5.3 Alternative 1: 2014 Governor's Work Group Recommendation

As described in Chapters 1 and 2 of the EIS, the Work Group published its 2014 Recommendation Report, outlining a program of integrated, long-term, flood damage reduction and aquatic species habitat restoration actions for further study in the 2015-17 state biennium budget. Since then, the Work Group membership has changed, and they are evaluating the alternatives in this EIS and public comments in crafting their recommendation to the Governor later in 2016. This recommendation, the 2014 Governor's Work Group Recommendation (Alternative 1), would achieve flood damage reduction through implementation of a dam with a temporary (FRO) or permanent (FRFA) reservoir, Airport Levee Improvements, the Aberdeen/Hoquiam North Shore Levee, and Local-scale Flood Damage Reduction Actions. The Aquatic Species Habitat Actions would be implemented to accomplish the restoration objectives outlined in this recommendation.

Alternative 1 would result in the greatest reduction in overall flood extents and depths within the Chehalis Basin during a major flood or greater when compared to the No Action Alternative, as well as to the other action alternatives. Most of the flood damage reduction from Alternative 1 would be realized in the Chehalis River floodplain.

In the long term, Alternative 1 would provide an increased benefit to aquatic species habitat function as compared to the No Action Alternative through implementation of Aquatic Species Habitat Actions. However, as compared to the other action alternatives, Alternative 1 would result in more impacts on native salmon and aquatic species as a result of permanent and large-scale changes to the Chehalis River and floodplain caused by a Flood Retention Facility.

5.3.1 Flood Damage Reduction

5.3.1.1 Benefits from Implementing Flood Damage Reduction Actions

Alternative 1 could help to moderate the extent and depth of flooding in downstream areas from more intense winter rains anticipated with climate change, and therefore broadly help to avoid future flood damage resulting from extreme floods in these areas. The No Action Alternative would not include actions that would address this possibility on a broad geographic scale. Alternatives 2 and 3 include elements that would help avoid future flood damage resulting from more intense winter storms if constructed properly (Airport Levee Improvements and Floodproofing); however, these would not affect as broad a geographic area as Alternative 1. Alternative 4 would increase the areal extent and depth of 100-year floods upstream of Newaukum River confluence. Downstream of the Newaukum River confluence, including in the Chehalis-Centralia area, Alternative 4 would reduce flood extents and depths but to a lesser degree than Alternative 1.

Alternative 1 would eliminate inundation in portions of the upper Chehalis Basin from Doty to the confluence with the South Fork Chehalis River, and reduce inundation by 1 to 10 feet in other portions of this area during a 100-year flood (see Figure 5.3-1). Downstream of the South Fork Chehalis River confluence to Centralia, inundation would be reduced by 1 to 5 feet in most locations, with portions of Chehalis behind the airport levee predicted to experience reductions of inundation up to 10 feet, or to be no longer inundated. Downstream of Centralia to approximately Elma, inundation is predicted to decrease by between 0.1 and 5 feet in the Chehalis River floodplain during a 100-year flood, depending on location. Downstream of Elma, inundation is predicted to decrease by between 0.1 and 1 foot (see Figures 5.3-1 through 5.3-3). Alternative 1 would not reduce flood inundation or flood damage in the South Fork Chehalis River floodplain upstream of approximately King Road, or in the Newaukum River floodplain upstream of approximately Stan Hedwall Park in Chehalis. It is anticipated that the Aberdeen/Hoquiam North Shore Levee would protect the areas behind the levee in Aberdeen and Hoquiam from coastal flooding (not shown in the figures), which would also be the case for Alternative 2.

Within the Chehalis River floodplain, the number of high-value residential, commercial, and agricultural structures flooded could be reduced from approximately 1,379 to 820 during a 100-year flood as result of the Flood Retention Facility and Airport Levee Improvements (protection of 559 structures). For the 2007 flood, the number of valuable residential and commercial structures flooded would have been reduced from 2,026 to 736 (WSE 2014c, 2014d; Karpack 2016c). The Aberdeen/Hoquiam North Shore Levee could prevent coastal flooding behind the levee, where up to 2,715 structures could potentially be protected (Franklin 2016); these structures have not been determined to be of high or limited value at this time. However, the Large-scale Flood Damage Reduction Actions in Alternative 1 would not eliminate flood damage to many residential, commercial, and industrial structures in the Chehalis River floodplain, nor in many Chehalis River tributaries. In locations where structures would remain inundated after implementation of Large-scale Flood Damage Reduction Actions, Floodproofing would still be necessary to protect structures and their contents from flood damage. The exact number of structures protected from flood damage as part of all of the action alternatives would be determined during project-level design and environmental review. Based on communication with cities, counties, and business owners in the Chehalis Basin, 75% of the residential structures and 25% of the commercial, industrial, and other non-residential structures in the Chehalis River floodplain could be protected through elevation, other floodproofing measures, and buy-outs.

Figure 5.3-1

Alternative 1 Changes in Downstream Inundation During 100-year Flood – Upper Chehalis Basin

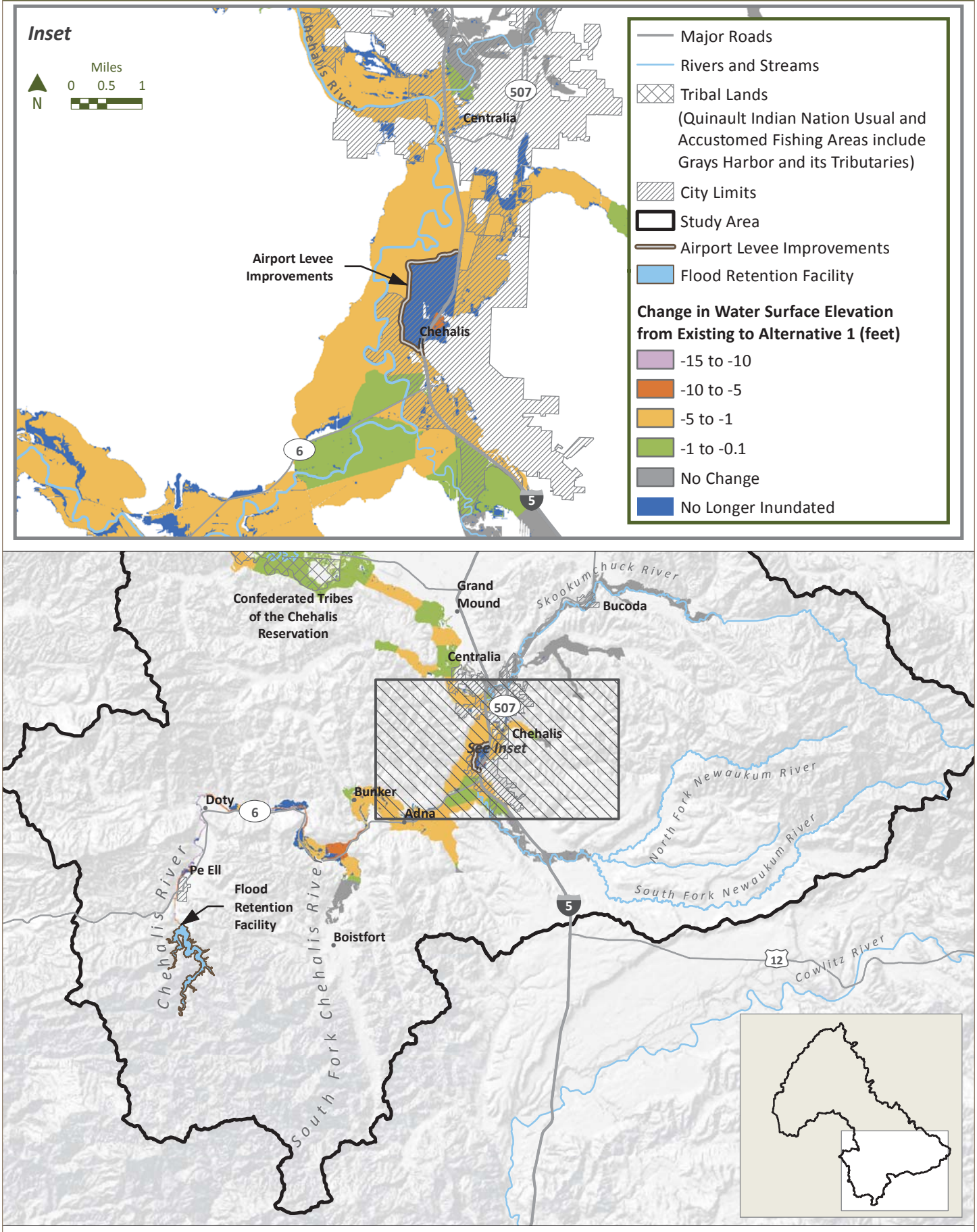


Figure 5.3-2

Alternative 1 Changes in Downstream Inundation During 100-year Flood – Middle Chehalis Basin

