Aquatic Species and Water Resources

Affected Environment

National Forest System lands in the Pacific Northwest Region occupy approximately 25 percent of the land area in Oregon and Washington. These lands comprise approximately 100,000 miles of streams and rivers, of which approximately 25,000 miles are fish bearing. Within the region, 1,961 subwatersheds (12-digit hydrologic units, 10-40,000 acres) contain more than 5 percent National Forest System lands.

Through the agency's Watershed Condition Framework[1] (USDA Forest Service 2011a) process, personnel from the 16 national forests and Columbia River Gorge National Scenic Area in the region evaluated and rated the condition of these 1,961 subwatersheds, using a watershed condition model composed of 12 watershed condition indicators in 4 watershed process categories (table 1). Subwatersheds were evaluated and classified as functioning properly, functioning-at-risk, or impaired function, as described in the Watershed Condition Framework Technical Guide[2] (USDA Forest Service 2011b). These condition ratings, the resources influenced by watershed conditions (for example, federally listed fish or municipal water supplies), and opportunities to maintain or improve those conditions (for example, partnerships with other agencies) are key criteria for selecting priority watersheds for restoration.

A watershed is considered to be functioning properly if it exhibits high geomorphic, hydrologic and biotic integrity relative to its natural potential. There is minimal adverse human impact on natural physical and biological processes and the subwatershed is resilient and able to recover when disturbed by large natural disturbances or land management activities. Restoration actions may be required in localized areas. In contrast, functioning-at-risk or impaired function indicates a subwatershed exhibits, respectively, moderate or low integrity relative to its natural potential; in other words, physical, hydrological, or biological threshold may have been exceeded or is at risk of being exceeded. Significant passive or active restoration, management changes, or both may be required to return the watershed to a properly functioning condition (USDA Forest Service 2011a and 2011b).

Overall, 982 (50 percent) subwatersheds were rated as functioning properly, 945 (48 percent) subwatersheds were rated as functioning-at-risk, and 34 (2 percent) subwatersheds were rated as impaired function. These results demonstrate that human use or lack thereof in 50 percent of the project area's subwatersheds occurs in such a way as to have limited or no substantial disruptions to critical watershed processes, while only 2 percent have been substantially degraded and require significant restoration actions to bring human use and management into alignment with local watershed processes. The remaining 48 percent of the subwatersheds require moderate levels of restoration to address human-related disruptions to watershed processes.

[1] The Watershed Condition Framework is a Forest Service process for documenting and tracking condition of subwatersheds and planning and implementing watershed and aquatic restoration programs on National Forest System lands throughout the nation. Detailed information about the Watershed Condition Framework can be found at https://www.fs.fed.us/biology/watershed/condition_framework.html

[2] http://fsweb.wo.fs.fed.us/wfw/watershed/watershed-classification.html

Table 1. Watershed condition process categories and indicators. The watershed condition model is composed of 12 watershed condition indicators in 4 watershed process categories.

Process Category	Indicator	Description
Aquatic Physical	Water Quality	Addresses alteration of physical, biological, or chemical impacts to water quality
Aquatic Physical	Water Quantity	Addresses changes to the natural flow regime
Aquatic Physical	Aquatic Habitat	Addresses aquatic habitat condition (fragmentation, large wood, channel function
Aquatic Biological	Aquatic Biota	Addresses distribution, structure, and density of native and introduced aquatic fauna
Aquatic Biological	Riparian Vegetation	Addresses function and condition of native riparian vegetation along waterbodies
Terrestrial Physical	Roads and Trails	Addresses changes to hydrologic and sediment regimes due to roads
Terrestrial Physical	Soils	Addresses alteration to natural levels of soil productivity, erosion and chemical contamination
Terrestrial Biological	Fire Regime	Addresses altered hydrologic and sediment regimes due to departures from historic fire regimes
Terrestrial Biological	Forest Cover	Addresses altered hydrologic and sediment regimes due to the loss of forest cover
Terrestrial Biological	Rangeland Vegetation	Addresses impacts to soil and water due to the vegetative health on rangelands
Terrestrial Biological	Terrestrial Invasive Species	Addresses impacts to soil, vegetation, and water due to invasive species
Terrestrial Biological	Forest Health	Addresses forest mortality impacts to hydrologic and soil function

As shown in table 2, the aquatic physical, aquatic biological, and terrestrial physical process categories compose the vast majority (90 percent) of the overall watershed condition scores. These are also the processes most relevant to the proposed action. As such, they are addressed in the greatest detail in this document. Within those three process categories, soils, water quantity, riparian vegetation, water quality were rated to be in the best condition across the region, with 2 percent, 9 percent, 12 percent, and 13 percent of subwatersheds rated to have impaired function. Aquatic biota, aquatic habitat, and roads and trails are generally more degraded, with 23 percent, 31 percent, and 41 percent of subwatersheds rated to have impaired function.

Ratings for each indicator were integrated to arrive at an overall watershed condition score. Ratings for indicators in the aquatic physical process category together compose 30 percent of the overall score, as do ratings for indicators in the aquatic biological and terrestrial physical categories. Ratings for indicators in the terrestrial biological process category together make up 10 percent of the overall watershed condition score.

Table 2. Indicator ratings for all 1,961 subwatersheds in the Pacific Northwest Region

Process Category	Indicator	Functioning Properly	Functioning-at-Risk	Impaired Function	Total Subwatersheds
Aquatic Physical	Water Quality	1,295 (66%)	415 (21%)	251 (13%)	1,961
Aquatic Physical	Water Quantity	1,539 (78%)	252 (13%)	170 (09%)	1,961
Aquatic Physical	Aquatic Habitat	587 (30%)	755 (39%)	619 (31%)	1,961
Aquatic Biological	Aquatic Biota	936 (48%)	794 (40%)	231 (12%)	1,961
Aquatic Biological	Riparian Vegetation	837 (43%)	665 (34%)	459 (23%)	1,961
Terrestrial Physical	Roads and Trails	445 (23%)	706 (36%)	810 (41%)	1,961
Terrestrial Physical	Soils	1,475 (75%)	456 (23%)	30 (02%)	1,961
Terrestrial Biological	Fire Regime	490 (25%)	1054 (54%)	417 (21%)	1,961
Terrestrial Biological	Forest Cover	1,548 (80%)	284 (15%)	113 (5%)	1,945*
Terrestrial Biological	Rangeland Vegetation	732 (62%)	391 (33%)	67 (5%)	1,190**
Terrestrial Biological	Terrestrial Invasive Species	1,855 (95%)	90 (4%)	16 (1%)	1,961
Terrestrial Biological	Forest Health	1,618 (83%)	343 (17%)	0 (0%)	1,961
Overall Watershed Condition	**Weighted average of all 12 indicators**	**982 (50%)**	**945 (48%)**	**34 (2%)**	**1,961**

*16 subwatersheds were not rated.
** 771 subwatersheds did not contain rangeland habitats and were not rated.

Degraded watershed conditions on National Forest System lands are generally due to impacts associated with diverse human uses over the last 150 years or more, including mining, logging, agriculture, water diversions, flood control, wildfire exclusion, grazing, road construction and maintenance, and hydro-electric development. The combined impacts of these past and sometimes ongoing land uses include, but are not limited to changes in vegetation conditions, simplification and loss of aquatic habitats, increases in sediment delivery to streams, and degradation of riparian and floodplain functions (McIntosh et al. 1994a, Wissmar 2004). The resulting degradation and fragmentation of aquatic and riparian habitats and impacts to water quality contributed to declines or localized extinction of many resident and anadromous fish stocks, the listing of several fish stocks under the Endangered Species Act, and the listing of many streams as water quality impaired.

Importantly, however, there is evidence that the aquatic restoration strategies adopted in the 1990s (Northwest Forest Plan Aquatic Conservation Strategy, PACFISH and INFISH) appear to be achieving their goals of maintaining or restoring aquatic and riparian habitats and key ecological processes at watershed and larger scales (Roper 2014, Archer and Ojala 2016, Miller et al. 2017, Reeves et al. 2018, Kershner et al. 2018). These improvements stem from both passive restoration (natural recovery) and active restoration (implementation of restoration actions such as those covered in this project). Recovery, however, is slow due to the timeframes required for ecosystems to naturally recover and the pace of active restoration relative to the need (Reeves et al. 2018). This suggests a need to more efficiently implement active restoration work, while facilitating ongoing natural recovery (passive restoration).

National Forest System lands are generally forested and situated in upstream portions of watersheds. While there has been substantial habitat degradation across all land ownerships including National Forest System lands, in general, habitat in many headwater stream segments is in better condition than in the largely non-federal lower portions of tributaries. In the past, valley bottoms were among the most productive fish habitats. Today, agricultural and urban land development and water withdrawals have significantly altered the habitat for fish and wildlife in these valleys and lower elevation areas. Streams in these areas typically have more issues with water temperatures, sedimentation problems, altered stream flows, simplified stream channels, and reduced riparian vegetation.

Affected Species

One-hundred and eleven aquatic animal species of special conservation concern occur in waterways within the project area. Twenty-three of these species are fish listed as either threatened or endangered under the Federal Endangered Species Act (1973), including six Chinook salmon stocks, two chum salmon stocks, three coho salmon stocks, six steelhead stocks, five bull trout populations, three sucker populations, and the Eulachon. The term “endangered” means that a species is in danger of extinction in all or significant portions of its range, while “threatened” is used when a species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.[3] Each of the 16 Forest Service units in the region are occupied by at least two federally listed fish.

Sensitive species are defined as those plant and animals for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density and habitat capability that would reduce a species existing distribution.[4] Twenty fish species are listed on the Pacific Northwest Region’s sensitive species list. These include Chinook salmon, steelhead, cutthroat and redband trout, whitefish, chub, dace, minnow, roach, sculpin, suckers, and lamprey. In addition, 32 mollusks, 1 crustacean, 16 macroinvertebrates, and 12 amphibians are designated as sensitive species. Every Forest Service unit in the region contains at least one sensitive species. Management of sensitive species “must not result in a loss of species viability or create significant trends toward federal listing.”[5]

Further, nine national forests in the region have identified seven management indicator species that include a variety of salmonid species. Refer to the project website for lists of aquatic species analyzed (https://www.fs.usda.gov/main/r6/landmanagement/projects).

