9 Potential Risk of Take

White papers prepared in 2006 (Bank Protection and Stabilization Structures, Overwater Structures and Non-Structural Piling, and Water Crossing Structures) and those prepared in 2007 (Channel Modifications, Fish Passage, Fish Screens, Flow Control Structures, Habitat Modifications, Marinas and Shipping Terminals, and Shoreline Modifications) used somewhat different methods and provided somewhat different levels of detail for estimating potential risk of take. Instead of revisiting the methodology and conclusions of the original white papers, this consolidation organizes the information to present general information, followed by information specific to a particular activity. It has been edited to minimize information that was repeated in several white papers. Unique tables have been retained from the original white papers. Specifically:

Section 9.1 consolidates the general discussion of the risk of take that was originally presented in the 2006 white papers.

Section 9.2 presents risk-of-take information specific to Bank Protection and Stabilization Structures, Overwater Structures and Non-Structural Piling, or Water Crossing Structures.

Section 9.3 consolidates the general discussion of the risk of take that was originally presented in the 2007 white papers.

Section 9.4 presents risk-of-take information specific to Channel Modifications, Fish Passage, Fish Screens, Flow Control Structures, Habitat Modifications, Marinas and Shipping Terminals, or Shoreline Modifications.

Discussions of “mechanisms of impact” are presented in the following order:

- Construction and Maintenance
- Operations
- Hydraulic and Geomorphic Modifications
- Ecosystem Fragmentation
- Riparian Vegetation Modifications
- Aquatic Vegetation Modifications
- Water Quality Modifications

However, not all of the original papers discussed all of the mechanisms of impact. If there was no discussion in the original paper, then that section is also missing from this consolidation.

9.1 General Risk of Take: 2006 White Papers (Bank Protection and Stabilization Structures, Overwater Structures and Non-Structural Piling, and Water Crossing Structures)

In its biological opinion for a bridge replacement on an Oregon river, NMFS (2006a) determined that the take caused by habitat-related effects of a project could not be accurately quantified (i.e., as a number of fish) because the relationship between habitat conditions and the distribution and abundance of those individuals in the action area was imprecise, and nearshore areas damaged by construction would require years to recover characteristics favorable for rearing and migration.

In such instances, NMFS uses the causal link established between the activity and the change in habitat conditions affecting the listed species to describe the extent of take as a numerical level of habitat disturbance, rather than stating an expected amount of take (50 Code of Federal Regulations 402.14(i)). NMFS (2006a) found that the best available indicators for the extent of take is the area of riparian habitat that will be permanently modified by the action, because it is directly proportional to long-term harm attributable to the project.

9.1.1 General Risk of Take from Construction, Operations, and Maintenance

9.1.1.1 Channel Dewatering

The primary risks of incidental take associated with channel dewatering result from the capture and handling of fish, the loss of small fish (particularly salmonid fry) that seek refuge in the substrate of the dewatered bed, and the use of pumped bypass systems. This conclusion is based on a review of several biological opinions.

Capture-related take, such as injury or mortality from electrofishing, varies from 2 percent (no distinction between injury and mortality) (NMFS 2006a) to 30 percent (25 percent injury and 5 percent mortality) (NMFS 2006b) of fish captured using electrofishing equipment. Some biological opinions did not distinguish between methods of capture (e.g., volitional movement of fish from the project site during slow dewatering, capture by seining or dip-netting, capture by electrofishing). One biological opinion estimated take due to stranding (i.e., fish not captured and removed and thus remaining in the work area to be dewatered) at 8 percent (NMFS 2006b). All such injury and mortality represent incidental take directly attributable to a project.

9.1.1.2 Noise

It is well established that impact pile driving can result in incidental take of fish. NMFS and USFWS biological opinions commonly identify such take and quantify it based on the area of habitat affected by sounds above the threshold levels and the duration of pile driving activities. However, the sound sensitivity of individual species is not well known. Species that lack internal gas-filled voids (such as swim bladders) appear to be less vulnerable to noise impacts than are fish, such as salmonids, that have gas-filled voids. For species without gas-filled voids, the risk of take is somewhat lower than it is for salmonids. Species-specific studies would be required to quantify the difference in risk.

Construction noise and activity associated with the La Conner Wharf and Float Project was thought to cause forage fish to temporarily leave the vicinity, which would temporarily reduce the prey base for Chinook and other fish species (NMFS 2005b); project effects on other predators, such as those eating young Chinook, were not addressed.

In the consultations reviewed, NMFS has not assigned quantifiable incidental take associated with construction noise other than pile driving.

9.1.1.3 Artificial Light

Incidental take for listed fish species as a result of artificial lighting has not been quantified in past biological opinions and corresponding incidental take statements. Studies indicate that artificial light has mixed effects; many of these effects are detrimental, and all of them represent a change from natural patterns of behavior. This suggests that although artificial light responses are unknown for most potentially covered species, there is a risk that nighttime illumination of the water surface may contribute to incidental take. Data are not adequate to define the magnitude of that risk; however, such impacts can generally be minimized.

9.1.1.4 Shading

Mechanisms of take related to shading include the following:

- The principal impact of shading is reduction in cover and productivity of underwater vegetation.

- Most studies of shading are focused on juvenile salmonids. However, available data on light sensitivity suggest that those impacts may reasonably be extrapolated to other small fishes, particularly nearshore marine species. For all other potentially covered species, almost nothing is known about sensitivity to shading.

- In freshwater environments that support significant bass populations, bass are effective, high-level predators that forage from under shade-producing structures.

- Migration of juvenile salmonids is sometimes impeded by shade-producing structures.

Shading from HPA-permitted structures could result in incidental take, if it is located where longshore movement of juvenile salmon might be affected. NMFS (2005b) identified incidental take of juvenile Puget Sound Chinook resulting from shading by a wharf and moorage float in Swinomish Slough, which may impede longshore movement during certain times of the day, and from a reduction in primary productivity and consequent reduction in food resources. Based on the shading footprint, the extent of take (identified as harm in this biological opinion) was determined to be any juvenile Puget Sound Chinook rearing and outmigrating within less than 1 acre around the structure.

Shade cast by HPA-permitted structures may also provide a site for predators to congregate. In a freshwater environment, NMFS (2006c) determined that the shading and structure resulting from the proposed expansion of a marina in the Columbia River will likely result in increased predation of listed juvenile salmon by a number of piscivorous fish species found in the area, although NMFS was unable to quantify the number of salmon expected to be killed.

9.1.1.5 Vessel Activities

Vessel activities may result in incidental take of potentially covered species via several mechanisms, including:

- Physical disturbance of sediment, organisms (Haas et al. 2002), and submerged vegetation through grounding or water turbulence caused by propeller wash, potentially resuspending sediment, physically dislodging vegetation and organisms, or damaging vegetation.

- Noise from vessel activity, which would most likely harm organisms by causing them to move from the affected area, potentially impairing foraging or reproductive activities or exposing them to increased risk of predation.

- Propeller wash-entrained air bubbles that combine with turbidity increases from disturbed sediment, with the potential consequences resulting from increased turbidity and from decreased light availability.

9.1.2 General Risk of Take from Hydraulic and Geomorphic Modifications

9.1.2.1 Channel Hydraulics

Impacts to potentially covered species may result when a vulnerable life-history stage of a species is exposed to an impact directly or indirectly caused by an HPA-approved structure. A direct impact arises when a structure alters the process of sediment transport, and an indirect impact arises when the change in sediment transport causes further habitat changes, such as bank erosion and loss of riparian vegetation.

Table 9-1. Potential Impacts of Changes in Stream Channel Hydraulics on Potentially Covered Species

Impact	Potentially Affected Species
No impact identified	Marine species or marine life stages of estuarine and anadromous species
Habitat destruction due to siting of structure	Species potentially occupying the affected stream
Embedding due to reduced sediment transport capacity or indirectly as a result of bank erosion	Species potentially occupying the affected streambed: gravel spawners and benthos
Scour due to locally increased transport capacity	Species potentially occupying the affected streambed: gravel spawners and benthos
Deposition downstream of scour areas	Species potentially occupying the affected streambed: gravel spawners and benthos
Loss of riparian vegetation due to bank erosion	Species potentially occupying the affected stream.

9.1.2.2 Habitat Loss

Habitat loss is the replacement of habitat with an artificial structure. Habitat loss includes temporary and permanent elements. Temporary habitat loss occurs when an area of habitat is inaccessible during or for a time following construction but becomes accessible within a reasonable time after construction, typically by the time work on the site concludes. Permanent habitat loss occurs when an area of habitat remains inaccessible for the service life of the structure or longer.

Permanent loss of channel habitat occurs when fill is placed in the channel or floodplain, usually in the form of fill intended to raise an area above the OHWL. Temporary channel habitat loss includes fill placement when it is not permanent, as well as channel dewatering resulting from the diversion of flow or flow exclusion via structures such as cofferdams. Habitat loss presents a high potential risk for incidental take; the risks are related to use of the habitat by potentially covered species, the area affected, the time frame during which the area is affected, and how potentially covered species respond to the loss or degradation of habitat.

The process of placing fill may cause harm to individual animals. However, in-water placement of fill generally requires isolating and dewatering the work site.

9.1.2.3 Embedding

Embedding gives the stream a relatively hard, impervious bed that provides a poor substrate for salmonid spawning, impairs hyporheic exchange, and provides poor habitat for benthic invertebrate infauna. Typically, several years of peak flow events are required after the fine sediment inputs have ended for the bed to be sufficiently reworked that embedding ceases.

Embedding is an issue principally in moderate-gradient channels that normally have a gravel or cobble bed, i.e., plane-bed and pool-riffle channels. Steeper channels have sufficient stream power that the “fines” consist of coarse sand and gravel, which do not substantially impair habitat quality. The less steep regime channels have fine-grained bed materials (generally defined as particles smaller than 0.04 inch [1 mm] in diameter) that are vulnerable to deposition rather than embedding. Embedding has a high risk of causing incidental take if it affects sediments used for spawning.

9.1.2.4 Scour

Scour is potentially an issue in all channel types, although it is most often a concern in plane-bed and pool-riffle channels, which have a relatively mobile bed. The term “scour” is usually used to refer to flow-driven excavation of the streambed, but it can also occur along stream margins and result in bank erosion. Scour that occurs in areas where it has previously been rare (for instance, due to the placement of HPA-permitted structures) may result in the loss of redds with eggs or of gravels containing fry or the benthic invertebrates that constitute part of the prey base for fish in the stream. Such scour events are particularly likely around hard structures placed in the channel, because shear stresses, and therefore energy available to mobilize sediments, are exceptionally high near such structures (Yager et al. 2004). The opposite effect is observed in the vicinity of aquatic vegetation (Bennett et al. 2002), raising the possibility that aquatic vegetation plantings may help to decrease scour around structures at some sites.

Scour can potentially result in incidental take via several mechanisms. Impacts to eggs and fry of potentially covered species (e.g. salmonids), or to sessile organisms such as mussels, constitute the potential for incidental take of animals. Impacts to the prey base can be interpreted as incidental take if the food supply is a limiting factor on fish productivity. The literature review did not specifically identify scour impacts on other potentially covered species, but such impacts are likely for sessile species and for species that spawn in benthic habitats.

9.1.2.5 Deposition

Deposition may occur in slackwater areas created upstream or downstream of an artificial structure, or it may occur farther downstream when sediment mobilized by scour is redeposited. Deposition can have a variety of effects, depending on the amount of sediment and its particle size distribution. Deposition of large quantities in a localized area results in the creation of bedforms. Deposition of somewhat smaller quantities that do not significantly modify bedforms may still result in burial of redds and benthic organisms such as mussels. Both coarse and fine sediment deposition can present potential for incidental take by burying animals living in the bed, such as eggs and alevins in redds and invertebrate infauna, and/or impairing habitat by reducing access to necessary resources such as prey and well-oxygenated water.

9.1.2.6 Littoral Drift

The littoral drift processes of wave action and littoral current affect benthic substrate and vegetation and therefore influence species assemblages (Thom et al. 1994). Primary productivity, organic matter flow, nutrient dynamics, benthic biota, and the entire local food web may also respond to alterations in littoral drift (Thom et al. 1994).

Pacific salmon, Pacific herring, surf smelt, sand lance, and a variety of other fish may be affected by habitat changes caused by structures that affect littoral drift (Thom et al. 1994). Altering substrate composition in surf smelt spawning areas can affect surf smelt spawning or reduce egg survival. One study found that suitable surf smelt spawning areas were adversely impacted by littoral drift alterations resulting from bulkheads along the Hood Canal (Penttila and Aguero 1978, in Thom et al. 1994). However, no studies were found identifying comparable changes in association with a water crossing structure; thus there are no data to identify the probability of incidental take via this mechanism.

Pacific sand lance spawn in the high intertidal zone on substrates varying from sand to sandy gravel. Sand lance also rely on sandy substrates for burrowing at night. Like surf smelt, sand lance are susceptible to deleterious effects of littoral alterations because they rely on a certain beach profile and specific substrate compositions.

Any species that depends on eelgrass, such as Pacific salmon or Pacific herring, is susceptible to changes in littoral drift. Benthic communities, including invertebrate populations, are impacted by sediment alterations (Nightingale and Simenstad 2001b). Impacts to littoral drift may change beach substrate characteristics and sediment deposition. Changes to these processes can alter benthic and epibenthic communities, fish spawning and rearing habitat, and vegetation (Thom et al. 1994).

Benthic communities, including invertebrate populations, are impacted by sediment alterations (Nightingale and Simenstad 2001b) caused by littoral drift. Local impacts to littoral drift can alter preferred substrate or smother oysters beneath silt.

9.1.2.7 Substrate Modifications

It appears that in marine environments, the primary direct impact of placing structures is to create hard substrates in settings where such substrates did not previously occur, increasing habitat diversity. This change would likely benefit rockfish and any other potentially covered species that use hard or rocky substrates. However, the indirect impact of increased shellhash deposition can harm productive natural habitat types, specifically eelgrass and macroalgae communities. In that case, the risk of incidental take will be the risk of adversely impacting eelgrass and macroalgae. In freshwater environments, the principal substrate modifications entail habitat loss due to placing fill within the channel or floodplain, and habitat modification by replacing native substrate with artificial structures.

9.1.2.8 Rapid Channel Change

Many streams in the Pacific Northwest are highly energetic and capable of rapid, sometimes dramatic changes in their channels. Examples of this include debris flows, dam-break floods, channel avulsions, and rapid channel migration. HPA-permitted activities can have an impact on rapid channel change.

Debris flows are commonly observed in areas that have experienced severe vegetation loss due to forest harvest, forest fire, or land clearance for development. Death and decay of tree roots on steep soils reduces soil cohesion, resulting in shallow-rapid landslides that usually occur during or shortly after severe rainfall events (Croft and Adams 1950, in Coho and Burges 1994). Shallow-rapid landslides commonly initiate on slopes steeper than the angle of repose (about 77 percent) and mix with streamflow in mountain channels to create debris flows that readily transit channels with gradients steeper than about 10 percent (Swanston 1991; Montgomery and Buffington 1993). Such flows entrain sediment and coarse wood that scour the stream channel, often to bedrock, devastating all habitats in the affected reach (Swanston 1991; Benda and Cundy 1990). Commonly, several years to a decade are required before riparian vegetation, fish populations, and water quality recover from the event. Debris flows can be regarded as a cumulative impact that may result from the placement of artificial structures in a channel.

Channel avulsions occur when a stream leaves its old channel and cuts a new one. It has been hypothesized that channel avulsion is the principal mode of channel migration in relatively high-gradient, sediment-rich rivers of Western Washington, such as the Nooksack, the Skykomish, the Green, the Nisqually, and the Queets (Latterell et al. 2006). Channel avulsion is also commonly observed in smaller mountain channels, where it can often be triggered by a debris flow; sediment and wood may fill the original channel and subsequent flows cut a new channel. Channel avulsion is also the dominant channel change process on alluvial fans, where channels are typically transport-limited and avulsion occurs in response to sediment aggradation within the channel. Channel avulsions typically are associated with severe deposition (amounting often to several meters of sediment) in the channel immediately upstream of the avulsion point and dewatering of the channel downstream to the point where the avulsed channel and the initial channel merge. Studies on the Queets River have found that the dewatered channel may be hundreds of meters long (Latterell et al. 2006). Channel avulsions on large rivers are usually not anthropogenic events or are only indirectly caused by human activity, but they may occur in unconfined reaches of smaller streams in response to a culvert becoming plugged by sediment and/or woody debris. Avulsions can be regarded as a cumulative impact that may result from placement of artificial structures in the channel.

Rapid channel migration occurs when bank cutting allows a channel to move laterally by a distance comparable to or greater than the initial channel width. Although the phenomenon has been observed on rivers in Washington, the literature does not contain examples of it happening in response to placement of an artificial structure in the channel.

9.1.3 General Risk of Take from Riparian Vegetation and Large Woody Debris Modifications

NMFS (2006a) found that the best available indicator for the extent of take is the area of riparian habitat that will be permanently modified by the action, because it is directly proportional to long-term harm attributable to the project. In another instance, NMFS (2006b) indicated that the risk of take associated with the removal or disturbance of riparian/shoreline vegetation should be described in terms of acres of riparian/shoreline or miles of stream affected.

9.1.4 General Risk of Take from Aquatic Vegetation Modifications

HPA-permitted structures can sometimes be sited to avoid eelgrass and macroalgae, but some structures must be sited within a narrowly defined area, and in some areas eelgrass and/or macroalgae are very common; thus some structures are likely to directly impact eelgrass and/or macroalgae.

Generally, the federal agencies have treated loss or reduced density of eelgrass as equivalent to loss of essential habitat for listed species known to occur in the area; as such, it constitutes a take of listed species such as salmon and bull trout. A similar perspective has been adopted by state jurisdictional agencies, including WDFW and the Washington Department of Natural Resources (WDNR).

Compensatory mitigation has been required, typically including consideration of temporal impacts related to the time between impact and full eelgrass recovery. Based on the regulatory background, the federal agencies are almost certain to evaluate eelgrass loss as resulting in incidental take of potentially covered species that use eelgrass. Those species include anadromous salmonids, anadromous and marine forage fishes, and certain larval pelagic fishes.

The federal agencies have generally not regarded impacts to macroalgae as amounting to incidental take. The macroalgae most critical to potentially covered species are kelps that chiefly occur in areas of rocky substrate, often in deep water.

Noxious aquatic weed introductions have a high probability of causing incidental take of ESA listed fish species, because noxious weeds can potentially out-compete native vegetation and alter water quality and food web interactions (WNWCB 2006). The impacts of noxious aquatic weeds are indirect, deriving mainly from their accidental introduction during the construction and use of artificial structures. There are no data that provide a basis for stating the likelihood that this impact might occur.

9.1.5 General Risk of Take from Water Quality Modifications

Incidental take risk associated with dissolved oxygen impacts is probably quite low.

Risk of incidental take of potentially covered species due to the use of treated wood appears to be related to factors that include proximity, dilution, and type of treatment. PAH releases from creosote pilings may pose risk of incidental take to some of the covered species, given that many types of organisms have significant PAH sensitivities at low exposure levels (Incardona et al. 2004; Incardona and Scholz 2006). Potentially vulnerable species include mollusks and mussels that may be sessile and juvenile fish that consume epibenthic prey inhabiting those sediments. ACZA-treated wood appears to be somewhat less harmful, with most impacts expected during initial leaching (up to 10 days [Poston 2001]), although recent investigations (Baldwin et al. 2003; Linbo et al. 2006) indicate that juvenile salmonids may have substantially higher sensitivities to dissolved copper (the primary active ingredient of ACZA) than previously suspected. That sensitivity includes an impaired sense of smell, with potential sublethal effects including reduced foraging efficiency and reduced predator avoidance ability.

Activities that allow significant increases in suspended sediment have a high risk of causing incidental take of potentially covered fish species exposed to this condition. Fine sediment deposition also poses an incidental take risk to invertebrates. The risk of take increases in proportion to:

- The magnitude and duration of the impact
- The vulnerability of the affected life-history stage
- The inability of the organism to avoid the impact through avoidance behavior
- The physiological, developmental, and behavioral impairments suffered by the fish
- Indirect mechanisms such as exposure to predation .

9.2 Activity-Specific Risk of Take: 2006 White Papers (Bank Protection and Stabilization Structures, Overwater Structures and Non-Structural Piling, and Water Crossing Structures)

9.2.1 Bank Protection and Stabilization Structures

Table 9-2 summarizes whether potentially covered species may be exposed to incidental take resulting from the impact mechanisms associated with bank protection and stabilization structures. Risk of take is rated as Y (yes; potential for take), N (no potential for take), or U (unknown potential for take). These ratings are based on general consideration of the species distribution (only in terms of fresh water versus marine), habitat use (e.g., movements into immediate shoreline areas during some life stage), habitat requirements (e.g., substrate preferences), prey resources (specifically related to habitat elements promoting their production), and water quality. The magnitude of the risk is highly dependent on how the impact is expressed. For species for which there is no potential for take, no additional conservation measures would be required apart from those currently employed. For species for which the potential for take is unknown, a lack of information on species life history or other data gaps preclude reaching a conclusion.

Table 9-2
Summary of Potential for Incidental Take of Potentially Covered Species

Common Name	Scientific Name	Impact Mechanisms of Bank Protection Projects							Comments
		Construction Activities	Channel Processes	Substrate Modifications	Habitat Accessibility	Aquatic Vegetation	Riparian Vegetation	Water Quality	
Green sturgeon	*Acipenser medirostris*	Y	Y	Y	N	N	N	Y	Most vulnerable to projects that limit availability of deep pools and lead to scour of substrate holding incubating eggs
White sturgeon	*Acipenser transmontanus*	Y	Y	Y	N	N	Y	Y	Most vulnerable to projects that limit availability of deep pools
Newcomb's littorine snail	*Algamorda subrotundata*	Y	N	Y	Y	N	Y	Y	Particularly vulnerable to projects that reduce *Salicornia virginica* habitat in Grays Harbor and Willapa Bay
Pacific sand lance	*Ammodytes hexapterus*	Y	N	Y	Y	N	Y	Y	Particularly vulnerable to marine projects that encroach intertidal zone or lead to reduction in availability of sand in upper intertidal
California floater mussel	*Anodonta californiensis*	Y	Y	Y	Y	U	U	Y	Particularly vulnerable to burial, substrate modifications, and water quality impairment
Mountain sucker	*Catostomus platyrhynchus*	Y	Y	U	Y	U	Y	Y	Most vulnerable to projects that reduce the availability/accessibility of side channel or backwater habitats
Pacific herring	*Clupea harengus pallasi*	Y	N	Y	Y	Y	Y	Y	Particularly vulnerable to projects that reduce availability of marine aquatic vegetation, especially eelgrass
Margined sculpin	*Cottus marginatus*	Y	Y	Y	Y	Y	Y	Y	Particularly vulnerable to projects that impair water quality or reduce availability of sand and gravel substrate
Lake chub	*Couesius plumbeus*	Y	Y	U	Y	Y	Y	Y	Particularly vulnerable to projects that impair water quality, reduce availability of gravel substrate, or reduce availability of terrestrial insects
Giant Columbia River limpet	*Fisherola nuttalli*	Y	Y	Y	N	U	U	Y	Particularly vulnerable to burial, substrate modifications, water quality impairment, and high flows

Common Name	Scientific Name	Impact Mechanisms of Bank Protection Projects							Comments
		Construction Activities	Channel Processes	Substrate Modifications	Habitat Accessibility	Aquatic Vegetation	Riparian Vegetation	Water Quality	
Great Columbia River spire snail	*Fluminicola columbiana*	Y	Y	Y	N	U	U	Y	Particularly vulnerable to burial, substrate modifications, and water quality impairment
Pacific cod	*Gadus macrocephalus*	Y	N	Y	N	Y	N	Y	Most vulnerable to projects affecting lower intertidal zone and availability of sand habitats for juveniles
Western ridged mussel	*Gonidea angulata*	Y	Y	Y	Y	Y	Y	Y	Particularly vulnerable to burial, substrate modifications, and water quality impairment; also vulnerable if larva distribution on fishes is limited by habitat accessibility conditions
Northern abalone	*Haliotis kamtschatkana*	Y	N	N	N	Y	N	Y	Particularly vulnerable to burial, substrate modifications, and projects that reduce the availability of marine aquatic vegetation, especially kelp beds
Surf smelt	*Hypomesus pretiosus*	Y	N	Y	Y	N	Y	Y	Particularly vulnerable to marine projects that encroach intertidal zone or lead to reduction in availability of sand and gravel in upper intertidal
River lamprey	*Lampetra ayresi*	Y	Y	Y	Y	N	N	Y	Particularly vulnerable to projects that impair water quality or reduce the availability/accessibility of backwater habitats and other areas with mud/silt accumulations
Western brook lamprey	*Lampetra richardsoni*	Y	Y	Y	Y	N	N	Y	Particularly vulnerable to projects that impair water quality or reduce the availability/accessibility of backwater habitats and other areas with mud/silt accumulations
Pacific lamprey	*Lampetra tridentata*	Y	Y	Y	Y	N	N	Y	Particularly vulnerable to projects that impair water quality or reduce the availability/accessibility of backwater habitats and other areas with mud/silt accumulations; species is often concentrated in extremely high numbers, therefore short-term lethal conditions (e.g., chemical spills or extremely high suspended solids) can affect large portion of population
Pacific hake	*Merluccius productus*	Y	N	Y	N	Y	N	Y	Most vulnerable to projects affecting lower intertidal zone and availability of sand habitats for juveniles
Olympic mudminnow	*Novumbra hubbsi*	Y	Y	Y	Y	Y	Y	Y	Particularly vulnerable to projects that impair water quality or reduce the availability/accessibility of quiet water habitats, such as bogs or swamps, with mud and dense aquatic vegetation

Common Name	Scientific Name	Impact Mechanisms of Bank Protection Projects							Comments
		Construction Activities	Channel Processes	Substrate Modifications	Habitat Accessibility	Aquatic Vegetation	Riparian Vegetation	Water Quality	
Coastal cutthroat trout	*Oncorhynchus clarki clarki*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Pink salmon	*Oncorhynchus gorbuscha*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Chum salmon	*Oncorhynchus keta*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Coho salmon	*Oncorhynchus kisutch*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Redband trout	*Oncorhynchus mykiss gairdneri*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Steelhead	*Oncorhynchus mykiss*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Sockeye salmon	*Oncorhynchus nerka*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Chinook salmon	*Oncorhynchus tschawytscha*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Lingcod	*Ophiodon elongatus*	Y	N	Y	N	Y	N	Y	Most vulnerable to projects affecting lower intertidal zone and availability of sand habitats for juveniles
Olympia oyster	*Ostrea lurida*	Y	N	Y	Y	N	Y	Y	Particularly vulnerable to burial, substrate modifications, and water quality impairment
Pygmy whitefish	*Prosopium coulteri*	Y	Y	U	Y	U	U	Y	Most vulnerable to projects that impair water quality or reduce the availability/accessibility of shallow water and tributary streams
Leopard dace	*Rhinichthys falcatus*	Y	Y	U	Y	Y	Y	Y	Most vulnerable to projects that reduce the availability/accessibility of slow-moving shallow water, decrease habitat structure used for refuge, or reduce prey availability
Umatilla dace	*Rhinichthys umatilla*	Y	Y	U	Y	U	U	Y	Most vulnerable to projects that impair water quality; lack of information on food habits precludes evaluation of impacts to prey availability

Common Name	Scientific Name	Impact Mechanisms of Bank Protection Projects: Construction Activities	Channel Processes	Substrate Modifications	Habitat Accessibility	Aquatic Vegetation	Riparian Vegetation	Water Quality	Comments
Bull trout	*Salvelinus confluentus*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Dolly Varden	*Salvelinus malma*	Y	Y	Y	Y	Y	Y	Y	Potential vulnerability via all impact mechanisms
Brown rockfish	*Sebastes auriculatus*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Copper rockfish	*Sebastes caurinus*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Greenstriped rockfish	*Sebastes elongates*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Widow rockfish	*Sebastes entomelas*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Yellowtail rockfish	*Sebastes flavidus*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Quillback rockfish	*Sebastes maliger*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Black rockfish	*Sebastes melanops*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
China rockfish	*Sebastes nebulosus*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Tiger rockfish	*Sebastes nigrocinctus*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Bocaccio rockfish	*Sebastes paucispinis*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Canary rockfish	*Sebastes pinniger*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects, but often associated with kelp beds
Redstripe rockfish	*Sebastes proriger*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects
Yelloweye rockfish	*Sebastes ruberrimus*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects

Common Name	Scientific Name	Impact Mechanisms of Bank Protection Projects: Construction Activities	Channel Processes	Substrate Modifications	Habitat Accessibility	Aquatic Vegetation	Riparian Vegetation	Water Quality	Comments
Longfin smelt	*Spirinchus thaleichthys*	Y	Y	U	Y	N	N	Y	Most vulnerable to projects that impair water quality and access to streams
Eulachon	*Thaleichthys pacificus*	Y	Y	Y	Y	N	Y	Y	Most vulnerable to projects that impair water quality and availability of sandy habitats in marine, estuarine, and lower rivers
Walleye pollock	*Theragra chalcogramma*	Y	N	Y	N	Y	N	Y	Marine species not closely associated with immediate vicinity of bank protection projects

When evaluating risk of take for habitat-modifying projects, the federal agencies generally do not attempt to quantify the number of fish injured or killed because the relationship between habitat conditions and the distribution and abundance of those individuals in the action area cannot accurately be determined. Instead, the federal agencies tend to quantify the extent of anticipated take by measure of the amount of impacted habitat (e.g., length of streambank modified or area below the OHWL modified). In this way, every project had some level of take that was quantified only in terms of the physical size of the project. No explicit take thresholds (such as shoreline length) were identified during a review of bank protection-related biological opinions prepared by NOAA Fisheries and USFWS in recent years. However, it can be interpreted that by characterizing a project's incidental take based on project size, the federal agencies deem bank protection projects of any size as having some level of take. This approach provides the federal agencies with assurances that consultation with them will be re-initiated if a project is anticipated to expand in size and that such expansion cannot occur without additional consultation.

