fewer than 10 local populations, the Puyallup core area is considered to be at intermediate risk of extirpation and adverse effects from random naturally occurring events.

Adult Abundance

Rigorous abundance estimates are generally not available for local populations in the Puyallup core area. Currently, fewer than 100 adults probably occur in each of the local populations in the White River system, based on adult counts at Mud Mountain Dam's Buckley Diversion fish trap. Although these counts may not adequately account for fluvial migrants that do not migrate downstream of the facility, these counts do indicate few anadromous bull trout and few mainstem fluvial bull trout return to local populations in the White River system. Therefore, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess adult abundance in each local population.

Productivity

Due to the current lack of long-term, comprehensive trend data, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess productivity.

Connectivity

Migratory bull trout are likely present in most local populations in the Puyallup core area. However, the number of adult bull trout expressing migratory behavior within each local population appears to be very low compared to other core areas. Although connectivity between the Upper Puyallup and Mowich Rivers local population and other Puyallup core area local populations was reestablished with the creation of an upstream fish ladder at Electron Dam in 2000, this occurred after approximately 100 years of isolation. Very low numbers of migratory bull trout continue to be passed upstream at the Mud Mountain Dam's Buckley Diversion fish trap. The overall low abundance of migratory life history forms limits the possibility for genetic exchange and local population refounding, as well as limits more diverse foraging opportunities to increase size of spawners and therefore, overall fecundity within the population. Consequently, the bull trout population in the Puyallup core area is at intermediate risk of extirpation from habitat isolation and fragmentation.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, the Service has issued Biological Opinions that exempted incidental take in the Puyallup core area. These incidental take exemptions were in the form of harm and harassment, primarily from hydrologic impacts associated with increased impervious surface,

temporary sediment increases during in-water work, habitat loss or alteration, and handling of fish. None of these projects were determined to result in jeopardy to bull trout. The combined effects of actions evaluated under these Biological Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Of particular note, in 2003 the Service issued a Biological Opinion (FWS Ref. No. 1-3-01-F-0476) on the State Route 167 North Sumner Interchange Project. This project was located in Pierce County in the White River portion of the Puyallup watershed and was proposed by Washington State Department of Transportation. The project's direct and indirect impacts and cumulative impacts within the action area included urbanization of approximately 600 acres of land. We anticipated that conversion of this land to impervious surface would result in the permanent loss and/or degradation of aquatic habitat for bull trout and their prey species through reduced base flows, increased peak flows, increased temperatures, loss of thermal refugia, degradation of water quality, and the degradation of the aquatic invertebrate community and those species dependent upon it (bull trout prey species). These impacts will result in thermal stress and disrupt normal behavioral patterns. Incidental take of fluvial, adfluvial, and anadromous bull trout in the form of harassment due to thermal stress and the disruption of migrating and foraging behaviors was exempted for this project. These adverse effects were expected to continue in perpetuity.

Section 10(a)(1)(B) permits have also been issued for HCPs that address bull trout in this core area. Although these HCPs may result in both short and/or long-term negative effects to bull trout and their habitat, the anticipated long-term beneficial effects are expected to maintain or improve the overall baseline status of the species. Additionally, capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have directly affected some individual bull trout in this core area.

The number of non-Federal actions occurring within the Puyallup core area since the bull trout were listed is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance affect riparian and instream habitat which typically results in negative affects to bull trout and their habitat.

Threats

Threats to bull trout in the Puyallup core area include:

- Extensive past and ongoing timber harvest and harvest-related activities, such as road maintenance and construction, continue to affect bull trout spawning and rearing areas in the upper watershed.

- Agricultural practices, such as bank armoring, riparian clearing, and non-point discharges of chemical applications continue to affect foraging, migration, and overwintering habitats for bull trout in the lower watershed.

- Dams and diversions have significantly affected migratory bull trout in the core area. Until upstream passage was recently restored, the Electron Diversion Dam isolated bull trout in the Upper Puyallup and Mowich Rivers local population for nearly 100 years and has drastically reduced the abundance of migratory bull trout in the Puyallup River. Buckley Diversion and Mud Mountain Dam have significantly affected the White River system in the past by impeding or precluding adult and juvenile migration and degrading foraging, migration, and overwintering habitats in the mainstem. Despite improvements to these facilities, passage related impacts continue today but to a lesser degree.

- Urbanization, road construction, residential development, and marine port development associated with the city of Tacoma, have significantly reduced habitat complexity and quality in the lower mainstem rivers and associated tributaries, and have largely eliminated intact nearshore foraging habitats for anadromous bull trout in Commencement Bay.

- The presence of brook trout in many parts of the Puyallup core area and their potential to increase in distribution, including into Mount Rainer National Park waters, are considered significant threats to bull trout. Because of their early maturation and competitive advantage over bull trout in degraded habitats, brook trout in the upper Puyallup and Mowich Rivers local population is of highest concern because of past isolation of bull trout and the level of habitat degradation in this area.

- Until the early 1990s, bull trout fisheries probably significantly reduced the overall bull trout population within this and other core areas in Puget Sound. Current legal and illegal fisheries in the Puyallup core area may continue to significantly limit recovery of the population because of the low numbers of migratory adults.

- Water quality has been degraded due to municipal and industrial effluent discharges resulting from development, particularly in the lower mainstem Puyallup River and Commencement Bay.