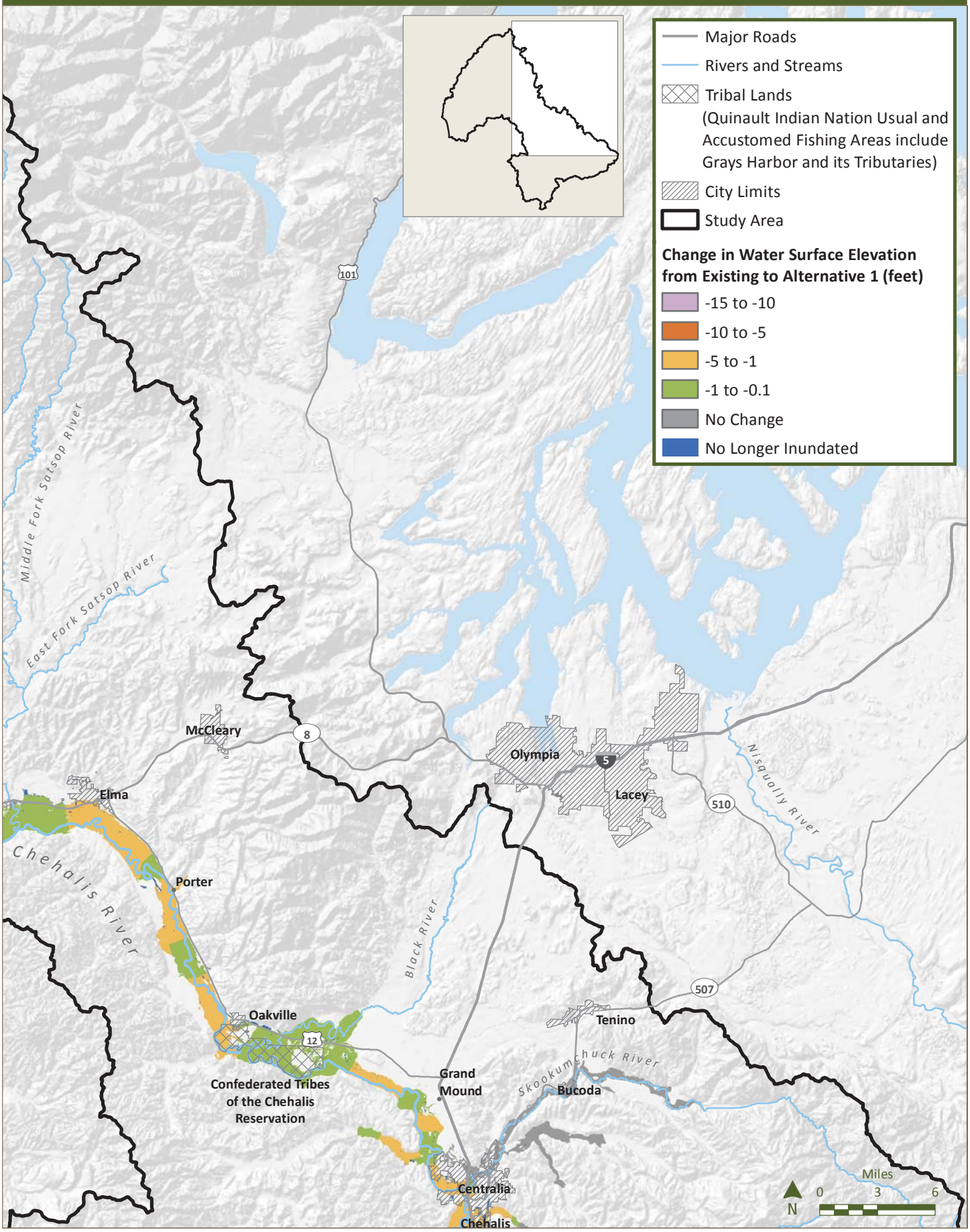
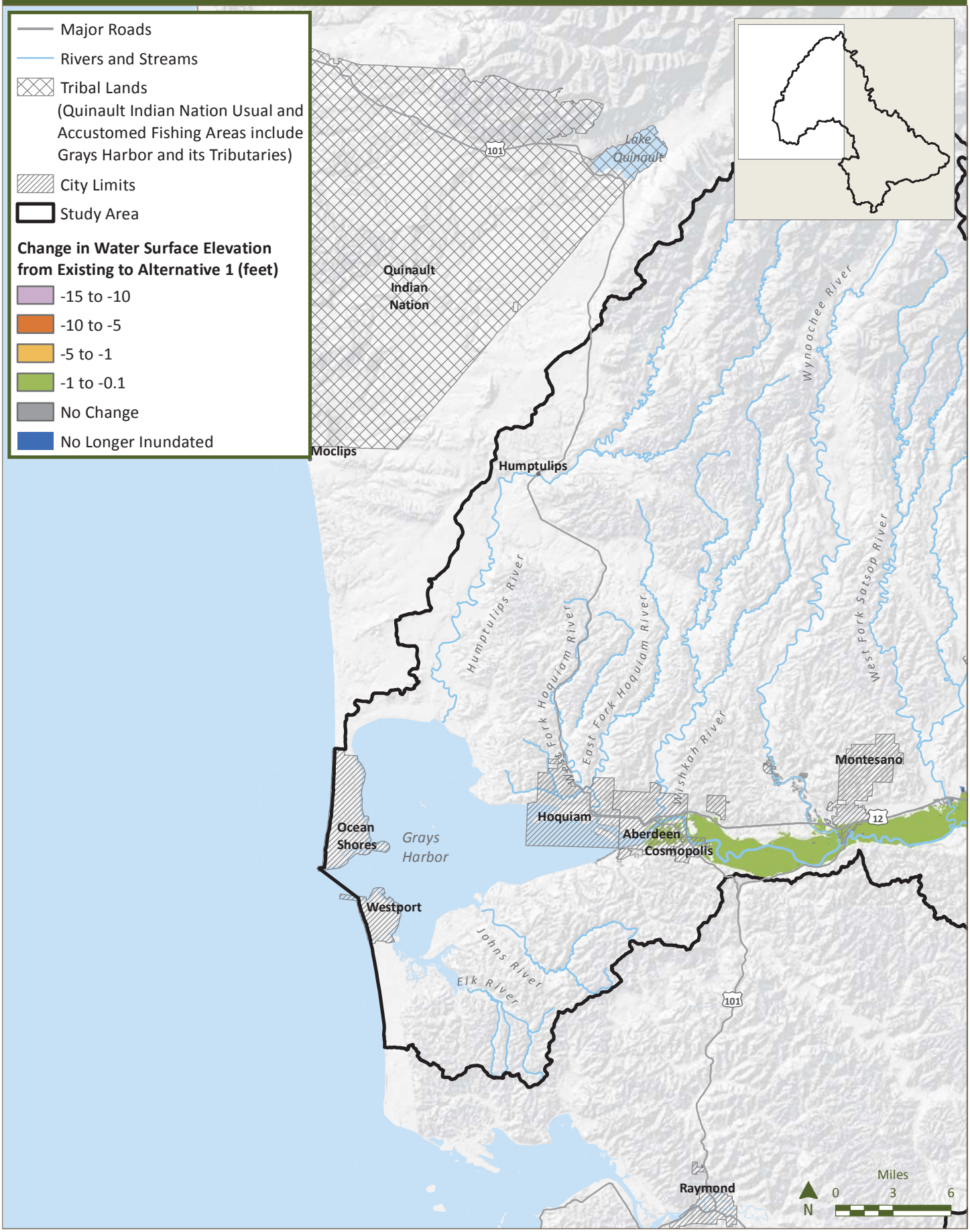


Figure 5.3-3

Alternative 1 Changes in Downstream Inundation During 100-year Flood – Lower Chehalis Basin



Implementation of the Flood Retention Facility and Airport Levee Improvements could reduce flooding in the Chehalis River floodplain during major floods on 4,481 acres, mostly located within Lewis County (see Tables 5.3-1 and 5.3-2). This includes 90 acres on Chehalis Tribe reservation, which is not shown in Table 5.3-1. Most of the reduction would be on agricultural/forestlands and residential land. In some portions of the Chehalis River floodplain, this land would no longer be inundated; in some locations, inundation would simply be reduced.