Water Resources

About 40 to 50 percent of the flow in the mainstem Columbia River originates on National Forest System lands in the Pacific Northwest, Northern, and Intermountain Regions. National Forest System lands in the region alone provide similar or greater flow contributions to many other major rivers and numerous smaller, headwater streams in Oregon and Washington (Lute and Luce 2016). Given these contributions, National Forest System lands are critical to sustaining the

[3] 16 U.S.C. Sec.3(6)(20)
[4] Forest Service Manual 2670.5
[5] Forest Service Manual 2670.32.

diverse set of beneficial uses of water, both on and downstream of these lands, that have been designated by the States of Oregon and Washington for the waterbodies within their jurisdictions. These uses include water supply, aquatic life, recreation, hydropower and other uses.

Given their importance and their sensitivity to changes in water quality and quantity, water supplies and aquatic life uses are perhaps the most relevant to management of National Forest System lands. A recent assessment, for example, concluded that virtually all National Forest System lands in the Pacific Northwest are at least moderately important and the majority of the lands west of the Cascade crest are very important to surface drinking water supplies (USDA Forest Service 2011c). These lands are also critically important to aquatic and riparian biota, as they contain approximately 100,000 miles of streams as well as myriad lakes and wetlands. National Forest System lands comprise some of best remaining, well-distributed, high-quality habitat in the Pacific Northwest for some aquatic species (Lee et al. 1998). In particular, they provide habitat for populations of salmon, steelhead, bull trout, and other federally listed species. National Forest System lands also provide water, nutrients, wood, and gravel to support downstream aquatic and riparian habitats on private, State, and Tribal lands (Vannote et al. 1980, Gregory et al. 1991, Reeves et al. 2018).

People have altered natural streamflow regimes across the Pacific Northwest by building dams and water diversions that enable various uses of water including irrigation, municipal uses, and hydroelectric power production. Through the Watershed Condition Framework assessment process, the quantity and timing of stream flows were rated to have no or minor departures from natural conditions (functioning properly) in 78 percent of the subwatersheds on National Forest System lands. However, water quantity problems are present in some areas of the region. Specifically, 13 percent of subwatersheds were rated as functioning-at-risk for this indicator and 9 percent were rated as impaired function (see table 2, water quantity indicator). These types of alterations have had various impacts on aquatic ecosystems and biota, including decreasing the amount or quality of habitat and altering the natural stream temperature and sediment regimes upon which aquatic biota depend. On the landscape scale, human activities have affected the timing and amount of peak and low flow water runoff from rain and snowmelt. For example, in forested areas, management practices including forest harvest and fire suppression have changed vegetation types and density that, along with road building, affect runoff timing and duration (Jones and Grant 1996, Matheussen et al. 2000, Perry and Jones 2017). Many riparian areas, floodplains, and wetlands that once stored water during periods of high runoff have been destroyed by development that paved over or compacted soil, thus increasing runoff and altering natural streamflow patterns. Importantly, a large number of studies on harvest effects on streamflow suggest that low and peak flows recover over time as vegetation recovers, usually within 1 to 3 decades after clearcutting or about 5 to 10 years after thinning (Grant et al. 2008, Troendle et al. 2010). Recent monitoring and evaluation within the region suggests forest vegetation, and by inference, some key hydrologic processes that govern streamflow, has been recovering across the Northwest Forest Plan area (Miller et al. 2017). Perry and Jones (2017), however, suggest summer flows may not yet be recovering in areas with extensive plantations.

Except during the first few years after severe fires, the quality of water from forests is generally high and suitable for most uses (National Research Council 2008). This is largely true of water from National Forest System lands in the Pacific Northwest. Nonetheless, 5,550 miles of stream on National Forest System lands in the region (about 5 percent of all streams on National Forest System lands) have been listed as “water quality impaired” under section 303(d) of the Federal Clean Water Act of 1972. Waterbodies on this list do not currently meet standards for one or more water quality parameters adopted by the State of Oregon or Washington to protect the beneficial uses they have specified for them; and the State has not yet and developed and adopted a total maximum daily load (TMDL) to attain those standards. In addition, there are other waterbodies that do not meet water quality standards but are not on the 303(d) list because a TMDL has been adopted for them. As a result of these and other water quality problems, through the Watershed Condition Framework assessment process, the Forest Service rated 34 percent of subwatersheds in the region as functioning-at-risk or impaired function for water quality. Among impaired waters, stream temperature listings are the most common, followed by listings associated with biological criteria (macroinvertebrates), dissolved oxygen, metals, and sediment/turbidity. There are also some limited listings for pH, bacteria, pesticides and other toxic compounds, and other parameters. Given this and the fact that stream temperature, sediment, and macroinvertebrates are the most relevant to this analysis, those three parameters will be addressed in further detail in this analysis.

Elevated water temperatures are largely an issue for fish, amphibians and other aquatic life, but can also have implications for human health, because warm waters can increase the frequency of toxic algal blooms. Specifically, elevated water temperatures adversely affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and migration of young fish to the ocean. Many factors have caused stream temperatures to increase above natural levels, but they are primarily related to land-use practices. Historic forest management, for example, often resulted in dramatic reductions in shade and associated increases in stream temperature, ranging from 2.5 to 20.5 degrees Fahrenheit for sites in the Pacific Northwest harvested without streamside buffers (Moore et al. 2005). Recent studies and monitoring, however, suggest that current practices on National Forest System lands are very likely enabling recovery of elevated stream temperatures associated with past management practices (Leinenbach 2013, Groom et al. 2011, Miller et al. 2017, Reeves et al. 2018).

Like elevated water temperatures, altered sediment regimes associated with historic land use has had myriad adverse effects on aquatic resources in the region. Increases in fine-grained suspended sediment (less than 2 millimeters) in freshwaters, for example, have contributed to both declines in populations of aquatic organisms and other negative ecological effects (Arismendi et al. 2017, Newcombe and Macdonald 1991, Wood and Armitage 1997, Henley et al. 2000). Species with a narrow range of suspended sediment tolerance have been affected the most (Arismendi et al. 2017). Specific adverse effects include direct damage to fish gills, reduced ability to catch prey, altered incubation of eggs due to siltation of stream beds and reduced oxygenation of redds (nests), and altered quantity and quality of aquatic habitats for fish and aquatic invertebrates (Gomi et al. 2005). High levels of suspended sediment can also cause public drinking water treatment systems to shut down, increase operation and maintenance costs, and/or reduce the effectiveness of chlorination in eliminating pathogens (Gomi et al. 2005).

These sediment regimes were altered by land management practices that increased the magnitude, timing and/or extent of erosion and sediment delivery. Gomi et al. (2005), for example, found that road building and forest harvest can substantially alter sediment regimes for up to one to six years or up to one or more decades where shallow landsliding and other mass wasting processes have been increased. Importantly, however, modern best management practices and other standards have been shown to substantially reduce or eliminate these effects. Gomi et al. (2005), for example, found that riparian buffers can generally protect streams by limiting disturbance near them and by filtering sediment delivery from upland areas. The work of Litschert and MacDonald (2009) supports this finding. In addition, Arismendi et al. (2017) concluded that forest road improvements and forest harvest using modern best management practices did not increase fine-suspended sediment concentrations in streams above biologically meaningful levels. Importantly, the various aquatic conservation strategies previously mentioned and other management direction like Forest Service best management practices (USDA Forest Service 2012) contain extensive provisions that address these issues. Black et al. (2017), for example, showed that modern road best management practices, such as road decommissioning and drainage and erosion control upgrades, applied at sites on National Forest System lands across the Pacific Northwest and other parts of western U.S. have been effective at substantially reducing sediment delivery to streams.

No consistent, broad-scale trend monitoring of suspended sediment or turbidity is available across broad areas of National Forest System lands in the Region. Regional scale monitoring of overall physical habitat conditions and macroinvertebrates, both which can be affected by fine sediment, shows small but statistically-significant positive trends for the Northwest Forest Plan area and small, not statistically-significant positive trends for areas east of the Cascade Mountains that manage under PACFISH and INFISH direction (Archer and Ojala 2016, Miller et al. 2017, Reeves et al. 2018). The various habitat metrics most directly related to fine sediments do not yet show a clear, collective set of trends. Importantly, however, monitoring of upslope conditions that exert a strong influence on stream conditions, suggests that processes associated with sediment delivery in the Northwest Forest Plan area are in fairly good condition (average score of 78 out of 100) across the area, with a slight improving trend. Overall, these findings are consistent with the expectations for slow ecological recovery from past human disturbances (FEMAT 1993).

Collectively, these results suggest that key watershed processes and the water resources that depend on them have been recovering and will continue to do so through a combination of natural recovery (passive restoration) and targeted active restoration, as guided by the existing aquatic strategies in the region. In particular, continued natural recovery of streamside vegetation and associated processes should continue to facilitate recovery of stream temperature towards more natural (cooler) conditions, although climate change is likely to exert a strong warming influence (see next section). In addition, continued targeted active restoration treatments (for example, stream channel restoration and riparian plantings) should help accelerate recovery of stream temperatures (Justice et al. 2017). With respect to fine-sediment, recent science and monitoring also suggest that ongoing passive restoration and implementation of protective standards is addressing this issue at the broad-scale. Nonetheless, continued targeted restoration actions are also needed. Unpaved roads are a particular concern given their documented effects on fine-sediment and the fact that only 23 percent of subwatersheds in the region were rated as properly functioning for this indicator (table 2, roads and trails indicator).