- Water quality has also been degraded by stormwater discharge associated with runoff from impervious surface. Impervious surface in the Puyallup watershed increased by 12 percent between 1990 and 2001 (PSAT 2007).

- Major flood events in November 2006 significantly impacted instream habitats within the Puyallup River system. These events are assumed to have drastically impacted bull trout brood success for the year, due to significant scour and channel changes that occurred after peak spawning. Significant impacts to rearing juvenile bull trout were also likely, further impacting the future recruitment of adult bull trout.

- In November 2006, an approximately 18,200 gallon diesel spill resulted in approximately 7,970 gallons entering the head waters of Spring Creek WDOE 2013, p. 1, website accessed 10/22/2013), a bull trout spawning area of the Upper White River local population, likely impacting the available instream spawning habitat. Of this, 6,974 gallons of spilled diesel were recovered by December 2006. Restoration actions have been completed as of 2012 (USFWS 2012, website accessed 10/22/2013).

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APPENDIX M
SKOKOMISH CORE AREA

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Skokomish Core Area

The Skokomish core area comprises the South Fork Skokomish River, North Fork Skokomish River (above and below the Cushman Dams), Vance Creek, and their tributaries. Mainstem habitat in the watershed provides important foraging, migration, and overwintering habitat for sub-adult and adult bull trout. Available spawning and early rearing habitat is limited and fragmented. One reservoir in the core area, Lake Cushman, supports an adfluvial population. The Skokomish River core area is the only identified core area with access to Hood Canal. Fluvial, adfluvial, and resident life history forms of bull trout occur in the Skokomish core area. It is believed that the anadromous life history form was present until the 1980s (USFWS 2010, pp. 59-61). Currently, the Skokomish core area population does not appear to have an anadromous component, based on otolith chemistry data (Larry Ogg, USFS, cited in Correa 2003, p. 49) and surveys in the estuary and lower river (Peters et al. 2011, pp. 157-163; Kowalski, in litt. 2013). However, low numbers of smolt-sized bull trout are often captured in a smolt trap near the river's mouth (Kowalski, in litt. 2013). These observations, combined with the habitat restoration and salmon and steelhead recovery efforts within the Skokomish basin and nearby Hood Canal, suggest that an anadromous component may reestablish in the future.

The Skokomish core area population is considered at "high risk" for extirpation (USFWS 2008b, p. 35; USFWS 2015b). The status of the bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, p. 135).

Number and Distribution of Local Populations

Bull trout are distributed throughout the Skokomish core area. Two local populations have been identified: 1) North Fork Skokomish River (including Elk and Slate Creeks), and 2) South Fork Skokomish River (including Church Creek). A third local population - Brown Creek, which is a tributary to the South Fork Skokomish River - does not currently exist, but is considered a potential local population. Water temperatures are favorable for bull trout in Brown Creek, and extensive habitat restoration efforts in recent years are improving conditions for bull trout spawning and rearing. Bull trout in the South Fork Skokomish local population are distributed throughout the river below an anadromous barrier. The North Fork Skokomish local population is comprised of fish that are isolated upstream of Cushman Dam No. 1 in the North Fork Skokomish River. Bull trout have also been observed in the lower North Fork Skokomish River, below the dams, but these are presumably fluvial fish from the South Fork Skokomish local population. With only two known local populations, bull trout in this core area are at increased risk of local extirpation and adverse effects from random, naturally occurring events (USFWS 2004, pp. 136-137).

Adult Abundance

There are limited data on adult abundance of Skokomish core area bull trout. The USFWS 2008 Five Year Review categorized the Dungeness core area as having 50 to 250 individuals (USFWS 2008b, p. 35). Peters et al. (2011, p. 161) estimated 115 (95 percent CI; 42-207) adult bull trout were present in the anadromous reaches of the Skokomish system during the summer of 2008.

Combined with Olympia National Park data for the isolated (above Cushman Dam No. 1) North Fork Skokomish River, Peters et al. (2011, p. 161) estimated approximately 419 adult bull trout in the Skokomish watershed in 2008. In the North Fork Skokomish River local population, peak adult counts from 1994 to 2015[1] averaged 147 adults, and ranged from 36 to 251 (Brenkman, in litt. 2016). In the South Fork Skokomish River, the Olympic National Forest and the Washington Department of Fish and Wildlife have completed annual redd surveys from 2000 to 2014. Redd counts have ranged from 3 to 26, but the actual number of redds is most likely higher because the river is difficult to survey in the fall due to high flows and marginal visibility. Nonetheless, the small number of redds observed suggest that the adult population is likely very low.

The bull trout population in this core area is one of the most depressed in the Coastal Recovery Unit. The 2015 Bull Trout Recovery Plan identifies "small population size" as one threat to this population (USFWS 2015a, p. A-20). The Skokomish core area is at risk from genetic drift because it likely contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 137-140). The South Fork Skokomish local population is at risk from inbreeding depression because it is believed to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 137-140).

Productivity

In the North Fork Skokomish local population, peak adult bull trout counts show a long-term increasing trend that has recently stabilized (Figure 1). The five-year running average increased steadily from a low of 72 in 2002, to a high of 185 in 2014. Since 2011, the five-year running average has fluctuated between 172 and 185. However, the population may be experiencing a short-term decline: The three-year running average of adults has declined every year since 2012, from a high of 198 in 2012 to a low 158 in 2015. The South Fork Skokomish local population is depressed and continues to decline (Figure 2). Three-year and five-year running averages of redd counts both show a gradual steady decline from the early 2000s through the present. Declining productivity places the South Fork Skokomish local population at increased risk of extirpation (USFWS 2004, pp. 140-141).