Table 5.3-1
Change in Acres Flooded by County and Land Use Zone for Alternative 1

GENERAL ZONE	LEWIS COUNTY	GRAYS HARBOR COUNTY	THURSTON COUNTY[1]
Agricultural/forestland	-1,351	-432	-173
Commercial/industrial	-551	-284	0
Parks	-40	0	0
Public land	-256	0	0
Residential	-1,134	-74	-94
Total	**-3,334**	**-790**	**-267**

Note:
1. Does not include Chehalis Tribe reservation

The implementation of Alternative 1 could reduce flood damage and result in beneficial effects on I-5, as well as other local and regional transportation systems. Installation of the Flood Retention Facility and Airport Levee Improvements could reduce the duration of closures of I-5 during a 100-year flood from the current 4 days to 1 day (WSDOT 2014). This includes reduced flooding depths of roadways near Chehalis and Centralia during a 100-year flood by up to 5 feet. Flood depths along SR 6 could also be reduced up to 5 feet in most areas, and up to 10 feet in areas east of Doty. Some areas east of Doty would no longer be inundated. Downstream, flood depths along US 12 could be reduced by 0.01 to 1 foot in most areas, and up to 5 feet near Oakville, Porter, and Elma. Flooding of roadways on the Chehalis Tribe reservation could be reduced by up to 1 foot. The Chehalis-Centralia Airport would be protected by the Airport Levee Improvements during a 100-year flood, and the Aberdeen/Hoquiam North Shore Levee would protect local roadways behind the levee during coastal floods. Flooding of rail lines, including BNSF, Union Pacific, and the Curtis Industrial Park line would also be reduced.

The decreased severity of flooding could reduce the need for emergency response, increase public safety, and reduce adverse impacts on public services and utilities. For example, the airport would remain functional and be able to provide a base for emergency response during floods, and the radio tower located on the airport property would be protected during 100-year floods. Reduction of the period of closure of I-5 would make it available as an emergency response route for a longer time during floods. The Aberdeen/Hoquiam North Shore Levee could protect public services and utilities in

Aberdeen and Hoquiam from coastal flooding. Local Projects, such as flood protection of WWTPs, could reduce the potential for floodwater contamination by keeping the WWTPs operable during floods. Land Use Management actions would require a higher level of protection for new critical facilities (facilities that are vital to flood response activities and public health and safety or could release hazardous waste during floods). Flood Warning System Improvements, such as improvements to flood forecasting and flood inundation maps, would improve predictions and increase the lead time for flood warning, improving public safety.

5.3.1.2 Impacts of Implementing Flood Damage Reduction Actions

While there would be beneficial effects as a result of implementing Alternative 1, unavoidable significant adverse impacts on water resources, geology, geomorphology, wetlands and vegetation, fish and wildlife, tribal resources, and cultural resources would occur—primarily as a result of implementing the Flood Retention Facility as described in more detail in Chapter 4.

As compared to natural conditions, higher levels of sediment could be delivered to the temporary or permanent reservoir area from landslides that could potentially be triggered by fluctuating water levels, resulting in highly turbid conditions in the reservoir (also see Section 4.2.2.2.1). The effects of these erosion processes have the potential to cause a significant adverse impact on water quality within the reservoir with respect to suspended sediment and turbidity conditions by violating the state water quality criterion for turbidity (5 NTU over background).

For both the FRO and FRFA facility types, the potential for prolonged, controlled releases of turbid water exists as the reservoir draws down after a major flood (occurrence once every 7 years on average). Reduction in sediment quantity when the reservoir pool is in operation (for both the FRO and FRFA facilities), or the release of higher rates of suspended sediment outside of flood retention periods (for the FRO facility), have the potential to result in a significant adverse impact on downstream water quality with regard to suspended sediment and turbidity conditions. The FRFA facility would also alter approximately 6.3 miles of the Chehalis River upstream of the dam from a free-flowing river to a reservoir, resulting in a significant adverse impact on water quality.

In the FRO reservoir, increased solar heating of the Chehalis River in the reservoir inundation area would occur due to a reduction in riparian vegetation. Predictions of a water quality model that simulated the anticipated changes to vegetation indicated that nearly a 4˚C increase in summer water temperatures (over existing conditions) could occur within the reservoir footprint (PSU 2016). In the Crim Creek tributary upstream of the dam, up to a 5˚C increase was predicted. Modeling predicts this temperature effect to diminish upstream along the mainstem Chehalis River, where at RM 114 the predicted increase is 2˚C. Because warmer waters hold less DO, and can also stimulate biological activity creating a greater demand for DO, lower DO in the reservoir area is expected. With the increase in temperature by up to 4˚C and decrease in DO, there would be a significant adverse impact on water quality.

Compared to the No Action Alternative and other action alternatives, the occurrence of landslides along the perimeter of the reservoir has the potential to increase as a result of fluctuating water levels with the Flood Retention Facility. Over the life of the Flood Retention Facility, an earthquake on the CSZ to the west or Doty Fault Zone to the north could occur, and cause damage to the dam due to strong shaking. This would result in a significant adverse impact, if it were to occur. However, the dam and appurtenant structures could be designed to withstand this potential situation. Alternative 1 would have significant adverse impacts on geomorphology, primarily as a result of the dam disrupting sediment and wood transport downstream during dam operations. Compared to the No Action Alternative and other action alternatives, impacts on geomorphic functions would be greater.

Alternative 1 would have a much greater degree of unavoidable adverse impacts on wetlands and vegetation than the No Action Alternative and other action alternatives. This is primarily due to the permanent loss of approximately 68 acres (FRO facility) to 98 acres (FRFA facility) of wetlands and approximately 6 acres (FRO facility) to 720 acres (FRFA facility) of forested vegetation that would be required to construct and operate the Flood Retention Facility, which is unique to this alternative. Permanent loss or conversion of wetlands and vegetation associated with the Airport Levee Improvements, Aberdeen/Hoquiam North Shore Levee, and Local-Scale Flood Damage Reduction Actions are expected to be limited to within the footprint of the actions, which are largely located in areas that are currently developed or have been previously disturbed by past industrial, commercial, and residential activities.

Implementing Alternative 1 could also result in changes in wetland water regimes, vegetation, nutrient cycling, functions, and hydrologic sources of downstream floodplain wetlands. Table 5.3-3 provides a comparison of the approximate area of wetlands in the Chehalis River floodplain under the No Action Alternative with those in the Chehalis River floodplain with the Alternative 1 action elements in place. As indicated, Alternative 1 would reduce the extent of floodplain wetlands that would receive flood flows from 100-year floods. In addition to the No Action Alternative, this reduction in flooding as a source of hydrology for floodplain wetlands would be greater under Alternative 1 than that for any of the other action alternatives.

Table 5.3-3
Wetlands Located in Future 100-year Floodplain for the No Action Alternative and Alternative 1

WETLAND TYPE	AREA (ACRES)	
	NO ACTION ALTERNATIVE	ALTERNATIVE 1
Potentially (previously) disturbed wetlands	4,276	3,902
Palustrine forested wetland	4,789	4,492
Palustrine scrub-shrub wetland	4,476	4,228
Palustrine emergent wetland	6,291	5,949
Estuarine emergent wetland	50	47
Unconsolidated shore	339	335
Open water	3,877	3,817
Palustrine aquatic bed wetland	71	71
Estuarine aquatic bed wetland	0	0
Total	**24,169**	**22,841**

Source: Ecology 2011b; modeled inundation extent (WSE 2014c)

Alternative 1 would result in the most adverse impacts on fish as compared to the No Action Alternative and other action alternatives because of permanent and large-scale changes to the Chehalis River and its floodplain caused by the Flood Retention Facility, as further described in Chapter 4. Permanent changes to water quality (turbidity, temperature, and DO), temporary or permanent inundation of what is currently stream habitat above the dam, and reductions in forces that shape habitat downstream (delivery of coarse sediment used for refuge and spawning or large wood that creates habitat structure) would occur. These impacts could be avoided and minimized through such measures as fish passage facilities, reduced drawdown rates to avoid or minimize landslide occurrences, release of cooler waters in late spring to early fall (FRFA facility only), gravel augmentation, and large wood relocation. However, there would be significant adverse impacts resulting in the potential decline of salmonids as further described in Chapter 4. These declines would be greater when factoring in climate change predictions during the next 100 years (see Section 5.3.3 for an analysis of climate change impacts for Alternative 1). Impacts from the combination of the Flood Retention Facility and Aquatic Species Habitat Actions on fish were modeled, and are included in the Aquatic Species Habitat Actions evaluation in Section 5.3.2. Impacts from the combinations of the Flood Retention Facility and Aquatic Species Habitat Actions with climate change on fish have also been modeled and are included in Section 5.3.3.2.