Climate Change

The climate system is changing in the Pacific Northwest and additional changes are projected to occur in coming decades. These changes will likely compound the effects of past land management and have major implications for water resources, native species, aquatic ecosystems, and infrastructure. Importantly, however, the magnitude of likely effects and the sensitivity of affected resources varies substantially across the landscape and not all anticipated effects are negative. In addition, the magnitude of other human impacts (for example, past and ongoing water quality and habitat degradation) may be much greater than climate impacts (ISAB 2007). As such, reducing those impacts through actions such as those evaluated in this analysis could more than offset some of the impacts of climate change in some areas (Justice et al. 2017, Wondzell et al. 2018).

Air temperatures in the Pacific Northwest increased by an average of 0.13 degrees Fahrenheit per decade over the past century and most of that warming occurred in the last 30 years (Kunkel et al. 2013). As the region's climate warms, winter snowpacks are diminishing. As more precipitation falls as rain rather than snow, watersheds that were historically characterized by a mix of rain and snow in winter will likely become more rain-dominated, and watersheds that were historically dominated by snowfall in winter may become more transitional, experiencing a mix of rain and snow (Lynn 2011, Kunkel 2013, Mote et al. 2003a and 2003b).

Changing snowpacks and precipitation patterns will likely cause increased flooding. Safeeq et al. (2015), for example, concluded that temperature-induced changes in snowpacks alone may result in large (more than 30 to 40 percent) increases in flood magnitude in some locations. More frequent severe floods may increase fish and amphibian egg mortality in the bed of streams due to gravel scour. These effects, however, are unlikely to extirpate entire populations of salmonids because, while scour magnitude may increase, the frequency of these events relative to typical salmonid life cycles is relatively low and not all streams are particularly sensitive to these effects (Goode et al. 2013, Sloat et al. 2016). Increased flood flows are also likely to result in more flood damage to infrastructure, especially to that which is located in floodplains and built to older design standards (Clifton et al. 2018).

Summer base flows have declined and will likely continue to do so as a result of smaller snowpacks, earlier and faster runoff, and increased summer evapotranspiration (Wenger et al. 2010, Safeeq et al. 2014). Regional-scale modeling using methods documented by Clifton et al. (2018), for example, suggest that summer flows may decline by up 50 percent or more in some areas. These declines in summer flows may be further compounded by longer-term trends arising from probable declines in mountain precipitation (Luce et al. 2013, Luce and Holden 2009). These declines may shrink the network of perennially flowing streams and thus force fish into smaller channels and less diverse habitats (Battin et al. 2006, ISAB 2007).

Declining flows, combined with increasing downwelling radiation from the atmosphere, have increased summer stream temperatures, when considering streams on all lands in the Pacific Northwest (Isaak et al. 2011). Model projections suggest that stream temperatures may increase in the future by 2.3 to 7.0 °F across the Pacific Northwest, with generally greater warming in larger, lower elevation streams and rivers (Isaak et al. 2017). These warmer water temperatures could increase physiological stresses for fish and some other aquatic organisms and potentially lower their growth rates. Summer peak temperatures may approach or exceed lethal levels for salmon and trout (Crozier and Zabel 2006, ISAB 2007, Crozier et al. 2008, Isaak et al. 2012). Higher temperatures will also favor species that are better adapted to warmer water, including potential predators and competitors (Reeves et al. 1987, Reese and Harvey 2002). The temperature sensitivity of different streams and rivers to climate warming varies, however. As such, the magnitude and consequences of stream temperature warming may differ substantially across the region (Luce et al. 2014, Isaak et al. 2015).

The frequency and extent of wildfires and forest pathogen and parasitic insect outbreaks is expected to increase in a changing climate. This, combined with larger floods, may improve habitat complexity in some ways, as a result of large wood recruitment and subsequent floodplain reconnection (ISAB 2007). These losses of forest cover, however, may further exacerbate the increases in stream temperature described previously (Luce et al. 2014).

Collectively, these effects have the potential to influence the distribution of fish and aquatic amphibian populations. They could, for example, reduce population resilience to natural disturbances, particularly drought (Battin et al. 2006, ISAB 2007). Even moderate climate-induced changes may significantly increase the risk of extirpating local populations of some salmonids (Rieman et al. 2007, ISAB 2007, Crozier et al. 2008). These problems will likely be exacerbated by remaining migration barriers found at surface water diversions and road crossings.

Because climate change will affect habitat in different ways and at different time scales, a diversity of conditions and habitat resiliency is needed for population stability (Crozier and Zabel 2006, ISAB 2007). Existing well-connected, high-elevation habitats on public lands will be important to supporting cold water fisheries as the climate continues to warm (Martin and Glick 2008). Isaak et al. (2015), for example, found that cold-water habitats in mountain streams are highly resistant to temperature increases and that many populations of cold-water species exist where they are well-buffered from climate change. As a result, there is hope that many native species dependent on cold water can persist this century and that mountain landscapes, including National Forest System lands in the Pacific Northwest, will play an important role in that preservation.

Maintaining and restoring these areas are fundamental goals of the actions covered under this proposed project. Most of the aquatic restoration actions are relevant to climate change in that they can, for example, maintain or improve stream flows, reduce flood peaks by enhancing floodplain connectivity and disconnecting roads from streams, improve migration for fish and other organisms by removing human barriers, and reduce water temperatures by improving stream shade, streamflows, and stream channel complexity (Seavy et al. 2009, Furniss et al. 2010, Beechie et al. 2012, Clifton et al. 2018). Importantly, some of these actions can reduce and, in some situations, more than offset some of the effects of climate change in some areas (Justice et al. 2017, Wondzell et al. 2018).

Issues for Analysis

Issue 1 – Stream Sediment and Turbidity

Description: As described in the Aquatic Restoration Biological Opinion II (ARBO II; NMFS 2013 and USFWS 2013), the actions evaluated in this analysis, especially when combined with the ongoing natural recovery and passive restoration previously described, are expected to have long-term, beneficial effects on stream sediment and turbidity (a measure of water clarity) by restoring erosion, sediment transport and depositional processes to more natural conditions. Nonetheless, the proposed action will cause temporary increases in stream sediment and turbidity at and immediately downstream of individual actions. This would result from activities such as the use of heavy equipment that dislodges soils into streams as they are operating in stream channels, side channels, and floodplains. In addition, road decommissioning often involves disruption and loosening of compacted road surfaces, which can cause short-term increases in erosion and sediment delivery to streams. Prescribed fire can also accelerate erosion by reducing ground cover. These effects are substantially constrained by the limited geographic scope of the activities to be implemented in the proposed action, through their dispersal in time and space and through robust best management practices and other project design criteria.

Issue Indicator for Analysis: Two issue indicators are used for analysis. Watershed condition relevant to sedimentation is the indicator used to assess effects at the larger (subwatershed) scales, over the long term. Compliance with water quality standards for turbidity and sedimentation adopted by the Oregon Department of Environmental Quality and Washington Department of Ecology is the indicator for short-term effects at the scale of individual restoration actions.

Measure: Longer-term effects at larger spatial scales are evaluated via expected changes in watershed condition class ratings for watershed condition indicators associated with sedimentation, including water quality condition (for example, scope of 303(d) listings for sediment and turbidity), aquatic habitat condition (for example, stream channel morphology) and road and trail conditions (for example, scope/magnitude of erosion risks and impacts associated with these features due to their density, length, and design features).

Short-term, activity-level effects associated with stream sedimentation and turbidity are assessed based on relevant State water quality standards and water quality certifications for the proposed activities issued by the Oregon Department of Environmental Quality and the Washington Department of Environmental Quality, under section 401 of the Clean Water Act.

In Oregon, the water quality standard adopted by the Department of Environmental Quality (OAR 340-041-0036) restricts allowable turbidity to no more than a 10 percent increase in natural stream turbidities, measured as nephelometric turbidity units (NTU). However, limited duration activities necessary to address an emergency or to accommodate essential dredging, construction or other legitimate activities and which cause these values to be exceeded may be authorized provided all practicable turbidity control techniques have been applied. Under these circumstances, emergency activities must be authorized by the State and dredging, construction and other activities must be authorized under the terms of section 401 or 404 of the Clean Water Act. Such authorizations include limitations and conditions governing the activity. Besides turbidity, Oregon standards also include provisions that do not allow the formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry.

In Washington, the water quality standard limits turbidity increases above natural background to 5 to 10 NTU when background is less than 50 NTU, depending on the type of habitat (char spawning and rearing; salmonid rearing and migration only). When background turbidity is greater than 50 NTU, increases cannot exceed 10 to 20 percent. These criteria can be modified to allow a temporary mixing area during and immediately after necessary in-water construction that disturbs sediments. Such mixing areas are only allowed after all other necessary local and state permits and approvals are received and after implementation of appropriate best management practices to avoid or minimize exceedances of turbidity criteria.

Importantly, both States allow for short-term degradation of water quality for some activities, including restoration of waterbodies and riparian areas, so long as there is a net ecological benefit to the actions and reasonable measures, such as best management practices, are used to minimize the degradation. In addition, formal agreements between the Forest Service and both States recognize the critical role of watershed restoration in meeting water quality standards over time.

Methodology: Watershed condition class ratings are evaluated via methods described in Watershed Condition Framework documents (USDA Forest Service 2011a, 2011b). Activity-scale effects on sediment and turbidity are analyzed based on scientific publications on the effects of land management, using direct observation and models. This information is coupled with qualitative reasoning regarding the degree to which sediment/turbidity might change, based on the nature of expected changes in watershed processes and conditions that control erosion and sedimentation. Effects are also analyzed in the context of State requirements to monitor turbidity during some activities and to adjust those projects in real time, as needed to meet standards.

Spatial and Temporal Boundaries: Effects are analyzed at two spatial scales: subwatershed and individual project sites. These scales were chosen because they are relevant to expected observable changes in erosion, sediment transport and depositional processes over the long and short-term. Effects are analyzed at scales ranging from hours and days to years and decades, since those are the timeframes over which observable changes in erosion, sediment transport and depositional processes are expected.