[1] The counts occurred in a reference reach (Red Reef Pool, below Staircase Rapids to Lake Cushman inlet). Survey effort was variable among years based on flow conditions.

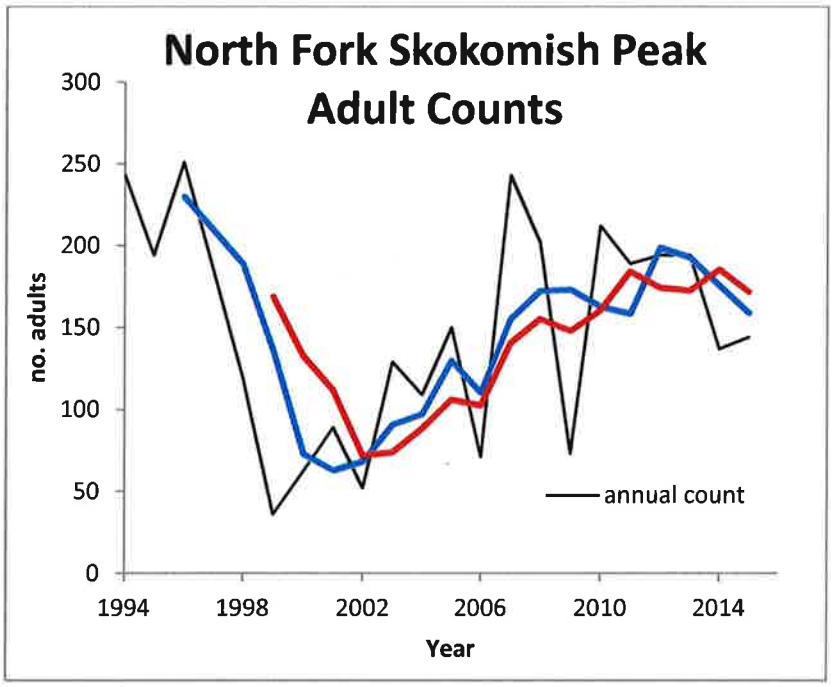

Figure 1. North Fork Skokomish peak adult count data for years 1994 through 2015. Source: Olympic National Park (Brenkman, in litt. 2016).

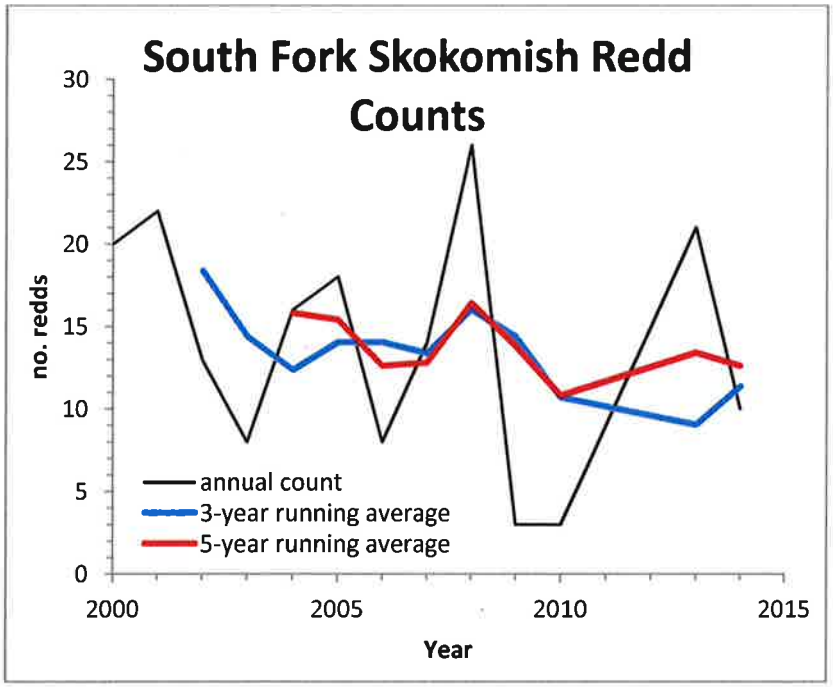

Figure 2. South Fork Skokomish redd count data for years 2000 through 2014. Note that no data were reported for 2011 or 2012. Source: Olympic National Forest (WDFW 2016).

Connectivity

Migratory bull trout are found in both the North Fork Skokomish (adfluvial and possibly fluvial) and the South Fork Skokomish (fluvial and historically anadromous with potential for future reestablishment) local populations. Connectivity between the two local populations has been completely blocked since the 1920s by the two Cushman Dams. However, as part of the Federal Energy Regulatory Commission relicensing effort that concluded in 2010, the owner and operator (Tacoma Power) installed fish passage infrastructure which became operational 2016. The effectiveness of the fish passage facilities and their use by bull trout is being evaluated by Tacoma Power during the first several years of operation. A seasonal connectivity barrier exists in the South Fork Skokomish River just above the confluence with the North Fork Skokomish. This reach of the river is highly aggraded and becomes completely dewatered (flowing subsurface) in some years. A U.S. Army Corps of Engineers General Investigation proposal has been approved to address causes of the aggradation and remedy passage issues, which are also a concern for listed Chinook salmon (*Oncorhynchus tshawytscha*). If funded, construction may occur as early as 2019. Both of these efforts are expected to improve connectivity between the two local populations and with Hood Canal, thereby diminishing risk to the population and potentially helping to restore the anadromous life history form in this core area.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, federal actions occurring in the Skokomish core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included the following: 1)statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; 2) federally funded transportation projects involving repair and protection of roads and bridges; and, 3) section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of sections 6 and 10(a)(1)(A) permits under the Endangered Species Act have directly affected bull trout in the Skokomish core area. A U.S. Army Corps of Engineers General Investigation proposal has been approved and includes substantial habitat restoration actions in the mainstem and lower south fork, including several levee removals and setbacks, and engineered log jam additions. If funded, construction may occur as early as 2019. The Olympic National Forest has been implementing extensive habitat restoration activities in Brown Creek, which may help establish this local population.