For the purposes of evaluating the risk of take, the potential impacts were divided into two categories: those associated with the installation of the bank protection structures and those associated with the existence of the structure once it is in place. Potential impacts associated with the construction of the bank protection structure are generally short term, e.g., elevated suspended solids and noise, although longer-term impacts can occur, e.g., lack of shade due to riparian vegetation removal. Many of the potential construction-related impacts can be avoided or minimized using BMPs or other conservation measures. The potential risk of take associated with construction activities will therefore be highly dependent upon the measures taken to avoid or minimize impacts. Little information is available on potential thresholds based on the available literature presented in Section 7, which almost exclusively focused on impacts to salmonids.

The presence of bank protection structures can generate lasting impacts that may have greater implications for species take, distribution, and population viability than any short-term construction-related impacts. These long-term impacts can vary greatly over time and are therefore less predictable and quantifiable. Bank protection projects for which the primary purpose and function is to prevent the habitat-forming and sustaining processes of water bodies, e.g., those projects focused on flood control and the protection of uplands, will generally have the most significant long-term impacts on the habitat and therefore the highest risk of take. However, project-specific details such as size, location (both in terms of species distributions and position/function within a reach), and technique all contribute significantly to the risk of take associated with a bank protection structure.

Many of the potential impacts associated with bank protection may be more evident in an evaluation of cumulative impacts than in a project-specific evaluation. For example, in rivers, bank protection structures generally limit or eliminate channel-forming and channel-sustaining processes along a finite portion of a water body and therefore incrementally diminish the water body's ability to naturally function. Neither a technique for evaluating the cumulative effects nor the outcome of such an evaluation was identified. The literature review did not identify information sources that would support a recommended threshold for the amount of shoreline with bank protection structures beyond which the degree of water body impairment becomes significant. The reasons for the lack of a threshold may include a lack of data as well as the existence of water body-specific conditions that would limit the applicability of a threshold to other systems. If such a technique were to be developed, then among the most significant water body-specific conditions that should be considered are spatial distribution of bank protection structures, spatial distribution of gravel sources, spatial distribution and width of floodplain, gradient, and flow.

In terms of the risk of take associated with different types of bank protection techniques, bank protection projects that incorporate natural features and/or allow for partial function of channel-forming and channel-maintaining processes would have a lower risk of take than techniques that stop the functions. Soft armoring techniques have a lower risk of take than hard armoring techniques. In situations where some hard armoring techniques are necessary to adequately protect a bank, then integrated techniques that incorporate hard and soft elements would produce an intermediate risk of take.

Activities that occur subsequently on land protected by bank protection structures can also contribute to the long-term risk of take. Bank protection structures can provide landowners with a false sense of safety, particularly regarding large floods and bluff erosion. As a result, upland structures are built closer to the shoreline or bluff than would occur otherwise and may be imperiled in the long term or may allow the landowner to aggressively maintain structures that significantly impact habitat for potentially covered species.

Bank protection projects can have beneficial impacts, and many bank protection projects are indeed designed as habitat restoration projects. For example, a bank protection project that addresses mass wasting and fine sediment contributions can be beneficial to habitats and species if properly designed. A distinguishing feature of beneficial bank protection projects is a project design that works with natural processes and that incorporates large wood to add habitat complexity to a reach. In river, stream, and estuarine environments, bank protection projects that allow continuation of full or partial function of the natural processes associated with floodplain connectivity, side channel formation, and sediment (gravel) source additions can provide beneficial outcomes. In marine and lake environments, bank protection structures that allow continuation of full or partial function of the natural littoral drift processes, including the sediment source entrainment and sediment transport, can provide beneficial outcomes. The placement of large wood in the channel (either random or designed) can add habitat complexity by creating habitats in areas where the natural processes, including LWD recruitment, have been altered. In fact, properly designed bank protection projects can re-establish natural processes, e.g., wood recruitment in pool-forming structures or littoral drift along marine shorelines. Along this same line of discussion, it should be noted that where bank protection projects are often needed is in highly modified (e.g., flow altered, channelized, armored, denuded) rivers and streams where, because of substantial capital improvements and infrastructure, it is unrealistic to expect that truly "natural river erosion/deposition processes" will be restored. In these rivers and streams, properly designed bank protection projects may provide some of the better fish habitat opportunities in the reach.

A long-term perspective is necessary when considering the potential impacts of a bank protection project. Potential short-term benefits of a bank protection project may not outweigh its long-term impacts. The location of the stream channel and bank protection project with respect to the floodplain is an important determining factor of potential impacts. If the bank protection is located on the stream channel at the outer limits of the 100- or 500-year floodplain, the potential impacts are much different (generally much less) than if the same project were implemented on property located in the middle of a 1-mile-wide floodplain

9.2.1.1 Evaluation of Relative Risk of Take Associated with Bank Protection Structures

All bank protection activities have potential for some take, unless no potentially covered species occur in the project area, including the areas upstream and downstream (or updrift and downdrift) that may be impacted by the structure. Table 9-3 provides some general guidelines regarding the project elements that contribute to a bank protection project of "low," "moderate," or "high" risk of take. These general categorizations are based on the best professional judgment of the analysis team and require interpretation beyond the empirical data available in the literature. The categorizations are intended to be widely applicable to potentially covered species; however, it is possible that the categorizations will not be valid for all species, particularly those with lesser known habitat and ecological requirements. Since much of the literature is based on impacts to salmonids, the categorizations are perhaps most applicable to salmonids.

For a bank protection project to be of "low" risk, it must meet all applicable requirements in the low-risk category, i.e., no "moderate" or "high" risk aspects to the project. In addition, the "low"-risk conditions in the row labeled "Construction-Related Activities" must also be satisfied for a project to be of "low" risk. In general terms, activities in the low-risk category appear to be well suited for programmatic approval, whereas activities in the high-risk category would likely require consideration of project-specific elements (e.g., environmental setting, size, and installation technique) and present a clear need to implement conservation measures to reduce the risk of take. The appropriateness of programmatic approval of activities in the moderate-risk category is debatable and would depend in part on the use of conservation measures. The risk evaluation summarized in Table 9-3 assumes that potentially covered species are present when the described impact occurs; thus, impacts may be avoided by performing the activities when or where potentially covered species are absent.

Table 9-3
Evaluation of Relative Risk of Take Associated with Bank Protection Structures

Activity or Structure	Risk of Take			Rationale and Assumptions
	Low	Moderate	High	
Construction-Related Activities	• In areas inhabited by only migratory potentially covered species (e.g., anadromous species) and/or species that move between habitats with some predictability (e.g., spawning runs from lakes to streams), activities that occur within allowable work windows based on tributary-specific species presence and periodicity data that avoid working during periods of species presence • Activities that do not entail removing native riparian vegetation, LWD, or small woody debris (SWD) • Pile-driving activities with peak underwater sound <150 dB • Activities that avoid need for dewatering	• In areas inhabited by only migratory potentially covered species (e.g., anadromous species) and/or species that move between habitats with some predictability (e.g., spawning runs from lakes to streams), activities that occur within allowable work windows based on general species presence information (e.g., statewide species distribution maps) and periodicity data that attempt to avoid working during periods of species presence • Project areas where non-migratory potentially covered fish species presence is presumed, but not documented • Activities that minimize the removal of native riparian vegetation and that replant (including maintenance) the cleared area's native vegetation upon construction completion • Pile-driving activities with peak underwater sound between 150 and 180 dB	• Project areas where potentially covered invertebrate species presence is documented • Project areas where any potentially covered fish species presence is documented and the construction timing coincides with their presence • Activities that do not minimize the removal of native riparian vegetation and/or that do not replant (including maintenance) the cleared area's native vegetation upon construction completion • Pile-driving activities requiring hammer pile driving with peak underwater sound >180 dB • Activities that include dewatering a portion of channel and either do not remove species from area or do not implement BMPs to reduce introduction of suspended	For areas inhabited by potentially covered species during in-water construction, bank protection activities represent a high risk of take due to the various disturbances to aquatic habitats that typically occur during in-water work. Risk of take is low when the project completely avoids timing in-water construction during species presence or known sensitivity periods. Moderate risk is indicated when in-water work is completed mostly within these periods, but still maintains some in-water work outside the periods. For bank protection activities that permanently remove native riparian vegetation, risk of take is high because bank vegetation is closely linked to habitat quality and direct survival (most importantly, via water temperature control) for many potentially covered species. For pile-driving activities, risk of take for potentially covered fish is set as high for bank protection projects that produce underwater sound above the injury and disturbance threshold for threatened and endangered salmonids, >180dB. Risk of take is moderate for projects producing peak underwater sound between the 180 dB injury threshold and the 150 dB threshold for behavioral disturbance.

Activity or Structure	Risk of Take			Rationale and Assumptions
	Low	Moderate	High	
		• Activities that minimize the dewatered area and length of time, remove species from area, and implement BMPs to minimize the addition of suspended solids	solids	Activities producing peak underwater sound below 150 dB would be expected to exhibit a low risk of take for potentially covered fish. Because invertebrate sound studies are sparse, it is expected that these risk levels, which are set based on effects to fish, will adequately apply to invertebrate responses to construction-related sound. Activities that require dewatering may minimize the dewatered area and length of time of dewatering, remove species from the area, and implement BMPs to minimize the addition of suspended solids; however, under the take definition, these activities would still constitute take. Therefore, risk of take is high and severe for dewatering activities that do not minimize the dewatered area and length of time dewatered, and for those that do not remove species from the area, and that do not minimize suspended solids. Risk of take is moderate and less severe if these minimization measures are implemented. Risk of take is low when dewatering can be avoided.

Activity or Structure	Risk of Take			Rationale and Assumptions
	Low	Moderate	High	
Vertical Retaining Walls, Rock Revetments, and Rock Toes	• Reaches in all environments that are not sediment sources (i.e., not feeder bluffs) and in which the structure does not extend into intertidal zone or below OHWL	• Marine and estuarine reaches that do not contain sediment sources (i.e., not feeder bluffs) and in which the structure does not extend into intertidal zone, but forage fish spawning is known to occur • All environments in which rock toes support soft armoring approaches along remainder of bank	• Reaches in all environments that contain sediment sources (i.e., feeder bluffs) • Marine and estuarine reaches that do not contain sediment sources (i.e., not feeder bluffs) but in which the structure extends into intertidal zone • All environments along known spawning areas for potentially covered fish species • All environments along known areas that contain sessile potentially covered invertebrate species • All environments in which rock toes support upper bank rock or wall revetments	For vertical retaining walls, risk of take is high in marine environments where forage fish spawning could occur and salmonid migration occurs. Take risk is also high in other environments due to indirect effects because these structures isolate sediment supply, cause scour, reflect wave energy, and contribute to a loss of fine sediment, causing ensuing effects to biota and vegetation. For rock revetments, similar to vertical retaining walls, risk of take is high in marine environments potentially supporting forage fish spawning and salmonid migration due to indirect effects in reducing gravel recruitment and sediment transport and affecting shoreline currents. In addition, rock revetments can disrupt flows, reduce food delivery, and create difficult swimming for smaller fish. For rock toes, risk of take is moderate when toes support upper bank biostabilization structures, which function to improve overall habitat, but risk of take is high where rock toes are placed to support rock or wall revetments.

Activity or Structure	Risk of Take			Rationale and Assumptions
	Low	Moderate	High	
Levees		• Levee "setbacks" that increase the width of the channel, provide high flow refuge habitat, and incorporate LWD	• Levees other than those described as moderate risk	Risk of take is high for levees, except when the project is attempting habitat restoration by setting back existing levees or other bank protection structures. This is because levees limit channel hydraulics and sediment recruitment, sometimes isolating sediment supply to the substrate and transport of that sediment through the system. In addition, levees fragment ecosystem connectivity and limit habitat accessibility for many potentially covered species, depending on the habitat. For example, in an estuary, levees can isolate marsh areas and limit LWD distribution.
Log/Rootwad Toes	• All environments in which the toe is combined with other biotechnical bank approaches	• All environments in which the toe is combined with rock or concrete bank approaches		Risk of take is low for log and rootwad toes where they typically are used to support upper bank biostabilization structures. They also increase habitat complexity along the bank.

Activity or Structure	Risk of Take			Rationale and Assumptions
	Low	**Moderate**	**High**	
Beach Nourishment	• Marine and freshwater environments using pre-washed substrate in which turbidity increases are not likely to occur • Marine environments in which macroalgae or eelgrass is not covered • Freshwater environments in which aquatic vegetation is not covered • All environments in which material is placed above the OHWL or MHHW. • Marine and freshwater environments in which similarly sized materials as compared to an appropriate reference site are placed	• Marine environments in which turbidity increases are likely to occur • All environments in which material is placed below the OHWL or MHHW	• Marine environments in which macroalgae or eelgrass is covered • Freshwater environments in which aquatic vegetation is covered	Risk of take due to beach nourishment is low if material is pre-washed or of larger (pebble/gravel) size and not likely to increase turbidity on site, if existing eelgrass or macroalgae will not be disturbed. Risk of take is moderate for all environments in which beach nourishment occurs on the upper beach only, because this material may move down the beach and ultimately affect species occurring in lower elevations. Risk of take is moderate if material is fine/sand, if eelgrass, macroalgae, or aquatic vegetation will be disturbed, and/or if material is placed to a large extent below the OHWL or MHHW.
Avulsion Prevention	• All environments in which avulsion prevention elements involve natural logs, brush, rootwad structures			Risk of take due to avulsion prevention is low because these structures are typically natural logs, brush rootwads placed in the habitat, which increases habitat complexity and a host of other habitat functions.
Subsurface Drainage Systems	• All environments in which drainage system elements involve natural logs, brush, rootwad structures	• All environments in which drainage system elements involve synthetic pipes or installations		Similar to avulsion prevention techniques, risk of take due to subsurface drainage systems is low where these structures consist of natural materials that will eventually degrade and become part of the environment and long-term bank stability solution.

Activity or Structure	Risk of Take			Rationale and Assumptions
	Low	Moderate	High	
Biotechnical Bank Protection Techniques	• All environments			Risk of take due to biotechnical bank protection is low because these structures typically provide beneficial effects to aquatic species, such as increases of refugia and habitat structure along the bank or shoreline, detrital inputs, and vegetative cover.
Bank Reshaping or Regrading	• All environments in which no in-water work is used • All environments in which bank reshaping/regrading is combined with biotechnical toe	• All environments in which in-water work is used • All environments in which bank reshaping/regrading is combined with rock toe		Risk of take due to bank reshaping or regrading is moderate if in-water work is used, because of the high potential for turbidity increases during regrading/reshaping work. If work is completed in the dry, risk of take is low. If bank reshaping/regrading entails placing a rock toe, risk of take is higher than if a log or rootwad toe is used.
Soil Reinforcement	• All environments			Risk of take due to soil reinforcements is low because these elements are typically surrounded by fabric and do not entail placing exposed soil or sediment on the bank or shore.
Coir and Straw Logs	• All environments			Similar to soil reinforcement, risk of take due to coir and straw logs is low because these elements typically consist of natural, biodegradable fabric or material and do not entail placing exposed soil or sediment on the bank or shore.
Integrated Approaches	• See Vertical Retaining Walls, Rock Revetments, and Rock Toes; see Bank Reshaping or Regrading	• See Vertical Retaining Walls, Rock Revetments, and Rock Toes; see Bank Reshaping or Regrading	• See Vertical Retaining Walls, Rock Revetments, and Rock Toes; see Bank Reshaping or Regrading	See Vertical Retaining Walls, Rock Revetments, and Rock Toes; see Bank Reshaping or Regrading

9.2.2 Overwater Structures

Table 9-4 summarizes the risk that potentially covered species may suffer incidental take resulting from twelve impact mechanisms. The potential that a species may experience incidental take is characterized in Table 9-4 as Y (yes; potential for take), N (no potential for take), or U (unknown potential for take). The magnitude of the risk is highly dependent on how the impact is expressed, which in turn is highly dependent on the suite of conservation measures employed to minimize the risk of causing take. For species for which there is no potential for take, no additional precautions would be required apart from those currently employed. For species for which the potential for take is unknown, a lack of information on species life history or other data gaps preclude reaching a conclusion.

The following decision rules explain most of the content of Table 9-4:

- Marine species are not at risk of take due to impacts to channel hydraulics, or to freshwater aquatic vegetation.
- Species that spend all of their lives in freshwater are not at risk of take due to impacts to eelgrass and macroalgae.
- For most species except salmonids, the effects of noise, artificial light, shading, and vessel activities are largely unknown.

Table 9-4
Summary of Potential for Incidental Take of Potentially Covered Species

Common Name	Scientific Name	Impact Mechanisms: Shading	Eelgrass and Macroalgae Modifications	Freshwater Aquatic Vegetation Modifications	Riparian and Shoreline Vegetation Modifications	Noise	Water Quality Modifications	Channel Hydraulic Modifications	Littoral Drift Modifications	Substrate Modifications	Channel Dewatering	Artificial Light	Vessel Activities
Green sturgeon	*Acipenser medirostris*	U	U	Y	Y	U	Y	Y	Y	Y	Y	U	U
White sturgeon	*Acipenser transmontanus*	U	U	Y	Y	U	Y	Y	Y	Y	Y	U	U
Newcomb's littorine snail	*Algamorda subrotundata*	U	Y	N	Y	U	Y	N	Y	Y	N	U	U
Pacific sand lance	*Ammodytes hexapterus*	Y	Y	N	Y	U	Y	N	Y	Y	N	U	U
California floater mussel	*Anodonta californiensis*	U	N	Y	Y	U	Y	Y	Y	Y	Y	U	U
Mountain sucker	*Catostomus platyrhynchus*	U	N	U	Y	U	Y	Y	N	U	Y	U	U
Pacific herring	*Clupea*	U	Y	N	Y	U	Y	N	Y	Y	N	U	U

Common Name	Scientific Name	Impact Mechanisms											
		Shading	Eelgrass and Macroalgae Modifications	Freshwater Aquatic Vegetation Modifications	Riparian and Shoreline Vegetation Modifications	Noise	Water Quality Modifications	Channel Hydraulic Modifications	Littoral Drift Modifications	Substrate Modifications	Channel Dewatering	Artificial Light	Vessel Activities
	harengus pallasi												
Margined sculpin	*Cottus marginatus*	Y	N	Y	Y	U	U	Y	N	U	Y	U	U
Lake chub	*Couesius plumbeus*	U	N	Y	U	U	U	U	N	U	U	U	U
Giant Columbia River limpet	*Fisherola nuttalli*	U	N	U	U	U	Y	Y	N	Y	Y	U	U
Great Columbia River spire snail	*Fluminicola columbiana*	U	N	U	U	U	Y	Y	N	Y	Y	U	U
Pacific cod	*Gadus macrocephalus*	N	Y	N	N	U	Y	N	Y	Y	N	U	U
Western ridged mussel	*Gonidea angulata*	U	N	Y	Y	U	Y	Y	Y	Y	Y	U	U
Northern abalone	*Haliotis kamtschatkana*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Surf smelt	*Hypomesus pretiosus*	U	Y	N	Y	U	Y	N	Y	Y	N	U	U
River lamprey	*Lampetra ayresi*	U	N	N	Y	U	Y	Y	Y	Y	Y	U	U
Western brook lamprey	*Lampetra richardsoni*	U	N	N	Y	U	Y	Y	N	Y	Y	U	U
Pacific lamprey	*Lampetra tridentata*	U	N	N	Y	U	Y	Y	Y	Y	Y	U	U
Pacific hake	*Merluccius productus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Olympic mudminnow	*Novumbra hubbsi*	U	N	Y	Y	U	Y	Y	N	Y	Y	U	U
Coastal cutthroat trout	*Oncorhynchus clarki clarki*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U	U
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	Y	N	Y	Y	Y	Y	Y	N	Y	Y	U	U
Pink salmon	*Oncorhynchus gorbuscha*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U
Chum salmon	*Oncorhynchus keta*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U
Coho salmon	*Oncorhynchus kisutch*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U

Common Name	Scientific Name	Impact Mechanisms											
		Shading	**Eelgrass and Macroalgae Modifications**	**Freshwater Aquatic Vegetation Modifications**	**Riparian and Shoreline Vegetation Modifications**	**Noise**	**Water Quality Modifications**	**Channel Hydraulic Modifications**	**Littoral Drift Modifications**	**Substrate Modifications**	**Channel Dewatering**	**Artificial Light**	**Vessel Activities**
Redband trout	*Oncorhynchus mykiss*	Y	N	Y	Y	Y	Y	Y	N	Y	Y	U	U
Steelhead	*Oncorhynchus mykiss*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U
Sockeye salmon	*Oncorhynchus nerka*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U
Chinook salmon	*Oncorhynchus tschawytscha*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U
Lingcod	*Ophiodon elongatus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Olympia oyster	*Ostrea lurida*	Y	Y	N	Y	U	Y	N	Y	Y	N	U	U
Pygmy whitefish	*Prosopium coulteri*	U	N	U	U	Y	U	Y	N	U	Y	U	U
Leopard dace	*Rhinichthys falcatus*	U	N	U	U	U	U	Y	N	U	Y	U	U
Umatilla dace	*Rhinichthys Umatilla*	U	N	U	U	U	U	Y	N	U	Y	U	U
Bull trout	*Salvelinus confluentus*	U	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U
Dolly Varden	*Salvelinus malma*	U	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U
Brown rockfish	*Sebastes auriculatus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Copper rockfish	*Sebastes caurinus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Greenstriped rockfish	*Sebastes elongates*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Widow rockfish	*Sebastes entomelas*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Yellowtail rockfish	*Sebastes flavidus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Quillback rockfish	*Sebastes maliger*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Black rockfish	*Sebastes melanops*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
China rockfish	*Sebastes nebulosus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Tiger rockfish	*Sebastes nigrocinctus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U

Common Name	Scientific Name	Impact Mechanisms											
		Shading	**Eelgrass and Macroalgae Modifications**	**Freshwater Aquatic Vegetation Modifications**	**Riparian and Shoreline Vegetation Modifications**	**Noise**	**Water Quality Modifications**	**Channel Hydraulic Modifications**	**Littoral Drift Modifications**	**Substrate Modifications**	**Channel Dewatering**	**Artificial Light**	**Vessel Activities**
Bocaccio rockfish	*Sebastes paucispinis*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Canary rockfish	*Sebastes pinniger*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Redstripe rockfish	*Sebastes proriger*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Yelloweye rockfish	*Sebastes ruberrimus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Longfin smelt	*Spirinchus thaleichthys*	U	Y	N	Y	Y	Y	Y	Y	U	Y	U	U
Eulachon	*Thaleichthys pacificus*	U	Y	N	Y	Y	Y	N	Y	Y	N	U	U
Walleye pollock	*Theragra chalcogramma*	U	Y	N	N	U	Y	N	Y	Y	N	U	U

Note: Species listed in alphabetical order by scientific name.

9.2.2.1 Hydraulic and Geomorphic Modifications

Non-structural piling and piling associated with other overwater structures (i.e., piers) could potentially cause scour in marine or estuarine areas with strong tidal currents, or riverine environments with strong currents.

As with scour, deposition impacts are most likely when an overwater structure and associated support structures and non-structural piling are installed and have not received proper hydraulic design. While significant amounts of deposition (i.e., amounts potentially causing measurable incidental take) are not likely to occur from the installation of an overwater structure or non-structural piling, some localized deposition may occur as a result of changes in hydraulics in the immediate vicinity of the structure. Potential impacts from deposition associated with installation of an overwater structure or non-structural piling would be localized and relatively minor with a low potential risk for take of the covered species.

9.2.2.1 Aquatic Vegetation Modifications: Eelgrass and Macroalgae

Overwater structures and non-structural piling can sometimes be sited to avoid eelgrass and macroalgae, but some structures must be sited within a narrowly defined area, and in some areas eelgrass and/or macroalgae are very common, thus some over water structures and/or non-structural piling are likely to directly impact eelgrass and/or macroalgae.

9.2.2.2 Risk Evaluation

Table 9-5 presents a summary of the incidental take risk analysis. This risk evaluation is at best a qualitative assessment and is based strongly on professional experience of the analysis team in the context of their work in ESA implementation. It assumes that potentially covered species are present when the described impact occurs; thus, impacts may be avoided by performing the activities when or where covered species are absent.

Table 9-5: Conclusions of the Risk Evaluation

Activity	Low Risk	Moderate Risk	High Risk
Freshwater structures per WAC 220-110-060	• Structures located in areas lacking submerged aquatic vegetation; • Structures causing little increased shading, either due to size or incorporation of grating or other light penetrating features • Pile-driving activities with peak sound <150 dB; • Structures in areas with little sediment transport; • Structures not increasing the volume of untreated stormwater; • Placing small areas of non-conforming substrate; • Activities avoiding the impacts potentially causing "moderate" or "high" risk.	• Structures removing riparian vegetation; • Structures that require removing LWD in lentic waters; • Pile-driving activities with peak sound between 150 and 180 dB; • Structures increasing the volume of untreated stormwater due to increased impervious surface; • Structures comprised of CCA- or ACZA-treated wood; • Structures that measurably alter channel hydraulics or littoral drift; • Structures causing nighttime illumination of the water surface.	• Structures in areas of submerged aquatic vegetation that are used by dependent species (e.g., Olympic mudminnow); • Structures that require removing LWD in lotic waters; • Pile-driving activities requiring hammer pile driving with peak sound >180 dB; • Structures that substantially alter channel hydraulics; • Placing large areas of non-conforming substrate; • Activities that require dewatering of the work area; • Activities requiring substantial in-water operation of mechanized equipment. • Structures in riverine environments that use creosote treated wood;
Saltwater structures per WAC 220-110-300	• Structures located in areas lacking submerged aquatic vegetation; • Structures causing low shade; • Pile-driving activities with peak sound <150 dB; • Structures in areas with little sediment transport; • Placing small areas of non-conforming substrate; • Activities avoiding the impacts potentially causing "moderate" or "high" risk.	• Structures removing riparian vegetation; • Pile-driving activities with peak sound between 150 and 180 dB; • Structures discharging stormwater; • Structures requiring CCA- or ACZA-treated wood; • Structures measurably altering littoral drift; • Structures causing nighttime illumination of the water surface.	• Structures located in areas of eelgrass or macroalgae; • Structures shading large areas; • Structures requiring hammer pile driving with peak sound >180 dB; • Structures that require creosote-treated wood; • Placing large areas of non-conforming substrate; • Activities that require dewatering of the work area; • Activities requiring substantial in-water operation of mechanized equipment.
Non-	• Pile-driving activities with	• Pile-driving activities with	• Piling located in areas of

structural or structural piling	peak sound <150 dB; • Structures that avoid the impacts potentially causing "moderate" or "high" risk.	peak sound between 150 and 180 dB • Structures requiring CCA- or ACZA-treated wood.	eelgrass or macroalgae; • Structures requiring hammer pile driving with peak sound >180 dB. • Structures requiring creosote-treated wood.