Current Condition: Per the Watershed Condition Framework process, 34 percent of the 1,961 subwatersheds evaluated were rated as functioning-at-risk or impaired function for water quality, while 70 percent and 77 percent were similarly rated for aquatic habitat and roads and trails, respectively (see table 2). All other subwatersheds were rated as properly functioning. These three watershed condition indicators are the most directly related to stream sediment and turbidity. Most streams on National Forest System lands in the Pacific Northwest Region meet current water quality standards for turbidity and sedimentation. However, 451 miles of stream have been documented as water-quality limited and placed on the 303(d) list for sedimentation and turbidity. This accounts for about 0.5 percent of the stream miles on National Forest System lands in the project area.

Environmental Consequences

Direct and Indirect Effects (long term)

Over the long term (that is, years to a decade or more), activities implemented as proposed would improve conditions related to stream sediment and turbidity. This is expected because these activities are being designed and implemented to restore important natural watershed processes that influence the production, transport and deposition of sediments throughout watersheds and their stream and river networks. Road decommissioning on National Forest System lands in the Pacific Northwest, Northern and Intermountain Regions, for example, has been shown to reduce human-caused sediment delivery to streams by more than 80 percent (Black et al. 2017). These findings are generally consistent with studies associated with National Forest System roads in other locations, such as Colorado (Sosa-Pérez and MacDonald, 2017). In addition, new stream crossings that provide fish passage and eliminate streamflow diversion potential are less likely to plug, fail and cause excessive erosion and sediment delivery to streams (Furniss et al. 1997, Gillespie et al. 2014). Stream channel reconstruction or relocation, streambank restoration, large wood placement, off and side-channel habitat restoration, beaver habitat restoration, and removal of berms, dikes and levees alter erosion rates to more natural levels and facilitate deposition and storage of sediment in key parts of streams and floodplains. Moreover, dam removal projects facilitate the natural processes that route and store sediment through stream networks (Roni et al. 2008, Beechie et al. 2010). More detailed descriptions of long-term beneficial effects on stream sediment and turbidity can be found in NMFS (2013) and USFWS (2013).

Over time, the collective effects of multiple restoration activities being implemented in priority watersheds, combined with ongoing natural recovery/passive restoration, is expected to result in improved watershed condition class ratings for the specific indicators most directly associated with stream sedimentation and turbidity. Specifically, through implementation of Watershed Condition Framework over the next 15 years, the water quality, aquatic habitat and road and trail scores are expected to improve in at least 90 subwatersheds in Oregon and Washington. Changed condition scores would be driven by fewer 303(d) listings associated with sediment and turbidity in these watersheds, more natural stream channel morphologies, and lower sedimentation risks for roads and trails (for example, fewer roads in areas with high erosion risk).

Direct and Indirect Effects (short term)

Proposed actions may result in slight, short-term sedimentation and turbidity impacts at the project scale. For example, short-term inputs of sediment could result from instream structure placement, opening of side channels, road treatments, dam removal, stream reconstruction and other activities that occur inside the bankfull channel. Resulting sediment plumes would be most concentrated within and immediately downstream of the immediate project area (generally less than hundreds to several thousand meters) during project activities, the duration of which can generally range from days to several weeks or months. As described in ARBO II (NMFS 2013, USFWS 2013) and/or State 401 certifications, the comprehensive set of best management practices and other project design criteria, including proper timing of work (during dry conditions and low flows), dewatering of sites, limitations on the area of disturbance, use of erosion controls, selection of appropriate equipment, and other measures are generally expected to limit turbidity increases to less than 10 percent above background. However, exceedances of more than 10 percent are allowed for limited times (for example, 2 to 8 hours) depending on the severity of the increase. Specifically, per ARBO II and the associated 401 water quality certifications issued by the States of Oregon and Washington, turbidity will be monitored upstream and 50 to 300 feet downstream of in-water work activities multiple times each day. If restoration work is causing elevated turbidities, activities would be modified or halted, depending on the frequency and severity of the exceedances. Sediment could also be delivered from disturbed and exposed ground adjacent to stream channels created by heavy equipment use and moderate-severity controlled burns. Delivery from these areas would occur during storm events, generally starting in the fall. Best management practices and project design criteria would also minimize these effects and ensure that water quality standards are attained. For example, site restoration activities, including the use of erosion controls like water bars and groundcover, will significantly reduce or eliminate erosion and sediment delivery in the near term (right after project activities) while revegetation will ensure recovery over the longer term (that is, months to a year or more, depending on site conditions).

Lastly, besides these direct project effects, some additional erosion and sedimentation is possible for up to a couple years after some activities (such as stream channel reconstruction), as streams adjust to newly established site conditions. Proper design, as assured by the project design criteria (including, for example, design reviews by a restoration review team) would eliminate or minimize these effects. Cleason and Coffin (2016) concluded that removal of a dam on National Forest System lands (which was larger than would be covered under this project) caused only small and very short-term effects on turbidity (a single pulse during channel rewatering), while restoring river connectivity and improving habitat for macroinvertebrates and fish. Recent best management practices monitoring (Clifton and Coffin 2018) conducted after restoration projects are implemented further supports this conclusion. Specifically, best management practices were rated as fully or mostly effective at 16 of 20 (80 percent) aquatic restoration projects evaluated during the 2015-2016 timeframe, and at least partially effective at 19 of 20 (95 percent) of sites.

In the limited areas exposed to elevated stream turbidity, fine sediments may coat channel substrates, compel fish to move downstream, and alter fish behavior patterns for a short time. Because the work will be conducted during the in-water work periods (a time when spawning is not expected and after emergence of fry), activities should not interfere with spawning, egg development, and the sac fry life stage. Juvenile fish, sub-adult and adult resident fish may be in the activity areas during project implementation and thus may move away from these areas. Fish exposed to a high degree of suspended sediment could experience gill abrasion, decreased feeding, stress, or be unable to use the action area, depending on the severity of the suspended sediment release. In cases of fall-spawning fish, the fine layer of sediment deposited on channel substrate would be cleared away as the fish construct redds. It is anticipated that all project related sediment would be flushed out during the first high flows after project completion, and site restoration measures are expected to prevent future project related sediment inputs into the stream.

Given these limited effects within individual restoration activity areas, the limited geographic scope of these activities, and the fact that individual actions will be dispersed in time and space within a watershed, consequential sedimentation and turbidity impacts on aquatic life are not expected (NMFS 2013; USFWS 2013). Beyond aquatic life, sedimentation and turbidity impacts to domestic water supplies are not expected because water supply intakes are generally located far enough downstream from restoration activities that the expected turbidity levels, as described above, are not expected to adversely affect water treatment systems. If unique circumstances are present (e.g., intakes for sensitive treatment systems in close proximity to projects), then the interdisciplinary team associated with the specific proposed project will work with water suppliers to consider and manage potential impacts within the scope of the analysis in this environmental assessment or evaluate and manage effects via a separate environmental analysis and decision. This conclusion is supported by the fact that the States of Oregon and Washington have issued 401 programmatic water quality certifications that conclude that these actions will protect and restore sediment-sensitive aquatic life and other beneficial uses of water.

The required ARBO II monitoring for stream turbidity (Clean Water Act 401 certification) validates the effects associated with these projects are within the Clean Water Act compliance thresholds. For example, the 450 ARBO II projects implemented during the period of 2013-17 and documented in table 1, greater than 99 percent of the projects (448) met turbidity compliance standards while the remaining two temporarily exceeded standards due to unforeseen circumstances. For instance, during a culvert replacement project in 2014, the location for a sump pump used to dewater the stream required in-channel excavation that resulted in a temporary exceedance of turbidity standards. Remedial actions were taken and included placing straw bales in the stream to trap sediment and the addition of another sump pump to preclude additional in-channel excavation. Next, a 2016 large-wood placement project encountered sediment layers in the channel that were difficult to avoid, resulting in the second temporary exceedance of turbidity standards. Post project discussions were held with the project proponent and Oregon Department of Environmental Quality staff to better address such situations in the future. Monitoring associated with the programmatic Clean Water Act Section 404 permits with Army Corp of Engineers and Oregon Division of State Lands shows similar results. Specifically, 100% of the 11 projects covered under this permit that were monitored from 2016-2018 properly implemented the specified project design criteria and conservation measures and the effects of all of those projects were within those described in the permits.

Issue 2 – Stream Temperature

Description: As described in the ARBO II (NMFS 2013, USFWS 2013), the proposed actions, especially when combined with the ongoing natural recovery and passive restoration previously described, are expected to have long-term, beneficial effects on stream temperature by restoring riparian vegetation, channel conditions, surface-groundwater interaction and other critical watershed processes that influence water temperature. Nonetheless, the proposed action may cause slight, short-term increases in stream temperature due to disturbance of riparian vegetation and stream channels and in some limited cases, increased stream length. These effects are substantially constrained by the limited geographic scope of the activities proposed to be implemented, through their dispersal in time and space and through robust best management practices and other project design criteria.

Issue Indicator for Analysis: Two issue indicators were used for analysis. Watershed condition relevant to stream temperature is the indicator used to assess effects at larger (subwatershed) scales, over the long-term. Compliance with water quality standards for temperature adopted by the Oregon Department of Environmental Quality and Washington Department of Ecology is the indicator for short-term effects at the scale of individual restoration actions.

Measure: Longer-term effects at larger spatial scales are evaluated via expected changes in watershed condition class ratings for watershed condition indicators associated with stream temperature, including water quality condition (for example, scope of 303d-listings for this stream temperature), aquatic habitat condition (for example, stream channel morphology) and riparian vegetation condition (for example, seral state, health and diversity).

Short-term, activity-level effects associated with stream temperature are assessed based on relevant State water quality standards and water quality certifications for the proposed activities issued by the Oregon Department of Environmental Quality and the Washington Department of Environmental Quality, under section 401 of the Clean Water Act.

In Oregon, the water quality standard adopted by the Department of Environmental Quality (OAR 340-041) establishes general numeric temperature criteria that are generally based on aquatic life considerations. For example, temperature criteria range from 53.6 degrees Fahrenheit (seven-day average maximum temperature) in streams with bull trout spawning and juvenile rearing, 55.4 degrees Fahrenheit for streams designated for salmon and steelhead spawning, 64.4 degrees Fahrenheit for salmon rearing and migration, and 68.0 degrees Fahrenheit for migratory corridors. Some streams have more site-specific criteria. Standards in Washington are similar.