The number of non-federal actions occurring in the Skokomish core area since the bull trout was listed are unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout. Conversely, non-federal salmon recovery efforts are improving conditions for bull trout. Although directed toward salmonids other than bull trout, the regional salmon recovery plan under the Shared Strategy for Puget Sound (SSPS 2007) and watershed-scale implementation under the Puget Sound Partnership have resulted in general aquatic habitat improvements that are likely benefitting bull trout.

Climate change is expected to adversely affect bull trout in the Skokomish core area due to several factors. Less annual snow pack and earlier loss of snow pack are predicted, which will reduce summer low flows and impact migration and rearing habitats. Fall and winter storm intensities are expected to increase, which is likely to increase redd scour. Seasonal summer and early fall low flows in the lower river are occasionally accompanied by elevated water temperature (Peters et al. 2011, p. 48), which will become more problematic with climate change.

Threats

There are six primary threats to bull trout in the Skokomish core area (USFWS 2015a, p. A-19 to A-20):

Upland/Riparian Land Management: Legacy Forest Management and Roads. The South Fork Skokomish River system is still undergoing recovery from past land management activities, specifically intensive timber harvest that lacked ecological safeguards. Additional restoration efforts are required to address further contribution to habitat degradation and channel aggradation.

Instream Impacts: Flood Control. The South Fork Skokomish River continues to aggrade due to past removal of large woody debris and installation of bank protection structures (i.e., levees). This has resulted in a highly simplified stream channel lacking the habitat complexity critical for supporting fish.

Connectivity Impairment: Fish Passage Issues. Effectiveness of passage efforts at the Cushman Dams on the North Fork Skokomish River are under evaluation. Ineffective passage would constrain migration and limit connectivity of local populations. 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 migrants, as well as anadromous migrants - should anadromy reestablish. Habitat conditions in the South Fork Skokomish River are likely to be further exacerbated by climate change

Fisheries Management: Angling or Harvest. Incidental catch of bull trout from other fisheries in mainstem and South Fork Skokomish River put the South Fork Skokomish local population at increased risk due to its small population size and the timing of fisheries.

Small Population Size: 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: Preybase. Depressed populations of salmon and steelhead, primarily in the South Fork Skokomish River, limit productivity and prey availability for this local population.

Additional threats to the Skokomish core area bull trout population include the following:

- Agricultural and livestock practices affect foraging, migration, and overwintering habitat in the lower watershed. Significant effects to habitat for bull trout in the floodplain are caused by activities that block fish passage, alter stream morphology, and degrade water quality.

- The reduction of flows in the North Fork Skokomish River by diversion of water for hydropower has reduced sediment transport capabilities and caused additional aggradation of the river.

- Rural development, including the presence of dikes and levees, in the lower watershed has degraded water quality, reduced floodplain connectivity, and increased bedload instability.

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APPENDIX N
DUNGENESS RIVER CORE AREA

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Dungeness River Core Area

The Dungeness River core area comprises the Dungeness and Gray Wolf Rivers, associated tributaries, and estuary. The Dungeness River core area is one of two core areas in the Coastal Recovery Unit that are connected to the Strait of Juan de Fuca. Bull trout occur throughout the Dungeness and Gray Wolf Rivers downstream of natural impassable barriers, which are present on both rivers (RM 18.7 on the Dungeness River; approximately RM 9.0 on the Gray Wolf River). Bull trout also occur in the Dungeness River estuary and Gold Creek, a Dungeness River tributary. Of 79 char known to have been sampled from anadromous reaches of the Dungeness River watershed, all but one were positively identified as bull trout via genetic analysis (Spruell and Maxwell 2002; Spruell 2006; DeHaan et al. 2011; DeHaan, in litt. 2014). Upstream of the anadromous barrier on the Dungeness River, all 50 char sampled were confirmed as Dolly Varden (*Salvelinus malma*) (Young 2001). It is likely that the Dolly Varden sampled below the falls was a fish that passed over the falls and was not able to return to its home range above the falls. Dungeness River bull trout are genetically unique from other nearby bull trout populations, including those in the Elwha and Skokomish Rivers and along the coast (DeHaan et al. 2011, pp. 468-469).