9.2.3 Water Crossing Structures

In Table 9-6, the potential that a species may experience incidental take is characterized as Y (yes; potential for take), N (no potential for take), or U (unknown potential for take). The magnitude of the risk is highly dependent on how the impact is expressed, which in turn is highly dependent on the suite of conservation measures employed to minimize the risk of causing take. For species for which there is no potential for take, no additional conservation measures would be required apart from those currently employed. For species for which the potential for take is unknown, a lack of information on species life history or other data gaps preclude reaching a conclusion. The "unknown" category may be the most problematic from the standpoint of ESA compliance, because we lack information needed for the federal agencies to determine whether incidental take would be likely to jeopardize continued existence of affected populations.

The following decision rules explain most of the content of Table 9-6:

- Marine species are not at risk of take due to impacts to channel hydraulics, substrate modification, or freshwater aquatic vegetation.
- Freshwater species are not at risk of take due to impacts to eelgrass and macroalgae.
- For most species except salmonids, the effects of noise, artificial light, shading, and vessel activities are largely unknown.

Table 9-6. Summary of Potential for Incidental Take of Potentially Covered Species

Common Name	Scientific Name	Impact Mechanisms											
		Shading	Eelgrass and Macroalgae	Freshwater Aquatic Vegetation	Riparian and Shoreline Vegetation	Noise	Water Quality	Channel Hydraulic Effects	Littoral Drift	Substrate Modifications	Channel Dewatering	Artificial Light	Vessel Activities
Green sturgeon	*Acipenser medirostris*	U	U	U	Y	U	Y	Y	Y	Y	Y	U	U
White sturgeon	*Acipenser transmontanus*	U	U	U	Y	U	Y	Y	Y	Y	Y	U	U
Newcomb's littorine snail	*Algamorda subrotundata*	U	Y	N	Y	U	Y	N	Y	Y	N	U	U
Pacific sand lance	*Ammodytes hexapterus*	Y	Y	N	Y	U	Y	N	Y	Y	N	U	U
California floater mussel	*Anodonta californiensis*	U	N	Y	Y	U	Y	Y	Y	Y	Y	U	U
Mountain sucker	*Catostomus platyrhynchus*	U	N	U	Y	U	Y	Y	N	U	Y	U	U
Pacific herring	*Clupea harengus pallasi*	U	Y	N	Y	U	Y	N	Y	Y	N	U	U
Margined sculpin	*Cottus marginatus*	Y	N	U	Y	U	U	Y	N	U	Y	U	U
Lake chub	*Couesius plumbeus*	U	N	U	U	U	U	U	N	U	U	U	U
Giant Columbia River limpet	*Fisherola nuttalli*	U	N	U	U	U	Y	Y	N	Y	Y	U	U
Great Columbia River spire snail	*Fluminicola columbiana*	U	N	U	U	U	Y	Y	N	Y	Y	U	U
Pacific cod	*Gadus macrocephalus*	N	Y	N	N	U	Y	N	Y	Y	N	U	U
Western ridged mussel	*Gonidea angulata*	U	N	Y	Y	U	Y	Y	Y	Y	Y	U	U
Northern abalone	*Haliotis kamtschatkana*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Surf smelt	*Hypomesus pretiosus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
River lamprey	*Lampetra ayresi*	U	N	N	Y	U	Y	Y	Y	Y	Y	U	U
Western brook lamprey	*Lampetra richardsoni*	U	N	N	Y	U	Y	Y	N	Y	Y	U	U
Pacific lamprey	*Lampetra tridentata*	U	N	N	Y	U	Y	Y	Y	Y	Y	U	U
Pacific hake	*Merluccius productus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Olympic mudminnow	*Novumbra hubbsi*	U	N	Y	Y	U	Y	Y	N	Y	Y	U	U
Coastal cutthroat trout	*Oncorhynchus clarki clarki*	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	U	U

		Impact Mechanisms											
Common Name	**Scientific Name**	**Shading**	**Eelgrass and Macroalgae**	**Freshwater Aquatic Vegetation**	**Riparian and Shoreline Vegetation**	**Noise**	**Water Quality**	**Channel Hydraulic Effects**	**Littoral Drift**	**Substrate Modifications**	**Channel Dewatering**	**Artificial Light**	**Vessel Activities**
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	Y	N	U	Y	Y	Y	Y	N	Y	Y	U	U
Pink salmon	*Oncorhynchus gorbuscha*	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	U
Chum salmon	*Oncorhynchus keta*	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	U
Coho salmon	*Oncorhynchus kisutch*	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	U
Redband trout	*Oncorhynchus mykiss*	Y	N	U	Y	Y	Y	Y	N	Y	Y	U	U
Steelhead	*Oncorhynchus mykiss*	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	U
Sockeye salmon	*Oncorhynchus nerka*	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	U
Chinook salmon	*Oncorhynchus tschawytscha*	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	U
Lingcod	*Ophiodon elongatus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Olympia oyster	*Ostrea lurida*	Y	Y	N	Y	U	Y	N	Y	Y	N	U	U
Pygmy whitefish	*Prosopium coulteri*	U	N	U	U	Y	U	Y	N	U	Y	U	U
Leopard dace	*Rhinichthys falcatus*	U	N	U	U	U	U	Y	N	U	Y	U	U
Umatilla dace	*Rhinichthys Umatilla*	U	N	U	U	U	U	Y	N	U	Y	U	U
Bull trout	*Salvelinus confluentus*	U	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	U
Dolly Varden	*Salvelinus malma*	U	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	U
Brown rockfish	*Sebastes auriculatus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Copper rockfish	*Sebastes caurinus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Greenstriped rockfish	*Sebastes elongates*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Widow rockfish	*Sebastes entomelas*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Yellowtail rockfish	*Sebastes flavidus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Quillback rockfish	*Sebastes maliger*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Black rockfish	*Sebastes melanops*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
China rockfish	*Sebastes nebulosus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U

		Impact Mechanisms											
Common Name	**Scientific Name**	**Shading**	**Eelgrass and Macroalgae**	**Freshwater Aquatic Vegetation**	**Riparian and Shoreline Vegetation**	**Noise**	**Water Quality**	**Channel Hydraulic Effects**	**Littoral Drift**	**Substrate Modifications**	**Channel Dewatering**	**Artificial Light**	**Vessel Activities**
Tiger rockfish	*Sebastes nigrocinctus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Bocaccio rockfish	*Sebastes paucispinis*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Canary rockfish	*Sebastes pinniger*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Redstripe rockfish	*Sebastes proriger*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Yelloweye rockfish	*Sebastes ruberrimus*	U	Y	N	N	U	Y	N	Y	Y	N	U	U
Longfin smelt	*Spirinchus thaleichthys*	U	Y	N	Y	Y	Y	Y	Y	U	Y	U	U
Eulachon	*Thaleichthys pacificus*	U	Y	N	Y	Y	Y	N	Y	Y	N	U	U
Walleye pollock	*Theragra chalcogramma*	U	Y	N	N	U	Y	N	Y	Y	N	U	U

Note: Species listed in alphabetical order by scientific name.

9.2.3.1 Hydraulic and Geomorphic Modifications

Water crossing structures can interrupt hyporheic exchange and groundwater recharge by placing fill and/or impervious surface on previously pervious areas. This impact is particularly severe in the case of full culverts, where both the approach fill and the base of the culvert represent surfaces that impede or prevent infiltration. In bottomless culverts, approach fills impede infiltration, and in bridges, the impact is due to approach fills and areas occupied by pilings or piers. In all cases, though, the impact of impaired hyporheic and groundwater function is generally minor in comparison to the permanent habitat loss represented by the loss of stream channel and floodplain areas overlain by fills, piers, pilings, and culvert bottoms.

9.2.3.1.1 Embedding

Fine sediment inputs leading to embedding may occur in association with water crossing construction when a poorly designed structure causes locally increased deposition or locally increased erosion of fine sediments in the bed or banks that may be deposited in gravel-bedded streams farther downstream. Ditches and stormwater discharges associated with water crossing structures may also contribute fine sediment to the stream. Since water crossing structures often alter channel hydraulics but seldom cause persistent increases in fine sediment supply, the resulting impacts are normally local, occurring in the immediate vicinity of the structure or at a deposition site a short distance downstream. Significant incidental take may occur if the affected area includes spawning habitat.

9.2.3.1.2 Scour

Scour may be observed upstream or downstream of culverts, around bridge piers or pilings, or in places where hydraulic effects direct streamflow against the bank. Scour effects are normally local, occurring very near the water crossing structure, but the scoured sediments may be transported downstream to contribute to impacts such as embedding and deposition.

9.2.3.1.3 Deposition

When a conduit is installed, direct impacts on waters can often be minimized by high-pressure directional drilling (HPDD), a trenchless method of crossing a watercourse using subsurface drilling with a pressurized bore fluid lubricant system (Fisheries and Oceans Canada 2006). HPDD is used to install cables and pipelines for gas, water, telecommunications, fiber optics, power, sewer, oil, and water lines underneath watercourses. WAC 220-110-100 provides little protection against potential habitat impacts arising from boring of conduits, providing only that launch and receiving pits be isolated from the water body and that wastewater from the activity be routed to an area outside the ordinary high water line.

"Frac-outs" constitute a distinctive form of fine sediment deposition that sometimes occurs during HPDD operations. A frac-out is the escape of drilling mud into the environment as a result of a spill, tunnel collapse, or rupture of mud to the surface. Frac-outs are caused when excessive drilling pressure results in drilling fluid propagating vertically toward the surface. The principal constituent of the drilling fluid is clay, specifically bentonite, although a variety of secondary constituents may be added to the fluid.

The potential for frac-outs can be limited by careful monitoring, use of appropriate equipment, sufficient depth of conduit placement, appropriate boring pit location, and having response plans ready in the event that a frac-out occurs (NMFS 2005a, FERC 2005).

9.2.3.1.4 Substrate Modification

NMFS (2006a) assesses incidental take due to fill placement or culvert installation as proportional to the area of habitat lost.

Substrate modification due to conduit placement was largely not addressed in the reviewed literature.

9.2.3.1.5 Rapid Channel Change

A plugged culvert at a road fill can cause debris flow damming. Debris flows occur in response to natural causes as well as forest practices, and past experience has shown that some debris flows occur in every severe rainfall event that affects Washington. Such events, because of their burden of LWD and sediment, can easily exceed the calculated 100-year flow volume of the affected stream and thus have a high risk of plugging a culvert that is designed to pass a 100-year flow volume, resulting in a dam-break flood, a more severe debris flow, or a channel avulsion. Because debris flows can be expected to occur in vulnerable channels conveyed via culverts, debris flows can be regarded as a cumulative impact risk resulting from culvert installation. Debris flow or dam-break floods triggered by blockage and subsequent failure of a water crossing have the potential to result in incidental take of any potentially covered species and their habitats in the affected stream reach.

9.2.3.2 Altered Riparian and Shoreline Vegetation

Altering riparian and shoreline vegetation could result in a moderate to high risk of take.

9.2.3.1 Water quality

Turbidity may occur during construction due to accidental discharge of high pressure directional drilling (HPDD) fluids, disturbance of the streambed, or runoff from the work site into the stream, and turbidity may occur during operations if the water crossing structure channels flows to the stream. One of the highest-risk activities, with potential to cause mortality due to short-term acute turbidity exposure, is HPDD.

Fine sediment deposition also poses an incidental take risk to invertebrates.

Incidental take risk associated with dissolved oxygen impacts is probably quite low.

9.2.3.2 Conclusions of the Risk Evaluation

Table 9-7 summarizes the analysis of incidental take risk from water crossing structures. This risk evaluation is at best a qualitative assessment and is based strongly on the professional experience of the analysis team within the context of their work in ESA implementation. In general terms, activities in the low-risk category appear to be well suited for programmatic approval, whereas activities in the high-risk category would require consideration of project-specific elements (e.g., environmental setting, size, and installation technique) and present a clear need to implement conservation measures to reduce the risk of take. The appropriateness of programmatic approval of activities in the moderate-risk category is debatable and would depend in part on the use of conservation measures. The risk evaluation summarized in Table 9-7 assumes that potentially covered species or their habitat are present when the described impact occurs; thus, impacts and risk may be avoided by avoiding habitat for potentially covered species and may be minimized by performing the activities when potentially covered species are absent from the site.

Table 9-7: Conclusions of the Risk Evaluation

Activity	Low Risk	Moderate Risk	High Risk
Water crossing structures per WAC 220-110-070	• Work not requiring channel dewatering; • Work that does not alter channel form; • Structures in areas with little sediment transport; • Structures not requiring fill placement within the channel or floodplain; • Structures that do not use treated wood; • Structures that do not channel runoff to the water body; • Structures located in areas lacking submerged aquatic vegetation; • Structures that do not require removal of riparian vegetation; • Work that does not require production of in-water sound with peak levels more than 150 dB; • Structures that are built and operated without artificial illumination of the water surface; • Structures causing little increased shading of the water surface; • Activities avoiding the impacts potentially causing “moderate” or “high” risk.	• Work not requiring channel dewatering; • Projects that use hydraulic modeling to demonstrate minimal alteration of channel form and minimal modification of the floodway; • Structures requiring little or no fill placement within the channel; • Structures use treated wood; • Structures that channel runoff to the water body, when that runoff is treated in accordance with state and local stormwater treatment requirements; • Structures that have only temporary impacts to submerged aquatic vegetation; • Structures that have only temporary impacts to riparian vegetation; • Work that does not require production of in-water sound with peak levels more than 180 dB; • Structures that are designed to minimize artificial illumination of the water surface; • Structures that are designed to minimize shading of the water	• Work requiring channel dewatering; • Projects that do not use hydraulic modeling to demonstrate minimal alteration of channel form and minimal modification of the floodway, or for which hydraulic modeling does not show minimal alteration; • Structures requiring fill placement within the channel; • Structures that channel untreated runoff to the water body, • Structures in areas of submerged aquatic vegetation that are used by dependent species (e.g., Olympic mudminnow, freshwater mussels); • Structures that require removing LWD in lotic waters; • Structures permanently removing riparian vegetation; • Work that requires production of in-water sound with peak levels more than 180 dB; • Structures that fail to minimize artificial illumination of the water surface; • Structures that fail to minimize shading of the water surface;

Activity	Low Risk	Moderate Risk	High Risk
		surface; • Activities requiring vessel use; • Activities avoiding the impacts potentially causing "high" risk.	• Activities requiring in-water operation of mechanized equipment other than vessels.
Conduit crossings per WAC 220-110-100	• All provisions above, plus: • Work not requiring HPDD; • Work not requiring trenching "in the wet"	• All provisions above, plus: • Work requiring HPDD but potentially covered species not present; • Work requiring trenching "in the wet" but potentially covered species not present; • Absence of potentially covered species confirmed via survey by qualified biologist.	• All provisions above, plus: • Work requiring HPDD and potentially covered species may be present; • Work requiring trenching "in the wet" and potentially covered species may be present
Utility lines per WAC 220-110-310	• All provisions above; no additional provisions	• All provisions above; no additional provisions	• All provisions above; no additional provisions

9.3 General Risk of Take: 2007 White Papers (Channel Modifications, Fish Passage, Fish Screens, Flow Control Structures, Habitat Modifications, Marinas and Shipping Terminals, and Shoreline Modifications)

The risk of take is rated by impact mechanism for each species based on the assumptions presented in Table 9-8. (Also appears earlier in the consolidation as Table 6-3.)

Table 9-8. Definitions of the terminology used for risk of take determinations.

Risk of Take Code	Potential for Take	Definition
H	High	Stressor exposure is likely to occur with high likelihood of individual take in the form of direct mortality, injury, and/or direct or indirect effects on long-term survival, growth, and fitness potential due to long-term or permanent alteration of habitat capacity or characteristics. Likely to equate to a Likely to Adversely Affect (LTAA) finding.

M	Moderate	Stressor exposure is likely to occur, causing take in the form of direct or indirect effects potentially leading to reductions in individual survival, growth, and fitness due to short-term to intermediate-term alteration of habitat characteristics. May equate to an LTAA or a Not Likely to Adversely Affect (NLTAA) finding depending on specific circumstances.
L	Low	Stressor exposure is likely to occur, causing take in the form of temporary disturbance and minor behavioral alteration. If that take is insignificant or discountable, it would equate to an NLTAA finding.
I	Insignificant	Stressor exposure may potentially occur, but the likelihood is discountable and/or the effects of stressor exposure are insignificant. Likely to equate to an NLTAA finding.
N	No Risk	No risk of take ratings apply to species with no likelihood of stressor exposure because they do not occur in habitats that are suitable for the activity in question, or the impact mechanisms caused by the activity will not produce environmental stressors.
?	Unknown	Unknown risk of take ratings apply to cases where insufficient data are available to determine the probability of exposure or to assess stressor response.

Assessing risk of take assumes the following:

- HPA-permitted activities result in significant modification of the project site and the surrounding area, altering the environmental characteristics of the natural shoreline, bed, or water body.
- The impact mechanisms produced by development of the structures create environmental stressors.
- The risk of take resulting from stressor exposure will vary by species, depending on the nature of stressor exposure, as well as the sensitivity of the species and life-history stage exposed to the stressor.
- The magnitude, timing, duration, and frequency of each impact mechanism will vary widely with the project scale and location.
- The assessment of risk of take associated with each impact mechanism is broad and applies a "worst-case scenario" standard.
- This assessment is conditioned by the species occurrence and life-history specific uses of habitats where the particular type of structure is typically developed. A structure that would be built only in deep water would not affect species that occur only in shallow

water; a structure that would be built only in fresh water would not affect marine species or life-stages.

9.3.1 General Risk of Take from Construction, Operations, and Maintenance

9.3.1.1 Visual and Physical Disturbance

Visual disturbance and physical disturbance are expected to produce moderate risks of take for motile life-history stages due to temporary disturbance and displacement. Specifically for fish behavior, visual and physical disturbance can cause temporary avoidance and startle responses, compelling individuals to move out of the affected habitats or to assume a cryptic posture. Such disturbances will increase stress and exertion, may alter spawning and foraging behavior, or increase the risk of predation if fish are startled away from protective habitat. These effects may lead to decreased survival, growth, fitness, and spawning success, which equates to a moderate risk of take. Non-motile species or life-history stages are unable to escape or avoid physical disturbance. Therefore, they are at increased risk of mechanical injury from crushing or burial during construction, which constitutes a high risk of take.

9.3.1.2 Noise

Specific information on the risk of take associated with underwater noise is relatively limited for the majority of HCP species. For the purpose of ESA consultation, most available research has focused on the effects of pile driving related underwater noise on fish. This subject has received the most scrutiny because pile driving is a relatively common activity that produces noise stressors of sufficient magnitude to cause observed injury and mortality in fish by a number of mechanisms (e.g., cardiovascular and other tissue damage, hearing organ damage). A sufficient base of information has been assembled to establish effects thresholds for disturbance and injury in the HCP salmonid species.

Aside from pile-driving, noise produced by the in-water operation of heavy equipment is unlikely to exceed established injury thresholds. Noise related disturbance may occur in the form of acute spikes in underwater sound pressure levels from equipment impacts, and continuous noise created by vessel engines, generators, and pump or dredge operation.

Noise stressors produced by construction are likely to exceed levels sufficient to cause disturbance and behavioral modification, or to cause other physiological responses detrimental to survival, growth and fitness. Behavioral modification and habitat displacement from noise exposure may lead to increased exertion, alteration of feeding behavior, and increased predation exposure. Auditory masking effects caused by protracted alteration of the ambient noise environment (e.g., from extended vessel and motorized equipment operation) may affect their ability to detect predators and prey. Behavioral and auditory masking effects would generally be temporary to short-term in nature, lasting for the duration of the construction activity. Prolonged exposure to elevated ambient noise levels may also cause temporary changes in hearing sensitivity in certain fish species. These hearing threshold effects may last for some period after activities are completed (e.g., hours to days). Collectively, these effects may limit the survival, growth, and fitness of individuals exposed to these stressors. Because these stressors are short-term in nature, stressor exposure equates to a moderate risk of take.

9.3.1.3 Channel Dewatering

Temporary dewatering and flow bypass with fish removal and relocation from work areas may be required for some construction projects. Even when dewatering is not required for construction and maintenance, exclusion areas are often created around the work sites to contain sediments and other pollutants and to reduce the magnitude of stressor exposure. This construction and maintenance activity poses a relatively high risk of take. Well-designed protocols and trained personnel are necessary to avoid high levels of mortality. Even with appropriate protocols and experienced field crews, high levels of mortality can result. For example, NOAA Fisheries evaluated take associated with dewatering and fish handling in a recent biological opinion. They estimated that salmonid mortality rates in the range of 8 to as high as 20 percent may occur even when trained personnel are used, and have assumed an injury rate of 25 percent (NMFS 2006).

Mortality rates may be even higher in areas with complex substrate and bathymetry. During the egg, larval, or juvenile life-history stage of many species, individuals may be too small or too cryptic to collect and relocate effectively (e.g., juvenile salmonids hiding in cobble interstices, river lamprey ammocoetes buried in fine substrate, larval or juvenile dace). Mortality is the expected outcome for any individuals stranded within the exclusion area. Even in the absence of mortality, fish handling and relocation may result in stress and injury, as well as increased competition for forage and refuge in the relocation habitat. Moreover, the act of capture, handling, or forced behavioral modification of an ESA-listed species constitutes harassment, which is considered a form of take. Thus, the permitting of channel and work area dewatering poses a high risk of take of varying levels of severity depending on habitat and species-specific factors.

In addition to these effects, the act of dewatering a stream and redirecting flow may pose a barrier to fish migration. Delays in migration can lead to adverse effects on spawning fitness, can increase exposure to predation and poaching, and can deny juvenile fish access to rearing habitats during critical periods. These effects also constitute a moderate risk of take of HCP species with migratory life-history stages.

9.3.2 General Risk of Take from Hydraulic and Geomorphic Modifications

Flow regime, channel geometry, and substrate composition and stability are dominant factors determining aquatic habitat structure in riverine environments. Alteration of any of these habitat components can change the suitability of the habitat for various life-history stages of HCP species. These habitat alterations are essentially permanent and continuous, and can lead to changes in the productivity of the habitat for spawning, forage, rearing, and refuge. In a worst-case scenario, these effects are in turn likely to lead to reduced spawning success, as well as reduced survival, growth, and fitness for species and life-history stages dependent on the affected habitat. This equates to a high risk of take for species with exposure to these impact mechanisms.

9.3.2.1 Altered Hyporheic Exchange

Hyporheic exchange is an important component of ecosystem function (including water quality moderation) in riverine environments. Alterations to hyporheic exchange have the potential to affect juvenile and/or adult survival, growth, and fitness, and in some cases the spawning productivity of a range of species in the long-term, equating to a high risk of take.

Species with a high risk of take include those with life-history stages that are dependent on hyporheic exchange for its beneficial effects on water temperature and dissolved oxygen levels. For example, most salmonids preferentially spawn in areas with groundwater-induced upwelling, which promotes oxygenation of spawning gravels. Alteration of hyporheic exchange in environments suitable for spawning could potentially affect egg survival and reduce the availability of suitable spawning habitat, resulting in reduced spawning success. Similarly, groundwater inflow can provide important thermal refugia for migrating adult and rearing juvenile salmonids during periods with high water temperatures. A reduction in the amount of thermal refugia may negatively affect survival during these life-history stages. Similar effects would be expected for other coldwater fish species with low thermal tolerance thresholds, such as pygmy whitefish. More generally, hyporheic exchange also plays a key role in nutrient cycling and food web productivity in alluvial bed rivers. Activities resulting in significant alteration of hyporheic exchange could adversely affect food web productivity, limiting foraging opportunities for fish and invertebrate species dependent on these types of environments.

9.3.2.2 Altered Wave Energy, Altered Current Velocities, and Altered Nearshore Circulation Patterns

Wave energy, current velocities, and circulation patterns are all important determinants governing nearshore habitat characteristics in marine and lacustrine systems. These factors determine habitat suitability for a number of species-specific life-history processes. For example, wave energy conditions, currents, and circulation patterns will have a strong influence on nearshore water temperatures, shoreline stability, sorting and transport of sediments, and the accumulation of allochthonous and autochthonous materials. Many fish species selectively spawn in locations where current and circulation patterns promote the settling of planktonic larvae in favorable environments for rearing. Alteration of these patterns can cause larvae to be transported to unfavorable environments. Similarly, juvenile fish rearing in nearshore environments selectively choose environments with suitable wave energy and current conditions. These impact mechanisms can fundamentally alter habitat suitability for these uses, leading to decreased survival, growth, and fitness. This translates to a moderate to high risk of take for those HCP species that are dependent on these habitats during some phase of their life history.

9.3.2.3 Altered Sediment Supply, Substrate Composition and Stability

Sediment supply and substrate composition are fundamental components of the nearshore ecosystem structure in marine and lacustrine systems. Because substrate composition is an important determinant of community structure in the nearshore environment, these habitat changes can fundamentally alter community structure and habitat suitability for species dependent on the original habitat condition. This equates to a moderate-to-high risk of take for species that are dependent on these habitats due to effects on the survival, growth, and productivity of exposed life-history stages.

9.3.2.4 Altered River-Floodplain Connectivity

Lateral habitat connectivity is an important feature of riverine environments that contributes to their productivity. The implications of this degraded connectivity are significant for ecosystem productivity. A number of HCP species are dependent on off-channel and floodplain habitats during one or more life-history stages. Reduction in the availability of suitable habitat will lead to increased competition for available habitat, decreased growth and fitness, increased exposure to predation, and potentially decreased availability of suitable spawning sites. While these effects primarily concern fish, invertebrate species such as mussels could also be affected due to reduced productivity of host fish populations. The effects on survival, growth, fitness, and productivity caused by long-term alteration of environmental and habitat characteristics imposed by altered river-floodplain connectivity equates to a high risk of take.

9.3.2.5 Altered Freshwater Inputs/Altered Groundwater-Surface Water Exchange

Freshwater inputs to the marine nearshore environment are demonstrably linked to a number of important habitat parameters such as temperatures in forage fish spawning substrates, eelgrass distribution, and habitat selection by certain fish species. Hyporheic exchange is also an important component of ecosystem function in lacustrine and riverine environments. Alteration of groundwater inputs would be expected to cause a corresponding alteration in the distribution of desirable habitat features and availability, which has the potential to affect survival, growth, fitness, and (in some cases) the spawning productivity of a range of species. This equates to a risk of take ranging from low to high, depending on species-specific life-history characteristics and habitat requirements.

9.3.3 General Risk of Take from Ecosystem Fragmentation

Ecosystem fragmentation is an impact mechanism that incorporates the collective effects of habitat modification in the footprint of the structure, the resulting effects on the migration and dispersal of organisms, hydraulic modification, the transport, distribution, and biogeochemical processing of LWD, other organic material, nutrients, and pollutants, and the impact mechanisms imposed by hydraulic and geomorphic modifications.

Modification of downstream transport processes can lead to alteration in habitat complexity, changes in nutrient cycling, and subsequent hydraulic and geomorphic modifications. Each of these perturbations is associated with some risk of take. Given the long-term nature of these effects and the significance of altered ecosystem function, the risk of take is generally considered high.

Complex channels capture and retain sediment, which promotes the formation of pools and other hydraulically complex features. Hydraulic complexity in turn encourages the sorting and deposition of sediments and organic material in diverse patches, supporting food web productivity and providing spawning and rearing habitat for a diverse array of species. Diverse habitat patches support a biologically diverse community. Channel simplification or channel downcutting reduces the longitudinal distribution and frequency of these habitat patches across the riverine landscape, and can lead to fragmentation of floodplain and off-channel habitats from the riverine ecosystem. Reduction in habitat complexity leads to reduced food web productivity, as well as the reduced availability of habitats suitable for HCP species that occur in these environments. For example, side channel habitats are preferentially selected by various species of salmonids (e.g., sockeye salmon) for spawning. These habitats also provide key winter rearing and storm refuge habitats for coho salmon, steelhead, spring Chinook, native char (bull trout and Dolly Varden), and other species. Floodplain wetlands are also highly productive refuge habitats for a variety of species, such as coho salmon, during high winter flows. The reduction in suitable refuge and foraging habitat area caused by ecosystem fragmentation increases competition for remaining habitat, predation risk, and risk of displacement to habitats unfavorable for rearing. Because these effects are extensive and intermediate term to long term in nature, this equates to a high risk of take for HCP species.

9.3.4 General Risk of Take from Riparian Vegetation and Large Woody Debris Modifications

9.3.4.1 Altered Riparian Shading and Altered Ambient Air Temperature Regime

The risk of take from riparian vegetation removal varies depending on the nature of the project and the type of environment in which it is implemented.