Importantly, both states also have provisions that allow for short-term temperature exceedances and effects on beneficial uses when watershed restoration actions will provide greater benefits to the health of aquatic ecosystems in the long-term. In addition, formal agreements between the Forest Service and both States recognize the critical role of watershed restoration in meeting water quality standards over time.

Methodology: Watershed condition class ratings are evaluated via methods described in Watershed Condition Framework documents (USDA Forest Service 2011a, 2011b). Activity-scale effects on stream temperature are analyzed based on scientific publications on the effects of land management on stream temperatures, using direct observation and models. This information is coupled with qualitative reasoning regarding the degree to which temperatures might change, based on the nature of expected changes in watershed processes and conditions that control those temperatures.

Spatial and Temporal Boundaries: Effects are analyzed at two spatial scales: subwatershed and individual project. These scales were chosen because they are relevant to potentially observable changes in stream temperature and the processes that govern it over the short and long-term. Effects are analyzed at scales ranging from a year or so to decades, since that is the timeframe over which observable changes could potentially occur.

Current Condition: Most streams on National Forest System lands in the Pacific Northwest meet current water quality standards for stream temperature or have a State approved plan (for example, a TMDL) to attain them. However, almost 1,864 miles of stream on these lands (less than 2 percent of all stream miles on National Forest System lands in the project area) have been documented as water-quality limited for water temperature and placed on the Clean Water Act 303(d) list. In addition, per the Watershed Condition Framework process, 34 percent of the 1,961 subwatersheds evaluated were rated as functioning-at-risk or impaired function for water quality either due to these 303(d) listings or other water quality problems. Many of these water quality listings and problems are associated with elevated stream temperatures. In addition, riparian vegetation and aquatic habitat condition, both of which can strongly influence stream temperatures, were rated as functioning-at-risk or impaired function for 52 and 70 percent, respectively, of the 1,961 subwatersheds on National Forest System lands.

These conditions on National Forest System lands and to an even greater degree on other lands, pose threats to the long-term viability of numerous cold-water dependent species, including federally listed salmon and steelhead trout, throughout the region (NMFS 2013, USFWS 2013). In addition, as described previously, climate change is expected to increase stream temperatures in the future. Importantly, however, stream temperatures on National Forest System lands are generally the coldest in the region (Isaak et al. 2017). Moreover, monitoring suggests that stream temperatures have declined slightly across large areas of National Forest System lands in the region over the past 10 to 15 years and some of the dominant processes that govern those temperatures (such as shade) are recovering (Miller et al. 2017).

Environmental Consequences

Direct and Indirect Effects (long term):

Improved stream temperatures or at least reduced rates of warming associated with climate change are expected over the long term (that is, years to a decade or more) because the restoration activities would restore numerous natural watershed processes that govern stream temperature. For example, the activities would improve streamside shade through revegetation of riparian areas; restore stream channel morphology in channels that are currently unnaturally wide and shallow or lack pools; improve surface water-groundwater interactions and hyporheic exchange; reduce stream heating associated with small dams; and reduce unnatural channel widening and associated loss of stream shade associated with overuse of streamside recreation sites and the presence of legacy structures (for example, channel spanning weirs).

Justice et al. (2017), for example, showed that in the Grande Ronde basin in eastern Oregon, watershed-scale restoration of riparian vegetation and stream channel morphology could reduce stream temperatures by 3.5 to 7 degrees Fahrenheit, even after accounting for significant climate change effects. In addition, Loheide and Gorelick (2006) showed that restoration of incised meadow and stream systems can reduce stream temperatures by more than 5 degrees Fahrenheit in downstream reaches. Restoration via beaver dams and beaver dam analogs can have similar effects. Pollock et al. 2014, for instance, found that they create pockets of water that are more than 7 degrees Fahrenheit cooler than the ambient stream temperatures. Moreover, Weber et al. (2017), found that a large increase in beaver dams in Bridge Creek in central Oregon resulted in a temperature regime that better corresponded with optimal conditions for steelhead trout.

Other restoration techniques have also been shown to have beneficial effects with respect to stream temperature. Large wood augmentation, for example, can increase the frequencies and depths of pools, which create critical thermal refugia for fish (Roni and Quinn 2001). Nielsen et al. (1994), for instance, found that temperatures at the bottom of deep pools can be 5 to 16 degrees Fahrenheit cooler than surface temperatures and that these cold waters provide critical refuges for steelhead trout when stream temperatures reach stressful or lethal levels. In addition, restoration of side-channels provides fish access to areas that can be substantially cooler than the mainstem.

Dam removal is also generally expected to decrease stream temperatures by decreasing the surface area of water exposed to direct sunlight, as well as the duration of this exposure (Bednarek 2001). A recent study on dam removal on National Forest System lands in Washington found that while daily maximum temperatures were not reduced, minimum temperatures were and temperature patterns were more natural (that is, variable throughout the day). These conditions were much more favorable to native fish in the area, including steelhead trout. In addition, temperatures may become even more favorable over time as the riparian vegetation planted in the former reservoir grows and provides additional shade (Claeson and Coffin 2016). Dam removal effects on stream temperature may require additional study, however. Foley et al. (2017) noted that relatively few dam removal projects have been rigorously evaluated and where they have, reduced stream temperatures were observed at fewer sites than expected.

Over time, the collective effects of multiple restoration activities being implemented in priority watersheds, combined with ongoing natural recovery/passive restoration, are expected to result in improved watershed condition scores for the specific indicators most directly associated with stream temperature. Specifically, through implementation of the Watershed Condition Framework over the next 15 years, the water quality, aquatic habitat and riparian vegetation scores are expected to improve in at least 90 subwatersheds in Oregon and Washington. Changed condition scores would be driven by recovery of a range of natural stream heating and cooling processes (for example, stream shade and surface-groundwater interactions) associated with more natural stream channel morphologies and/or riparian vegetation that is more vigorous, healthy, and diverse in age, structure, cover and/or composition.

Direct and Indirect Effects (short term):

The proposed action may result in slight, short-term temperature increases at the project scale. These increases could result, for example, from decreased shade as a result of removal or disturbance of vegetation in riparian areas for various activities (for example, stream channel reconstruction/relocation, large wood placement, controlled burning, fish passage). In addition, stream reconstruction/relocation projects often increase the sinuosity of stream channels to better reflect natural conditions. This can increase the length of stream exposed to solar radiation.

The project design criteria are expected to minimize stream temperature effects and limit them to the short-term, thereby ensuring compliance with State water quality standards and protecting critical aquatic life beneficial uses. For example, they specify that live conifers and other trees can be felled or pulled/pushed over in riparian areas for in-channel large wood placement only when conifers and trees are fully stocked. In addition, trees removed for large wood projects must be dispersed. They also specify that disturbance of riparian vegetation from project activities is to be minimized and staging areas must be located away from streams. Collectively, these and other project design criteria will minimize effects on stream shade and thus stream temperatures.

Stream channel reconstruction/relocation projects could potentially increase temperature slightly in some cases, because newly created stream channels may be exposed to increased solar radiation. However, these projects generally involve restoring streams that are currently incised, shallow and over-widened, and have highly altered riparian vegetation due to decreased water tables. As such, these streams currently provide poor quality habitat for fish and often have unnaturally elevated stream temperatures. Moreover, while these projects can increase the length of exposed stream, the widths of the new channels are often narrower, which reduces solar exposure. In addition, projects that also restore a range of other natural processes can reduce or more than offset potential temperature effects associated with increased stream length, such as increased surface water-ground water interaction and hyporheic exchange. Lastly, recovery of shade-producing riparian vegetation (overhanging herbaceous vegetation, woody plants) in these systems is relatively fast (no more than a few years).

Given these limited effects within individual restoration activity areas, the limited geographic scope of these activities, and the fact that individual actions will be dispersed in time and space within a watershed, consequential stream temperature impacts on aquatic life in the short-term are not expected (NMFS 2013; USFWS 2013). This is supported by the fact that the States of Oregon and Washington have issued 401 programmatic water quality certifications that conclude that these actions will protect and restore temperature sensitive aquatic life and other beneficial uses of water.

Issue 3 – Watershed, Aquatic Habitat, and Water Quality Restoration

Description: Implementation of most (80 percent) of the proposed aquatic restoration actions will be concentrated in 50 focus watersheds and 66 priority subwatersheds in the region. These actions will be planned an implemented in an integrated manner at a watershed scale. As such, they will maintain or improve aquatic habitat, water quality and the dynamic watershed conditions that sustain them at watershed scales.

Issue Indicator for Analysis: Overall watershed condition class ratings (functioning properly, functioning-at-risk or impaired function).

Measure: The number of subwatersheds moved to an improved condition class over the next 15 years.

Methodology: The number of subwatersheds moved to an improved condition class is assessed based on accomplishments in recent years (2016-2018), projected forward over the next 15 years. Per the Watershed Condition Framework (USDA Forest Service 2011a, 2011b), a watershed is moved to an improved condition class once: (1) the condition of all subwatersheds are assessed on a national forest, per USFS (2011b); (2) the relevant line officer identifies the subwatershed as a priority for restoration; (3) a watershed restoration action plan, which outlines the full suite of essential restoration projects needed to restore critical watershed conditions and processes at a whole watershed scale is developed by an interdisciplinary team based on a more detailed analysis of the subwatershed; and (4) all essential projects are implemented, tracked and monitored. Over longer periods of time, changes in watershed condition are also expected to be reflected in overall condition class scores, as a result of both active restoration activities covered under this EA and passive restoration/natural recovery.

Spatial and Temporal Boundaries: The localized specialist approach associated with implementing individual actions under this analysis.

Spatial: Changes in watershed condition are assessed at the subwatershed scale.

Temporal: Changes in watershed condition are assessed over a 15-year timeframe.