The anadromous and fluvial life-history forms occur in the Dungeness River core area (USFWS 2004, pp. 60-61; Ogg et al. 2008). Anadromy was observed in 27 percent of 48 radio tagged bull trout in 2003 and 2004 (Ogg et al. 2008, p. 19). The resident form is also likely, but has not been confirmed. Mainstem rivers within the core area provide spawning, rearing, foraging, migration, and overwintering habitats. The estuary also provides important foraging habitat. During a study in 2006 and 2007 by the Jamestown S'Klallam Tribe that targeted salmon smolts, a number of bull trout were incidentally captured in fyke nets located in estuary feeder channels and during beach seining. These fish ranged in size from 117 to 380 millimeters and were often captured in the midst of juvenile pink and chum salmon and post larval surf smelt.

Fish passage into Canyon Creek was blocked by an impassable diversion dam near its mouth from the early 1900s until March 2016, when fish passage was restored. Bull trout are not known to currently occupy Canyon Creek, but it is believed it will provide important foraging and potentially spawning and rearing habitat for bull trout (USFWS 2010, p. 19).

The Dungeness River core area population is considered at "high risk" for extirpation (USFWS 2008, p. 35; USFWS 2015b). Key status indicators have not changed since 2008; therefore, this designation is still valid. The status of the bull trout core area population can be described by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, p. 135).

Number and Distribution of Local Populations

Two local populations - the Dungeness River and the Gray Wolf River - are recognized within the Dungeness River core area (USFWS 2004, p. 61; USFWS 2015a, p. A-150). The Gray Wolf River local population occurs in the Gray Wolf River downstream of the anadromous barrier at river mile (RM) 8.5 to the confluence with the Dungeness River (USFWS 2004, p. 61; Ogg et al. 2008, pp. 23-26). The Dungeness River local population occurs from the anadromous barrier at

RM 18.7 downstream to the confluence with Canyon Creek at RM 10.8 (USFWS 2004, p. 62), although spawning has not been documented downstream of RM 15. This local population includes Gold and Canyon Creeks. Both of these local populations spawn primarily from September through November (Ogg et al. 2008, pp. 24-27). Ogg et al. (2008, pp. 23-26) observed a seemingly distinct third group, which spawned near the Gray Wolf River confluence in December. Further study and analysis is needed to determine whether this late spawning group constitutes a third local population. With only two local populations, bull trout in this core area are considered to be at increased risk of extirpation and adverse effects from random naturally occurring events (USFWS 2004, pp. 136-137).

Adult Abundance

In 2005, the USFWS concluded that the number of spawning bull trout in the Dungeness River core area appeared to be very low (USFWS 2005, p. 622), although this conclusion was based on very limited data. The USFWS 2008 Five Year Review categorized the Dungeness River core area as having 50 to 250 individuals (USFWS 2008, p. 35). In 2004, Ogg et al. (2008, p. 26) observed 17 bull trout redds in the Dungeness River between the anadromous barrier and the Gray Wolf River confluence during thirteen surveys. In the Gray Wolf River, 33 redds were observed during twelve surveys (Ogg et al. 2008, p. 26). These surveys were considered intensive and likely captured the majority of redds within the core area (USFWS 2005, p. 620), although the December spawning group was not represented (no surveys were performed in December). Surveys performed in December 2005 identified ten redds in the Dungeness and Gray Wolf Rivers within about one-half mile of the confluence (Ogg et al. 2008, pp. 26-27). There are no reasons to believe that abundance has appreciably changed since these surveys were completed. The small numbers of redds observed suggest that the adult abundance of both local populations is likely very low.

The bull trout population in this core area is one of the most depressed in the Coastal Recovery Unit. The 2015 Bull Trout Recovery Plan identifies "small population size" as one threat to this population (USFWS 2015a, p. A-17). The Dungeness River core area is at risk from genetic drift because it likely contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 137-140). Both local populations are at risk from inbreeding depression because they are believed to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 137-140).

Productivity

There are limited data on bull trout productivity in the Dungeness River watershed. The Washington Department of Fish and Wildlife (WDFW) has operated a smolt trap near the mouth of the river since 2005. Bull trout catch in the trap provides the only available indicator of productivity in the watershed. Between 2005 and 2016, bull trout catch in the trap varied between 10 and 77 fish, except for 2014 when catch jumped to 148 fish (Figure 1) (Topping, in litt. 2014; Topping, in litt. 2015; WDFW 2015; Topping, in litt. 2016). These data suggest that bull trout productivity is generally low and has not varied much since 2005, the apparent increase in 2014 notwithstanding. The 148 fish captured in 2014 was a considerable increase over previous years, but was not sustained in 2015 and 2016 when catch was 16 bull trout each year. The anomalously large catch in 2014 substantially influences the 5-year running average,

suggesting a flat trend in productivity. However, the 5-year running average shows a declining trend when the 2014 data are removed. Declining productivity would place the Dungeness River core area at increased risk of extirpation (USFWS 2004, pp. 140-141). Juvenile trap data has limitations and must be used with caution. Abundance of outmigrating anadromous juveniles may not be closely correlated with adult abundance. In addition, there are no trap efficiency estimates for bull trout; therefore, catch cannot be expanded to estimate the actual number of bull trout passing the trap, nor can confidence intervals be calculated to determine statistical significance of trends. Bull trout in the Dungeness River core area are considered at risk of extirpation until sufficient information is collected to properly assess the productivity of this core area.