Alternative 1 would temporarily or permanently inundate habitat above a dam, and constrain or eliminate instream breeding and foraging habitat for stream- and stillwater-breeding amphibians. Over time, potential changes to wildlife habitat could change the composition of wildlife species currently occurring within habitats by creating habitat conditions more favorable to some wildlife species, while eliminating characteristics favorable to other wildlife species as described in Section 4.2.4. Disturbed areas could be repopulated with non-native, invasive species that compete with native wildlife for

resources. The long-term adverse impacts range from minor to significant because different classes of wildlife species (e.g., amphibians, reptiles, categories of mammal and bird species) have a variety of habitat needs and home ranges with different vulnerabilities and potential responses to the disturbance and conversion of habitat features.

Impacts on tribal resources would occur with implementation of Alternative 1, primarily related to impacts on fish resources, although disruption to plant, wildlife, and traditional cultural practices could also occur. The extent of potential impacts on tribal resources is pending additional coordination with tribes and continued government-to-government consultations.

Impacts on cultural resources that could occur following construction of elements of Alternative 1 include potential sedimentation of any submerged resources; changes in stream channels and streambanks, resulting in erosion and potential exposure of resources; and increased or changed vehicular and foot traffic patterns that could affect resources. These changes could expose, damage, destroy, and/or alter cultural resources within construction footprints, as well as within the footprints of reservoirs or areas of changed river or tributary flows. In addition, erosion and other changes to stream channels and banks could require the removal of a cultural resource from its original location, or change the use or physical features of a cultural resource. Moderate to significant adverse impacts on cultural resources could occur due to the predicted archaeological potential in several areas of proposed construction.

Installation of the Flood Retention Facility and Airport Levee Improvements could result in increased development pressure in the Chehalis River floodplain due to a reduction of flooded area on developable parcels. In Lewis County, this could result in approximately 649 parcels, mostly located in residential incorporated and UGA areas of Lewis County, experiencing increased development pressure. Commercial/industrial parcels that have a lower risk of being flooded, and could be subject to greater development pressure, are mainly located in incorporated areas of Lewis County. Agricultural parcels that would contain area no longer inundated under Alternative 1 are located in unincorporated Lewis County.

During the next 100 years, population growth in the Chehalis River floodplain could result in development similar to that expected for the No Action Alternative, approximately 4 to 9 structures per year (total of 407 to 914 structures during the next 100 years). As a result of decreased flooding extents and the corresponding increase in development pressure on those parcels, future Chehalis River floodplain development rates under this alternative may tend toward the high end of the range in Lewis County, where flood extents would be most substantially reduced. Further analysis related to future development in the Chehalis River floodplain is included in Appendix L.

5.3.2 Aquatic Species Habitat Actions Evaluation

Alternative 1, when implemented as a comprehensive strategy, could substantially increase abundance of native aquatic species, reduce the potential for future ESA listings, and enhance tribal and non-tribal

fisheries as compared to the No Action Alternative. As described in the introduction to Section 5.3, Alternative 1 would result would result in more impacts on native salmon and aquatic species as compared to the other action alternatives because of permanent and large-scale changes to the Chehalis River and its floodplain caused by the Flood Retention Facility.

Implementation of Aquatic Species Habitat Actions would result in beneficial effects to native aquatic and semi-aquatic species and salmonids at a Basin-wide scale, due to the following:

- Restoring and protecting riparian habitat throughout the Chehalis Basin
- Opening up more than 295 miles of streams for migrating fish by removing partially or totally blocked fish passage barriers
- Restoring off-channel habitat on the mainstem Chehalis River and its tributaries, reconnecting the floodplain, adding wood, and reducing bank erosion to naturally occurring rates
- Creating, restoring, or enhancing wetlands for use by semi-aquatic species

As described in Chapter 2, the low restoration scenario focuses on reaches in the middle and upper Chehalis Basin that improve habitat for spring-run Chinook salmon, whereas the high restoration scenario occurs across a greater geographic area with improvements to habitat focused on areas with the highest restoration potential for all salmonid species. While these scenarios were developed based on habitat potential for salmonid species, the restoration actions will have benefits for other fish and amphibians as well.

Changes to the potential of the habitat in modeled tributaries in the Chehalis Basin to support salmon and steelhead in response to the combined actions in Alternative 1 was modeled for the different salmonid species that occur in WRIAs 22 and 23. The resulting changes in Chehalis Basin salmon populations are depicted for a range of dam and restoration scenarios (see Table 5.3-4). Modeled results of salmon habitat potential for Alternative 1 include the maturation of riparian areas in managed forestlands and active restoration from the Aquatic Species Habitat Actions compared to current conditions. The contribution of managed forestlands to total salmonid abundance would, on average, contribute 59% of the restoration benefit under the low scenario and 27% under the high scenario. Most of the benefit of riparian and fish passage improvements in managed forestlands would accrue to coho and steelhead because a larger portion of their habitat is located in the Satsop, Humptulips, and Wynoochee basins that are largely managed forestland[3].

Without Aquatic Species Habitat Actions, the Flood Retention Facility type that would have the most adverse impact on salmon populations would depend on the species. The FRFA facility would have a greater adverse impact for coho salmon and fall-run Chinook salmon, whereas the FRO facility would have a greater adverse impact for winter/fall-run chum salmon, spring-run Chinook salmon, and winter-

[3] Refer to Draft EIS Addendum dated October 17, 2016.

run steelhead. Under low and high restoration scenarios, impacts of the FRFA facility would be greater than the FRO facility, largely because restoration of riparian areas upstream of the dam and inundation footprint would reduce water temperatures. Elevated water temperature is an adverse impact of the FRO facility that has a strong effect on salmon productivity in areas of the inundation footprint and extending downstream of the FRO facility. Although the FRFA facility would be designed to provide cool water downstream to benefit salmon, it would generally result in a greater magnitude of adverse impacts than an FRO facility, primarily due to loss of stream habitat and salmon spawning and rearing habitat in the permanent conservation pool. The predicted impacts of the facilities to salmonid abundance are shown in combination with the beneficial effects of the low and high restoration scenarios in Table 5.3-4 and Figure 5.3-4.