Current Condition: Overall, 982 (50 percent) subwatersheds were rated as functioning properly, 945 (48 percent) subwatersheds were rated as functioning-at-risk, and 34 (2 percent) subwatersheds were rated as having impaired function.

Environmental Consequences

Direct and Indirect Effects: The National Marine Fisheries Service (2013) and U.S. Fish and Wildlife Service (2013) have concluded that the 19 restoration activity categories included in this EA have predictable effects to federally listed threatened and endangered species and their habitats—short-term adverse and long-term beneficial—regardless of where on National Forest System lands they are executed. The long-term beneficial effects include restoration of fish access to historic habitats through removal of impassable barriers; creation of more complex habitats through the addition of wood and boulder structures to streams and floodplains; increased stream length, floodplain connectivity, and riparian vegetation corridors through channel reconstruction, reconnection of side channels and removal of berms, dikes and levees; reduction or elimination of impacts to streams and riparian areas from roads and recreation; restoration of riparian plant species composition through planting, non-commercial thinning, and controlled burning; reduction or elimination of non-native fish that compete with native species; habitat restoration for recolonization of beaver. For a detailed description of effects, refer to ARBO II (NMFS 2013; USFWS 2013) Similar long-term benefits, as described in the ARBO II, are expected for non-listed species as well as water quality, since the restoration projects will also restore natural watershed conditions and processes (for example, sufficient shade and natural sediment regimes) that sustain native species and protect and restore water quality. Because the proposed projects result in long-term benefits, subwatershed condition-class ratings are expected to improve.

These findings are supported by the work of Roni et al. (2008), who found that many techniques (e.g., reconnecting isolated habitats, restoring floodplains, and placing instream structures) have either been proven to be effective in improving habitat and water quality and increasing local fish abundance and others (e.g., riparian rehabilitation, road improvements, dam removal and stream flow restoration) show promise in restoring critical watershed processes. Roni et al. (2002) came to similar conclusions, rating most restoration treatments as having a moderate to high probability of success generally within 1-5 years for most types of treatments, but extending into one to two decades for a few others. The work of O'Neal et al. (2016) provides additional supporting evidence. They concluded that restoration projects being implemented in Washington and Oregon are generally leading to improvements in physical habitats and, in some cases, fish numbers. Importantly, however, all of these studies concluded that additional research, especially that focused on fish populations, is needed over larger spatial scales and over longer timeframes to address remaining uncertainties about the outcomes of restoration programs. Importantly, the proposed restoration work is expected to have long-term benefits because the process by which it is being planned and implemented addresses the short-comings identified with some watershed and aquatic restoration work (Roni et al. 2002, Beechie et al. 2010, Rieman et al. 2015). Specifically, the restoration actions are one component of broader, landscape level aquatic conservation strategies (Northwest Forest Plan Aquatic Conservation Strategy, PACFISH, and INFISH) intended to maintain and restore aquatic and riparian conditions and key watershed processes at landscape scales. As such, the finer-scale (reach to watershed) active restoration work is built on a foundation of passive restoration/natural recovery at the landscape scale (millions of acres). In addition, the restoration work is guided by strategic priority-setting at multiple scales, ranging from the entire Northwest Forest Plan area for example, to individual subwatersheds and ultimately critical areas within those subwatersheds. These prioritization processes are expected to be more effective than past approaches, in that watersheds in the "best" condition are now generally treated first, with a focus on preventing significant impacts by reducing or eliminating conditions that alter or threaten key watershed processes. In contrast, past approaches generally focused on treating symptoms, rather than causes of degradation and this work was often first concentrated in the most degraded watersheds (Heller 2002 and 2004). In addition, consistent with current science (Roni et al. 2002, Beechie et al. 2010), the Pacific Northwest Region's current approach to restoration is to implement a wide range of projects that address multiple impacts and threats at a watershed scale in a phased and coordinated manner. These projects, documented in watershed restoration action plans, are informed by the Watershed Condition Framework assessment, finer-scale watershed analyses, and other assessments and plans (e.g., recovery plans for federally listed species, TMDLs, and water quality restoration plans). This suite of essential projects is designed to achieve specific and explicit restoration goals and objectives for the watershed, address the root causes (rather than symptoms) of degradation, be fit to the local ecological potential of the watershed and ecosystem, and be of sufficient scope and scale to address these problems (Beechie et al. 2010).

Through implementation of the Watershed Condition Framework over the next 15 years, overall watershed condition scores are expected to improve in at least 90 subwatersheds in Oregon and Washington. This would increase the total number of subwatersheds rated as properly functioning from 982 subwatersheds to approximately 1,072 subwatersheds (from 50 percent of the region's subwatersheds to 55 percent), assuming conditions in other watersheds are not degraded. This assumption is sound based on the demonstrated success of the Northwest Forest Plan Aquatic Conservation Strategy, PACFISH, and INFISH in halting the degradation and enabling the recovery of aquatic habitats and watershed conditions since they were adopted in the mid-1990s.

Beyond these improvements in overall conditions at the watershed scale, these restoration actions are expected to increase the quantity and/or quality of wetlands on NFS lands in the region in the near-term (i.e., immediately to within a few years) and even moreso over the long-term. Restoration of incised meadow streams, channel reconstruction, beaver dam analogs and beaver habitat restoration, for example, have all been demonstrated to improve the quality and quantity of wetlands and the ecological functions they provide (Demmer and Beschta 2008, Bouwes et al. 2016, Weber et al. 2017, Nash et al. 2017). In the near-term, however, restoration actions may result in limited adverse effects to wetlands (e.g., localized disturbance of vegetation, soils and hydrologic processes). The project design criteria and Clean Water Act, Section 404 permit conditions, however, will ensure that these effects are localized and of limited duration (weeks to months, up to a year or so). As described previously, monitoring has shown that the design criteria and permit conditions are being implemented and the effects are of limited scope and duration.

Some research (e.g., Hammersmark et al. 2008, Nash et al. 2017) suggests that some of these projects may result in localized decreases in the magnitude and duration of summer baseflows in some systems, leading Pilliod et al. (2017) to speculate that flow effects could raise water rights concerns in some locations. Other research in other areas (e.g., Tague et al. 2008, Beechie et al. 2012, Majerova et al. 2015, Hunt et al. 2018), however, points towards increased summer baseflows. The proposed action will not injure valid existing water rights because the project design criteria require Forest staff: to identify and evaluate potential effects on existing valid water rights, through coordination with the Oregon Department of Water Resources and the Washington Department of Ecology; and to design and implement projects in a manner that does not injure those rights. Comparable project design criteria will also prevent other private property from being affected by the proposed action.

Issue 4 – Injury and Mortality to Aquatic Organisms

Description: Forest Service staff would capture and relocate aquatic organisms[6] while conducting aquatic organism passage and stream channel relocation/reconstruction/projects. Some of these organisms may be injured or killed during capture and relocation. Further, such organisms may be disturbed, injured, and killed through inadvertent crushing by heavy equipment during implementation of other instream, side-channel, and floodplain restoration projects.

Healthy population characteristics include species with a wide distribution, a variety of life history forms and age classes, and densities required to carry our successful breeding and life history expressions. As such, the primary concern is that fish population attributes (USDA Forest Service 2011b)—distribution, structure, and density—can be adversely impacted by the capture, injury, and mortality of such fish.

Issue Indicator for Analysis: Aquatic organisms captured, injured, or killed during implementation of aquatic organism passage and stream channel relocation/reconstruction projects is the indicator for short-term effects at the scale of individual restoration actions.

Measure: Short-term, activity-level effects would be determined by comparing project-level fish capture, injury and mortality numbers to federally listed fish capture, injury, and mortality thresholds provided by National Marine Fisheries Service (NMFS 2103) and U.S. Fish and Wildlife Service (2013). Thresholds are specific to National Marine Fisheries Service recovery domains and U.S. Fish and Wildlife Service recovery units, both of which are geographic regions that support distinct, discernable populations of federally listed fish. Refer to Table 3.3. Threshold numbers are not required and do not exist for nonlisted fish. However, the threshold numbers permitted by the National Marine Fisheries Service and U.S. Fish and Wildlife Service, as well as the reasoning behind such numbers, would be used as a guide to assess the effects of injury and mortality to nonlisted fish species.

Methodology: At the project scale, Forest Service personnel will document the number of fish captured, injured, and killed to determine if such numbers fall below or exceed capture, injury, and mortality thresholds provided by the National Marine Fisheries Service (2013) and U.S. Fish and Wildlife Service (2013). Refer to table 3.

[6] The primary focus of this section will be directed at federally listed fish due to the precarious nature of these populations. Other aquatic organisms, such as nonlisted fish amphibians, mussels, crustaceans, and aquatic insects will be addressed in the Sensitive Fish, Aquatic Mollusk, Crustacean, Macroinvertebrates, and Amphibian Species and Management Indicator Species effects analysis.

Table 3. Threshold numbers for the capture, injury or mortality of federally listed juvenile fish per year for aquatic restoration actions implemented under the ARBO II in National Marine Fisheries Service recovery domains and U.S. Fish and Wildlife Service recovery units

Recovery Domains*	Capture (permitted no./year)	Injury/Mortality (permitted no./year)
Puget Sound	1,228	62
Willamette/Lower Columbia	4,218	211
Interior Columbia	3,327	167
Oregon Coast	8,257	413
Southern Oregon & Northern California	2,228	112
Recovery Unit**	**Capture**	**Injury/Mortality**
Columbia River	646	31
Coastal Puget Sound	42	2
Klamath River	268	14
Warner Basin	200	2

* National Marine Fisheries Service ARBO II, Table 36, page 170.
** U.S. Fish & Wildlife Service ARBO II, Tables 38 and 39, page 345.

Spatial and Temporal Boundaries: The project area in which aquatic organisms are captured depends on the project type. For aquatic organism passage projects, the length of stream channel where aquatic organisms are captured is typically less than 150 feet, while the length for stream channel relocation/reconstruction projects can reach ½ mile. The temporal boundary begins at the time aquatic organisms are captured until the time of relocation, which typically is no more than two hours.