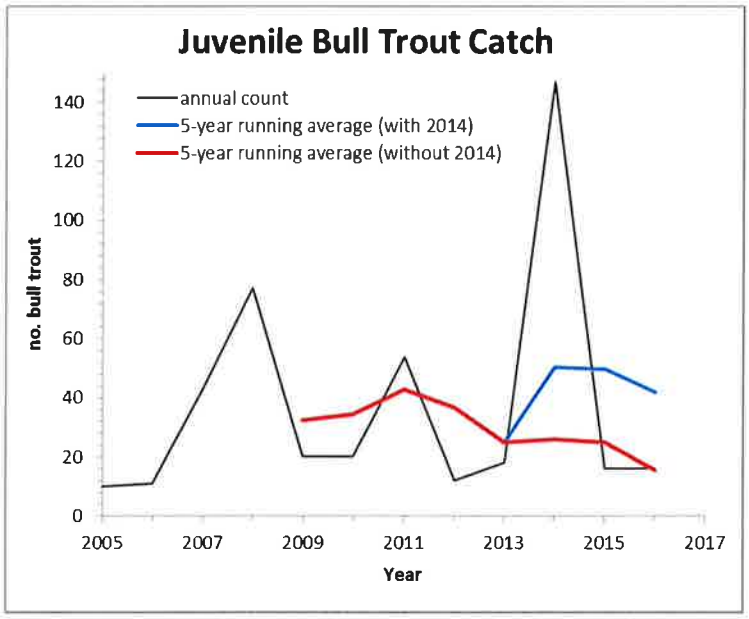

Figure 1. Catch of juvenile bull trout in the Washington Department of Fish and Wildlife's Dungeness River salmonid smolt trap located at RM 0.5. (Sources: Topping, in litt. 2014; Topping, in litt. 2015; WDFW 2015; Topping, in litt. 2016)

Connectivity

There are no dams or other large water management structures within the Dungeness or Gray Wolf Rivers affecting connectivity within the mainstems. Connectivity between the lower Dungeness River and its floodplain has been eliminated by diking to prevent flooding. Migration during late summer and early fall can be blocked by reduced flows in the lower watershed from water diversions for irrigation and municipal water supplies. Water rights in the Dungeness River basin are severely overappropriated, and, although these rights are apparently not fully utilized, they take a substantial proportion of the river flow during the natural annual low flow period from August to early November (Haring 1999, pp. 99-104; EDPU 2005, Chapter 2.3). This period overlaps the upstream and downstream migration timing of bull trout in the Dungeness River (Ogg et al. 2008). Decreased flows may inhibit passage of adult salmonids in

the Dungeness River (Haring 1999, pp. 99-104), although the extent to which anthropogenically diminished flows inhibits the migration of adult bull trout has not been evaluated. Nonetheless, instream flows have been identified as a primary threat to bull trout in the Dungeness River (USFWS 2015a, p. A-17).

A number of barriers to fish movement and migration in the Dungeness River core area are due to improperly sized or installed culverts. Migration at certain times of the year may be obstructed by the WDFW fish hatchery collection weir on the lower Dungeness River. The hatchery water intake on Canyon Creek was a complete barrier to fish passage until March 2016 when the infrastructure was retrofitted with a fish ladder to provide fish passage.

Despite these impairments to connectivity, migratory bull trout persist in both local populations. The full extent to which connectivity impairments in the Dungeness River watershed directly affect bull trout reproduction, abundance, and distribution via migration delays and habitat fragmentation is not known. It appears likely that direct effects have at least some negative impact. In addition, impaired connectivity in the Dungeness watershed indirectly affect bull trout by impacting naturally-spawning salmonids (Haring 1999, pp. 85-107), a primary driver of freshwater ecosystem productivity and important forage resource for bull trout. For these reasons, bull trout in this core area are at increased risk of extirpation from impairments to connectivity.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, federal actions occurring in the Skokomish core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of sections 6 and 10(a)(1)(A) permits under the Endangered Species Act have directly affected bull trout in the Skokomish core area.

The number of non-federal actions occurring in the Dungeness River core area since the bull trout was listed are unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout. Conversely, non-federal salmon recovery efforts are improving conditions for bull trout. Although directed toward salmonids other than bull trout, the regional salmon recovery plan under the Shared Strategy for Puget Sound and watershed-scale implementation under the Puget Sound Partnership have resulted in general aquatic habitat improvements that are likely benefitting bull trout.

Climate change is expected to affect both river flow and water temperatures to the detriment of bull trout and other salmonids. Increases in late fall and winter flow in the Dungeness River, and decreases in the spring, summer, and early fall flow are expected (Halofsky et al. 2011, p. 25; Whited et al. 2012). Less annual snow pack and earlier loss of snow pack are predicted, which will reduce summer low flows and impact migration and rearing habitats. By 2020, a 20 percent

decrease in late summer low flow is expected from pre-2006 levels. By 2080, this will reach 40 percent. This will exacerbate threats already posed by current anthropogenic water withdrawals and low flow in the lower watershed. Fall and winter storms are expected to intensify, which is likely to increase redd scour. In addition, water temperatures are expected to warm due to the projected increases in air temperature, especially in the lower elevations of this core area (Halofsky et al. 2011, p. 44). This will be exacerbated by the lower late summer flows which will increase the influence of air temperature on water temperature.

Threats

There are four primary threats to bull trout in the Dungeness River core area (USFWS 2015a, p. A-17):

Instream Impacts: Flood Control. Flood and erosion control associated with agricultural and residential development continues 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: Altered Flows. Agricultural and residential water use continues to result in poor instream flow and dewatering within the lower Dungeness River, impairing FMO habitat.