The influence of riparian shading on water temperatures in the nearshore marine environment is limited in most circumstances. However, specific microhabitats (e.g., upper intertidal beaches used as spawning habitat by various fish species, and pocket estuaries that are isolated during tidal exchange) can experience significant changes in microclimatic conditions when riparian vegetation is altered. This equates to a moderate-to-high risk of take for those species with a demonstrable dependence on these habitats because the reduction in suitable habitat area caused by these impact mechanisms will lead to reduced survival, growth, and fitness, and these effects will be long term in nature.

Riparian shading in lacustrine environments can have a pronounced effect on nearshore water temperatures. The effect of riparian modification on the ambient air temperature regime is less clear and depends on a range of site-specific environmental factors. In general, water temperatures in lacustrine environments are predominantly driven by solar radiation exposure, seasonal stratification, turnover rate, and the temperature of source water. However, specific microhabitats such as shallow waters in protected embayments may be sensitive to temperature effects if shading and ambient air temperatures are altered by riparian modification. Such temperature effects may alter the suitability of these habitats for species that use them during some portion of their life history. These effects would be long term in duration and seasonal in frequency, meaning that these habitats may be unavailable or unsuitable for rearing for a significant segment of a population’s life history. This equates to a moderate-to-high risk of take for those species with a demonstrable dependence on these habitats because the reduction in suitable habitat area caused by these impact mechanisms will lead to reduced survival, growth, and fitness.

Removal of riparian vegetation can affect the temperatures of streams and smaller rivers, producing a range of potential effects on fish and wildlife species. In smaller streams, stream temperature effects may influence local habitat suitability and by extension affect the survival, growth, and fitness of exposed species and life-history stages.

In larger rivers, this effect will be far less pronounced. Water temperatures in larger rivers are less influenced by localized shading and ambient air temperature than by the combined effects of basin conditions in upstream areas of the watershed, hydromodification (e.g., dam and reservoir development), and other factors that influence water temperatures flowing through the affected area. The risk of take associated with altered temperatures is insignificant and the localized effects discountable in large rivers.

9.3.4.2 Altered Allochthonous Inputs

Riparian vegetation is an important source of nutrient input to the aquatic environment, strongly influencing the productivity of the aquatic food chain. Allochthonous nutrient inputs include sources such as insect-fall, leaf litter, and other organic debris, and LWD inputs that contribute both organic material and habitat complexity. These inputs clearly contribute to aquatic food web productivity in nearshore, lacustrine, and riverine environments. In riverine environments, the importance of allochthonous inputs to food web productivity decreases along a downstream gradient. As rivers grow in size, the contributions of autochthonous production and nutrient cycling to the food web increase. The science regarding the significance of allochthonous inputs in marine nearshore environments is relatively limited.

In smaller streams, allochthonous inputs are more important to food web productivity, while they provide a minor contribution in the lower reaches of large river systems. The loss of allochthonous production from a project that removes riparian vegetation or LWD near the mouth of a large river will produce related stressors of potentially far lower magnitude than a series of projects in a small, higher elevation stream. In smaller streams, a localized reduction in food web productivity might result, leading to decreased foraging opportunities, decreased overall habitat suitability, and decreased growth and fitness. This equates to a moderate risk of take for a range of HCP species that are dependent on riverine rearing conditions.

In marine, lacustrine, and riverine environments, LWD recruitment is an important contributor to habitat structure. Because removal of riparian vegetation and LWD has the potential to alter food web productivity and habitat complexity, it is likely to affect the survival, growth, and fitness of those species dependent on the nearshore environment for foraging and rearing during some portion of their life history. This equates to a moderate-to-high risk of take for those species with demonstrable dependence on these habitats.

9.3.4.3 Altered Habitat Complexity

In marine or lacustrine ecosystems, the physical structure of riparian vegetation, allochthonous inputs of LWD, shoreline stability, and effects on localized microhabitat conditions all contribute to habitat structure and complexity of the nearshore environment. Alteration of habitat complexity can have demonstrable effects on the productivity of aquatic species dependent on the nearshore environment, particularly fish species that spawn and rear in these areas, through effects on survival, growth, and fitness. These effects will be long-term. This equates to a moderate-to-high risk of take for species with demonstrable dependence on these habitats.

In riverine systems, modification of riparian vegetation alters habitat complexity primarily through the loss of undercut banks, root structure, and LWD inputs to the channel. The hydraulic and geomorphic effects of riparian vegetation modification can lead to further alterations in habitat complexity. Changes in flow and sediment transport conditions can lead to channel simplification and reduced availability of valuable habitat features, limiting the productive capacity of the affected habitat. Depending on the particular life history of the affected species, alteration in habitat complexity may limit the availability of suitable spawning, resting, and rearing habitat, and may alter foraging opportunities and predation exposure. In general, fish species that are dependent on habitats potentially affected through this mechanism of impact are likely to experience decreased spawning success and/or decreased survival, growth, and fitness due to an overall reduction in suitable habitat area. This equates to a high risk of take for those HCP fish and invertebrate species occurring in riparian habitats.

9.3.4.4 Altered Shoreline and Bluff Stability

In riverine systems, removal of riparian vegetation can affect shoreline stability through the reduction in root cohesion and the loss of large woody debris (LWD) inputs that affect localized erosion and scour conditions. These effects may become pronounced in smaller stream systems where riparian modification effects are imposed over a considerable length of channel relative to the overall size of the stream. In the worst-case scenario, this type of riparian vegetation modification could result in decreased stream bank and shoreline stability, leading to erosion and elevated turbidity along the length of affected channel. These effects will be pronounced during seasonal high-flow conditions. Risk of take associated with this stressor varies depending on species-specific sensitivity to increased turbidity and dependence on the habitat structure provided by intact stream banks and shorelines. In general, more motile fish species experience only temporary behavioral alterations and low risk of take. In contrast, less motile fish life-history stages or sessile invertebrates could experience a high risk of take from decreased survival due to substrate sedimentation or mortality from smothering, as well as decreased growth and fitness due to the effects of high turbidity on foraging success. These effects can become chronic and intermediate- to long-term in nature. Therefore, these effects equate to a high risk of take.

Modifications of marine or lacustrine riparian vegetation can lead to physical alteration of the shoreline and to bluff instability. In general, this would be expected to alter shoreline habitat conditions and habitat suitability for those species dependent on the nearshore environment during some portion of their life history. This equates to a moderate-to-high risk of take for those species with a demonstrable dependence on these habitats because the reduction in suitable habitat area caused by these impact mechanisms will lead to reduced survival, growth, and fitness.

9.3.4.5 Altered Groundwater-Surface Water Exchange

In the nearshore environment in both marine and lacustrine ecosystems, freshwater inputs are demonstrably linked to a number of important habitat parameters such as temperatures in forage fish spawning substrates, eelgrass distribution, and habitat selection by certain fish species (for instance, beach spawning sockeye salmon populations in lacustrine systems). Alteration of groundwater inputs would be expected to cause a corresponding alteration in the distribution of desirable habitat features and availability for species dependent on the nearshore environment. This equates to a high risk of take for species with demonstrable dependence on these habitats because the reduction in suitable habitat area caused by these impact mechanisms will lead to reduced survival, growth, and fitness, and these effects will be intermediate term to long term in duration.

In riverine systems, the influence of riparian vegetation on hyporheic exchange is well documented as an important component of ecosystem health. Alteration of riparian vegetation can lead to alteration of surface water and groundwater exchange, with important effects on the riverine ecosystem. For example, some salmonid populations that spawn in the mainstems of large river systems are dependent on groundwater inflow to maintain spawning habitat quality. For rearing salmonids and other temperature-sensitive species, groundwater inflow may provide thermal refuges important for survival during summer rearing periods. Hyporheic connectivity is also an important component of food web productivity. As such, this impact mechanism has the potential to affect juvenile and/or adult survival, growth, and fitness, and in some cases the spawning productivity of a range of species. Therefore, this mechanism is generally equated with a high risk of take for species exposed to this stressor, depending on species-specific life-history characteristics.

9.3.5 General Risk of Take from Aquatic Vegetation Modifications

Stressors imposed by aquatic vegetation modification occur through

- reduction in autochthonous productivity provided by the plant community; and
- the changes in habitat structure imposed by the removal of vegetation.

Autochthonous production by submerged aquatic vegetation is a source of primary and secondary production in the aquatic food web of the marine littoral zone. A diversity of species feed directly on live and fragmented submerged aquatic vegetation, forming the basis of the food web for a number of other species. Numerous species use submerged aquatic vegetation for cover and rearing during larval and juvenile life-history stages. Of specific interest, Pacific herring are (primarily) effectively obligate spawners on submerged aquatic vegetation in the low intertidal and subtidal zone.

The risk of take associated with alteration of aquatic vegetation varies depending on the environment type.

Aquatic vegetation plays a key role in the productivity of the nearshore marine ecosystem. Alterations of the submerged aquatic vegetation community through reduction in aerial extent or conversion to other habitat types (e.g., conversion of eelgrass habitat to algae and kelp) can reduce the productivity of these habitats, possibly affecting foraging opportunities for dependent life-history stages. This translates to a moderate to high risk of take for species dependent on these habitats through reduced survival, spawning success, or growth and fitness. In nearshore marine environments, submerged aquatic vegetation also provides habitat structure, creating vertical dimension and overhead cover. Alteration of habitat complexity can decrease the availability of suitable rearing habitat for species and life-history stages dependent on the nearshore environment, leading to increased predation risk and increased competition for suitable space, resulting in long-term effects on survival, growth, and fitness. This equates to a moderate to high risk of take for species dependent on aquatic vegetation functions in these environments. A high risk of take would only apply to species adapted to habitats with naturally abundant aquatic vegetation. Otherwise, only a moderate risk of take would be expected.

In most river systems in the Pacific Northwest, particularly in coldwater streams, aquatic vegetation plays a relatively small ecological role. Aside from native emergent vegetation confined to a relatively narrow range of depths, most aquatic vegetation species in rivers and lakes are invasive species. Therefore, changes in autochthonous production and habitat complexity imposed by alteration of aquatic vegetation may have relatively minor effects on the majority of HCP species occurring in riverine environments. The risk of take associated with altered autochthonous production and habitat complexity is expected to be low to moderate, except in specific cases where species are known to be dependent on aquatic vegetation (e.g., Olympic mudminnow), which would be associated with a high risk of take.

Vegetation plays a more significant role in lacustrine habitats, where emergent and submerged aquatic vegetation are often abundant in the photic zone and play a larger role in habitat structure and food web productivity.

9.3.6 General Risk of Take from Water Quality Modifications

Depending on the nature and concentration of the contaminant, toxic substance exposure can cause a range of adverse effects in exposed species. In extreme cases, these effects can include direct mortality (e.g., exposure of immobile lamprey ammocoetes buried in bottom substrates, fish exposed to accidental vessel spills in enclosed embayments). Even in the absence of mortality, exposure to a variety of contaminants can cause physiological injury and/or contaminant bioaccumulation, leading to decreased growth and fitness. Changes in nutrient loading may lead to detrimental changes in food web community structure, which may be limiting to growth and fitness.

9.4 Activity-Specific Risk of Take: 2007 White Papers (Channel Modifications, Fish Passage, Fish Screens, Flow Control Structures, Habitat Modifications, Marinas and Shipping Terminals, and Shoreline Modifications).

This section consolidates narrative and tabular summaries of the risk of take from white papers prepared in 2007: channel modifications, fish passage activities and structures, fish screens, flow control structures, habitat modifications, marinas and shipping terminals, and shoreline modifications. Each of these major categories is broken down into separate activity types. The risk-of-take summaries are organized by the type of activity or structure, the mechanism of impact, and the type of environment. In cases where the physical effects and related risk of take are similar between environment types, the risk of take discussion is grouped to avoid redundancy. A risk of take matrix for each type of activity, identifying the overall risk of take for each of the 52 HCP species (Tables 9-9 through 9-43) is presented at the end of each narrative. These matrices provide an individual risk of take for each species by impact mechanism category and environment type (i.e., riverine, marine and lacustrine). The matrices are derived from the impact mechanism and stressor specific risk of take ratings developed for the 52 HCP species in the exposure response matrices, which are presented in Appendix A to the original white papers. This risk of take assessment was developed based on the likelihood of exposure, for each of these 52 species, to the impact mechanisms and stressors imposed by each type of structure or activity as well as the sensitivity of exposed life-history stages to these stressors. The summary risk of take presented in the narrative and the matrices represents the greatest overall risk of take; a given activity could have a lower risk of take in some circumstances.

9.4.1 Channel Modifications: Dredging, Gravel Mining and Bar Scalping, Sediment Capping, and Channel Creation and Alignment

Channel modification activities are typically designed to promote human uses of the aquatic environment for purposes including navigation, flood control, pollution management, and landscape conversion. The resulting alteration of ecological process and imposition of stressors may persist well after project construction is completed. The magnitude of these stressors will vary depending on the scale of the project in question and the degree to which it modifies ecological conditions and processes.

In the original white papers, the risk of take for each type of channel modification was discussed separately. Those discussions concluded that, for the most part, the risks of take for each type of channel modification are quite similar to one another for the environments in which they occur. In this consolidation, the common risks are grouped. A risk of take matrix for each type of channel modification, identifying the overall risk of take for each of the 52 HCP species (Tables 9-9 through 9-12) is presented at the end of the narrative.

Of the four types of channel modification, **dredging** takes place in the widest variety of environments, including marine, lacustrine, large rivers and small streams. The nature and scale of an individual dredging activity can vary widely depending on its specific purpose and the environment in which it is implemented. A broad range of HCP species face the potential for stressor exposure from dredging. Species-specific risk of take ratings for dredging operations are presented by impact mechanism in Table 9-9. The species level risk of take ratings are conditioned based on the nature of the stressor exposure anticipated in each environment type.

Gravel mining and bar scalping is anticipated to occur only in alluvial bed rivers where the desirable substrate resources are abundant. Gravel mining and bar scalping operations are expected to impose impact mechanisms and related ecological stressors similar to those caused by dredging in riverine environments. Therefore, the risk of stressor exposure and resulting risk of take are considered to be essentially the same as those described for dredging activities in smaller riverine environments. Species specific risk of take ratings for gravel mining and scalping operations are presented by impact mechanism in Table 9-10.

Sediment caps are used primarily as a means of sequestering contaminated substrate material, isolating these materials from the aquatic environment and limiting potential exposure pathways for toxic substances. Predominantly employed in the marine environment, sediment caps are occasionally used in lacustrine environments and in riverine environments in depositional settings where scour of the cap is unlikely to occur. These environments are most commonly found in estuarine reaches, which for the purpose of this white paper are considered to be part of the marine environment. Species specific risk of take ratings for sediment cap development and maintenance are presented by impact mechanism in Table 9-11.

Artificial or realigned channels are extensive hydromodifications specifically designed to reconfigure the aquatic environment to promote human uses. (Channel realignment projects conducted for the primary purpose of habitat restoration are discussed under Habitat Modifications.) Extensive in size and pervasive in effect, artificial or realigned channels impose a number of ecological stressors on the environment through essentially permanent alteration of habitat and water quality conditions. These types of channel modifications are commonly accompanied by dike and levee development and may be maintained by maintenance dredging, structures, and activities that impose their own risk of take. HCP species occurring in environments modified by this type of project will typically experience a high risk of take from one or more impact mechanisms. Species specific risk of take ratings for channel creation or alignment are presented by impact mechanism in Table 9-12.

9.4.1.1 Construction, Operations, and Maintenance

The construction component of a channel modification activity is typically temporary to short-term in duration, lasting from days to weeks. Stressors associated with channel modification include visual, physical, and noise related disturbance from vessel and equipment operation. The risk of take associated with these stressors varies depending on the nature of the exposure and the sensitivity of species and life-history stages exposed. Motile species and life-stages may face a moderate risk of take resulting from behavioral avoidance, stress, and habitat displacement.

Construction-related stressors unique to one type of channel modification include the following.

- Dredging: Entrainment of organisms. Entrainment is the unintentional capture of organisms within the dredged material or the surrounding water column, and the unintentional removal of these organisms from the environment. Entrainment is a likely occurrence regardless of equipment type if non-motile species or life-history stages are present during dredging activities. Motile fish species and life-history stages are most likely able to avoid entrainment. Entrainment is likely to cause mortality through mechanical injury, smothering, or stranding. Species with one or more non-motile life-history stages (i.e., fish eggs and demersal or planktonic larvae and juveniles, as well as the HCP invertebrate species) are vulnerable to entrainment, and in environments suitable for dredging activities face a high risk of take from injury or mortality.

- Dredging: Reoccurrence. Dredging may recur at interannual to decadal frequencies. Larger projects (such as Columbia River navigation channel dredging) may extend over several months of continuous activity.

- Channel creation or realignment: Effects of connection to the existing channel. The construction and maintenance of artificial channels involves significant disturbance and alteration of stream banks and lacustrine and marine shorelines. Channel and bed disturbance may lead to behavioral and physiological stress on species or life-history stages exposed to the disturbance, or may limit the availability and suitability of habitats for sensitive life-history stages during critical periods. Non-motile species exposed to these stressors may face immediate effects on survival if occupied habitats are eliminated. Once the barriers isolating the newly excavated channel are breached, it will fill by drawing surface water from existing surface water, creating a potential dewatering and stranding hazard as well as potential entrainment into the new channel environment. In marine and larger lacustrine systems, the dewatering and stranding hazard is likely limited, because the volume of the new channel will be relatively insignificant. In contrast, in riverine environments the creation of the new channel may redirect the entire surface flow leading to dewatering of the existing channel. Aquatic species trapped in rapidly dewatering habitats face risk of mortality from stranding, particularly non-motile species and life-history stages. Motile species able to avoid stranding will be displaced from existing habitats and forced to relocate within disturbed and/or occupied habitat that may present limited foraging opportunities, which could limit survival, growth, and fitness. It is generally presumed that care will be taken during channel connection to dewater slowly, reducing stranding risk. Consistent with a worst-case scenario approach however, this activity must be associated with a high risk of take, particularly for non-motile species and life-history stages that may be exposed to this stressor. These effects would be equated with a moderate to high risk of take, depending on species specific sensitivity.

9.4.1.2 Hydraulic and Geomorphic Modifications

Channel modifications impose significant changes in the hydraulic and geomorphic characteristics of the project area and the surrounding environment. These modifications can in turn significantly alter the suitability of the affected habitats for HCP species. Dredging, sediment capping, gravel mining and bar scalping, and channel creation and realignment are expected to cause similar hydraulic and geomorphic modifications. These activities may range in scale from removing or placing a relatively small amount of sediment using equipment operating from a bank, to multi-year maintenance dredging projects on the Columbia River employing ships, barges, or other floating platforms. The risk of take ratings are therefore applicable across a broad range of environment types.

Channel modifications change flow regimen, channel geometry, and substrate composition. These alterations are likely to change local channel hydraulics and sediment transport and stability. The effects on survival, growth, fitness, and productivity caused by long-term alteration of environmental and habitat characteristics equates to a high risk of take.

Channel modifications can lead to the alteration of groundwater exchange in riverine environments through changes imposed on channel geometry. Increased flood conveyance may lead to reduced water surface elevations, and reduced connectivity between the river and the floodplain during peak flows. This is likely to lead to changes in hyporheic exchange with detrimental effects on ecological productivity.

Channel modifications in the marine environment will modify hydraulic and geomorphic conditions in and around the project area, resulting in the imposition of several impact mechanisms and related stressors. Risk of take resulting from these impact mechanisms is strongly linked to species-specific dependence on the affected nearshore environment.

Channel geometry and substrate composition and stability are dominant factors determining aquatic habitat structure in riverine environments. Alteration of any of these habitat components can change the suitability of the habitat for various life-history stages of HCP species. These habitat alterations are essentially permanent and continuous, and can lead to changes in the productivity of the habitat for spawning, forage, rearing, and refuge. In a worst-case scenario, these effects are in turn likely to lead to reduced spawning success, as well as reduced survival, growth, and fitness for species and life-history stages dependent on the affected habitat. This equates to a high risk of take for species with exposure to these impact mechanisms.

Artificial channels and channel realignments that are put in place to facilitate conversion of land to human uses (rather than those that are put in place for habitat restoration) alter flow conditions in riverine environments by simplifying the channel geometry, often by straightening the channel and changing (increasing) the stream gradient. Artificial channels are often created in conjunction with dikes and levees to accelerate the flow of water through the landscape, concentrating high flows in the stream channel, accelerating flow velocity and erosive forces. Substrate composition and stability in the channel change through the loss of sources of sediment and altered sediment transport capacity. The effects of artificial channels on HCP species are complex and variable, depending on the position of the hydromodification in the riverine environment and how the affected habitats are used by HCP species. Applying a worst-case scenario perspective, these pervasive long-term effects would be expected to reduce habitat suitability for species utilizing the affected environment, limiting individual survival, growth, and fitness and overall population productivity. This equates to a high risk of take.

Changed hydraulic, geomorphic, and riparian conditions imposed by channel modifications are likely to alter groundwater and surface water exchange in the project area and downstream. This hyporheic exchange is an important component of ecosystem function (including water quality moderation) in riverine environments. Therefore, this impact mechanism has the potential to affect juvenile and/or adult survival, growth, and fitness, and in some cases the spawning productivity of a range of species. Because this effect will be pervasive and essentially permanent, this mechanism is generally equated with a high risk of take for species exposed to this stressor, depending on species-specific, life-history characteristics. Species facing high risk of take include those with life-history stages that are dependent on hyporheic exchange for its beneficial effects on water temperature and dissolved oxygen levels.

9.4.1.3 Ecosystem Fragmentation

Depending on their siting and configuration, channel modifications can present a significant potential for habitat loss and fragmentation in marine, lacustrine, and riverine environments. Large projects have the most potential for adverse effects.

In estuarine environments, channel modification projects that remove shallow bars at the riverine and marine interface potential accelerate the flow of water from estuaries into open ocean waters. Altering bathymetry and flow conditions may in turn lead to changes in salinity, tidal exchange, and circulation patterns within the estuarine and nearshore environment, altering habitat conditions and potentially eliminating certain desirable habitat types.

Channel modification projects in nearshore environments may cause the conversion of shallow water to deeper water habitats, reducing the suitability of these habitats for certain species. For example, many salmonid species typically migrate as juveniles in shallow water along marine and lacustrine shorelines. The fragmentation of shallow water habitat along the shoreline may increase predation exposure and reduce foraging opportunities.

Channel modification projects can alter wave energy, current, and circulation patterns in the nearshore and offshore environment. Alteration of these habitat characteristics may render productive habitats less suitable for a given species or, in the case of organisms with a planktonic life-history stage, may hinder the dispersal and retention of eggs and larvae in areas suitable for rearing. Collectively, this can result in take through effects on survival, growth, and fitness of affected populations, which equates to a moderate risk of take for exposed species.

Channel modification projects reduce the structural complexity of instream habitat by changing channel geometry. They can simplify channel structure, disconnecting floodplain, off-channel, and terrestrial riparian habitats from the riverine ecosystem. They can alter longitudinal connectivity. They can influence the recruitment, transport, and retention of sediments, organic matter and nutrients and LWD. They can disconnect the channel from important sinks for pollutants. Reduction in habitat complexity leads to reduced food web productivity, and the reduced availability of habitats suitable for HCP species that occur in these environments. The reduction in suitable refuge and foraging habitat area caused by ecosystem fragmentation increases competition for remaining habitat, predation risk, and risk of displacement to habitats unfavorable for rearing. These effects are extensive and long lasting. Ecosystem fragmentation in riverine environments equates to a high risk of take.

The intended purpose of channel modification projects in smaller rivers and streams is often to improve flood conveyance capacity, limiting floodplain connectivity during high flow events. Localized changes in water surface elevation may lead to decreased inundation of off-channel and side channel habitats during high flow events. The effects on survival, growth, fitness, and productivity caused by the long-term alteration of environmental and habitat characteristics imposed by altered connectivity equates to a high risk of take.

9.4.1.4 Riparian Vegetation Modifications

In large bodies of water, channel modifications are expected to take place from floating platforms, barges/vessels, and/or existing overwater structures. Therefore, no modification of the riparian environment would be expected to occur and there will be no related risk of take.

On small to moderate sized streams and rivers that cannot practically be accessed from a floating dredge platform, channel modifications may result in riparian vegetation modification. Examples include:

- Modified stream channels in agricultural and urban settings that rapidly accumulate sediment and lose flood conveyance capacity. Some of these systems may incorporate sediment traps that are subject to routine maintenance dredging. Dredging activities in stream systems of this type can lead to extensive modification of riparian vegetation over a significant length of channel. Riparian recovery may be retarded if dredging activities occur at a high frequency (e.g., annually or biennially), meaning that the stressor exposure will occur over an extended duration.

- Building and maintaining dikes and levees along realigned channels may require removal of riparian vegetation.

- Gravel mining and bar scalping may require removal of riparian vegetation.

Loss of riparian shading can affect the temperatures of streams and smaller rivers, producing a range of potential effects on fish and wildlife species. In smaller stream systems, temperature effects of channel modifications can become pronounced. Increased stream temperatures can lead to a variety of unfavorable effects on HCP species occurring in these environment types. Due to their potential to occur over an extended duration, these effects are equated with a high risk of take. In higher order river environments, this effect is far less pronounced. Water temperatures in systems of this nature are less influenced by localized shading and ambient air temperature than by the combined effects of basin conditions in upstream areas.

Channel modifications that repeatedly alter an extensive length of riparian zone relative to channel size may lead to chronic reduction in allochthonous inputs. In such cases, a localized reduction in food web productivity might result, leading to decreased foraging opportunities, decreased overall habitat suitability, and decreased growth and fitness. This equates to a high risk of take for a range for species that are dependent on riverine rearing conditions. This impact is likely to be greater in small streams than in the lower reaches of large river systems, where allochthonous inputs provide a minor contribution to food web productivity.

The influence of riparian vegetation on hyporheic exchange is well documented as an important component of ecosystem health. Alteration of riparian vegetation can in turn lead to an alteration of surface water and groundwater exchange, with important effects on the riverine ecosystem, especially in smaller streams and rivers. Altered surface and groundwater exchange has the potential to affect juvenile and/or adult survival, growth, and fitness, and in some cases the spawning productivity of a range of species. Applying a worst-case scenario perspective, channel modifications that cause chronic degradation of riparian vegetation may permanently alter groundwater-surface water interactions. This level of stressor exposure would impose a high risk of take on those HCP species dependent on groundwater/surface water exchange.

9.4.1.5 Aquatic Vegetation Modifications

Channel modification projects may lead to the modification, loss, or burial of aquatic vegetation in the project footprint and within the zone of hydraulic and geomorphic effects imposed by the channel modification. The resulting risk of take associated with these stressors varies based on the sensitivity of the HCP species and the environment type in which stressor exposure occurs.

Channel modification activities in the marine environment are most likely to be permitted only if they can demonstrate that losses of aquatic vegetation will be substantially limited and mitigated. However, in a worst case scenario a project could result in the loss of a substantial amount of aquatic vegetation habitat with extensive localized losses of autochthonous productivity and habitat structure. Because local bathymetry and substrate conditions are usually altered in the process, reduced habitat suitability may limit the potential for natural recovery following project completion. Alteration of marine littoral vegetation may in some cases lead to localized shifts in food web productivity, possibly affecting foraging opportunities for dependent species and life-history stages. This translates to a high risk of take resulting from decreased growth and fitness.

The effects of channel modification on aquatic vegetation in lacustrine and riverine habitats varies considerably depending on the scale of the activity, the nature of the affected habitat, and the sensitivity of the species exposed to the resulting ecological stressors. Modification of the submerged aquatic vegetation community in lakes and rivers can lead to decreased primary and secondary productivity, which in turn may affect overall food web productivity. In systems where the aquatic vegetation community is an important component of food web productivity, this can lead to a high risk of take through long-term, indirect effects on foraging success, growth, and fitness of species and life-history stages that depend on forage in the nearshore environment. A high risk of take would only apply to those species adapted to habitats with naturally abundant aquatic vegetation. Otherwise, only a moderate risk of take would be expected.

Aquatic vegetation-related stressors unique to one type of channel modification include the following.

- Dredging is used to manage aquatic vegetation in lakes, particularly for controlling invasive species.

- Sediment caps may alter substrate conditions, reducing the suitability of the substrates for rooted vegetation or the availability of hard substrates for encrusting vegetation or kelp holdfasts.