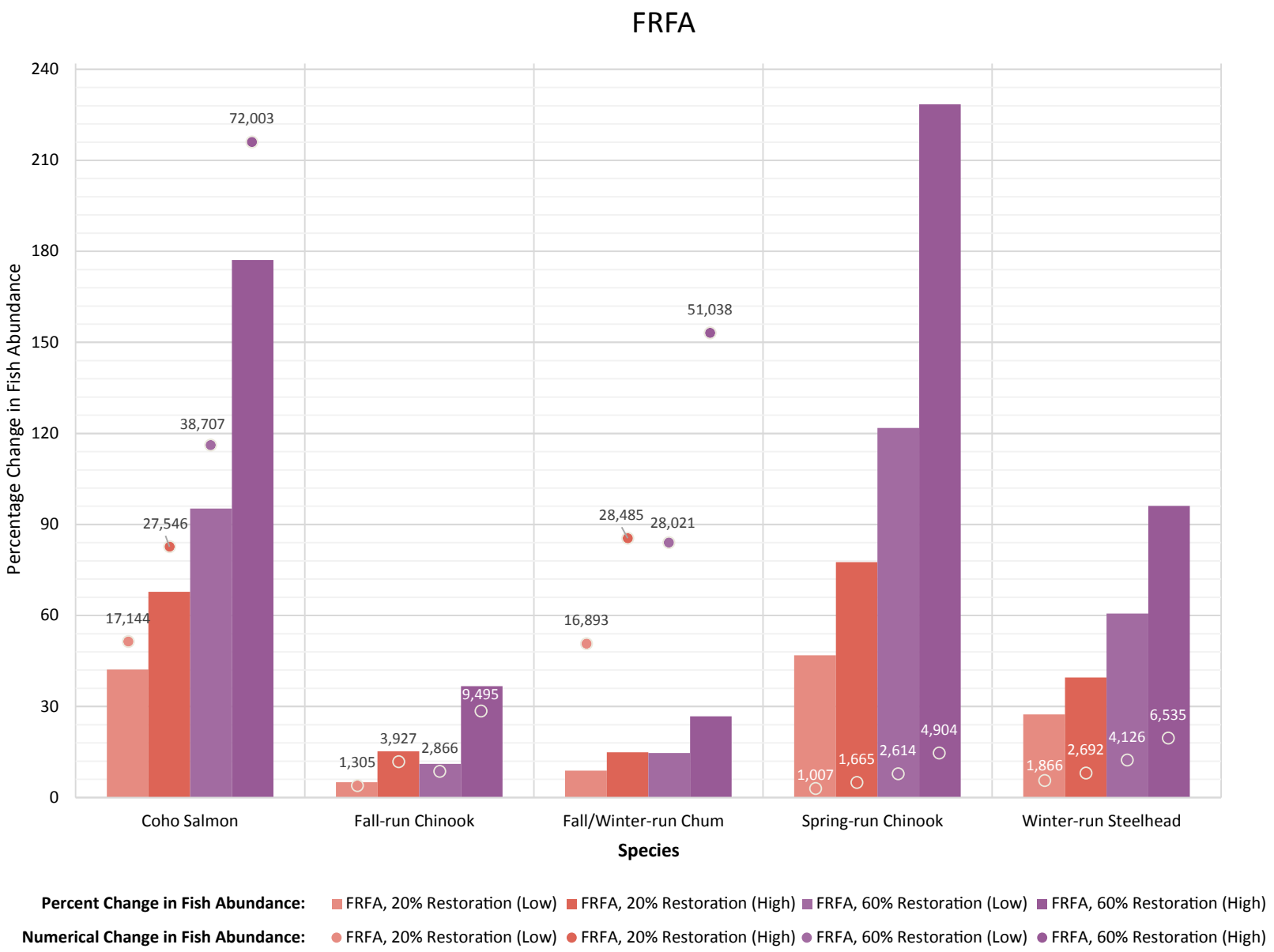
Table 5.3-4
Potential Response in Salmonid Abundance for the Chehalis Basin with Alternative 1

SPECIES (CURRENT HABITAT POTENTIAL)	FLOOD RETENTION FACILITY SCENARIO	CHANGE IN ABUNDANCE IN NUMBER OF FISH (%)				
		NO RESTORATION	WITH LOW RESTORATION; 20% OF REACHES	WITH HIGH RESTORATION; 20% OF REACHES	WITH LOW RESTORATION; 60% OF REACHES	WITH HIGH RESTORATION; 60% OF REACHES
Coho salmon (40,642)	FRO 100	-325 (-1%)	21,167 (52%)	38,831 (96%)	50,560 (124%)	94,930 (234%)
	FRO 50	-308 (-1%)	21,200 (52%)	38,866 (96%)	50,623 (125%)	94,998 (234%)
	FRFA	-622 (-2%)	17,144 (42%)	27,546 (68%)	38,707 (95%)	72,003 (177%)
Fall-run Chinook salmon (25,844)	FRO 100	-82 (<-1%)	2,860 (11%)	9,078 (35%)	4,366 (17%)	19,282 (75%)
	FRO 50	-80 (<-1%)	2,876 (11%)	9,100 (35%)	4,384 (17%)	19,311 (75%)
	FRFA	-150 (-1%)	1,305 (5%)	3,927 (15%)	2,866 (11%)	9,495 (37%)
Fall/winter-run chum salmon (190,550)	FRO 100	-1,837 (-1%)	18,589 (10%)	29,068 (16%)	30,641 (17%)	55,747 (30%)
	FRO 50	-1,837 (-1%)	18,589 (10%)	29,068 (16%)	30,641 (17%)	55,747 (30%)
	FRFA	-1,548 (-1%)	16,893 (10%)	28,485 (16%)	28,021 (15%)	51,038 (28%)
Spring-run Chinook salmon (2,146)	FRO 100	-82 (-4%)	1,990 (93%)	4,520 (211%)	5,448 (254%)	15,175 (707%)
	FRO 50	-75 (-3%)	2,013 (94%)	4,555 (212%)	5,506 (257%)	15,265 (711%)
	FRFA	-56 (-3%)	1,007 (47%)	1,665 (78%)	2,614 (122%)	4,904 (228%)
Winter-run steelhead (6,800)	FRO 100	-117 (-2%)	1,996 (29%)	2,963 (44%)	4,488 (66%)	7,426 (109%)
	FRO 50	-103 (-2%)	2,078 (31%)	3,056 (45%)	4,662 (69%)	7,655 (113%)
	FRFA	-95 (-1%)	1,866 (27%)	2,692 (40%)	4,126 (61%)	6,535 (96%)

Source: ICF 2016

Figure 5.3-4a

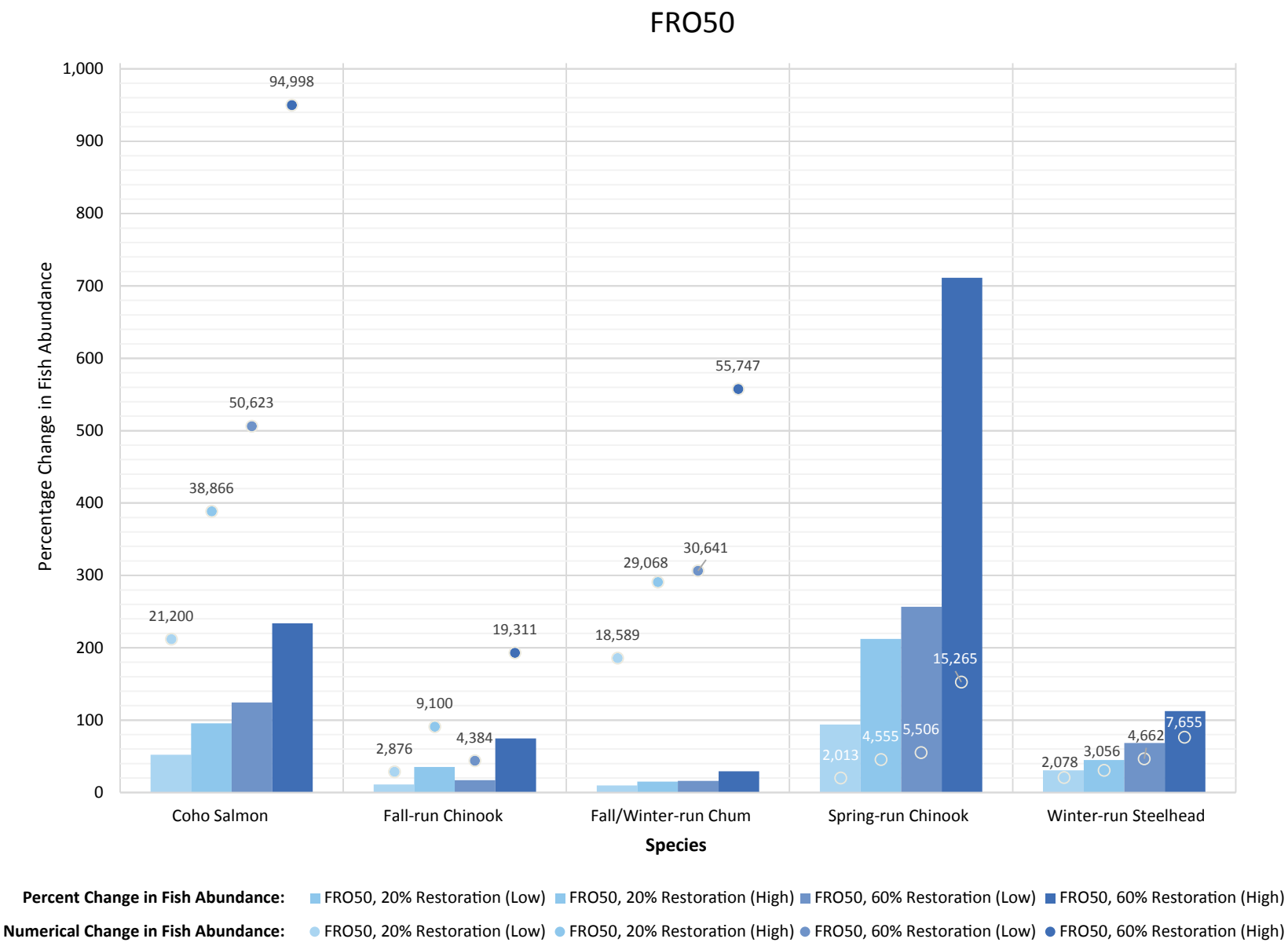
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Alternative 1