Small Population Size: Genetic and Demographic Stochasticity. Available spawner abundance data indicates the low number of adults results in increased genetic and demographic stochasticity in both the Dungeness River and Grey Wolf River local populations.

Forage Fish Availability: Prey Base. Depressed populations of salmon and steelhead limits the available freshwater prey base within this system even though abundance of some species (i.e., pink salmon) has significantly improved.

Additional threats to Dungeness watershed bull trout include:

- Climate change. Climate change is expected to negatively affect spawning and rearing bull trout via elevated water temperatures during migration, spawning, and rearing periods; redd scour due to increased peak flows; and decreased habitat quantity as a result of lower summer flows. Climate change will exacerbate the already problematic low flow issues caused by over-appropriated water rights.

- Fisheries. Bull trout are highly susceptible to incidental capture and mortality associated with fisheries directed at hatchery-origin coho and steelhead in the anadromous reaches of the Dungeness River watershed and Dungeness Bay. In 2003, the WDFW conducted creel surveys in the Dungeness River from mid-October through November, covering the lower watershed from the Dungeness Hatchery downriver to within one mile of the mouth. Anglers reported capturing 32 bull trout (Cooper, in litt. 2015). This likely underestimates the actual number of bull trout captured because the entire fishing season was not surveyed, surveys were not conducted on every day of the survey period, not all

anglers were interviewed on each day of the survey, and the entire area open to fishing was not surveyed. The Gray Wolf recreational steelhead fishery overlaps completely the time and place of significant bull trout spawning by this local population. Illegal lethal take associated with poaching and negative perceptions by some steelhead anglers toward bull trout are also concerns.

Dungeness River core area bull trout may also be susceptible to capture in Dungeness Bay recreational and Tribal fisheries targeting hatchery-origin coho and steelhead. The coho fisheries are generally open from mid-September through late-November; steelhead from early December through February. There are no direct empirical data on timing of bull trout movement into the Dungeness River. Adult Dungeness bull trout outmigrate from the river into marine waters primarily from May through August (Ogg et al. 2008, p. 2), which is several months later than other western Washington populations (Brenkman and Corbett 2005, pp. 1078-1079; Goetz et al. 2007, p. 18; Hayes et al. 2011, p. 394; Goetz et al., *in litt.* 2012). Assuming Dungeness River bull trout exhibit similar marine residency times as these other populations, their return through Dungeness Bay to the river mouth would occur from July through October, exposing the later returners to capture in the coho fisheries. Substantial impacts from capture in non-sport fisheries have been documented in the Hoh River (Brenkman and Corbett 2005, pp. 1077-1080).

- High anadromous mortality. Ogg et al. (2008) observed 14 tagged bull trout emigrating from the Dungeness River into the marine environment. Only one of these returned to the Dungeness River. Of those that did not return, the authors noted that half were confirmed mortalities likely due to natural predation and/or sport fishing in the estuary and lower river (Ogg et al. 2008, pp. 30-31). The rest migrated to saltwater and were never detected afterward, or were tracked to nearby watersheds (Valley Creek and Morse Creek) and confirmed deceased from unknown causes.

- Past logging and logging-related activities, such as roads, have degraded habitat conditions (e.g., fisheries, water quality, and connectivity) in the upper watershed, which has a naturally unstable geology with steep slopes that are susceptible to mass wasting.

- Past and current agricultural practices and the over appropriation of water rights negatively affect instream flow, increase water temperatures, and increase sediment deposition in the streambed. Other impacts include blocked migration, decreased juvenile rearing areas, straying into other streams, transportation of pollutants in irrigation flows, reduced amounts of large woody debris, and loss of estuarine rearing and foraging habitat.

- Water quality has been degraded by municipal, agricultural, and industrial effluent discharges and development.

- Residential and urban developments along the shore that include intertidal filling, bank armoring, and shoreline modifications have caused the loss of extensive eelgrass meadows in the nearshore.

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APPENDIX O
ELWHA RIVER CORE AREA

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Elwha River Core Area

The Elwha River core area, part of the Coastal Recovery Unit, includes the Elwha River and its tributaries including Boulder, Cat, Prescott, Stony, Hayes Godkin, Buckinghorse, and Delabarre Creeks; Lake Mills and Lake Aldwell; and the estuary of the Elwha River. The Elwha River core area is one of two core areas on the Olympic Peninsula that drain to the Strait of Juan de Fuca.

Anadromous, fluvial, and resident life-history forms are all present within the Elwha River core area. With the removal of the Elwha River dams and resulting elimination of the reservoirs, the adfluvial life-history form that was present is reverting back to the historical fluvial and anadromous forms (Crain and Brenkman 2010, p. 16; DeHaan et al. 2011, p. 472). Prior to the dam removals, bull trout were documented spawning in the area directly above Lake Mills (approximately river mile 25) (Crain and Brenkman 2009, p. 7). Dam removal likely altered this known spawning site (Crain and Brenkman 2010, pp. 16-19, 22). Another suspected spawning location may occur in the Elwha River near the confluence of the Hayes River (Crain and Brenkman 2009, p. 7). It is anticipated that new spawning habitat/sites for bull trout will develop over time in the restored reaches. There is little habitat suitable for bull trout spawning and incubation downstream of the dams.

The Elwha River core area population is considered "at risk" for extirpation (USFWS 2008a, p. 35). The status of a bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, Vol. II, p. 135).