9.4.1.6 Water Quality Modifications

Channel modification projects can result in an alteration of the temperature regime. In marine and lacustrine settings, temperature alterations occur primarily through changes in current circulation and stratification induced by wave energy, current circulation and vertical mixing, and other hydraulic and geomorphic effects. In riverine environments, channel modifications can alter temperatures through reduction in riparian shading and change in groundwater-surface water interactions. Effects will persist for the life of the structure. Alteration in temperature regime attributable to channel modification is unlikely to be of sufficient magnitude to cause acute mortality, but may cause increased stress leading to decreased survival, growth, and fitness. Motile species may also exhibit behavioral avoidance of affected areas, increasing competition for available suitable habitats with attendant effects on survival, growth, and fitness. Ultimately, the suitability of the habitat for a range of species may be affected. Applying a worst-case scenario perspective, these effects are likely to lead to a high risk of take because channel modifications can cause long-term changes in the ecological factors that contribute to temperature regime changes.

Channel modifications can lead to altered dissolved oxygen levels through changes in water temperature regime, hydraulic and geomorphic effects leading to altered nutrient cycling and eutrophication, and chemical weathering of substances in substrate exposed by dredging. These effects vary in duration from short-term to long-term and their magnitude is dependent on site specific conditions. Altered dissolved oxygen levels are unlikely to lead to acute mortality, but may cause increased stress leading to decreased survival, growth, and fitness. Motile species may also exhibit behavioral avoidance of affected areas, increasing competition for available suitable habitats with attendant effects on survival, growth, and fitness. Applying a worst-case scenario perspective, these effects are likely to lead to a high risk of take because channel modifications can cause long-term changes in the ecological factors that contribute to dissolved oxygen levels.

Channel modifications are likely to result in a short-term increase in suspended sediment levels in the aquatic environment. Subsequent geomorphic effects may lead to increased erosion or changes in wave energy that may cause chronic elevation in suspended sediment loading as the system adjusts to the new hydraulic and hydrologic regime imposed by changes in channel geometry or local bathymetry. Non-motile species or life-history stages exposed to pulses of high concentrations of suspended sediment may suffer direct mortality, injury, or extreme physiological stress from burial and smothering or gill irritation and injury, while motile species may be able to avoid these stressors. Chronic elevation in suspended sediment levels caused by hydraulic and geomorphic adjustments would be less likely to reach levels sufficient to cause direct mortality, but may be sufficient to affect growth and fitness over the intermediate-term by limiting ecological productivity and the ability to detect prey species. The long-term risk of take from changes in suspended sediment concentrations and turbidity caused by channel modifications will be variable depending on the specific site conditions. However, given the potential for short-term injury or mortality resulting from elevated suspended sediment levels, a high risk of take must be assumed for HCP species that occur in suitable environments.

Channel modifications can induce changes in nutrient and pollutant loading through a number of mechanisms. In the marine environment, channel modifications have been associated with changes in estuarine tidal dynamics, which affects the processing and distribution of nutrients and pollutants. The effects of channel modifications on marine aquatic vegetation can lead to changes in nutrient cycling and pollutant sequestration. Dredging and sediment capping in Puget Sound has often been associated with the resuspension of contaminated sediments, creating new exposure pathways for organisms in the water column. In riverine environments, fragmentation of floodplain habitats due to channel modifications may affect the riparian buffering capacity and limit the contribution of floodplain habitats to nutrient cycling, leading to detrimental changes in water quality.

Equipment operations present the potential for the introduction of toxic substances from accidental spills from equipment used during the activity. Because some contaminant exposure and changes in nutrient loading induced by channel modifications may be intermediate-term to long-term in duration, these stressors are equated with a high risk of take in riverine, marine, and lacustrine environment types.

Table 9-9. Species- and habitat-specific risk of take for mechanisms of impact associated with dredging

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	M	M	H	H	H	H	H	H	H	N	N	M	H	M	H	M	M
Coho salmon	H	M	M	H	H	H	H	H	H	H	N	N	M	H	M	H	M	M
Chum salmon	H	M	I	H	H	I	H	H	I	H	N	N	M	H	I	H	M	I
Pink salmon	H	M	I	H	H	I	H	H	I	H	N	N	M	H	I	H	M	I
Sockeye salmon	H	M	M	H	H	H	H	H	H	H	N	N	M	H	M	H	M	M
Steelhead	H	M	M	H	?	H	H	?	H	H	?	N	M	?	M	H	?	M
Coastal cutthroat trout	H	M	M	H	H	H	H	H	H	H	N	N	M	H	M	H	M	M
Redband trout	H	N	M	H	N	H	H	N	H	H	N	N	M	N	M	H	N	M
Westslope cutthroat trout	H	N	M	H	N	H	H	N	H	H	N	N	M	N	M	H	N	M
Bull trout	H	M	M	H	H	H	H	H	H	H	N	N	M	H	M	H	M	M
Dolly Varden	H	M	M	H	H	H	H	H	H	H	N	N	M	H	M	H	M	M
Pygmy whitefish	H	N	M	H	N	H	H	N	H	H	N	N	M	N	M	H	N	M
Olympic mudminnow	H	N	N	H	N	H	H	N	H	H	N	N	H	N	N	H	N	N
Lake chub	H	N	M	H	N	H	H	N	H	H	N	N	M	N	M	H	N	H
Leopard dace	H	N	M	H	N	H	H	N	H	H	N	N	M	N	M	H	N	H
Margined sculpin	H	N	N	H	N	H	H	N	N	H	N	N	M	N	N	H	N	N
Mountain sucker	H	N	M	H	N	H	H	N	H	H	N	N	M	N	M	H	N	H
Umatilla dace	H	N	M	H	N	H	H	N	H	H	N	N	M	N	M	H	N	H
Pacific lamprey	H	I	H	H	N	H	H	H	H	H	N	N	M	I	M	H	L	H
River lamprey	H	M	H	H	N	H	H	H	H	H	N	N	M	H	M	H	M	H
Western brook lamprey	H	N	H	H	N	H	H	N	H	H	N	N	M	N	M	H	N	H
Green sturgeon	N	M	N	N	N	N	N	?	N	N	N	N	N	?	N	N	L	N
White sturgeon	H	M	H	H	N	H	H	?	H	H	N	N	H	?	H	H	L	H
Eulachon	H	H	N	H	N	N	H	H	N	M	N	N	I	H	N	H	H	N
Longfin smelt	H	H	H	H	N	H	H	H	N	M	N	N	I	H	H	H	H	N
Pacific sand lance	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Surf smelt	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Pacific herring	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Lingcod	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Pacific cod	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Pacific hake	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Walleye pollock	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Black rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Bocaccio rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Brown rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Canary rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
China rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Copper rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Greenstriped rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Quillback rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Redstripe rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Tiger rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Widow rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Yelloweye rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Yellowtail rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Olympia oyster	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Northern abalone	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Newcomb's littorine snail	N	N	N	N	H	N	N	H	N	N	N	N	N	N	N	N	H	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
California floater (mussel)	H	N	H	H	N	H	H	N	H	H	N	N	M	N	M	H	N	H
Western ridged mussel	H	N	H	H	N	H	H	N	H	H	N	N	M	N	M	H	N	H

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-10. Species- and habitat-specific risk of take for mechanisms of impacts associated with gravel mining and scalping.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Coho salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Chum salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Pink salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Sockeye salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Steelhead	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Coastal cutthroat trout	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Redband trout	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Westslope cutthroat trout	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Bull trout	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Dolly Varden	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Pygmy whitefish	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Olympic mudminnow	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Lake chub	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Leopard dace	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Margined sculpin	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Mountain sucker	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Umatilla dace	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Pacific lamprey	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
River lamprey	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Western brook lamprey	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White sturgeon	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Eulachon	H	N	N	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N
Longfin smelt	H	N	N	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
California floater (mussel)	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Western ridged mussel	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.

Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-11. Species- and habitat-specific risk of take for mechanisms of impacts associated with sediment caps.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentations			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	N	M	M	N	H	H	H	H	H	N	N	N	N	H	M	N	M	M
Coho salmon	N	M	M	N	H	H	H	H	H	N	N	N	N	H	M	N	M	M
Chum salmon	N	M	I	N	H	I	H	H	I	N	N	N	N	H	I	N	M	I
Pink salmon	N	M	I	N	H	I	H	H	I	N	N	N	N	H	I	N	M	I
Sockeye salmon	N	M	M	N	H	H	H	H	H	N	N	N	N	H	M	N	M	M
Steelhead	N	M	M	N	?	H	H	?	H	N	?	N	N	?	M	N	?	M
Coastal cutthroat trout	N	M	M	N	H	H	H	H	H	N	N	N	N	H	M	N	M	M
Redband trout	N	N	M	N	N	H	H	N	H	N	N	N	N	N	M	N	N	M
Westslope cutthroat trout	N	N	M	N	N	H	H	N	H	N	N	N	N	N	M	N	N	M
Bull trout	N	M	M	N	H	H	H	H	H	N	N	N	N	H	M	N	M	M
Dolly Varden	N	M	M	N	H	H	H	H	H	N	N	N	N	H	M	N	M	M
Pygmy whitefish	N	N	M	N	N	H	N	N	N	N	N	N	N	N	M	N	N	M
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lake chub	N	N	M	N	N	H	N	N	H	N	N	N	N	N	M	N	N	H
Leopard dace	N	N	M	N	N	H	H	N	H	N	N	N	N	N	M	N	N	H
Margined sculpin	N	N	N	N	N	H	N	N	N	N	N	N	N	N	N	N	N	N
Mountain sucker	N	N	M	N	N	H	H	N	H	N	N	N	N	N	M	N	N	H
Umatilla dace	N	N	M	N	N	H	H	N	H	N	N	N	N	N	M	N	N	H
Pacific lamprey	N	I	H	N	N	H	H	H	H	N	N	N	N	I	M	N	L	H
River lamprey	N	M	H	N	N	H	H	H	H	N	N	N	N	H	M	N	M	H
Western brook lamprey	N	N	H	N	N	H	N	N	H	N	N	N	N	N	M	N	N	H
Green sturgeon	N	M	N	N	N	N	N	?	N	N	N	N	N	?	N	N	L	N
White sturgeon	N	M	H	N	N	H	H	?	H	N	N	N	N	?	H	N	L	H
Eulachon	N	H	N	N	N	N	H	H	N	N	N	N	N	H	N	N	H	N
Longfin smelt	N	H	H	N	N	H	H	H	H	N	N	N	N	H	H	N	H	N
Pacific sand lance	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Surf smelt	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Pacific herring	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Lingcod	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Pacific cod	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Pacific hake	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentations			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Walleye pollock	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Black rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Bocaccio rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Brown rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Canary rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
China rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Copper rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Greenstriped rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Quillback rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Redstripe rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Tiger rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Widow rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Yelloweye rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Yellowtail rockfish	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Olympia oyster	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Northern abalone	N	H	N	N	N	N	N	H	N	N	N	N	N	H	N	N	H	N
Newcomb's littorine snail	N	N	N	N	H	N	N	H	N	N	N	N	N	N	N	N	H	N
Giant Columbia River limpet	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
California floater (mussel)	N	N	H	N	N	H	H	N	H	N	N	N	N	N	M	N	N	H
Western ridged mussel	N	N	H	N	N	H	H	N	H	N	N	N	N	N	M	N	N	H

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.

Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-12. Species- and habitat-specific risk of take for mechanisms of impacts associated with channel creation and alignment.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Coho salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Chum salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Pink salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Sockeye salmon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Steelhead	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Coastal cutthroat trout	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Redband trout	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Westslope cutthroat trout	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Bull trout	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Dolly Varden	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Pygmy whitefish	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Olympic mudminnow	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Lake chub	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Leopard dace	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Margined sculpin	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Mountain sucker	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Umatilla dace	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Pacific lamprey	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
River lamprey	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Western brook lamprey	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White sturgeon	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Eulachon	H	N	N	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N
Longfin smelt	H	N	N	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
California floater (mussel)	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Western ridged mussel	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.

Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

9.4.2 Fish Passage (Culverts, Fish Ladders/Fishways, Roughened Channels, Weirs, Trap and Haul)

Fish passage structures are usually intended to improve fish passage conditions relative to the existing state. While fish passage structures often do provide improvements in passage, for the purpose of assessing risk of take, in this analysis the baseline condition is the stream system in the absence of artificial structures. There are so many possible combinations of existing conditions and new fish passage structures (for example, installing a new structure where one doesn't exist, replacing a barrier culvert with a new culvert, replacing an old bridge with a new bridge, replacing a culvert with a bridge, etc.) that it would not have been possible to characterize the potential take associated with all of the possibilities. By comparing fish passage structures to a situation without a water crossing, the analysis evaluates the worst case scenario. The worst case analyses assume that the structure is likely to produce stressors of the greatest magnitude.

Culvert retrofits are not expected to cause riparian modification of any significance; therefore, the resulting stressors are expected to be minor and the risk of take low. **Culvert removal or replacement** requires significant in-water work and channel modification. Stressors associated with these activities would be associated with a high risk of take.

The impact mechanisms associated with **fish ladders, fishways,** and **weirs** produce a number of environmental stressors with the potential to impose risk of take of HCP species. The degree of risk associated with each impact mechanisms varies. Some mechanisms are expected to produce stressors with relatively low risk of take due to their limited extent and/or short-term nature. In contrast, some mechanisms may result in stressors with the potential to produce direct mortality or injury, or long-term modifications in habitat conditions detrimental to survival, growth, and fitness. These impact mechanisms would be associated with a high risk of take.

The impact mechanisms associated with the creation of **roughened channels** present several environmental stressors that lead to potential risk of take of HCP species. The degree of risk associated with each of these impact mechanisms varies, but roughened channels are generally associated with a relatively high risk of take in total.

The majority of **trap-and-haul** facilities are expected to be associated with a weir or some other type of flow control structure (with rare exceptions for trap-and-haul operations at natural barriers). The risk of take analysis for trap-and-haul operations considers only the effects of the operation itself, and not the effects of the barrier structures that necessitate the operation.

Species-specific risk of take ratings for fish passage structures are presented by impact mechanism and by ecosystem (marine, lacustrine, riverine) in Tables 9-13 through 9-17. Fish passage structures are almost always placed in riverine environments, so there is no risk of take in marine and lacustrine environments.

9.4.2.1 Construction and Maintenance

Culverts, fishways, fish ladders, and weirs are associated with a high risk of take due to the potential for direct injury or mortality from several possible impact mechanisms.

Roughened channel creation may require extensive in-channel work involving one or more impact mechanisms with the potential for direct injury or mortality. This equates to a high risk of take.

Trap-and-haul operations are associated with a high risk of take of target species because they involve the capture, handling, transport, and release of fish. These actions have the potential for direct or delayed mortality from stress or injury, even when the most thoughtful precautions are taken. The acts of capture and handling constitute take as defined for the purpose of Section 7 ESA consultations. The risk of take for nontarget species is generally considered to be low. Some potential for take exists via the introduction of toxic substances from accidental spills during operations. However, this potential is limited if proper BMPs are in place. Western ridged mussels, which are dependent on migratory salmonids that are typically the target species for trap-and-haul would be expected to incur a high risk of take due to the long-term indirect effects of fish passage operations on host-fish species.

9.4.2.1.1 Equipment Operation and Materials Placement

The risk of take resulting from construction and/or operation of fish passage structures varies by species depending on the species occurrence, the nature of stressor exposure, the sensitivity of the species, the life-history stage exposed to the stressor, and the habitats where fish passage facilities are typically developed. The magnitude, timing, duration, and frequency of each impact mechanism vary widely with project scale and location. The assessment of risk of take associated with each impact mechanism is broad and applies a “worst-case scenario” standard.

The construction of fish passage structures involves the use of heavy machinery and the placement of structural materials in and around the stream channel. Use of machinery (e.g., excavators) generates noise and visual and physical disturbance. At a minimum, underwater noise and visual and physical disturbance are likely to displace HCP fish species from occupied habitats, and otherwise modify behavior in ways that could affect survival, growth, and fitness. At worst, construction activities that produce intense underwater noise (e.g., installation of steel piles to support a fish ladder chute using an impact hammer) could lead to direct injury or mortality. For invertebrates, the risk of take could range from moderate (e.g., from displacement) to high (e.g., from crushing or other forms of mechanical injury).

9.4.2.1.2 Dewatering and Handling

Temporary dewatering and flow bypass with fish removal and relocation from work areas are common and necessary practices during construction and maintenance of fish passage structures. Even when dewatering is not required for construction and maintenance, exclusion areas are often created around the work sites to contain sediments and other pollutants as well as to reduce the magnitude of stressor exposure. This construction and maintenance activity poses a relatively high risk of take.

The act of dewatering the stream and redirecting flow may pose a barrier to fish migration. Delays in migration can lead to adverse effects on spawning fitness, can increase exposure to predation and poaching, and can deny juvenile fish access to rearing habitats during critical periods. These effects constitute a moderate risk of take of HCP species with migratory life-history stages.

9.4.2.1.3 Dredging and Fill

Dredging and fill activities associated with construction would ideally be conducted within a dewatered exclusion area to limit risk of take on HCP species. If this activity occurs in the open channel, it presents the potential for burial and entrainment. Each HCP species that occurs in freshwater environments where fish passage is likely to be implemented has at least one life-history stage with a high likelihood of suffering mortality or injury when exposed to either burial or entrainment. Therefore, dredging and fill activities must be associated with a high risk of take.

9.4.2.1 Hydraulic and Geomorphic Modifications

Hydraulic and geomorphic modifications associated with fish passage structures are expected to range considerably depending on specific circumstances. In general, however, fish passage structures are expected to have less extensive effects than activities such as the installation of large flow control structures. The construction and physical presence of fish passage structures can lead to alteration of physical habitat features. Because these structures are typically intended for long-term use, these habitat alterations are essentially permanent and continuous. If the effects are extensive, they can alter the productivity of the affected habitat for spawning, foraging, rearing, refuge, and other uses by HCP species. In a worst-case scenario, these effects in turn are likely to lead to reduced spawning success, as well as reduced survival, growth, and fitness for species and life-history stages dependent on the affected habitat. In cases where hydraulic and geomorphic modifications are extensive, a broad array of research has demonstrated that detrimental effects on survival, growth, and fitness are likely to occur for many of the HCP species that occur in riverine environments. In comparison to a water body with no structures present, this equates to a high risk of take.

Culverts are associated with a low risk of take for the majority of cases because the physical extent of hydraulic and geomorphic effects is expected to be limited. However, culverts that create upstream impoundments may cause more extensive hydraulic and geomorphic effects that are intermediate term in duration. These special cases are associated with a high risk of take due to the potential for direct mortality or injury in species reliant on the affected habitats. Culverts retrofitted with baffles or other internal structures to promote fish passage have reduced hydraulic capacity. This may in turn promote a backwater effect that leads to sediment deposition at the upstream end of the structure, creating flow conditions that limit fish passage. In some cases, existing culverts have arrested migrating headcuts, and removal or replacement will allow the nickpoint to continue migrating upstream causing channel downcutting. Existing undersized culverts can also cause upstream sediment aggradation that is subject to incision and downcutting when the culvert is removed. Channel downcutting from the migrating headcut can simplify channel geometry and influence the recruitment, transport, and retention of sediments and LWD. This type of channel simplification can affect habitat suitability for HCP species.

Fishways are associated with a low risk because the physical extent of hydraulic and geomorphic effects is expected to be limited.

Roughened channels are associated with a high risk of take. This conclusion is based on the specific design challenges, which create the potential for unexpected and potentially adverse hydraulic and geomorphic conditions to develop over time.

Most weirs are associated with a low risk of take because the physical extent of hydraulic and geomorphic effects is expected to be limited. Weirs constructed to manage (prevent) fish passage could have broad-reaching hydraulic and geomorphic effects, influencing habitat complexity both upstream and downstream of the structure. Weirs intended to block upstream passage of certain species may form impoundments that alter the transport of wood, sediment, and organic material. Temporary weirs would be expected to have negligible influence on groundwater/surface water interactions; therefore, the risk of take associated with this type of structure would likely be considered insignificant. In contrast, a structure such as a larger barrier weir may alter these interactions more extensively, leading to effects similar to those of a small dam.

9.4.2.1 Ecosystem Fragmentation

Compared to a water body with no structures present, fish passage projects have the potential to impose a number of barrier conditions that could potentially lead to take of HCP species. Specifically, fish passage structures or operations may fail to provide passage for all species as intended, may place unintended selection pressures on affected populations that limit or alter phenotypic diversity, or may become less effective at passing fish over time if improperly designed for the conditions present or if maintenance is neglected. Fish passage structures may limit the upstream movement of certain invertebrate species, or indirectly affect upstream dispersal through direct effects on the migration and productivity of host-fish populations. Limitations on fish passage may in turn result in long-term reductions in the abundance of migratory fish reaching areas upstream of the barrier. This may result in decreased food web productivity by reducing the delivery of nutrients derived from allochthonous sources. Given these potential ecosystem fragmentation effects, fish passage structures are considered to be associated with a high risk of take.

Culverts are associated with a high risk of take because even a well-designed structure may pose some risk of long-term ecosystem fragmentation in comparison to the natural system baseline. This may occur through effects on fish passage, or hydraulic and geomorphic effects. Culvert removal and replacement projects have the potential to alter lateral and longitudinal habitat connectivity in ways that can be detrimental to HCP species. Culverts have the potential to become significant barriers to the transport of LWD and sediment. If an improperly designed culvert results in the creation of an upstream impoundment, downstream transport of organic material may also be interrupted, altering nutrient cycling.

Fishways are generally expected to have limited effects on habitat complexity as a whole, which would be more than balanced by increased access to productive habitats. A fishway around a dam will have limited effects in comparison to the effects of the dam itself. The additional incremental effect of the structure will be slight, and the risk of take would be considered low. Fish ladders are associated with a high risk of take because they pose at least some risk of long-term ecosystem fragmentation in comparison to the natural system baseline.

Roughened channels are associated with a high risk of take because they pose at least some risk of long-term ecosystem fragmentation in comparison to a natural stream baseline.

The risk of weirs causing ecosystem fragmentation varies depending on the type of weir. Temporary weirs installed for fisheries management purposes are expected to produce only minor and temporary effects associated with a low risk of take. In contrast, permanent weirs intended to promote passage or to restrict passage of undesirable species are associated with a high risk of take because of the broad implications of unintended effects on movement of HCP species and on ecological processes.

Depending on specific configuration, trap-and-haul can impose a number of unintended effects related to ecosystem fragmentation. Imposing an artificial management regime during a critical phase in the life history of migratory fish species has the potential to create selection pressures that partially disconnect the adaptive capacity of the affected population from the natural environment. Alteration of migratory corridors by modifying release location may lead to decreased survival, fitness, and/or spawning productivity, potentially affecting long-term population viability. These effects would extend indirectly to freshwater mussels that are dependent on affected host-fish species. Any effects that reduce or modify the upstream transport of allochthonous nutrients may lead to altered food web productivity, an effect with broad consequences for all HCP species occurring in affected habitats. Given the range and breadth of these potential effects, as well as the typical longevity of trap-and-haul operations (which are usually associated with long-lived structures such as dams), ecosystem fragmentation must be associated with a high risk of take.

9.4.2.2 Riparian Vegetation Modifications

Riparian vegetation modification associated with fish passage is generally expected to be limited. In most cases, fish passage structures will be placed in areas that are already modified by human activities, and the incremental degradation associated with their construction will be insignificant. Most riparian vegetation modifications associated with fish passage structures is likely to be associated with construction impacts and therefore subject to restoration. This implies that any modest temperature effects would be intermediate term in nature. Therefore, the degree to which shade, solar exposure, and air temperature regime are affected is likely to be at best insignificant or at worst extremely small. The risk of take is expected to be low. In specific circumstances where more extensive and permanent vegetation modification occurs, a higher risk of take rating may be warranted. Examples of possible exceptions include roughened channel creation and the placement of fishways around natural passage barriers.

Culverts are associated with a low risk of take for the majority of cases because the physical extent of riparian vegetation modification is likely to be limited. However, in certain circumstances (i.e., where removal or replacement dewaters upstream impoundments), riparian vegetation effects may be more pronounced, resulting in a moderate risk of take due to their intermediate-term duration. The risk of take associated with altered allochthonous inputs is expected to be low.

Fishways are associated with a low risk of take because the physical extent of riparian vegetation modification is likely to be limited. However, in certain circumstances riparian vegetation effects may be more pronounced, resulting in a high risk of take.

Roughened channels are associated with a moderate risk of take because the physical extent of riparian vegetation modification associated with construction is likely to be relatively extensive in comparison to other fish passage structures. However, these effects are likely to be intermediate term in nature, as roughened channels lend themselves to riparian restoration.

Weirs are associated with a low risk of take because the physical extent of riparian vegetation modification is likely to be limited. However, in certain circumstances (i.e., permanent weirs installed to prevent upstream passage), riparian vegetation effects may be more pronounced, resulting in a high risk of take.

9.4.2.3 Aquatic Vegetation Modifications

The effects of fish passage structures on aquatic vegetation are generally expected to be limited because in-water footprints of most fish passage structures are usually relatively small. However, in specific circumstances, indirect effects due to changes in nutrient cycling may occur. Fish passage projects that result in a decrease in upstream transport of allochthonous nutrients may in turn limit habitat productivity and, by extension, aquatic vegetation growth. Alternatively, the increased delivery of allochthonous nutrients derived from marine or other productive downstream sources is likely to have the opposite effect. Given the potential for ill-conceived fish passage projects to increase ecosystem fragmentation, some effects on aquatic vegetation may occur.

Culverts and fishways are associated with a low risk of take for the majority of cases because the physical extent of aquatic vegetation modification is likely to be limited. However, in certain circumstances (i.e., where removal/replacement of a culvert dewaters upstream impoundments), aquatic vegetation effects may be more pronounced, resulting in a low to moderate risk of take (depending on species-specific reliance on aquatic vegetation) due to their intermediate-term duration.

Where aquatic vegetation is an important component of the riverine landscape, the physical extent of aquatic vegetation modification associated with roughened channel creation is likely to be relatively extensive in comparison to other fish passage structures. Because these effects are expected to be short term to intermediate term in nature, this impact mechanism imposes a moderate risk of take.

9.4.2.1 Water Quality Modifications

Fish passage structures have the potential to alter aquatic temperature regimes through alterations of riparian vegetation, reducing shading, altering ambient air temperatures, and altering groundwater/surface water interactions. The extent of effects on water temperature from removing riparian vegetation would be expected to be quite limited. The risk of take from altered temperature regime is expected to range from low to moderate depending on the specific type of structure and site-specific circumstances.

Construction of fish passage structures is likely to result in bank and channel disturbance through the use of heavy equipment, materials placement, dredging and fill, and rewatering of exclusion areas. This disturbance is in turn likely to produce a short-term increase in suspended sediment loading to riverine environments downstream of the structure. In certain cases, such as culvert removal or replacement that dewaters upstream impoundments, subsequent geomorphic effects may lead to ongoing bank and channel bed erosion, leading to a chronic elevation in suspended sediment load as the channel adjusts to the new hydraulic and hydrologic regime. The effects of elevated suspended sediments vary depending on the magnitude of the stressor and the sensitivity of the species or life-history stage exposed to the stressor. Given the potential for short-term injury or mortality resulting from elevated suspended sediment levels associated with construction, a high risk of take must be assumed for HCP species that occur in riverine habitat types where fish passage projects are likely to be implemented.

Generally, the direct effects of fish passage structures on dissolved oxygen conditions are not expected to be significant, and the risk of take associated with these effects is insignificant. Indirect effects on dissolved oxygen may occur as a result of improved ecosystem connectivity and hydraulic and geomorphic modifications. Increased upstream delivery of allochthonous nutrients, particularly large quantities of marine-derived nutrients in the form of salmon carcasses, has the potential to significantly increase ecosystem productivity. This in turn could increase biochemical oxygen demand resulting in decreased dissolved oxygen levels in certain cases. Restoration of fish passage to relatively unimpaired stream systems would generally not be expected to produce these conditions. However, if passage is restored to systems that are in a eutrophic state due to nutrient pollution from other sources, more extensive effects could occur. Fish passage work that results in dewatering of upstream impoundments (e.g., removing or replacing culverts) can result in the release of a pulse of sequestered nutrients when fine sediments in the impoundment bed are scoured. This is most likely to occur when large wetland areas are created by artificial barriers. A large pulse of nutrients could cause temporary eutrophication that, depending on the nature of the downstream environment, could cause a relatively rapid decrease in dissolved oxygen levels with the potential to adversely affect HCP species. Due to the short- to intermediate-term nature of these effects in freshwater environments, these effects are equated with a moderate to high risk of take for species occurring in the affected environment. Nonmotile species and life-history stages are most likely to experience high risk of take because they lack the capacity for avoidance.