Source: ICF 2016

Figure 5.3-4b

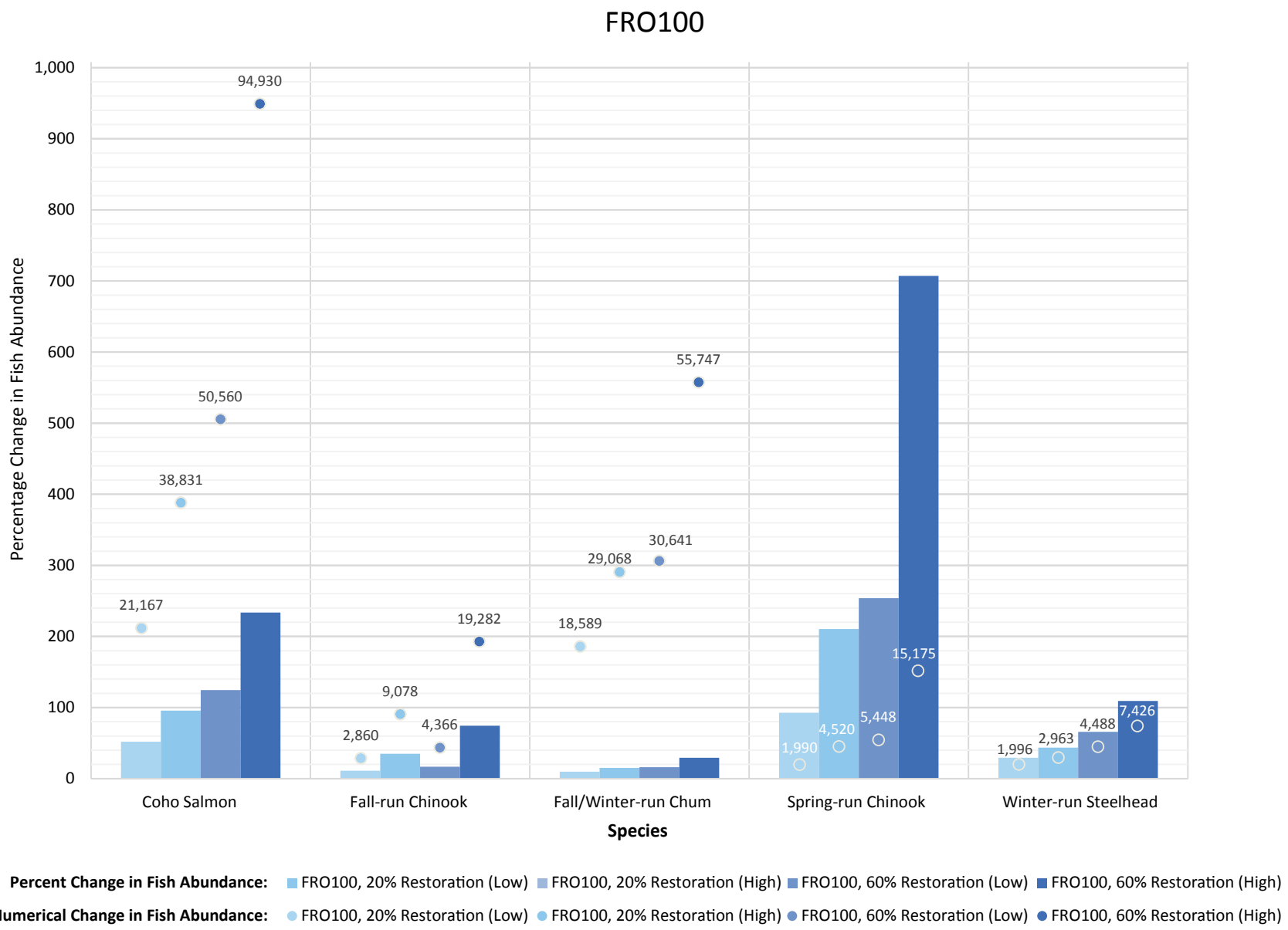
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Alternative 1



Source: ICF 2016

Figure 5.3-4c

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Alternative 1



Source: ICF 2016

As described in Chapter 4, with the exception of potential significant adverse impacts on cultural resources, implementation of the Aquatic Species Habitat Actions would result in beneficial effects, no impact, or minor to moderate adverse impacts on most elements of the environment. For cultural resources, the degree or severity of the impact would depend on the nature of cultural resources that would be disturbed as determined during a project-level environmental review, and could range from minor to significant adverse impacts depending on the location. The extent of potential impacts on tribal resources from Aquatic Species Habitat Actions is pending additional coordination with tribes and continued government-to-government consultations. Climate change would reduce the effectiveness of restoration for salmonid populations and other aquatic species (see Section 5.3.3.2).

5.3.3 Climate Change Analysis

Alternative 1 is anticipated to provide substantial beneficial effects in response to the effects of climate change when considering the combined action elements. However, Alternative 1 also results in generation of the most GHG of all alternatives as a result of construction of the Flood Retention Facility, which adversely affects climate conditions. The Flood Retention Facility is not part of the other action alternatives.

Adverse impacts from climate change on Alternative 1 are anticipated to be minor when combining all of the action elements. Alternative 1 would temper the effects of a changing climate in the Chehalis Basin more than the No Action Alternative, as the elements within Alternative 1 are designed to moderate those effects in a large-scale fashion.

5.3.3.1 Adverse Effects Contributing to Climate Change

The minor adverse impacts anticipated under Alternative 1 that would contribute to climate change would occur as the result of permanent loss of vegetation with the Flood Retention Facility, which reduces carbon sequestration (i.e., carbon storage). Construction of the FRFA facility would generate moderately greater GHG emissions equivalent than construction of the FRO facility—889 acres and 107,569 MT CO_2e versus 411 acres and 49,731 MT CO_2e. However, the vegetation losses associated with construction represent less than one-fifth of 1% of the existing forestland within the Chehalis Basin.

Aquatic Species Habitat Actions would result in a benefit to the resiliency of natural systems in the Chehalis Basin in the face of climate change under Alternative 1. This action element would increase or protect vegetation across floodplains in the Chehalis Basin, and result in an increase in carbon storage ranging from 900,000 to 1.93 million MT CO_2 (Ecology 2011c). These benefits exceed the potential adverse impacts contributing to climate change described previously.

5.3.3.2 Effects of Climate Change on Alternative 1

Alternative 1 would moderate the extent of flooding in downstream areas from the more intense winter rains anticipated with climate change, reduce the frequency of major floods originating in the Chehalis River headwaters, and reduce flood damage to land and to structures in the Chehalis River floodplain

more than the No Action Alternative and other action alternatives. Hydraulic modeling of peak flows under climate change conditions indicate that a FRO or FRFA dam would reduce peak flows to a greater degree in a 100-year flood in the future than under existing conditions, indicating Alternative 1 could help reduce flooding impacts from climate change (Karpack 2016a). In addition, the FRFA facility could moderate increases in summer instream temperature resulting from climate change by releasing cool water into the Chehalis River during late spring through early fall, although it could increase river temperatures at other times.

The design of facilities included in this alternative is expected to anticipate changes in precipitation, increased flooding, and drought conditions that are predicted with climate change forecasts.

Impacts of the Flood Retention Facility coupled with the Aquatic Species Habitat Actions on fish abundance were modeled using EDT. The results indicate that when combined with a dam, both the low and high scenarios for Aquatic Species Habitat Actions would be effective in overcoming the modeled effects of climate change on salmon population abundance in the Chehalis Basin (ICF 2016). See Table 5.3-5 and Figure 5.3-5 for a summary of modeled results. Modeling related to salmon abundance and climate change for the other action elements that are included in Alternative 1 has not been conducted.