Number and Distribution of Local Populations

Two local populations and one potential local population are recognized within the Elwha River core area (USFWS 2015, p. A-150). One local population is located in the Elwha headwaters (upstream of Carlson Canyon) and appears to primarily consist of the resident life-history form (DeHaan et al. 2011. pp. 471-472). The other local population occupies the area downstream of Carlson Canyon and primarily contains the migratory life-history form. The Little River tributary has been identified as a potential local population, based on the availability of suitable habitat and the likelihood that this high quality spawning habitat will be utilized by migratory bull trout once the dams are removed. With only two local populations, bull trout in the Elwha River core area are considered at increased risk of extirpation and adverse effects from random naturally occurring events (USFWS 2004, Vol. II, pp. 136-137).

Adult Abundance

Bull trout abundance is not known (USFWS 2008a, p. 35). Prior to the dam removals, the numbers were assumed to be moderately low. Prior to listing, bull trout observations were limited in the Elwha River below the Elwha Dam at the WDFW Chinook rearing channel (Travers, in litt. 2002; Greg Travers, WDFW, pers. comm. in WDFW 2004, p. 149). Thirty-one bull trout, ranging in size from 250 to 620 millimeters, were documented in this section of the river during snorkel surveys in 2003 (Pess, in litt. 2003). In 2007, 215 bull trout were observed

during snorkel surveys from river mile 41 to the mouth of the Elwha River (USFWS 2008b, p. 1785). There is no information on trends in abundance of Elwha River bull trout. Core areas with fewer than 1,000 spawning adults per year are at risk from genetic drift, and local populations with fewer than 100 spawning adults per year are at risk from inbreeding depression (USFWS 2004, Vol. II, pp. 137-140). Bull trout in the Elwha River core area are considered at risk from these effects until more is known about adult abundance.

The bull trout population in the Elwha River core area is considered at risk of extirpation (USFWS 2008a, p. 35). The Elwha River core area showed reduced levels of within population genetic variation when compared to larger populations from other core areas; there was no indication that the fragmentation caused by the Elwha dams has led to the evolution of genetically distinct spawning populations within the Elwha River core area (DeHaan et al. 2011, pp. 471-472).

Productivity

There has been only limited monitoring of the bull trout in the Elwha River, so no trend data is currently available. Low bull trout abundances in the Elwha River core area indicates that this population is at risk of extirpation.

Connectivity

In August, 2014, the removal of the Elwha and Glines Canyon Dams was finished. With full restoration of fish passage complete with the removal of the dams, future studies will indicate bull trout movement throughout the watershed. No barriers exist within the mainstem Elwha River and the lower reaches of its tributaries. The removal of the dams on the Elwha River has provided connectivity between the local populations within the Elwha River core area.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, federal actions occurring in the Elwha River core area have resulted in harm to, or harassment of, bull trout, many specifically related to construction activities. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and Section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. The removal of Elwha and Glines Canyon Dams, as part of the Elwha River Restoration Project, represents a federal action with long-term improvement of bull trout habitat and core population. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have also directly affected bull trout in the Elwha River core area (e.g., Crain and Hugunin 2012, pp. 3-4).

The number of non-federal actions occurring in the Elwha River core area since the bull trout listing is unknown. However, because most of the core area is in federal ownership, few non-federal actions likely have occurred in this core area.

Threats

There are four primary threats to bull trout in the Elwha River core area (USFWS 2015, pp. A-17-18).

Instream Impacts: Fish Passage Issues – Fish passage difficulty at former dam sites.

Water Quality: Instream Flows – Adequate water quantity within the lower river will need to be maintained nto 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.

Forage Fish Availability: 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 prey base in Elwha River watershed.

Nonnative Fishes: Competition and Hybridization – With the removal of the dams, 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 threats to bull trout in the Elwha River core area include:

- Past logging on private lands in the Elwha River core area, outside of the Olympic National Park, has affected water quality through the release of fine sediment, which potentially affects bull trout egg incubation success and juvenile rearing.

- Impacts from residential and urban development occur mainly in the lower Elwha River. Dike construction has constricted the channel and severely affected nearshore and estuary habitat and processes.

- Bull trout are susceptible to incidental mortality associated with fisheries that target commercially desirable species such as coho and steelhead in the lower river and recreational fishing in Olympic National Park. There is currently a 5-year moratorium on all fishing in the Elwha River to assist with the recovery and colonization of this watershed following dam removal.

- Stranding and crushing of bull trout occurs during Port Angeles Water District's routine maintenance and repair operations.

- Most of the Elwha River watershed (85 percent) is within the Olympic National Park, which minimizes outside stressors to bull trout and their habitat. The watershed is identified as a "transient" watershed with regard to it being rain dominated versus a snowmelt dominated system. It is projected to become a rain dominated system due to climate change (Halofsky et al. 2011, p. 45). This change will result in modifications to

stream flow and temperature which will cause a decline in the quality and quantity of bull trout habitat. Simulations of the monthly and average total baseflow based on global climate models indicate that average total runoff and base flow depths will increase during the fall through early spring, and decrease in the summer compared to simulated historical (Halofsky et al. 2011, p. 24). The lower summer flows will allow streams to be more influenced by increased air temperatures (ISAB 2007 in Halofsky et al. 2011, p. 44). With projected increases in air temperature, especially in the lower elevations of this core area (Halofsky et al. 2011, p. 44), water temperatures are also anticipated to increase.

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