The construction of fish passage structures can in some cases lead to the temporary alteration of pH levels. Many types of fish passage structures are constructed using concrete, a material that produces caustic leachate while curing. Concrete leachate released to surface waters from runoff or curing surfaces “in the wet” can increase pH levels well beyond levels capable of causing injury or mortality of all HCP species. This effect is typically short term in nature and moderates as the concrete cures, and is easily minimized using appropriate BMPs. However, due to the significant level of potential adverse effects, this stressor is equated with a high risk of take.

Construction of fish passage structures could introduce toxic substances into the aquatic environment through accidental spills from heavy equipment. Depending on the nature and concentration of the contaminant, toxic substance exposure can cause a range of adverse effects on exposed species. In extreme cases, these effects can include direct mortality (e.g., exposure of nonmotile larvae to fuel spills). More commonly, intermittent low-level exposure to a variety of contaminants is likely to cause physiological injury and/or contaminant bioaccumulation, leading to decreased survival, growth, and fitness. This presents a moderate risk of take to species potentially exposed to this stressor.

Culverts, fishways, and weirs are associated with a high risk of take due to the potential for short-term water quality impacts that can cause direct mortality or injury. Other mechanisms of impact associated with culverts, fishways, and weirs result in a moderate risk of take.

Certain types of weir structures may create impoundments that expand surface area, increasing solar radiation inputs and raising water temperatures.

Roughened channels require extensive in-channel work and have a large wetted area footprint, suggesting the potential for relatively extensive short-term water quality impacts in comparison to other fish passage types. Roughened channels can be associated with a high risk of take in some cases, as many water quality impacts have the potential to cause direct mortality or injury in sensitive species experiencing acute exposure. In many cases, however, a moderate risk of take is more appropriate because stressor exposure is more likely to result in nonlethal responses, and these stressors are typically short term in duration.

Table 9-13. Species- and habitat-specific risk of take for mechanisms of impact associated with culvert removal/replacement/retrofit.

Species	Construction & Maintenance Activities			Water Quality Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Coho salmon	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Chum salmon	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Pink salmon	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Sockeye salmon	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Steelhead	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Coastal cutthroat trout	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Redband trout	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Westslope cutthroat trout	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Bull trout	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Dolly Varden	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Pygmy whitefish	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Olympic mudminnow	N	N	N	N	N	N	M	N	N	M	N	N	H	N	N	H	N	N
Lake chub	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Leopard dace	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Margined sculpin	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Mountain sucker	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Umatilla dace	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Pacific lamprey	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
River lamprey	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Western brook lamprey	H	N	N	H	N	N	M	N	N	L	N	N	H	N	N	H	N	N
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Longfin smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Eulachon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	Construction & Maintenance Activities			Water Quality Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	H	N	N	H	N	N	M	N	N	M	N	N	H	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	M	N	N	M	N	N	H	N	N	H	N	N
California floater (mussel)	H	N	N	H	N	N	M	N	N	M	N	N	H	N	N	H	N	N
Western ridged mussel	H	N	N	H	N	N	M	N	N	M	N	N	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-14. Species- and habitat-specific risk of take for mechanisms of impact associated with fish ladders/fishways.

Species	Construction & Maintenance Activities			Water Quality Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Coho salmon	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Chum salmon	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Pink salmon	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Sockeye salmon	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Steelhead	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Coastal cutthroat trout	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Redband trout	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Westslope cutthroat trout	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Bull trout	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Dolly Varden	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Pygmy whitefish	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Olympic mudminnow	N	N	N	N	N	N	N	N	N	L	N	N	L	N	N	H	N	N
Lake chub	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Leopard dace	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Margined sculpin	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Mountain sucker	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Umatilla dace	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Pacific lamprey	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
River lamprey	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Western brook lamprey	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White sturgeon	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Longfin smelt	H	N	N	H	N	N	M	N	N	I	N	N	I	N	N	H	N	N
Eulachon	H	N	N	H	N	N	M	N	N	I	N	N	I	N	N	H	N	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	Construction & Maintenance Activities			Water Quality Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
California floater (mussel)	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N
Western ridged mussel	H	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-15. Species- and habitat-specific risk of take for mechanisms of impact associated with roughened channels.

Species	Construction & Maintenance Activities			Water Quality Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Coho salmon	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Chum salmon	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N	N
Pink salmon	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N	N
Sockeye salmon	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Steelhead	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Coastal cutthroat trout	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Redband trout	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Westslope cutthroat trout	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Bull trout	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Dolly Varden	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Pygmy whitefish	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Olympic mudminnow	N	N	N	N	N	N	N	N	N	M	N	N	H	N	N	H	N	N
Lake chub	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Leopard dace	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Margined sculpin	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Mountain sucker	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Umatilla dace	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Pacific lamprey	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
River lamprey	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Western brook lamprey	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White sturgeon	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Longfin smelt	H	N	N	H	N	N	M	N	N	M	N	N	H	N	N	H	N	N
Eulachon	H	N	N	H	N	N	M	N	N	M	N	N	H	N	N	H	N	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	Construction & Maintenance Activities			Water Quality Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
California floater (mussel)	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N
Western ridged mussel	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-16. Species- and habitat-specific risk of take for mechanisms of impact associated with weirs.

Species	Construction & Maintenance Activities			Water Quality Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Coho salmon	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Chum salmon	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Pink salmon	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Sockeye salmon	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Steelhead	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Coastal cutthroat trout	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Redband trout	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Westslope cutthroat trout	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Bull trout	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Dolly Varden	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Pygmy whitefish	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Olympic mudminnow	N	N	N	N	N	N	N	N	N	L	N	N	H	N	N	H	N	N
Lake chub	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Leopard dace	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Margined sculpin	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Mountain sucker	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Umatilla dace	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Pacific lamprey	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
River lamprey	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Western brook lamprey	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White sturgeon	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Longfin smelt	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N	H	N	N
Eulachon	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N	H	N	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	Construction & Maintenance Activities			Water Quality Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
California floater (mussel)	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N
Western ridged mussel	H	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-17. Species- and habitat-specific risk of take for mechanisms of impact associated with trap-and-haul fish passage techniques.

	Operational Activities			Ecosystem Fragmentation		
Species	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	N	N	H	N	N
Coho salmon	H	N	N	H	N	N
Chum salmon	H	N	N	H	N	N
Pink salmon	H	N	N	H	N	N
Sockeye salmon	H	N	N	H	N	N
Steelhead	H	N	N	H	N	N
Coastal cutthroat trout	H	N	N	H	N	N
Redband trout	H	N	N	H	N	N
Westslope cutthroat trout	H	N	N	H	N	N
Bull trout	H	N	N	H	N	N
Dolly Varden	H	N	N	H	N	N
Pygmy whitefish	H	N	N	H	N	N
Olympic mudminnow	N	N	N	N	N	N
Lake chub	M	N	N	N	N	N
Leopard dace	M	N	N	N	N	N
Margined sculpin	M	N	N	N	N	N
Mountain sucker	H	N	N	H	N	N
Umatilla dace	M	N	N	N	N	N
Pacific lamprey	H	N	N	H	N	N
River lamprey	H	N	N	H	N	N
Western brook lamprey	M	N	N	N	N	N
Green sturgeon	N	N	N	N	N	N
White sturgeon	H	N	N	H	N	N
Longfin smelt	I	N	N	N	N	N
Eulachon	I	N	N	N	N	N
Pacific sand lance	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N
Lingcod	N	N	N	N	N	N
Pacific cod	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N
Walleye pollock	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N

Species	Operational Activities			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Newcomb's littorine snail	N	N	N	N	N	N
Giant Columbia River limpet	N	N	N	H	N	N
Great Columbia River spire snail	N	N	N	H	N	N
California floater (mussel)	N	N	N	H	N	N
Western ridged mussel	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

9.4.3 Fish Screens

Fish screens are intended to protect against adverse effects on aquatic species caused by entrainment into or impingement on water intake or diversion systems. Current design guidance encourages the selection of screen designs that are appropriate for their ecological context. However, for the purpose of assessing risk of take, the baseline condition for this analysis is the stream system in the absence of artificial structures. Although fish screens provide an environmental benefit compared to unscreened water intakes or diversions, they present some risk of take when compared to a stream system with no structures.

In-channel screens in smaller streams and rivers are typically small, often temporary, end-of-pipe style structures. The impacts and resulting ecological stressors are relatively small in magnitude, and the risk of take associated with these types of structures will generally be quite low. In-channel screen designs employed in larger rivers, estuaries, large lakes and reservoirs, and the marine environment are commonly larger, permanent structures with greater potential for adverse effects, and therefore a greater risk of take. Bankline screens in marine and lacustrine systems, as well as larger rivers, may be located in embayments where they can impose ecosystem fragmentation effects. Bankline screens may employ pump or lift-driven bypass systems with additional potential for adverse effects.

Off-channel screens vary widely in scale, but are employed solely in riverine environments. Off-channel screens range from small, modular structures to large and complex systems. The impact mechanisms and resulting ecological stressors produced by small, modular screen systems installed by hand will be of lesser magnitude or intensity than those produced by large, permanent structures.

Species-specific risk of take ratings by impact mechanism are provided in Tables 9-18 and 9-19.

9.4.3.1 Construction and Maintenance

Construction and maintenance requirements for fish screens vary widely.

Temporary pump intake screens require little construction. They are simply placed in the source body with the intake pipe and anchored in place using some type of anchoring mechanism. They are commonly placed by hand, resulting in little disturbance of the stream bank or substrate. They are removed at the end of the use period. Screen placement and removal would be expected to result in minor visual and noise-related disturbance and minor pulses of suspended sediments, resulting in temporary behavior modification. Screen maintenance involves removal, cleaning, and replacement, resulting in similarly limited effects. This would equate to a low risk of take.

The worst-case scenario for in-channel screen construction would be associated with large, permanent end-of-pipe intake screens or bankline screen structures. These screen designs would likely require extensive in-water construction activity, potentially including dewatering and fish handling, pile driving (for cofferdam placement), and in-water use of heavy equipment. At best, underwater noise and visual and physical disturbance are likely to displace HCP fish species from occupied habitats, and to otherwise modify their behavior in ways that could affect survival, growth, and fitness. These short-term stressors would equate to a moderate risk of take. At worst, construction activities that produce intense underwater noise (e.g., installation of sheet piles for temporary construction cofferdams using an impact hammer) could lead to direct injury or mortality. This equates to a high risk of take. For invertebrate species, direct physical disturbance imposes some risk of take. Depending on the nature and severity of the disturbance, the risk of take could range from moderate (e.g., from displacement) to high (e.g., from crushing or other forms of mechanical injury). This is associated with a high risk of take due to the potential for direct injury or mortality from noise, visual disturbance, physical disturbance, dewatering, and fish handling.

Off-channel screens are constructed outside of the aquatic environment, either in an artificial diversion channel or entirely “in the dry”. When screen systems are constructed in the dry, the potential for construction-related disturbance and water quality impacts is considerably diminished. Even when placed in existing diversion channels, the structures can be placed behind splashboard dams or similar flow control structures avoiding the need for dewatering. In such cases, the need for in-water construction work in most circumstances would be limited to the connection of bypass channels to the aquatic ecosystem. Off-channel configuration also allows for relatively simple isolation of the structure as required for maintenance purposes. This in turn limits the potential for construction and maintenance related impacts on HCP species. Risk of take from off-channel screen construction and maintenance is expected to range from insignificant to low in the case of modular and smaller permanent screen systems. Screen construction and maintenance constructed “in the dry” are associated with an insignificant risk of take.

Temporary dewatering and flow bypass with fish removal and relocation from work areas are common and necessary practices during fish screen installation and possibly during maintenance. Even when dewatering is not required for construction and maintenance, exclusion areas are often created around the work sites to contain sediments and other pollutants as well as to reduce the magnitude of stressor exposure. This construction and maintenance activity may pose a relatively high risk of take.

Dewatering the stream and redirecting flow may pose a barrier to fish migration. Delays in migration can lead to adverse effects on spawning fitness, can increase exposure to predation and poaching, and can deny juvenile fish access to rearing habitats during critical periods. These effects constitute a moderate risk of take of HCP species with migratory life-history stages.

If dredging and fill associated with construction would ideally occur in the open channel, they present the potential for high risk of take from burial and entrainment. The sensitivity to these stressors generally varies by species and life-history stage. However, each HCP species that occurs in freshwater environments where fish screens are likely to be used has at least one life-history stage with a high likelihood of suffering mortality or injury when buried or entrained. Therefore, dredging and fill activities are considered to be associated with a high risk of take.

9.4.3.2 Operations

Correctly operating fish screens avoid and minimize adverse effects on aquatic species caused by water withdrawal or diversion. While the benefits of a correctly operating screen are fairly clear, the fact that these structures are continuously interacting with the aquatic environment indicates the potential for adverse effects on HCP species.

The risks and mechanisms of take associated with fish screen operation are variable depending on the type of screen design in question. Small, temporary screen structures employing passive debris clearing (e.g., T-screens on temporary pump intakes) or continuous active debris clearing (e.g., low velocity water jets or mechanical brushes) have minimal effect on the aquatic environment. Operational risk of take for these types of screens is generally considered to be low, providing that the structures are adequately maintained. Large in-channel fish screens pose additional risk of take from the operation of active debris-clearing and bypass systems.

Both in-channel and off-channel fish screens produce some noise, visual, and physical disturbance when in operation. Some in-channel screen designs, typically the larger systems associated with large industrial or agricultural water intake systems, incorporate hydraulic jet or air burst debris-clearing systems that are activated periodically. The related disturbance is intermittent in frequency and short-term in duration. Stressor response is expected to vary depending on the sensitivity of the species exposed, with the most extensive effects involving behavioral alteration and habitat avoidance. Under a worst-case scenario, the long-term operations of these types of systems would be associated with a high risk of take for HCP species that are sensitive to low-level disturbance (e.g., hearing specialists species such as suckers and dace), while species that are relatively insensitive (i.e., HCP invertebrates) would be expected to experience an insignificant risk of take.

Off-channel screens generally create disturbance that is more continuous in nature. For example, motorized rotating barrel screens or designs with mechanical debris-clearing systems produce continuous underwater noise, splashing, and visual disturbance during operation. The level of disturbance produced is generally expected to be limited to levels associated with behavioral avoidance, or potential habituation. Risk of take resulting from these stressors varies by species and life-history stage. Species such as HCP invertebrates that are insensitive to disturbance would be expected to face an insignificant risk of take. In contrast, fish species that become habituated to continuous disturbance may experience auditory masking effects that result in increased vulnerability to predation or reduced foraging success. These effects are associated with a high risk of take for hearing specialist species such as cyprinids (which include HCP dace, chub, and suckers). This risk is minimized by the fact that off-channel screens produce this stressor primarily in an artificially constructed environment (the diversion channel). This means that exposure would occur only for those species that are entrained into and occupy the diversion channel for extended periods. Hearing generalist species, such as salmonids, would be expected to be less sensitive to these effects. Because off-channel screens are configured to limit loitering by organisms drawn into the head ditch, exposure to these stressors will be limited and are therefore associated with a low risk of take.

Both in-channel and off-channel fish screens pose some unavoidable risk of entrainment or impingement of aquatic organisms when in operation. Risk of impingement is a function of screen design, operation, and maintenance, and the swimming ability of the HCP species in question. In general, this impact mechanism is associated with a high risk of take due to the potential for mortality and injury. It is necessary to qualify this risk against the level of take that would likely occur from unmitigated entrainment of organisms into unscreened intakes or diversions. A lessened probability of impingement or entrainment with fish screens is preferable to entrainment into unscreened diversions.

For certain species, specifically those with planktonic life-history stages, entrainment of free-floating eggs or larvae may simply be unavoidable if they are in the water column when an intake or diversion is in operation. HCP species that are likely to be in proximity to screens during their juvenile life-history stage, and/or are small in body size as adults have a high risk of impingement. The needs of weak-swimming organisms may not be fully accommodated by current screen design criteria. Given the potential for direct injury or mortality for small individuals, entrainment or impingement on fish screens must be equated with a high risk of take. Operational entrainment risk may also occur due to site-specific design limitations, or poor performance due to improper maintenance.

While a high risk of take rating is appropriate based on entrainment risk, the actual potential for population-level effects varies considerably by species, and should be considered when assessing impacts. For example, considerable numbers of Olympia oyster larvae may be entrained by a screened intake structure, but the resulting risk of take may be insignificant relative to natural larval mortality rates. In such a case, even though larval mortality may occur, the actual effect on population productivity would likely be insignificant. In contrast, the same intake may entrain larval lingcod at rates that greatly exceed natural mortality, suggesting the potential for significant population-level effects.

Fish species that come into proximity with fish screens only as large adults are less likely to experience impingement due to their stronger swimming ability. Research has demonstrated that many fish species, including HCP species such as bull trout, can withstand short periods of screen impingement with no apparent ill effects. Low-motility HCP invertebrate species (e.g., Olympia oyster, freshwater mussels) are unlikely to come into contact with fish screens as adults. Risk of take for these species/life-history stages from entrainment is rated as insignificant.

Bypass system operation can create circumstances take could occur. Organisms inhabiting or transiting bypass channels can become stranded when the intake and screen is shut off and the channel is dewatered. In the absence of flowing water, stranded organisms may be exposed to rapidly increasing or decreasing temperatures, creating the risk of injury or mortality from thermal stress, increased predation exposure, and lack of forage. This potential equates to a high risk of take, with the recognition that this risk can be limited through screen design and operation. Rapid dewatering of bypass channels that are recognized to provide habitat functions for aquatic species of interest is not permitted. Bypass flows are often maintained in these channels to support beneficial habitat functions.

9.4.3.3 Hydraulic and Geomorphic Modifications

The hydraulic and geomorphic effects of fish screens are expected to be relatively modest in comparison to the intake or diversion structure they are associated with, but some level of effect may result from fish screens themselves. The magnitude of hydraulic and geomorphic impacts, resulting stressors, and risk of take vary depending on the scale and placement of the screen in question.

In many cases, the design parameters of fish screens provide a means for controlling diversion flows, limiting diversion rates that exceed water rights. This provides a mechanism for preservation of base flows that may negate the influence of bypass system operation on base flow conditions.

Small end-of-pipe screens on temporary pump intakes are expected to have little if any measurable hydraulic and geomorphic effect in most settings. They have little potential to alter flow conditions, channel geometry, or substrate composition (Schille 2008). The resulting risk of take associated with this type of structure is expected to be insignificant.

Large permanent bankline or end-of-pipe screens may require placement of significant structures, with shoreline armoring and other forms of erosion protection. This presents the potential for a broader range of hydraulic and geomorphic effects and a greater risk of take. However, these requirements are considered to be components of the intake or diversion system with which the screen is associated. The related effects and resulting risk of take are therefore considered also to be the result of the intake or diversion, rather than of the screen.

Off-channel screens, which are typically intended for long-term use, can cause permanent and continuous changes in flow regime, channel geometry, and substrate composition and stability in the bypassed reach, especially if flow-mediated vegetation encroachment changes the trajectory of channel evolution. If these effects are extensive, they can alter the productivity of the affected habitat for spawning, foraging, rearing, refuge, and other uses by HCP species. In cases where hydraulic and geomorphic modifications are extensive, a broad array of research has demonstrated that detrimental effects on survival, growth, and fitness are likely to occur for many of the HCP species that occur in riverine environments. Effects of this nature equate to a high risk of take, with the recognition that the circumstances where this is likely to occur are rare.

9.4.3.1 Ecosystem Fragmentation

In-channel fish screens have the potential to produce ecosystem fragmentation effects in specific circumstances. Intakes employing bankline screens in marine environments, lakes, and large rivers are commonly located in embayments. Because there is little or no available hydraulic head to operate bypass systems in embayments, aquatic organisms drawn into the intake must be pumped or lifted into bypass systems. HCP species with planktonic eggs and larvae may be drawn into these embayments by the intake and either retained or bypassed by the screen. Bypass systems have their own inherent potential to cause injury and mortality. From a worst-case scenario perspective, this type of screen could also impose ecosystem fragmentation effects if organisms drawn into the embayment area cannot be effectively bypassed, or if they are repeatedly bypassed and drawn back into the intake system. These effects are associated with a high risk of take.

Off-channel fish screens have the potential to impose barrier conditions that could potentially lead to take of HCP species. Fish screens may unintentionally delay or otherwise hinder passage of migrants due to design limitations. A fish screen may delay or affect passage of only certain species, and may place unintended selection pressures on affected populations that limit or alter phenotypic diversity. Screens may entrain more organisms or create passage barriers over time, if improperly designed for the conditions or if maintenance is neglected.

Although the overall effects of fish screens on fish passage are relatively minor in comparison to the effects imposed by the flow control structures and channel modifications associated with water diversions and withdrawals, the long-term nature of fish screen effects is consistent with a high risk of take.

Fish screens could have an effect on HCP invertebrate species if the screens affect the migration and productivity of host-fish populations.

In rivers, limitations imposed by screens on upstream fish passage may result in long-term decreases in food web productivity through reduced delivery of nutrients derived from allochthonous sources. The overall extent of this effect due to fish screens is expected to be small relative to the related flow control structures. The risk of take associated with this impact mechanism is expected to be insignificant. Upstream transport of nutrients is not relevant in marine and lacustrine environments.

Fish screens designs that collect debris in troughs for disposal, or that divert water into bypass channels that require maintenance clearing, may modify the downstream transport of woody debris. The actual amount of wood and organic debris trapped on fish screens is not likely to represent a significant proportion of the natural flux. The incremental effect of the fish screen is likely to be minor in comparison to the flow control structure or channel modification associated with the water diversion. Because the extent of this effect on the environment is not quantified, the associated risk of take is unknown.

9.4.3.2 Riparian Vegetation Modifications

Installation of bankline in-channel screens and all off-channel screen types may result in some level of riparian vegetation modification to install the bypass system. The scale of the bypass system may range from a simple pipe with erosion protection at the outfall, to excavation of an artificial channel. The extent of effects on riparian vegetation, and the resulting risk of take, is expected to vary depending on the scale of the screen and bypass system in question. Piped diversion systems associated with modular off-channel screens on small diversions would not be expected to have extensive effects on riparian vegetation. The resulting risk of take associated with these designs would be expected to range from insignificant to low. Excavation of artificial bypass channels to support large off-channel or bankline screens would be expected to have potentially significant effects on riparian vegetation, resulting in a high risk of take.

9.4.3.1 Water Quality Modifications

Fish screen operation has a limited capacity to affect water temperatures through riparian vegetation modification. The extent of riparian vegetation modification associated with the fish screen structures is expected to be limited. Riparian modification associated with bypass channel creation should be considered a component of intake or diversion development and/or artificial channel creation instead. Piped bypass systems are more arguably attributable to the fish screen system, but the magnitude of riparian vegetation modification associated with these structures is expected to be limited. On this basis, the temperature effects resulting from this impact mechanism are expected to be similarly limited and the related risk of take insignificant relative to the effects of flow diversion.

Bypass channel operation that results in dewatering and stranding can result in increased water temperatures and decreased dissolved oxygen. In a worst case scenario, when operation of bypass systems (i.e., rapid dewatering) exposes organisms in bypass channels to stranding, the combination of higher temperatures and lower dissolved oxygen levels can increase the likelihood of injury or lethality. This is equated with a high risk of take. Rapid dewatering is not permitted in channels that are known to be used as rearing habitat by aquatic organisms. Fish screens are otherwise expected to have limited influence on dissolved oxygen, and the risk of take is insignificant.

Construction of fish screens may result in short-term impacts due to elevated suspended sediments through the use of heavy equipment, materials placement, dredging and fill, and rewatering of exclusion areas. Given the potential for short-term injury or mortality resulting from elevated suspended sediment levels associated with construction, a high risk of take must be assumed.

The construction of fish screen structures may in some cases lead to the temporary alteration of pH levels. Many fish screens are constructed using concrete, a material that produces caustic leachate while curing. This stressor is equated with a high risk of take.

Fish screens could introduce toxic substances into the aquatic environment through accidental spills from heavy equipment during construction and maintenance, and through failure of mechanical equipment (i.e., debris-clearing systems) during operations. Depending on the nature and concentration of the contaminant, toxic substance exposure can cause a range of adverse effects on exposed species. In extreme cases, these effects can include direct mortality (e.g., exposure of nonmotile larvae to fuel spills). More commonly, intermittent low-level exposure to a variety of contaminants is likely to cause physiological injury and/or contaminant bioaccumulation, leading to decreased survival, growth, and fitness. This presents a moderate risk of take.

Table 9-18. Species- and habitat-specific risk of take for mechanisms of impact associated with in-channel fish screens.

Species	Construction & Maintenance Activities			Operations			Water Quality Modifications			Riparian Vegetation Modifications			Hydraulic & Geomorphic Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	H	H	H	H	H	H	H	H	L	L	L	I	I	I
Coho salmon	H	H	H	H	L	H	H	L	H	L	U	L	I	I	I
Chum salmon	H	H	I	H	H	I	H	H	I	L	L	I	I	I	I
Pink salmon	H	H	I	H	H	I	H	H	I	L	L	I	I	I	I
Sockeye salmon	H	H	H	H	L	H	H	L	H	L	U	L	I	I	I
Steelhead	H	H	H	H	L	H	H	L	H	L	U	L	I	I	I
Coastal cutthroat trout	H	H	H	H	L	H	H	L	H	L	U	L	I	I	I
Redband trout	H	N	H	H	N	H	H	N	H	I	N	L	I	N	I
Westslope cutthroat trout	H	N	H	H	N	H	H	N	H	I	N	L	I	N	I
Bull trout	H	H	H	H	L	H	H	L	H	L	L	L	I	I	I
Dolly Varden	H	H	H	H	L	H	H	L	H	L	L	L	I	I	I
Pygmy whitefish	H	N	H	H	N	H	H	N	H	I	N	I	I	N	I
Olympic mudminnow	H	N	H	H	N	H	H	N	H	I	N	I	I	N	I
Lake chub	H	N	H	H	N	H	H	N	H	I	N	I	I	N	I
Leopard dace	H	N	H	H	N	H	H	N	H	L	N	L	I	N	I
Margined sculpin	H	N	H	H	N	H	H	N	H	I	N	I	I	N	I
Mountain sucker	H	N	H	H	N	H	H	N	H	L	N	L	I	N	I
Umatilla dace	H	N	H	H	N	H	H	N	H	L	N	L	I	N	I
Pacific lamprey	H	H	H	H	H	H	H	L	H	L	I	L	I	I	I
River lamprey	H	H	H	H	H	H	H	L	H	L	U	L	I	I	I
Western brook lamprey	H	N	H	H	N	H	H	N	H	I	N	I	I	N	I
Green sturgeon	N	H	N	N	L	N	N	L	N	N	I	N	N	I	N
White sturgeon	H	H	H	H	L	H	H	L	H	L	I	L	I	I	I
Longfin smelt	H	H	H	H	H	H	H	H	H	I	I	L	I	I	I
Eulachon	H	H	N	H	H	N	H	H	N	I	I	N	I	I	N
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Surf smelt	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Pacific herring	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Lingcod	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Pacific cod	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Pacific hake	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Walleye pollock	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Black rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Bocaccio rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Brown rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Canary rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
China rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N

	Construction & Maintenance Activities			**Operations**			**Water Quality Modifications**			**Riparian Vegetation Modifications**			**Hydraulic & Geomorphic Modifications**		
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**
Copper rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Greenstriped rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Quillback rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Redstripe rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Tiger rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Widow rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Yelloweye rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Yellowtail rockfish	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Olympia oyster	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Northern abalone	N	H	N	N	H	N	N	H	N	N	L	N	N	I	N
Newcomb's littorine snail	N	H	N	N	N	N	N	L	N	N	L	N	N	I	N
Giant Columbia River limpet	H	N	H	I	N	I	M	N	N	L	N	N	I	N	N
Great Columbia River spire snail	H	N	H	I	N	I	M	N	N	L	N	N	I	N	N
California floater (mussel)	H	N	H	H	N	H	M	N	I	L	N	N	I	N	N
Western ridged mussel	H	N	H	H	N	H	M	N	M	L	N	N	I	N	I

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.

Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-19. Species- and habitat-specific risk of take for mechanisms of impact associated with off-channel fish screens.