The combination of the FRFA facility and high restoration would result in the greatest benefits to the modeled fish species under climate change, notably spring-run Chinook salmon. Model results indicate this combination would not only lessen the predicted decline in abundance, but is predicted to result in increased populations across all species.

Table 5.3-5

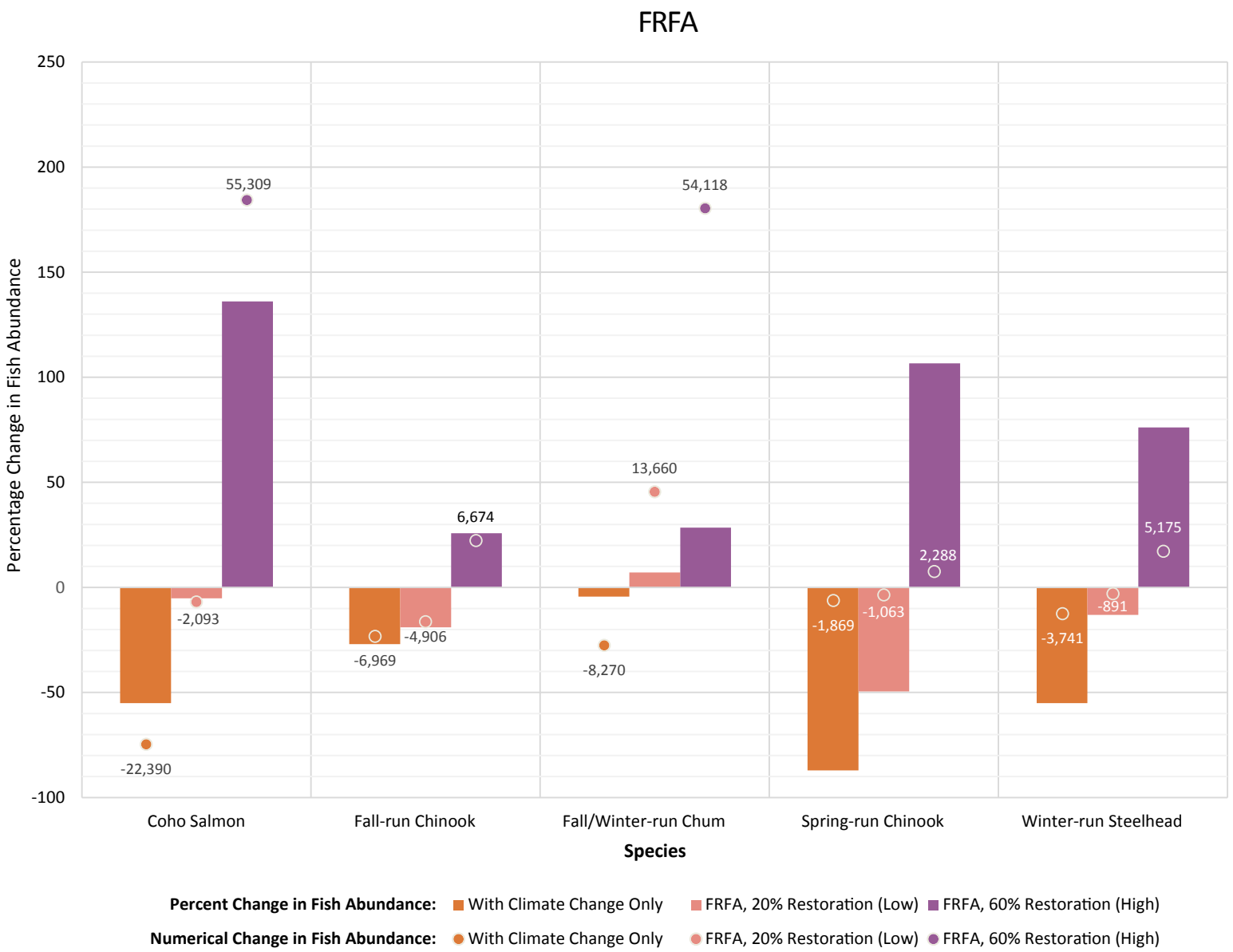
Potential Response in Salmonid Abundance for the Chehalis Basin with Alternative 1 and Climate Change

SPECIES (CURRENT HABITAT POTENTIAL)	FUTURE HABITAT POTENTIAL WITH CLIMATE CHANGE	FLOOD RETENTION FACILITY SCENARIO	CHANGE IN ABUNDANCE IN NUMBER OF FISH (%)	
			WITH FLOOD RETENTION AND LOW RESTORATION; 20% OF REACHES AND CLIMATE CHANGE	WITH FLOOD RETENTION AND HIGH RESTORATION; 60% OF REACHES AND CLIMATE CHANGE
Coho salmon (40,642)	-22,390 (-55%)	FRO 100	-2,115 (-5%)	49,030 (121%)
		FRO 50	-2,104 (-5%)	49,065 (121%)
		FRFA	-2,093 (-5%)	55,309 (136%)
Fall-run Chinook salmon (25,844)	-6,969 (-27%)	FRO 100	-4,785 (-19%)	6,935 (27%)
		FRO 50	-4,780 (-18%)	6,945 (27%)
		FRFA	-4,906 (-19%)	6,674 (26%)
Fall/winter-run chum salmon (190,550)	-8,270 (-4%)	FRO 100	16,899 (9%)	63,264 (33%)
		FRO 50	16,899 (9%)	63,264 (33%)
		FRFA	13,660 (7%)	54,118 (28%)
Spring-run Chinook salmon (2,146)	-1,869 (-87%)	FRO 100	-1,138 (-53%)	2,151 (100%)
		FRO 50	-1,138 (-52%)	2,151 (100%)
		FRFA	-1,063 (-50%)	2,288 (107%)
Winter-run steelhead (6,800)	-3,741 (-50%)	FRO 100	-936 (-14%)	6,468 (95%)
		FRO 50	-963 (-14%)	6,521 (96%)
		FRFA	-891 (-13%)	5,175 (76%)

Source: ICF 2016

Figure 5.3-5a

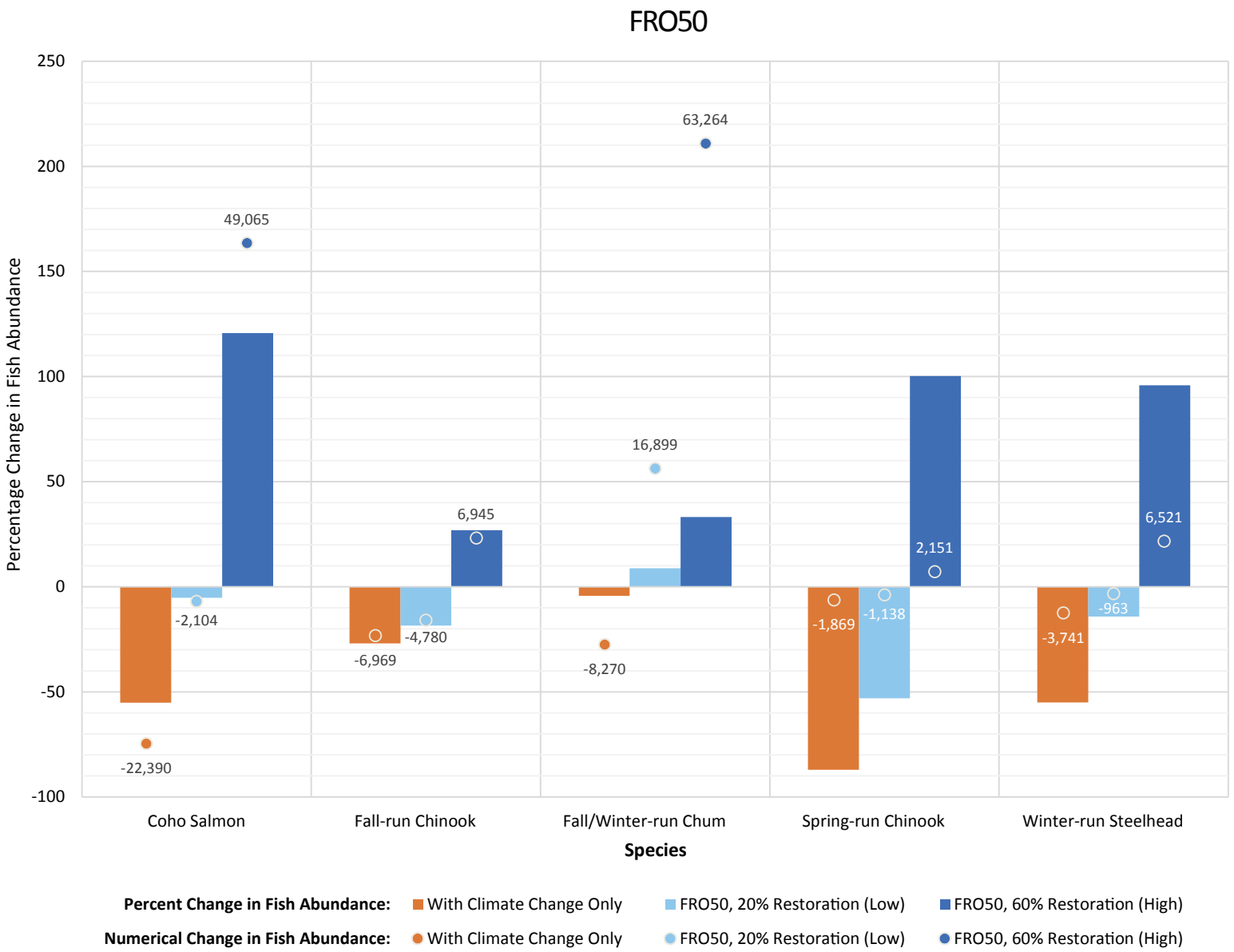
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Climate Change and Alternative 1