Current Condition: At project locations occurring throughout the region from 2013to 2017, the number of fish handled, injured or killed during aquatic organism passage and stream channel relocation, reconstruction, and other projects was well below the threshold numbers permitted under the ARBO II (NMFS 2013; USFWS 2013). Refer to table 4. The actual injury and mortality numbers are low compared to threshold values, in part, due to adequacy of stream isolation and fish capture project design criteria used by the Forest Service and the fact that juvenile fish abundance is often low in project areas due to degraded habitat conditions.

Further, Table 3.5 demonstrates that projects, where fish capture, injured, or killed, were distributed over time and space. For instance, at the temporal scale, 40 projects account for the fish capture, injury, and mortality numbers presented in table 5, with an average of eight projects per year. At the spatial scale, projects were distributed across four recovery domains and two recovery units.

Table 4. The average number of federally listed fish captured, injured or killed per year during aquatic organism and stream channel reconstruction/relocation projects implemented under the ARBO II located in National Marine Fisheries Service recovery domains and U.S. Fish and Wildlife Service recovery units

Recovery Domains*	Permitted federally listed Fish Capture Numbers/Year	Average No. of Federally listed Fish Captured/Year (2013-17)	Permitted Federally listed Fish Injuries and Mortalities/Year	Average No. of Federally listed Fish Injured and Killed/Year (2013-17)
Puget Sound	1,228	8	62	0.2
Willamette/Lower Columbia	4,218	5	211	2
Interior Columbia	3,327	260	167	6
Oregon Coast	8,257	50	413	0.6
Southern Oregon & Northern California	2,228	0	112	0
Recovery Unit**	**Permitted federally listed Fish Capture Numbers/Year**	**Average No. of Federally listed Fish Captured/Year (2013-17)**	**Permitted Federally listed Fish Injuries and Mortalities/Year**	**Average No. of Federally listed Fish Injured and Killed/Year (2013-17)**
Columbia River	646	8	31	0
Coastal Puget Sound	42	0	2	0
Klamath River	268	14	14	1
Warner Basin	40	0	2	0

* National Marine Fisheries Service ARBO II, Table 36, page 170.
** U.S. Fish & Wildlife Service ARBO II, Tables 38 and 39, page 345.

Table 5. The number of federally listed fish captured, injured or killed per year during aquatic organism and stream channel reconstruction/relocation projects implemented under the ARBO II located in National Marine Fisheries Service recovery domains and U.S. Fish and Wildlife Service recovery units

Recovery Domain or Recovery Unit	2013	2013	2014	2014	2015	2015	2016	2016	2017	2017
Recovery Domains	**C**	**IK**	**C**	**IK**	**C**	**IK**	**C**	**IK**	**C**	**IK**
Puget Sound	0	0	38	1	0	0	0	0	0	0
Willamette/Lower Columbia	4	0	17	10	0	0	0	0	2	0
Interior Columbia	336	19	182	3	74	1	245	5	460	3
Oregon Coast	103	3	0	0	135	0	0	0	12	0
Southern Oregon & Northern California	0	0	0	0	0	0	0	0	0	0
Totals	**443**	**22**	**237**	**14**	**209**	**1**	**245**	**5**	**474**	**3**
Recovery Unit	**H**	**IK**	**H**	**IK**	**H**	**IK**	**H**	**IK**	**H**	**IK**
Columbia River	21	0	11	0	2	0	3	0	3	0
Coastal Puget Sound	0	0	0	0	0	0	0	0	0	0
Klamath River	0	0	56	4	0	0	0	0	15	0
Warner Basin	0	0	0	0	0	0	0	0	0	0
Totals	**21**	**0**	**67**	**4**	**2**	**0**	**3**	**0**	**18**	**0**
Project Area	**H**	**IK**	**H**	**IK**	**H**	**IK**	**H**	**IK**	**H**	**IK**
Nonlisted Fish	228	3	2,395	0	498	14	38	0	1,234	34

C = captured; IK = injured or killed; H = handled

Environmental Consequences

Direct and Indirect Effects to Federally Listed Fish

The proposed action would result in an increased number of fish captured, injured and killed relative to numbers documented in table 4. Even with an increased capacity to implement projects through the proposed action, the Forest Service would not implement enough projects to exceed the National Marine Fisheries Service (2013) and U.S. Fish and Wildlife Service (2013) thresholds listed in table 3. For instance, a tenfold increase in aquatic organism and stream reconstruction and relocation projects, which is an unreasonable expectation given current and expected funding and staffing, would not exceed fish capture, injury and mortality threshold numbers (assuming similar rates of capture, injury, and mortality numbers that occurred during 2013-17 projects). The National Marine Fisheries Service (2013) and U.S. Fish and Wildlife Service (2013) concluded that the permitted numbers for capture, injury, and mortality of federally listed fish species allowed for ARBO II projects is far too few to affect the abundance, productivity, distribution, or genetic diversity of any salmon or steelhead and other fish populations.

Because juvenile-to-adult survival rate for salmon and steelhead and other fish populations is generally very low (NMFS 2013; USFWS 2013), the effects of a proposed action would have to kill hundreds or even thousands of juvenile fish in a single population before those effects would be equivalent even to a single adult, and would have to kill many times more than that to affect the abundance or productivity of the entire population. The adverse effects of each proposed individual action would be too infrequent, short-term, and limited to kill more than a small number of juvenile fish at a particular site or even across the range of a single population, much less when that number is even partly distributed among all populations within the action area. Thus, the proposed actions would simply kill too few fish, as a function of the size of the affected populations and the habitat carrying capacity after each action is completed, to meaningfully affect population growth rate for any single population.

For the fish that are captured and not injured, the handling of fish increases their stress levels and can cause a variety of injurious conditions, including reduced disease resistance, osmoregulatory problems, decreased growth, decreased reproductive capacity, and increased mortality. There is a potential for some (up to 5 percent) of juvenile fish present in the dewatered section to avoid being captured and relocated, and thus increase the potential of death because they remain undetected in stream margins under vegetation, rocks, or gravels (NMFS 2013; USFWS 2013). It is unlikely embryonic fish will be adversely affected by the proposed action because all in-water construction would be deferred until after spawning season has passed and fry have emerged from gravel. Uncaptured adult fish have the potential to leave project locations once activity begins.

Effects Analysis for Sensitive Fish, Aquatic Mollusk, Crustacean, Macroinvertebrate, and Amphibian Species and Management Indicator Fish Species

The reasoning presented above regarding the limited impacts to federally listed fish species can also be applied to sensitive and management indicator species. There are 23 fish, 32 mollusks, 1 crustacean, 16 macroinvertebrates, and 12 amphibian species dependent upon aquatic habitat and riparian areas for at least part of their life history on the Pacific Northwest Regional Foresters Sensitive Species list. In addition, nine national forests in the region have fish management indicator species that vary from types of fish (such as salmon and trout) to species (such as Bull

Trout or Cutthroat Trout). Complete lists of these species are located on the project website at https://www.fs.usda.gov/main/r6/landmanagement/projects.

Overall, implementing the aquatic restoration projects proposed in this analysis may impact individuals or habitat, but will not likely contribute to a trend toward federal listing or cause a loss of viability to the population or species. The projects will also not impact the aquatic management indicator species identified by the Forest Service to the degree the species, habitat, and ecological conditions they represent are measurably negatively affected. The reasoning for this is the overall intent of the projects, the overall distribution of the species in relation to the limited scale of the projects, the multiple life history stages of the species, the extensive project design criteria, and the localized specialist approach associated with implementing individual actions under this project.

The actions proposed are intended to improve the quality and quantity of the aquatic and riparian habitat these species depend upon, so, over the long term, the proposed action will benefit these species since they are dependent upon this type of habitat (Alexander and Allen 2007, Bednarak 2001, Burchsted et al. 2010, Major et al. 2012, Palmer et al. 2005, Powers 2015, Pollock et al. 2015, USDA Forest Service 2008, Walter et al. 2012). In the short term, there is the potential that individuals within populations of these species may be impacted, particularly if there is a large amount of restoration activity within their habitat. An example would be dewatering a stream segment to implement an aquatic organism passage project. Sensitive and management indicator species would be captured, injured and killed during salvage. Further, aquatic species may be desiccated during project site dewatering, and some individuals, particularly macroinvertebrates, may be overlooked during salvage operations due to their size and location. The species occurring below the streambed surface (Bo et al. 2007) could survive during the construction period if there is enough interstitial water and flow available to fulfill their requirements. It is more likely the Sensitive a fish, mollusks, crustacean, and amphibians as well as management indicator fish species occur near or above the stream bed surface or in the riparian area, so they are more likely to be detected during pre-project salvage and translocation above or below the restoration reach (NRCS 2007, NatureServe 2017, Olson and Weaver 2007).

Another potential impact to individuals missed during the salvage effort is being directly impacted by heavy equipment used for implementing restoration. If individuals are impacted, the limited surface area of project disturbance in relation to the overall distribution of the species and the diverse life history of the species will further sustain the population over the short term, with a long-term benefit as the habitat improves because of the project. For example, the macroinvertebrates and amphibians are dependent upon aquatic habitat for part of their life history, but may also be aerial or terrestrial for other parts of their life history. In many cases, while some are in the water, others are in the air or on terrestrial habitat. The migratory behavior associated with the management indicator fish species provides the opportunity for individuals to redistribute into the project area after restoration has been completed. This biodiversity helps sustain viable populations over the long term, considering stochastic events such as wildfires, floods, and landslides.

When a specific project is proposed, a local interdisciplinary team would form to address potential impacts of the specific project. If the proposed project is within the range of one of these sensitive or management indicator species, the biologist on the team would provide project-specific recommendations regarding surveying and protection of the species. There is a potential that sensitive and management indicator species may be impacted by the implementation of restoration projects if they are in the project area at the time of implementation. However, the impacts would be limited to individuals and the species would benefit over the long term due to the intent of the project to improve their habitat and increase its resiliency (Miller et al. 2010). Any potential impacts would not lead to Federal listing of Sensitive species or negative effects upon the species, habitat, or ecology the management indicator species represent.