Species	Construction & Maintenance Activities			Operations			Water Quality Modifications			Riparian Vegetation Modification			Hydraulic & Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	L	L	L	H	H	H	H	H	H	L	L	L	H	I	I	I	I	I
Coho salmon	L	L	L	H	L	H	H	L	H	L	U	L	H	I	I	I	I	I
Chum salmon	L	L	I	H	H	I	H	H	I	L	L	I	H	I	I	I	I	I
Pink salmon	L	L	I	H	H	I	H	H	I	L	L	I	H	I	I	I	I	I
Sockeye salmon	L	L	L	H	L	H	H	L	H	L	U	L	H	I	I	I	I	I
Steelhead	L	L	L	H	L	H	H	L	H	L	U	L	H	I	I	I	I	I
Coastal cutthroat trout	L	L	L	H	L	H	H	L	H	L	U	L	H	I	I	I	I	I
Redband trout	L	N	L	H	N	H	H	N	H	I	N	L	H	N	I	I	N	I
Westslope cutthroat trout	L	N	L	H	N	H	H	N	H	I	N	L	H	N	I	I	N	I
Bull trout	L	L	L	H	L	H	H	L	H	L	L	L	H	I	I	I	I	I
Dolly Varden	L	L	L	H	L	H	H	L	H	L	L	L	H	I	I	I	I	I
Pygmy whitefish	L	N	L	H	N	H	H	N	H	I	N	I	H	N	I	I	N	I
Olympic mudminnow	L	N	L	H	N	H	H	N	H	I	N	I	H	N	I	I	N	N
Lake chub	L	N	L	H	N	H	H	N	H	I	N	I	H	N	I	I	N	I
Leopard dace	L	N	L	H	N	H	H	N	H	L	N	L	H	N	I	I	N	I
Margined sculpin	L	N	L	H	N	H	H	N	H	I	N	I	H	N	I	I	N	I
Mountain sucker	L	N	L	H	N	H	H	N	H	L	N	L	H	N	I	I	N	I
Umatilla dace	L	N	L	H	N	H	H	N	H	L	N	L	H	N	I	I	N	I
Pacific lamprey	L	L	L	H	I	H	H	L	H	L	I	L	H	I	I	I	I	I
River lamprey	L	L	L	H	H	H	H	L	H	L	U	L	H	I	I	I	I	I
Western brook lamprey	L	N	L	H	N	H	H	N	H	I	N	I	H	N	I	I	N	I
Green sturgeon	N	L	N	N	I	N	N	L	N	N	I	N	N	I	N	N	N	N
White sturgeon	L	L	L	H	I	H	H	L	H	L	I	L	I	I	I	N	N	N
Longfin smelt	L	L	L	H	H	H	H	H	H	I	I	L	H	I	I	I	I	I
Eulachon	L	L	N	H	H	N	H	H	N	I	I	N	H	I	N	I	I	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	Construction & Maintenance Activities			Operations			Water Quality Modifications			Riparian Vegetation Modification			Hydraulic & Geomorphic Modifications			Ecosystem Fragmentation		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	L	N	L	I	N	I	H	N	N	L	N	N	H	N	I	?	N	I
Great Columbia River spire snail	L	N	L	I	N	I	H	N	N	L	N	N	H	N	I	?	N	I
California floater (mussel)	L	N	L	H	N	H	H	N	H	L	N	N	H	N	I	I	N	I
Western ridged mussel	L	N	L	H	N	H	H	N	H	L	N	N	H	N	I	I	N	I

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take;
? = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

9.4.4 Flow Control Structures

Flow control projects are typically designed with the intent of withdrawing water and/or modifying the hydraulic and hydrologic characteristics to promote human uses of the aquatic environment and the surrounding landscape. These projects lead to a fundamental alteration of ecological processes. They impose a range of direct and indirect effects on the environment, resulting in an array of ecological stressors, during both the construction phase and over the course of operation. The magnitude of these stressors varies depending on the scale of the project in question and the degree to which it modifies ecological conditions and processes.

Flow control structures include the following:

Dams are a significant form of hydromodification that impose broad and pervasive effects on riverine environments. Dam projects range in scale from the relatively modest on small stream systems to immense projects on large river systems, such as the Mossy Rock Dam on the Cowlitz River or the Grand Coulee Dam on the Columbia River. Dams are channel spanning structures that create upstream impoundments. These structures impose stressors on aquatic organisms through a range of impact mechanisms and fundamentally alter the characteristics of riverine ecosystems, and in some cases lacustrine ecosystems (e.g., where dams are created at lake outlets). The hydrologic and water quality effects of dams can extend to marine ecosystems as well.

Weirs include both temporary and permanent structures constructed to control the movement of water, sediments, or organisms in riverine and floodplain environments. Flow control weirs create impoundments or divert streamflow and act similar to a dam. The risk of take analysis for weirs focuses on the worst-case scenario: permanent, typically concrete structures that span the entire channel and create a barrier to fish passage.

Dikes and levees are extensive hydromodifications designed to prevent flooding in low-lying landscapes, and to protect and promote human uses. By preventing regular tidal or floodwater inundation, these structures facilitate the conversion of wetland, floodplain, or estuarine habitats for terrestrial uses such as agriculture and development.

Outfalls discharge water or effluent.

Water diversion and water intake structures include a broad range of designs with purposes ranging from municipal and irrigation water diversions, to power plant and industrial water intakes, to hatchery water supply systems. Structure designs associated with these types of facilities can range from bankline intake systems oriented parallel to the shoreline in any environment type, to dam or weir type diversion structures in river systems oriented perpendicular to streamflow.

Tide gates and flood gates are structures designed to facilitate the flow of water out of floodplain, wetland, or estuarine habitats, as well as manage or prevent the reflooding of these lands by tidal fluctuations or flood flows. Tide gates and flood gates range in scale from simple, corrugated metal culverts with metal or fiberglass flap gates buried in dikes, to larger, more complex wood or concrete structures with mechanically controlled gates. They are typically incorporated into dikes and levees to promote the conversion of these habitat types into terrestrial or modified aquatic environment types for human uses. In some cases, tide gates are used to manage habitat conditions within an impounded area to support recreational fish and wildlife populations, but in many cases these structures are intended to facilitate the conversion of estuarine or floodplain wetlands to terrestrial habitats for agricultural or industrial uses.

Risk of take is rated for each species by impact mechanism and environment type (i.e., riverine, marine, and lacustrine) in Tables 9-20 through 9-25. The summary risk of take presented in the narrative and the matrices represents the greatest overall risk of take for the category.

9.4.4.1 Dams and Weirs

9.4.4.1.1 Construction and Maintenance

Construction, operation, and maintenance of dams involve a diverse array of activities that can impose a variety of environmental stressors on HCP species occurring in riverine and lacustrine environments. Construction and maintenance may include such activities as heavy equipment operation, materials placement, pile driving, and flow bypass and dewatering around work areas. The majority of construction and maintenance activities are temporary in nature, lasting from a few days to several weeks, depending on the size of the project and the nature of the activity. In the case of large dams, however, construction and maintenance activities may last for months or even years, with continuous activity occurring throughout. The risk of take associated with construction activity varies by impact mechanism and is dependent on the project-specific magnitude of that impact mechanism. Some mechanisms may produce a high risk of individual take due to their intensity, while others may result in a low risk of take due to their limited magnitude and duration.

Construction-related effects during dam removal must also be considered. Many of the activities associated with dam removal, such as equipment use, materials placement, and visual, noise, and physical disturbance, are similar to those imposed during construction. However, the dewatering of impoundments creates the potential for unique effects in the form of stranding in dewatered areas that must be considered when evaluating risk of take.

Applying a worst-case scenario perspective, the largest weirs may be comparable in scale to smaller dams, implying that the construction-related impacts would also be similar.

The construction, operation, and maintenance of dams will result in some alteration of the underwater noise environment. The nature of this habitat modification will vary depending on the phase of the project. During construction and maintenance, intense sources of underwater noise such as pile driving, materials placement, or in-water equipment operation may create short-term pulses of high intensity sound pressure. Auditory masking effects caused by continuous noise sources that alter the ambient noise level (e.g., from extended operation of construction and maintenance vessels, in-water equipment use, or spillway and turbine operation) may affect the ability of fish to detect predators and prey, affecting their survival, growth, and productivity.

The construction of dams requires the operation of heavy equipment and the placement of materials in and around aquatic habitats and adjacent terrestrial habitats, including riparian zones and floodplains. In-water use of equipment and the placement of materials impose stressors in the form of physical and visual disturbance. The magnitude of these stressors will vary widely, depending on the scale of the project in question and the specific construction measures used. Applying a worst-case-scenario perspective, the magnitude of these stressors can be significant.

Construction-related bank, channel, and shoreline disturbance could result in decreased stream bank and shoreline stability, as well as increased erosion and turbidity. Motile fish species would be expected to experience only temporary behavioral alteration and low risk of take. Less motile fish life-history stages or sessile invertebrates could experience a high risk of take due to mortality caused by smothering, as well as decreased growth and fitness due to the effects of high turbidity on foraging success.

Temporary dewatering and flow bypass with fish removal and relocation from work areas is a common and necessary practice during dam construction and maintenance. Even when dewatering is not required for construction and maintenance, exclusion areas are often created around the work sites to contain sediments and other pollutants and to reduce the magnitude of stressor exposure. This construction and maintenance activity poses a relatively high risk of take, depending on habitat and species and life-history stage-specific factors.

Dewatering and redirecting flow may pose a barrier to fish migration. Delays in migration can lead to adverse effects on spawning fitness, can increase exposure to predation and poaching, and can deny juvenile fish access to rearing habitats during critical periods. These effects constitute a moderate risk of take of HCP species with migratory life-history stages.

Dewatering is also associated with dam removal. Once a dam is breached, the impoundment behind the structure will drain. Aquatic species in the impoundment trapped in rapidly dewatering habitats face risk of mortality from stranding, particularly non-motile species and life-history stages. Motile species able to avoid stranding will be displaced from existing habitats and forced to relocate within disturbed habitats that may present limited foraging opportunities, which could similarly limit survival, growth, and fitness. It is generally presumed that care will be taken during dam removal to dewater slowly, reducing stranding risk. Consistent with a worst-case scenario approach, however, this activity must be associated with a high risk of take, particularly for non-motile species and life-history stages.

9.4.4.1.2 Hydraulic and Geomorphic Modifications

Dams impose significant changes in the hydraulic and geomorphic characteristics of riverine and lacustrine environments, and can modify the characteristics and suitability of the affected habitats for HCP species adapted to riverine environments. The impact mechanisms associated with dams are complex, even before considering the complexity of the responses of HCP species to stressor exposure. Therefore, we view the risk of take in a holistic fashion. With the exception of altered flow regime, the mechanisms of impact, stressors, and related risk of take from hydraulic and geomorphic modifications associated with weir development are similar to those for dams.

Dams fundamentally alter flow regime, channel geometry, and substrate composition and stability by converting a flowing water environment upstream of the structure to a slack water impoundment, altering the hydrologic regime and interrupting the transport of wood, sediment, and organic material. Downstream of the structure, alteration of flow regime and reduced transport of LWD and sediment from upstream sources are likely to lead to changes in channel morphology, with detrimental effects on habitat structure. Operational water level fluctuations may also affect habitat productivity, creating risk of stranding for non-motile fish life-history stages and invertebrates, which is likely to lead to mortality. All of these effects that dams impose on ecosystem structure and function are interrelated, as is the risk of take. These effects alter habitat suitability for fish and invertebrate species adapted to the original environmental condition and affect the survival, growth, and fitness of many of the HCP species that occur in riverine environments. In some cases, these effects have been shown to limit productivity at the population level, depending on the nature of the facility and the species affected. The long-term alteration of flow regime, channel geometry, and substrate composition and stability equates to a high risk of take.

The effects that dams impose on the connectivity between surface water and groundwater are complex and change over time. Most dams are designed to be relatively impermeable at their base to prevent the loss of impounded water to groundwater. However, the large hydraulic head created by dams can, in some cases, increase groundwater exchange, resulting in increased hyporheic flow to downstream reaches. Over time, however, the accumulation of fine sediments in the impoundment decreases bed permeability and retards groundwater exchange. Changes in flow regime, sediment transport, and substrate composition will all affect in-channel hyporheic exchange as well. The effects on survival, growth, fitness, and productivity caused by long-term alteration of hyporheic exchange equate to a high risk of take.

9.4.4.1.3 Ecosystem Fragmentation

Ecosystem fragmentation is a significant and multifaceted component of the effects that dams impose on the aquatic environment. Weirs have similar effects, but to a lesser degree. Because weirs are not intended to create impoundments, the fragmentation of longitudinal connectivity associated with these structures is restricted to effects on the passage of fish and other organisms, as well as the downstream transport of LWD and organic material. Similarly, there is a lesser effect on community composition. The effects and related risks of take from altered longitudinal connectivity, altered river-flood plain connectivity, altered LWD transport, and altered groundwater-surface water interactions are otherwise similar.

The predominant effect of dams is the fragmentation of longitudinal connectivity of the river continuum. Dams interrupt the downstream transport of water, wood, sediment, and organic material, and, depending on design and scale, may also prevent the upstream and downstream movements of migratory fish and invertebrates. The impoundment also creates a lentic habitat that is discontinuous within the riverine landscape, capable of altering temperature, nutrient loading, and food web productivity. These changes to longitudinal connectivity equate to a high risk of take.

Dams can cause a significant alteration in the connectivity of the river system to floodplain and terrestrial habitats. In the impoundment, the channel, floodplain, and portions of the surrounding valley are inundated. Depending on site-specific topography, the natural gradient between the river and floodplain is replaced by a steeper ecological gradient between the new aquatic and surrounding terrestrial habitat. This gradient may be quite abrupt if impoundment management causes extreme water level fluctuations, creating simplified habitat conditions at the impoundment margin that are not suitable for rearing, spawning, refuge, or other important life-history requirements. In downstream habitats, changes in flow regime and sediment starvation may lead to channel degradation, causing fragmentation of the main channel from off-channel and floodplain habitats. The connectivity between river and floodplain habitats is reduced over a broad range of flow conditions. In smaller rivers and streams, dams also affect water temperature, with further effects on river–floodplain connectivity, decreasing the influence of stream shading and altered ambient temperatures in downstream reaches. A number of HCP species are dependent on off-channel and floodplain habitats during one or more life-history stage. A reduction in the availability of suitable habitat will lead to increased competition for the remaining available habitat, decreased growth and fitness, increased exposure to predation, and potentially decreased availability of suitable spawning sites. While these effects primarily concern fish, invertebrate species such as mussels would also be affected due to reduced productivity of host fish populations. These changes to river-floodplain connectivity equate to a high risk of take.

Dams interrupt the transport of LWD along the longitudinal gradient in riverine environments. Modification of the flow regime in downstream reaches and channel downcutting caused by sediment starvation may also lead to lateral river-floodplain fragmentation, which could limit the recruitment in downstream reaches, further starving the channel of LWD. The hydraulic and geomorphic effects of reduced LWD density in the channel network can lead to further alterations in habitat complexity. Reduced LWD presents a potential risk of take for a broad range of species dependent on riverine aquatic ecosystems through a variety of species-specific stressors. Depending on the particular life history of the affected species, alterations in habitat complexity may limit the availability of suitable spawning, resting, and rearing habitat, and may alter foraging opportunities and predation exposure. In general, fish species that are dependent on habitats potentially affected by changes to LWD are likely to experience decreased spawning success and/or decreased survival, growth, and fitness due to an overall reduction in suitable habitat area. These changes equate to a high risk of take.

The conversion of riverine habitats from lotic to lentic environments upstream of dams, and alterations of flow and thermal regime both upstream and downstream of the structure can lead to changes in community composition within the riverine ecosystem. By creating lentic habitats and altering downstream habitat complexity and water quality conditions, dams may create suitable conditions for a range of species that would not otherwise be able to survive in the undisturbed system. For example, impoundments create warm water habitats that promote the growth of emergent vegetation, creating habitat conditions suitable for warm water fish (e.g., bass, perch, and sunfish) that would not normally survive in a flowing river with naturally cool temperatures. These species may compete with juvenile salmonids for food resources, or may prey on them directly, affecting their survival, growth, and productivity. By causing reductions in downstream habitat complexity and interrupting the transport of coarse particulate organic matter, dams may indirectly cause a shift in macroinvertebrate community structure, affecting food web diversity. This may in turn limit foraging opportunities for HCP species exposed to this stressor, affecting survival, growth, and fitness. The effects of altered community structure on HCP species are complex and variable depending on the nature of the changes and how these species interact with the altered environment. From an ecological perspective, alterations in community structure are generally viewed as negative overall, even though effects on individual species can be negative, positive, or neutral. Applying a worst-case scenario perspective, the effects must be viewed as negative because of the potential for adverse effects on survival, growth, and fitness of any native species within the affected environment. Because these effects are effectively permanent or at least long term on the scale of the life of the structure, they are equated with a high risk of take.

9.4.4.1.4 Riparian Vegetation Modifications

Dams alter the extent to which riparian vegetation influences temperature in riverine environments. By greatly expanding the surface area, impoundments limit the shading and ambient temperature buffering influence of the riparian zone upstream of the dam. In downstream reaches, alterations in riparian vegetation characteristics and channel morphology caused by the effects of dams can alter the influence of vegetation on stream temperatures, allochthonous inputs to the riverine ecosystem, and the influence of riparian vegetation on habitat complexity.

The mechanisms of impact, stressors, and related risk of take from riparian vegetation modifications associated with weir development are similar to those described for dams, but occur to a lesser degree.

Water temperatures in riverine systems suitable for dams are less influenced by localized shading and ambient air temperature than by the combined effects of basin conditions in upstream areas. The risk of take associated with temperature changes due to removal of riparian vegetation is variable, depending on the nature of the project and the type of environment in which it is implemented. Using the worst-case scenario perspective, the effects of altered stream temperatures must be equated with a high risk of take due to the long-term nature of the habitat alteration and the potential effects on survival, growth, and fitness of HCP species.

Dam projects may cause intermediate-term alteration of riparian conditions in downstream reaches when vegetation is removed. Once riparian vegetation is established adjacent to the modified channel bank, instability is likely to decrease, unless downcutting caused by sediment starvation leads to long-term instability. The risk of take from increased turbidity associated with riparian vegetation removal varies; motile fish experience only temporary behavioral alteration and a low risk of take. Less motile fish life-history stages or sessile invertebrates could experience a moderate to high risk of take from decreased survival due to substrate sedimentation and smothering, as well as decreased growth and fitness due to the effects of high turbidity on foraging success.

Removing riparian vegetation for a dam, and the associated loss of allochthonous production near the mouth of a large river will produce related stressors of potentially lower magnitude than a dam on a small, higher elevation stream. On smaller streams, a localized reduction in food web productivity might result, leading to decreased foraging opportunities, decreased overall habitat suitability, and decreased growth and fitness. This equates to a moderate risk of take for a range of HCP species that are dependent on riverine rearing conditions.

Altered habitat complexity due to riparian vegetation removal equates to a moderate risk of take, which applies broadly across all exposed species.

9.4.4.1.5 Aquatic Vegetation Modifications

Dams and weirs can modify the aquatic vegetation community through the effects of the structure on hydraulic and geomorphic conditions in riverine ecosystems, through the alteration or elimination of vegetation in the construction footprint, through changes from a lotic to a lentic environment suitable for the establishment of emergent vegetation, and by providing colonization opportunities for invasive species. However, aquatic vegetation is a relatively minor component of the ecological structure of riverine and lacustrine systems in Washington State. Aside from native emergent vegetation confined to a relatively narrow range of depths, a large portion of aquatic vegetation species in rivers and lakes are invasive species. Moreover, once the channel has adjusted to the presence of the structure, the aquatic vegetation community would be expected to recover to some extent. The risk of take resulting from altered autochthonous production and altered habitat complexity is expected to be low to moderate depending on the species-specific sensitivity to these impacts.

9.4.4.1.6 Water Quality Modifications

Dams have significant and pervasive effects on water quality conditions. Dam construction is a large undertaking, involving a number of water quality effects such as increased sedimentation, alteration of pH, and the potential introduction of toxic substances to surface waters. Once in place, the ecological fragmentation imposed by the structure, changes in biogeochemical processes that occur within the impoundment, and the effects of hydraulic and geomorphic modification on downstream reaches can in turn result in a number of changes in water temperature and chemistry. Sources of water quality modification resulting from weir development are associated primarily with project construction and include increases in suspended sediments and turbidity, altered pH levels, and the introduction of toxic substances, and are similar to those described for dams.

Dams result in the long-term alteration of the aquatic temperature regime in riverine predominantly by converting riverine habitats to lacustrine environments exposed to increased insolation. Impoundments tend to stratify during summer months, significantly increasing water in the impoundment temperatures. Depending on how dams are constructed and operated, they can also significantly alter downstream temperatures. Dams that spill water from surface layers of the impoundment during summer months when the impoundment is stratified may cause significant increases in downstream temperatures. Dams that release flows drawn from deeper, cold water layers of the reservoir may create downstream temperatures that are significantly cooler than the natural temperature range. Temperature effects will persist for the life of the structure and have the potential to affect the survival, growth, and fitness of HCP species, equating to a high risk of take.

Dams can lead to alterations in the concentration of dissolved oxygen and other gases in surface waters through decreased dissolved oxygen concentrations caused by eutrophication in the impoundment and potentially surface waters downstream of the dam, and through supersaturation of dissolved gases (predominantly DO, but also nitrogen). If dissolved oxygen concentrations drop below optimal levels, fish will begin to exhibit stress and avoidance behavior. DO concentrations below tolerance thresholds, or depressed DO in combination with elevated water temperatures, may be sufficient to cause mortality, particularly for less-motile life-history stages. Gas supersaturation can occur from the extreme turbulence created by spillways and other dam structures. Sufficient exposure to supersaturated conditions can cause mortality under laboratory conditions, and gas bubble disease, which has been shown to cause injury to juvenile salmonids, is known to occur *in situ*. Less specific information is available regarding the effects of depressed DO levels on invertebrate HCP species. Mussels are known to be intolerant of low DO levels, while the sensitivity of other species is less certain. Given the predilection of all freshwater mollusk HCP species for flowing water environments, however, it is reasonable to conclude that these species are adapted to environments with relatively high natural DO levels. Therefore, depression of DO levels caused by eutrophication in impoundments would be considered a likely adverse effect. Both increased and decreased DO levels can lead to adverse effects on survival, growth, and fitness of fish populations exposed to these conditions. The collective effects of dams on dissolved oxygen conditions will last for the lifetime of the structure. Therefore, they must be equated with a high risk of take.

Dams can alter turbidity during construction and while the channel adjusts to the new hydraulic and hydrologic regime imposed by the hydromodification. Dams can lead to a reduction in natural suspended sediment loading downstream of the structure, because impoundments encourage settling of fine sediments transported from upstream. Eutrophication in impoundments may elevate turbidity levels in the impoundment, which would be transported to downstream reaches. On balance, the long-term risk of take from changes in suspended sediments and turbidity caused by dams will be variable depending on site-specific conditions. However, given the potential for short-term injury or mortality resulting from elevated suspended sediment levels associated with construction, a high risk of take must be assumed for HCP species that occur in suitable riverine and lacustrine environments.

Dams may provide a mechanism for the accumulation of contaminated sediments within the impoundment, due to their tendency to capture fine sediments and the tendency of certain contaminants to sorb to small organic and inorganic particles. In general, these sediments are sequestered and typically become capped as new layers of sediment recruitment are deposited in the impoundment. However, these sediments may be released into the environment during maintenance dredging, or during eventual dam removal. This could result in the release of large volumes of contaminated material over a relatively short period of time, in combination with high levels of suspended sediments overall. Beyond the effects of suspended sediment loading, exposure to toxic substances in contaminated sediments can lead to effects on the survival, growth, and fitness of exposed species. These effects would be expected to be short term and acute in duration and are therefore equated with a moderate risk of take.

Dams that are constructed of concrete can lead to the alteration of pH levels through concrete leachate released to surface waters from runoff or curing surfaces. This effect is typically short-term in nature and moderates as the concrete cures. If adequate procedures are not in place to protect against this water quality impact, this effect is equated with a high risk of take with potential exposure over a short-term period.

Within impoundments, conditions can be favorable for eutrophication, which can significantly alter pH and DO levels. CO_2 combines with water in solution to form carbonic acid, which measurably decreases pH. Photosynthesis by aquatic vegetation and phytoplankton leads to decreased CO_2 and increased DO during daylight hours, while respiration causes the opposite effect after dark. In eutrophic systems, phytoplankton blooms and subsequent die-offs of aquatic vegetation and plankton can cause a rapid spike in respiration, which rapidly depletes DO levels and increases CO_2. These changes can lead to pH fluctuations within the impoundment that may exceed effects thresholds for certain HCP species. In combination with depleted DO, elevated temperatures, and other water quality effects imposed by impoundments, this stressor could cause behavioral avoidance, increased stress and physiological injury, or even mortality to HCP species adapted to cold water and high DO environments with relatively stable pH conditions. In certain impoundment environments, altered pH conditions could occur chronically on a seasonal or annual basis over the life of the structure, and could be limiting to the survival, growth, fitness, and/or spawning productivity of HCP species living within or migrating through the affected environment. Therefore, these effects would be equated with a high risk of take.

Dam projects present multiple pathways for the introduction of a range of toxic substances to the aquatic environment, primarily through construction activities and, in some cases, the use of treated wood materials in the structure. Dams may also indirectly encourage pollutant and nutrient loading by supporting the development of additional infrastructure and expanded recreational vessel use in the impoundment. Depending on the nature and concentration of the contaminant, toxic substance exposure can cause a range of adverse effects in exposed species. In extreme cases, these effects can include direct mortality (e.g., exposure of immobile lamprey ammocoetes buried in bottom substrates, fish exposed to accidental vessel spills in enclosed embayments). More commonly, chronic, low-level exposure to a variety of contaminants is likely to cause physiological injury and/or contaminant bioaccumulation, leading to decreased growth and fitness. This presents a moderate risk of take to species potentially exposed to this stressor.

9.4.4.2 Dikes and Levees

Extensive in size and pervasive in effect, dikes and levees impose a number of ecological stressors on the environment through essentially permanent alteration of habitat and water quality conditions. HCP species occurring in environments modified by these types of structures will typically experience a high risk of take from one or more impact mechanisms.

9.4.4.2.1 Construction and Maintenance

The construction of dikes and levees uses heavy machinery, places extensive fill, and the removes riparian vegetation throughout the length of the project. Maintaining these structures includes similar activities, at a lesser magnitude and scale, at an annual to decadal frequency.

The operation of heavy construction equipment to build or maintain dikes and levees imposes stressors in the form of physical and visual disturbance of bank and channel habitat, and, potentially, increased underwater noise from in-water equipment use and materials placement. The magnitude of these stressors varies widely, depending on the scale of the project in question and the specific construction measures used. Applying a worst-case-scenario perspective, the magnitude of these stressors can be significant.

Bank, channel, and/or shoreline disturbance during the construction and maintenance of dikes causes short-term water quality impacts, as well as long-term (essentially permanent) modification of hydraulic and geomorphic conditions and ecosystem connectivity. The short-term water quality effects of channel and bed disturbance may lead to behavioral and physiological stress on species or life-history stages exposed to the disturbance, or may limit the availability and suitability of habitats for sensitive life-history stages during critical periods. Non-motile species exposed to these stressors may face immediate effects on survival if occupied habitats are eliminated, or may experience injury or mortality from related water quality effects. These effects would be equated with a moderate to high risk of take, depending on species-specific sensitivity.

The effects of temporary dewatering and flow bypass during construction and maintenance of dikes and levees are equated with a high risk of take.

9.4.4.2.2 Hydraulic and Geomorphic Modifications

Dikes and levees may cause a significant modification of hydraulic and geomorphic processes. These effects are effectively permanent, given the longevity of these structures and the tendency for valuable property improvements and infrastructure to develop landward of them.

Dikes and levees alter flow conditions in riverine environments by preventing the flooding of adjacent terrestrial and riparian habitats, concentrating high flows in the stream channel, accelerating flow velocity and erosive forces. Reduced floodplain storage of water in hydromodified areas may induce flooding in reaches upstream and downstream of the structure in areas where flooding otherwise would not occur. The effects of altered flow conditions on HCP species are complex and variable, depending on the position of the hydromodification in the riverine environment and how the affected habitats are used by HCP species. In a worst-case scenario, these pervasive, long-term effects would be expected to reduce habitat suitability for species utilizing the affected environment, limiting individual survival, growth, and fitness and overall population productivity. This equates to a high risk of take.

Dikes and levees change channel geometry and substrate composition and stability. They are often built in conjunction with channel straightening and simplification to accelerate the flow of water through the landscape, to facilitate the conversion of this land to human uses. Substrate composition and stability can be altered through the loss of sources of sediment recruitment and altered sediment transport capacity. These habitat alterations are essentially permanent and continuous, and can lead to changes in the productivity of the habitat for spawning, forage, rearing, and refuge. In a worst-case scenario, these effects can lead to reduced spawning success, reduced survival, growth, and fitness for species and life-history stages dependent on the affected habitat. This equates to a high risk of take.