Source: ICF 2016

Figure 5.3-5b

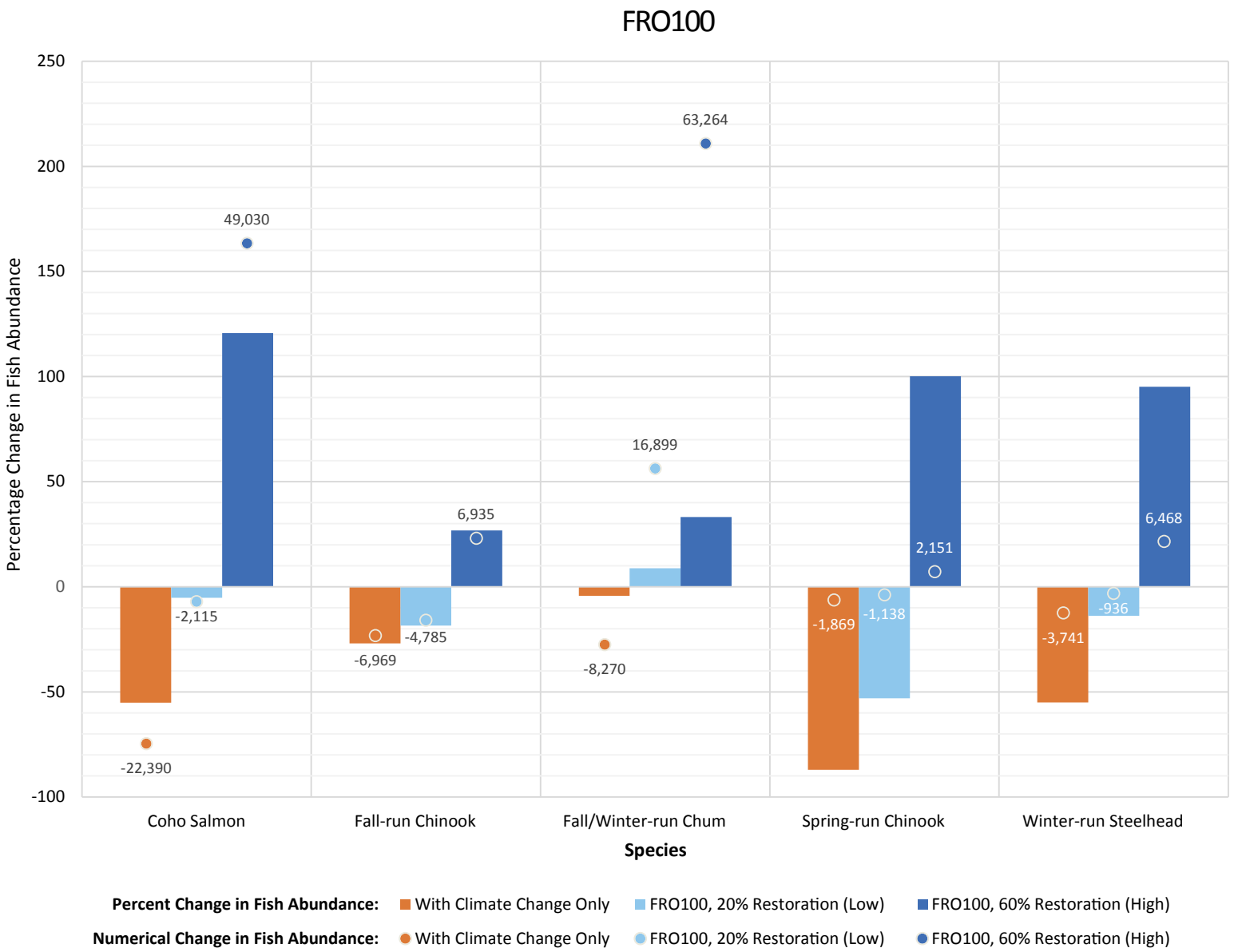
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Climate Change and Alternative 1



Source: ICF 2016

Figure 5.3-5c

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Climate Change and Alternative 1



Source: ICF 2016

5.3.4 Mitigation

Specific mitigation measures to address potential unavoidable adverse impacts resulting from the implementation of Alternative 1 would be identified during project-level design and environmental review.

Some unavoidable, adverse impacts could be minimized through such measures as designing the dam to withstand the effects of earthquakes and shaking on the CSZ and other nearby faults (including the Doty Fault). Other mitigation measures for unavoidable adverse impacts could include incorporating fish passage into the dam, reducing reservoir drawdown rates to minimize landslide potential, and releasing cooler waters in spring to early fall (FRFA facility only). A Reservoir Operations and Management Plan would be developed and incorporated into the design to minimize impacts on water resources, geology and geomorphology, vegetation, and fish and wildlife to the extent feasible. The Reservoir Operations and Management Plan would be developed to minimize adverse impacts on flow from maintaining water in a reservoir, water quality (including turbidity, temperature, and DO), wood and sediment management, and landslides resulting from a dam and reservoir. Additionally, a Post-construction Vegetation Management Plan and Fisheries Management Plan (to evaluate fish passage performance) would be prepared and include monitoring and adaptive management requirements. Project-specific mitigation plans, such as downstream sediment and wood supplementation, could also be prepared to address unavoidable impacts on geomorphology.

For project elements that are anticipated to have long-term, significant, or unavoidable impacts on wetlands, compensatory mitigation measures would be required during project-level design and environmental review to ensure no net loss of ecological function. To achieve this, the goals of the mitigation would be based on the following guidelines from the joint Ecology, USACE, and EPA document *Wetland Mitigation in Washington State – Part 1*:

- Replace impacted wetland with the same or higher category of wetland
- Provide equal or greater area of wetlands through re-establishment or creation
- Locate mitigation in areas where compensation could contribute to ecosystem functioning
- Clearly identify how the compensation actions would replace the functions lost or provide measureable gains in other functions that are important in the area

Potential compensatory mitigation for long-term impacts on vegetation could include purchasing and preserving adjacent and off-site areas of forestlands within the same watershed, which could mitigate unavoidable adverse climate change impacts.

Compensatory mitigation would be required for loss of fish habitat and fish habitat function, and reduced fish population performance above and below the dam. Examples of compensatory mitigation include fish habitat restoration, protection, or acquisition of land that presents an opportunity for in-kind compensation for fish habitat lost. Mitigation actions associated with wetlands, vegetation, and fish would also benefit wildlife.

Potential compensatory mitigation measures for potential impacts on tribal resources and cultural resources would be the same as those described in Sections 4.2.5 and 4.2.12, respectively. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

As noted in Section 4.1.3, identified compensatory mitigation measures may not completely reduce or eliminate potential adverse impacts; significant unavoidable impacts for which effective mitigation measures have not been identified may remain.