Summary of Environmental Effects

Federally Listed Fish

Long-term effects: In the long term, restoration projects carried out in federally listed fish critical habitat will improve the condition of that habitat at the site and watershed scale. In watersheds where multiple restoration projects are carried out, greater improvement of the condition of critical habitat at the watershed scale will be realized. Therefore, these beneficial effects will improve abundance, spatial structure, and productivity of the fish populations, resulting in a decreased risk of extinction for all of the species addressed by the ARBO II and this analysis (NMFS 2013; USFWS 2013).

Short-term Effects: The dominant short-term effects (few hours to one year or a few years) are related to increased stream sedimentation and turbidity primarily during construction activities with subsequent turbidity emanating from disturbed areas. Fish disturbance, injury, and mortality may occur with projects that use heavy equipment, especially during projects that rely on stream isolation and fish capture.

Endangered Species Act Effects Determination: A "may effect, likely to adversely effect" determination was made by the National Marine Fisheries Service (2013) and U.S. Fish and Wildlife Service (2013).

Pacific Northwest Region Sensitive Species and Effects Summary

Long-term Effects: In the long term, restoration projects carried out will improve habitat condition at the site and watershed scale. In watersheds where multiple restoration projects are carried out, greater improvement of habitat condition at the watershed scale will be realized. Therefore, these beneficial effects will improve abundance, spatial structure, and productivity of sensitive aquatic species populations.

Short-term Effects: The dominant short-term effects are related to increased stream sedimentation and turbidity primarily during construction activities with subsequent turbidity emanating from disturbed areas. Sensitive species disturbance, injury, and mortality may occur with projects that use heavy equipment, especially during projects that rely on stream isolation and species relocation out of the project area.

Effects Determination: Aquatic restoration projects proposed in this analysis may impact individuals or habitat, but will not likely contribute to a trend toward federal listing or cause a loss of viability to the population or species.

Management Indicator Species

Long-term Effects: In the long-term, restoration projects carried out will improve habitat condition at the site and watershed scale. In watersheds where multiple restoration projects are carried out, greater improvement of habitat condition at the watershed scale will be realized. Therefore, these beneficial effects will improve abundance, spatial structure, and productivity of designated management indicator species populations.

Short-term Effects: The dominant short-term effects are related to increased stream sedimentation and turbidity primarily during construction activities with subsequent turbidity emanating from disturbed areas. Management indicator species disturbance, injury, and mortality may occur with projects that use heavy equipment, especially during projects that rely on stream isolation and species relocation out of the project area.

Effects Determination: Aquatic restoration projects proposed in this analysis may impact some individuals in certain situations, but will not noticeably affect the species, habitat, and ecology the management indicator species represent.

Cumulative Effects

Potential direct and indirect adverse effects associated with the proposed action, including slightly altered sediment and stream temperature regimes and the injury or killing of aquatic organisms, will be of limited magnitude, duration and extent. This is due to: 1) the restorative nature of the activities; 2) the limited number and size of the activities and the fact that they are highly dispersed in time and space; 3) the extensive set of proven project design criteria and permit conditions that govern project design and implementation; and 4) inclusion of an activity-specific assessment and planning process at the Forest level that will address any unique local circumstances. Decades of successful agency implementation of these activities and formal project-specific monitoring of restoration actions (e.g., regional BMP monitoring, ESA compliance monitoring, CWA Section 404 monitoring) has demonstrated that project design criteria are being consistently implemented and are effective and substantially limiting adverse effects to those evaluated and documented in this EA and in other documents (e.g., NMFS 2013; USFWS 2013). Importantly, those effects were agreed to by multiple federal and state water quality and fisheries agencies as sufficient to protect water quality and aquatic habitats in the near-term, while facilitating recovery over the long-term.

As described previously in this document, the longer-term direct and indirect beneficial effects of the proposed action will far outweigh any limited, short-term adverse effects. These beneficial effects include improved aquatic habitat conditions, water quality, stream sediment and temperature regimes and the watershed processes needed to sustain them. This conclusion is strongly supported by extensive research and monitoring (e.g., Roni et al. 2002, Roni et al 2008, O’Neal et al. 2016). It is further supported by the explicit recognition of the overall benefits of the restoration actions via numerous supporting laws, regulations, policies and funding programs being implemented by multiple fisheries and water quality agencies in Oregon and Washington.

Other management activities on NFS and adjacent lands would continue as the activities covered under this project are implemented. These ongoing and reasonably foreseeable actions include various forms of vegetation management (e.g., riparian thinning), road management, grazing, recreation at developed and dispersed sites, mining, fire and fuels management, and other watershed and aquatic restoration actions not covered under this project (e.g., decommissioning of system roads). All of these activities have the potential to have one or more of the same kind of effects as those associated with this project. As such, there is a potential that the effects of this project and those associated with other activities could overlap in time and space, and thus generate cumulative effects.

The potential for any significant cumulative effects to occur, however, is very low given the limited effects of the project and the fact that these and all other management activities will be planned and implemented according to the three comprehensive aquatic conservation strategies in the Region (i.e., Northwest Forest Plan Aquatic Conservation Strategy, PACFISH, and INFISH) or potential updated versions of those strategies. In particular, these strategies require all management activities to move landscape conditions towards or not retard attainment of Aquatic Conservation Strategy objectives, PACFISH and INFISH riparian goals and riparian management objectives, or other comparable outcomes. As such, the magnitude, duration and extent of any adverse effects, including cumulative effects, are severely constrained.

Importantly, as previously described, current research and monitoring suggests that these strategies appear, over the last several decades, to be achieving their goals of maintaining or restoring aquatic and riparian habitats and key ecological processes at watershed and larger scales (Roper 2014, Archer and Ojala 2016, Miller et al. 2017, Reeves et al. 2018, Kershner et al. 2018). Implementation of this project's active restoration in targeted areas, combined with broad-scale passive restoration, would very likely result in a continuation and perhaps an acceleration of those positive recovery trends. Climate change, however, is likely to adversely affect aquatic and riparian resources, creating some uncertainties about future conditions.

Consistency Statement

This analysis and the proposed action are consistent with agency laws and policies directing the protection and restoration of fisheries and watershed resources.

Endangered Species Act

This proposed action is consistent with the Endangered Species Act. Agency responsibilities for the protection and restoration of endangered species are met through the Aquatic Restoration Biological Opinion (ARBO II). All of the aquatic restoration project types proposed in this document are covered in this previous regionwide biological opinion from U.S. Fish and Wildlife Service and National Marine Fisheries Service. In addition, a project-specific Endangered Species Act assessment will be prepared by local biologists when specific projects are proposed. If listed fish, wildlife, or plants are not protected by the regionwide approach, local biologists will prescribe additional protections.

National Forest Management Act

The proposed action is consistent with the National Forest Management Act. All of the proposed restoration activities are within riparian habitat conservation areas, as described by the Northwest Forest Plan Aquatic Conservation Strategy, PACFISH, and INFISH. The interdisciplinary team reviewed the applicable standards and guidelines of this proposal, and determined that this proposed action is consistent with land management plans within the region, as amended by these strategies.

Aquatic Conservation Strategies

The proposed action is consistent with the Northwest Forest Plan Aquatic Conservation Strategy, PACFISH, and INFISH. The actions will restore or maintain all indicators that make up the elements of the nine Aquatic Conservation Strategy objectives in the Northwest Forest Plan. The indicators address water quality, habitat access, habitat elements, channel conditions and dynamics, flow, hydrology, and watershed conditions. The proposed actions will improve and restore the nine objectives by restoring riparian areas and stream channels. Similarly, the proposed action is consistent with PACFISH, and INFISH direction, including improving riparian management objectives.

Sensitive and Management Indicator Species

The proposed action is consistent with direction to protect and restore sensitive species on the Pacific Northwest Region sensitive species list, and management indicator species identified in the forest plans of nine national forests and the Columbia Gorge National Scenic Area plan within the region. In addition to analysis at the regional level, specific projects will be assessed by local interdisciplinary teams to protect these species. If surveys are warranted, they will occur. If these species occur in the specific project area, project plans will be adjusted to protect these species.

Clean Water Act and State Water Quality Laws

The proposed action is consistent with the Clean Water Act and State water quality laws. Project design criteria and best management practices will protect against impacts to water quality inconsistent with these laws.

Invasive Species

This proposed action is consistent with direction to manage against existing and potential populations of invasive species, including previous Forest Service proposed actions, State laws, regional direction, and national direction. The intent of the proposed restoration project types is to restore natural conditions and increase resiliency. This often includes the removal of invasive species and replacement with native species. Ground-disturbing activities have a weed management component to protect against post-project invasion.

The Wilderness Act of 1964, as enacted September 3, 1964, and amended October 21, 1978

This proposed action is consistent with the Wilderness Act because, if a project is proposed to occur within Wilderness, a Minimum Requirements Decision Guide must be prepared where Section 4 (c) prohibited uses are considered. Proposed projects must be consistent with Wilderness values or will not be approved by the Regional Forester. Approval of any project that may affect designated wilderness areas is contingent upon subsequent evaluation and finding that it is consistent with the Act and the agency's responsibility to preserve wilderness character.

Wild and Scenic Rivers Act of 1968 as amended

The proposed action is consistent with the Wild and Scenic Rivers Act. Approval of any proposed specific project that may affect designated Wild and Scenic Rivers or congressionally authorized study rivers is contingent upon subsequent evaluation and determination, consistent with section 7 of the Act, that free-flowing condition and other values will be protected. In addition, such projects must be consistent with the mandate in section 10 of the Act to administer wild and scenic rivers to protect and enhance their free flow, water quality, and outstandingly remarkable values. When activities are proposed within wild and scenic river corridors under this proposed action, they are required to conserve the free flowing nature and outstandingly remarkable values associated with the river segment.

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