Dikes and levees can alter groundwater and surface water exchange in the project area and downstream. This has the potential to affect juvenile and/or adult survival, growth, and fitness, and in some cases the spawning productivity of a range of species. Because this effect will be pervasive and essentially permanent, this mechanism is generally equated with a moderate to high risk of take for species exposed to this stressor, depending on species-specific life-history characteristics.

Hydraulic and geomorphic effects waterward of a dike or levee in a river delta or estuary can alter bathymetry, current patterns, circulation patterns, salinity, and tidal exchange, potentially altering desirable habitat types.

9.4.4.2.3 Ecosystem Fragmentation

Dikes and levees can fragment ecological connectivity between aquatic and terrestrial environments. By aiding the conversion of low-lying floodplain and wetland habitats to terrestrial uses, these structures sharpen the gradient between the aquatic and terrestrial landscape.

In riverine environments, dikes and levees reduce the structural complexity of instream habitat by changing the channel geometry and influencing the recruitment, transport, and retention of sediments and LWD. Such simplification reduces habitat complexity, leads to reduced food web productivity, and reduces availability of habitats suitable for HCP species. Because these effects are extensive and effectively permanent, this impact mechanisms equates to a high risk of take for HCP species.

Dikes and levees purposefully disconnect of floodplain and off-channel habitats from the riverine ecosystem. This disconnects the stream channel from important sources and sinks of organic matter, nutrients, and pollutants. Such disconnection may limit food web productivity, affecting the survival, growth, and fitness of any species dependent on the riverine environment for rearing. In addition, this loss of connectivity may limit the availability of important habitat types for HCP species. The reduction in suitable refuge and foraging habitat area increases competition for remaining habitat, predation risk, and risk of displacement to habitats unfavorable for rearing. Collectively, these long-term ecological stressors pose a high risk of take for HCP species that occur in the affected riverine environment.

Dikes and levees could potentially be built in lacustrine or marine environments, for example in river deltas. Such projects prevent access to habitats and facilitate their conversion for terrestrial uses. The associated risk of take is strongly linked to species-specific dependence on floodplain, nearshore, or estuarine environments. In the case of organisms with a planktonic life-history stage, the effects of dikes and levees may limit the dispersal and retention of eggs and larvae to areas suitable for rearing. Habitat fragmentation caused by dikes and levees in the lacustrine or marine environment would be expected to affect the survival, growth, and fitness of affected species, as well as the overall population productivity. These effects are associated with a high risk of take because they are essentially permanent.

9.4.4.2.4 Riparian Vegetation Modifications

Riparian vegetation is often removed to create dikes and levees. Once the structures are established, vegetation is often managed to prevent the degradation of structural integrity caused by root penetration. Using the worst-case scenario perspective, in riverine systems, the effects of altered stream temperatures, altered allochthonous inputs, and altered habitat complexity associated with removal of riparian vegetation are equated with a high risk of take due to the long-term nature of the habitat alteration and the potential effects on survival, growth, and fitness of HCP species.

In marine environments, altered allochthonous inputs and altered habitat complexity are likely to affect the survival, growth, and fitness of those HCP species dependent on the nearshore environment. This equates to a high risk of take for species with demonstrable dependence on these habitats because these effects will be long term in duration.

9.4.4.2.5 Aquatic Vegetation Modifications

Newcomb's littorine snail is found only on *Salicornia* spp. (glasswort) in saltmarsh environments. Dike or levee projects that convert saltmarsh environments for terrestrial uses would effectively eliminate the only habitat used by this obligate species. This equates to a high risk of take, based on the dependence of the species on nearshore aquatic vegetation and the effectively permanent nature of the habitat modification.

9.4.4.2.6 Water Quality Modifications

Sources of water quality modification associated with dikes and levees include increased suspended sediments and the potential introduction of toxic substances during project construction, as well as the effects of riparian and hydraulic and geomorphic modification on stream temperatures, similar to the effects and risks of take associated with dams.

9.4.4.3 Outfalls

Outfalls are commonly relatively small in scale and have relatively limited physical effects on the aquatic environment in comparison to other types of flow control structures. However, outfalls are a significant source of potential take because they facilitate the delivery of nutrients and pollutants to surface waters.

9.4.4.3.1 Construction and Maintenance

The construction of outfalls typically involves disturbance of bank and shoreline habitat to place the outfall structure and related erosion protection at the outlet. In lacustrine and marine environments, outfall construction may extend through the littoral zone to place the outlet below the water surface, preventing beach erosion. Regardless of configuration, outfall construction involves the use of heavy equipment to place the structure.

Underwater noise effects would likely be insufficient to cause direct injury, meaning that stressor response would likely be limited to short-term disturbance and behavioral modification. Stressor exposure of this magnitude is equated with a low to moderate risk of take, depending on the size scale of the structure in question.

In a worst-case scenario, outfall construction may include in-water equipment use and material placement or significant disturbance of the bank/shoreline. These activities could result in potential injury or mortality of HCP species having sessile or non-motile life-history stages. These effects are equated with a high risk of take. Motile species or life-history stages would experience temporary disturbance and displacement, potentially affecting survival, growth, and productivity. These effects are equated with a moderate risk of take.

Outfall construction may require temporary dewatering and/or flow bypass during construction. Creation of exclusion areas, fish removal and relocation, and work area dewatering/flow bypass are all activities with the potential to cause injury or mortality to HCP species. These effects are equated with a high risk of take.

9.4.4.3.2 Hydraulic and Geomorphic Modifications

The effects of hydraulic and geomorphic modifications caused by outfalls in riverine environments are relatively limited because these structures are typically located on the stream bank and have a relatively small footprint. A broad array of riverine habitat types may be considered suitable for outfall projects. Therefore, effectively all riverine species and life-history stages could be exposed to stressors and experience a resulting risk of take due to hydraulic and geomorphic modification caused by outfalls.

Outfalls in rivers can alter hydraulic and geomorphic conditions through altered channel geometry, altered flow regime, and altered substrate composition, but because outfall size is typically relatively limited, the magnitude of the effects caused by individual outfall projects is not likely sufficient to affect HCP species survival, growth, and fitness at a large scale. Therefore, the resulting risk of take associated with these effects is likely to be moderate.

Outfalls in the marine environment are typically more extensive structurally than those in lacustrine and riverine environments. Marine outfalls typically extend from upland habitats through the littoral zone and discharge into subtidal habitats. These projects modify hydraulic and geomorphic conditions in the nearshore marine environment, resulting in the imposition of several impact mechanisms and related stressors. The risk of take resulting from these impact mechanisms is strongly linked to species-specific dependence on the nearshore environment.

Outfall structures that are exposed (whether by design or unintentionally) could potentially attenuate wave energy, alter localized circulation patterns, interrupt longshore sediment transport, alter sediment supply or alter substrate composition. This equates to a high risk of take for species that are dependent on nearshore habitats due to the long-term existence of outfall structures.

Outfalls change fresh water inputs to the nearshore marine environment, and may carry undesirable pollutants leading to degradation of water quality. The alteration in freshwater inputs imposed by outfalls is viewed to be an ecologically undesirable effect that is long term in duration, potentially leading to reduced survival, growth, and fitness. This equates to a high risk of take for species experiencing stressor exposure.

In lakes, the effects of outfalls on wave energy, current, and circulation patterns are equated with a high risk of take for species that are dependent on these habitats during some phase of their life history. Applying a worst-case scenario perspective, an exposed outfall could cause long-term alteration of substrate conditions in the vicinity of the structure. This equates to a high risk of take for species that are dependent on these habitats due to effects on the survival, growth, and productivity of exposed life-history stages given the long-term nature of stressor exposure.

9.4.4.3.3 Ecosystem Fragmentation

The degree to which outfalls cause ecosystem fragmentation in riverine environments is limited. Outfalls in riverine environments are typically located on the bank and discharge at the edge of the stream channel. If concentrated discharge of stormwater or effluents create a dilution zone with water quality conditions that are sufficiently unfavorable to cause avoidance behavior, and if this mixing zone extends across a majority of the channel, it could impose a barrier to fish passage. This would represent fragmentation of longitudinal connectivity. Depending on the duration and frequency of the effect, this could deny access to productive habitats, potentially limiting the survival, growth, fitness, and productivity of affected populations. Under a worst-case scenario, this effect would equate to a high risk of take.

The risk of take from ecosystem fragmentation caused by outfalls in marine or lacustrine environments ranges from insignificant (e.g., for buried outfall pipes with discharge points located far offshore) to high (e.g., for exposed outfalls or outfall pipes that create a perpendicular barrier and causing hydraulic and geomorphic modifications of the nearshore environment).

9.4.4.3.4 Riparian Vegetation Modifications

In general, outfalls would be expected to have a relatively limited effect on riparian vegetation because their onshore footprint is relatively small. However, should the structure impose extensive hydraulic and geomorphic effects that alter bank stability, effects on riparian vegetation could be more extensive. In general, outfall structures are not expected to be associated with bank erosion to a degree that would cause widespread losses of riparian vegetation; therefore, effects would be expected to be intermediate-term in nature as riparian vegetation adjusts to changing conditions. The risk of take associated with stressors resulting from this impact mechanism is expected to be moderate.

9.4.4.3.5 Aquatic Vegetation Modifications

The effects of outfalls on aquatic vegetation from project construction are expected to be relatively minor given the limited footprint of these structures. Over time, however, these structures may modify the aquatic vegetation through their effects on hydraulic and geomorphic processes, as well as on water quality conditions.

In lakes and rivers, modification of the submerged aquatic vegetation community would typically be limited to the footprint of the structure, and possibly the effects of effluent on vegetation growth. Assuming that effluent concentrations are managed properly, the effects of outfalls on autochthonous productivity and habitat structure would be expected to be minor, and are equated with an insignificant risk of take.

In marine systems, buried outfall pipes discharging offshore may have a limited effect on the aquatic vegetation community following recovery from construction impacts. In contrast, exposed outfall pipes may affect vegetation community structure through hydraulic and geomorphic effects imposed on the nearshore environment. Outfall discharges may cause alteration of the aquatic vegetation community through the introduction of toxics or through eutrophication induced by nutrient loading. Alterations of the submerged aquatic vegetation community through reduction in aerial extent or conversion to other habitat types (e.g., conversion of eelgrass habitat to algae and kelp) can reduce the productivity of these habitats for dependent life-history stages. Applying a worst-case scenario perspective, outfalls could result in the long-term alteration of the nearshore aquatic vegetation community through their effects on habitat structure and water quality. This equates to a high risk of take for species dependent on these habitats due to long-term effects on spawning productivity, as well as larval survival, growth, and fitness.

9.4.4.3.6 Water Quality Modifications

Outfalls deliver pollutants into surface waters. Stormwater and effluent discharges may contain a variety of toxic substances or other pollutants, including PAHs, metals, agricultural chemicals, and nutrients. Alteration of water quality conditions is associated with long-term detrimental effects on the survival, growth, and fitness of aquatic species exposed to the component stressors. Eutrophication caused by nutrient inputs may ultimately lead to decreased DO levels and altered pH conditions, also having potential effects on the survival, growth, and fitness of aquatic receptors. Exposure to these stressors is equated with a high risk of take based on the potential for long-term, chronic exposure.

9.4.4.4 Intakes and Diversions

For the purpose of assessing the risk of take, a worst-case scenario perspective is applied. In riverine environments, the worst-case scenario design is a cross-channel type diversion structure similar to a dam or a weir. In marine and lacustrine environments, the worst-case scenario design is a bankline structure similar in magnitude to large tide gates or similar structures.

9.4.4.5 Tide Gates and Flood Gates

For the purpose of assessing risk of take, a worst-case scenario perspective is taken.

9.4.4.5.1 Construction and Maintenance

Tide gate construction usually takes place in environments that are already highly modified by dikes and levees. Degraded channel and bank conditions may not present suitable habitat for HCP species and life-history stages that would otherwise occupy the affected environment. Therefore, while the risk of take ratings are representative of the effects of stressor exposure, the potential for stressor exposure is likely to be more limited than in more pristine environments. Tide gates present a smaller magnitude of risk due to the smaller size of the construction footprint.

Due to the potential for injury and mortality, the risk of take associated with underwater noise is rated as high for species with life-history stages that occur in environments suitable for tide gates. However, the potential for stressor exposure is more limited because tide gate construction would typically be expected to be more limited and to take less time than dam construction.

In a worst case scenario, tide gate construction and maintenance may involve in-water work, including equipment use and material placement. These activities could result in potential injury or mortality of HCP species occurring in the vicinity that have sessile or non-motile life-history stages. These effects are equated with a high risk of take. Motile species or those with motile life-history stages would experience temporary disturbance and displacement, potentially affecting survival, growth, and productivity. These effects are equated with a moderate risk of take.

In a worst case scenario, tide gate construction may require significant disturbance of the bank/shoreline and substrate, degrading habitat conditions in the affected habitat and resulting in the release of suspended sediments. These activities could result in potential injury or mortality of HCP species having sessile or non-motile life-history stages. These effects are equated with a high risk of take. Motile species or those with motile life-history stages would experience temporary disturbance and displacement, potentially affecting survival, growth, and productivity. These effects are equated with a moderate risk of take.

Creation of exclusion areas, fish removal and relocation, and work area dewatering/flow bypass are all activities with the potential to cause injury or mortality to HCP species, and are equated with a high risk of take.

9.4.4.5.2 Hydraulic and Geomorphic Modifications

Alteration of tidal and/or floodwater exchange is the primary way tide gates impose their effects on aquatic systems. Tide gates concentrate and thereby accelerate the rate at which floodwaters drain from inundated habitats. This change in flow regime may cause the displacement of small or relatively non-motile species adapted to slow-water environments. Accelerated flows draining the wetland and stream system caused by the installation of a dike and flood gate system could lead to the displacement of Olympic mud minnows, potentially to a riverine environment with unsuitable habitat conditions. In such special cases, mortality would be likely, and would be equated with a high risk of take, but this stressor would be considered a relatively minor component of the overall impacts of the conversion of floodplain wetland habitat into a managed terrestrial habitat.

Tide gates and flood gates alter channel geometry and alter substrate composition. The structure can force scouring, deposition, and simplification of channel structure by changing inundation frequency and flow velocities in channel networks landward of the structure. By encouraging sedimentation of the channel network over time, distributary channels and ponds gradually fill and become terrestrial habitat (or are converted to managed ditches that are dredged). This alters the habitat suitability and productivity for HCP species adapted to this type of environment, and these effects will be long term and progressive in nature. This is equated with a high risk of take, with this stressor considered to be one component of the broader risk of take resulting from the conversion of aquatic habitat into a managed terrestrial environment.

Waterward of the structure, high-velocity flows out of the tide gate can cause localized scour, mobilizing fine sediments and changing the bed composition. These effects would be limited in scale to a relatively small area, and would occur in an already-modified channel. The additive risk of take is considered to be moderate for HCP species with life-history stages that occur in the affected environment.

9.4.4.5.3 Ecosystem Fragmentation

The purpose of tide gates is to facilitate the flow of water out of floodplain, wetland, or estuarine habitats, while preventing these lands from being reflooded by tidal exchange or flood waters. The alteration and conversion of habitats to conditions that are poorly suited for HCP species are the ultimate results within the zone of effect of the structure, and are long-term in duration. The essentially permanent modification of high-value habitats to unsuitable conditions equates to a high risk of take for those species dependent on these habitats during some portion of their life history.

9.4.4.5.4 Riparian Vegetation Modifications

Tide gate construction may require the permanent alteration of riparian vegetation within the footprint of the structure, as well as additional temporary modification of the surrounding habitat during construction. Tide gates are typically developed in environments where riparian conditions have already been extensively modified for dike and levee development; therefore, the actual risk of take associated with this impact mechanism may be insignificant in comparison to that imposed by the dike or levee.

9.4.4.5.5 Aquatic Vegetation Modifications

Aquatic vegetation modifications associated with tide gates are equated with a high risk of take for those HCP species dependent on floodplain, wetland, and estuarine marsh habitats during some portion of their life history, particularly species such as Newcomb's littorine snail that are obligate occupants of emergent saltmarsh vegetation. The effects of tide gates and flood gates on aquatic vegetation are compounded by water quality related effects exacerbated by the exposure of anaerobic sediments in floodplain and estuarine environments.

9.4.4.5.6 Water Quality Modifications

Tide gates alter the ambient water temperature in aquatic environments landward of the structure by limiting the exchange and flushing effects of tidal inundation and floodwaters. These effects occur predominantly in tidally influenced areas where the flushing effects of tidal exchange normally occur on a daily basis. In such circumstances, aquatic habitats landward of the structure would be expected to experience elevated water temperatures, particularly during summer months. Organisms exposed to chronic elevations in water temperatures beyond tolerance thresholds would be expected to experience reduced survival, growth, and fitness. Due to the essentially permanent nature of these effects, this is equated with a high risk of take.

Tide gates alter the salinity of surface waters upstream of the structure by preventing the tidal inflow of marine water, resulting in conversion to freshwater habitat over time. This conversion from estuarine or marine to freshwater habitat represents a fundamental alteration in habitat suitability for species adapted to the original habitat conditions. Because these effects will persist for the life of the structure, they are associated with a high risk of take for HCP species that utilize environments suitable for tide gate development.

Alteration of flow regime and inundation frequency in saltmarsh and wetland environments has been demonstrated to cause depleted oxygen conditions as organic matter in anoxic soils becomes exposed and available for aerobic decomposition. These combined effects have been demonstrated in saltmarsh ecosystems regulated by tide gates to deplete DO concentrations below levels sufficient to cause direct mortality of fish. Even in the absence of mortality, stress from DO depletion in combination with increased water temperatures and poor habitat suitability may lead to decreased survival, growth, and fitness of HCP species occurring within the modified habitat. Freshwater wetland environments would be expected to experience similar effects, where the operative physical, biological, and chemical processes are similar. Due to their long-term and progressive nature, these effects are equated with a high risk of take for species occurring in the affected environment.

Some tide gate and flood gate structures are built using concrete, a material capable of causing acute changes in surface water pH if appropriate best management practices are not employed during construction. Once a tide gate or flood gate is in place, the alteration in inundation frequency describe above can lead to the exposure of anaerobic sediments to open air. Oxidation of sulfides released from anaerobic sediments can in turn rapidly reduce the pH of surface waters. This effect is well documented in the literature in natural systems, and may be compounded in environments that are undergoing a conversion to terrestrial habitat imposed by a dike/tide gate system. Rapid reductions in pH are capable of causing physiological stress, injury, and mortality in many fish and invertebrate species. Therefore, this is equated with a high risk of take.

Tide gate and flood gate construction may introduce toxic substances from accidental spills. Once a tide gate or flood gate is in place, the processes enabled when anaerobic sediments are exposed to oxidation can release potentially toxic substances into the aquatic environment. Decreased surface water pH and altered redox conditions in exposed soils can cause rapid leaching of toxic metals, including aluminum, cadmium, copper, and silver into the water column. Decreased pH can, in some cases, produce rapidly precipitating iron flocs capable of smothering wildlife and vegetation. Water quality modifications initially occur landward of the structure but can extend beyond the dike into the nearshore environment as the altered surface water drains during low tide or low streamflow conditions. These kinds of effects are well documented in natural systems and may be compounded in environments that are undergoing a relatively rapid conversion to terrestrial habitat imposed by a dike/tide gate system. Exposure to dissolved metals and floc precipitates can impose physiological stress, injury, and mortality on HCP species exposed to these stressors. These stressors may also weaken or kill aquatic vegetation, altering habitat structure and suitability for organisms dependent on these habitat types. Due to the potential for direct mortality and the intermediate to long-term nature of these effects, this is equated with a high risk of take.

Table 9-20. Species- and habitat-specific risk of take for mechanisms of impacts associated with dams.

	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**
Chinook salmon	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Coho salmon	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Chum salmon	H	N	I	H	N	I	H	N	I	H	N	I	M	N	I	H	N	I
Pink salmon	H	N	I	H	N	I	H	N	I	H	N	I	M	N	I	H	N	I
Sockeye salmon	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Steelhead	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Coastal cutthroat trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Redband trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Westslope cutthroat trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Bull trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Dolly Varden	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Pygmy whitefish	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Olympic mudminnow	N	N	N	H	N	H	H	N	H	N	N	N	N	N	N	N	N	N
Lake chub	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Leopard dace	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Margined sculpin	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Mountain sucker	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Umatilla dace	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Pacific lamprey	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
River lamprey	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Western brook lamprey	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White sturgeon	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Longfin smelt	H	N	N	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N
Eulachon	H	N	N	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
California floater (mussel)	H	N	H	H	N	H	H	N	H	H	N	H	H	N	H	H	N	H
Western ridged mussel	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-21. Species- and habitat-specific risk of take for mechanisms of impacts associated with weirs.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	N	H	H	N	M	H	N	H	I	I	I	M	N	M	H	N	H
Coho salmon	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Chum salmon	H	N	I	H	N	I	H	N	I	H	N	I	M	N	I	H	N	I
Pink salmon	H	N	I	H	N	I	H	N	I	H	N	I	M	N	I	H	N	I
Sockeye salmon	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Steelhead	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Coastal cutthroat trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Redband trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Westslope cutthroat trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Bull trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Dolly Varden	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Pygmy whitefish	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Olympic mudminnow	N	N	N	H	N	H	H	N	H	N	N	N	N	N	N	N	N	N
Lake chub	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Leopard dace	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Margined sculpin	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Mountain sucker	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Umatilla dace	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Pacific lamprey	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
River lamprey	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Western brook lamprey	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White sturgeon	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Longfin smelt	H	N	N	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N
Eulachon	H	N	N	H	N	N	H	N	N	M	N	N	I	N	N	H	N	N
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Species	**Construction & Maintenance Activities**			**Hydraulic and Geomorphic Modifications**			**Ecosystem Fragmentation**			**Riparian Vegetation Modifications**			**Aquatic Vegetation Modifications**			**Water Quality Modifications**		
	Riverine	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb’s littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
California floater (mussel)	H	N	H	H	N	H	H	N	H	H	N	H	H	N	H	H	N	H
Western ridged mussel	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-22. Species- and habitat-specific risk of take for mechanisms of impacts associated with dikes and levees.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	H	H	H	H	M	H	H	H	H	H	M	M	H	M	H	H	H
Coho salmon	H	H	H	H	H	M	H	H	H	H	H	M	M	H	M	H	H	H
Chum salmon	H	H	I	H	H	I	H	H	I	H	H	I	M	M	I	H	H	I
Pink salmon	H	H	I	H	H	I	H	H	I	H	H	I	M	M	I	H	H	I
Sockeye salmon	H	H	H	H	H	M	H	H	H	H	H	M	M	H	M	H	H	H
Steelhead	H	M	H	H	?	M	H	?	H	H	?	M	M	?	M	H	M	H
Coastal cutthroat trout	H	H	H	H	H	M	H	H	H	H	H	M	M	H	M	H	H	H
Redband trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Westslope cutthroat trout	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Bull trout	H	H	H	H	H	M	H	H	H	H	H	M	M	H	M	H	H	H
Dolly Varden	H	H	H	H	H	M	H	H	H	H	H	M	M	H	M	H	H	H
Pygmy whitefish	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Olympic mudminnow	N	N	N	H	N	H	H	N	H	N	N	N	N	N	N	N	N	N
Lake chub	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Leopard dace	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Margined sculpin	H	N	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Mountain sucker	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Umatilla dace	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Pacific lamprey	H	I	H	H	I	M	H	I	H	H	I	M	M	I	M	H	I	H
River lamprey	H	H	H	H	H	M	H	H	H	H	H	M	M	H	M	H	H	H
Western brook lamprey	H	N	H	H	N	M	H	N	H	H	N	M	M	N	M	H	N	H
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N
White sturgeon	H	?	H	H	?	M	H	?	H	H	?	M	M	?	M	H	?	H
Longfin smelt	H	H	N	H	H	N	H	N	N	M	I	N	I	?	?	H	H	N
Eulachon	H	H	N	H	H	N	H	N	N	M	I	N	I	?	N	H	H	N
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Surf smelt	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Pacific herring	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Lingcod	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**
Pacific cod	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Pacific hake	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Walleye pollock	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Black rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Bocaccio rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Brown rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Canary rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
China rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Copper rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Greenstriped rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Quillback rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Redstripe rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Tiger rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Widow rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Yelloweye rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Yellowtail rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Olympia oyster	N	H	N	N	H	N	N	N	N	N	I	N	N	I	N	N	H	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	H	N	N	H	N	N	H	N	N	H	N	N	N	N	N	L	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
California floater (mussel)	H	N	H	H	N	H	H	N	H	H	N	H	H	N	H	H	N	H
Western ridged mussel	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-23. Species- and habitat-specific risk of take for mechanisms of impacts associated with outfalls.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	H	H	M	H	H	H	H	H	I	I	I	I	H	I	H	H	H
Coho salmon	H	H	H	M	H	H	H	H	H	I	I	I	I	H	I	H	H	H
Chum salmon	H	H	I	M	H	I	H	H	I	I	I	I	I	H	I	H	H	I
Pink salmon	H	H	I	M	H	I	H	H	I	I	I	I	I	H	I	H	H	I
Sockeye salmon	H	H	H	M	H	H	H	H	H	I	I	I	I	H	I	H	H	H
Steelhead	H	M	H	H	?	H	H	?	H	H	?	I	I	?	I	H	?	H
Coastal cutthroat trout	H	H	H	M	H	H	H	H	H	I	I	I	I	H	I	H	H	H
Redband trout	H	N	H	M	N	H	H	N	H	I	N	I	I	N	I	H	N	H
Westslope cutthroat trout	H	N	H	M	N	H	H	N	H	I	N	I	I	N	I	H	N	H
Bull trout	H	H	H	M	H	H	H	H	H	I	I	I	I	H	I	H	H	H
Dolly Varden	H	H	H	M	H	H	H	H	H	I	I	I	I	H	I	H	H	H
Pygmy whitefish	H	N	H	M	N	H	H	N	H	I	N	I	I	N	I	H	N	H
Olympic mudminnow	H	N	H	M	N	H	H	N	H	I	N	I	N	N	N	H	N	H
Lake chub	H	N	H	M	N	H	H	N	H	I	N	I	I	N	I	H	N	H
Leopard dace	H	N	H	M	N	H	H	N	H	I	N	I	I	N	I	H	N	H
Margined sculpin	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Mountain sucker	H	N	H	M	N	H	H	N	H	I	N	I	I	N	I	H	N	H
Umatilla dace	H	N	H	M	N	H	H	N	H	I	N	I	I	N	I	H	N	H
Pacific lamprey	H	I	H	M	I	H	H	I	H	I	I	I	I	I	I	H	I	H
River lamprey	H	H	H	M	H	H	H	H	H	I	I	I	I	H	I	H	H	H
Western brook lamprey	H	N	H	M	N	H	H	N	H	I	N	I	I	N	I	H	N	H
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N
White sturgeon	H	?	H	H	?	M	H	?	H	H	?	I	M	?	M	H	?	H
Longfin smelt	H	H	H	M	H	H	H	H	H	I	I	I	I	?	I	H	H	H
Eulachon	H	H	N	M	H	N	H	H	N	I	I	N	I	?	N	H	H	N
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Surf smelt	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Pacific herring	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Lingcod	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Pacific cod	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Pacific hake	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Walleye pollock	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Black rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Bocaccio rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Brown rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Canary rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
China rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Copper rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Greenstriped rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Quillback rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Redstripe rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Tiger rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Widow rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Yelloweye rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Yellowtail rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Olympia oyster	N	H	N	N	H	N	N	N	N	N	I	N	N	I	N	N	H	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	I	N	N	H	N
Newcomb’s littorine snail	N	H	N	N	H	N	N	N	N	N	H	N	N	N	N	N	L	N
Giant Columbia River limpet	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	H	N	N
Great Columbia River spire snail	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	H	N	N
California floater (mussel)	H	N	N	M	N	N	H	N	M	H	N	N	M	N	N	H	N	N
Western ridged mussel	H	N	N	M	N	N	H	N	M	H	N	N	M	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-24. Species- and habitat-specific risk of take for mechanisms of impacts associated with diversion structures and water intakes.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Chinook salmon	H	H	H	H	H	H	H	H	H	H	I	I	M	H	M	H	H	H
Coho salmon	H	H	H	H	H	H	H	H	H	H	I	I	M	H	M	H	H	H
Chum salmon	H	H	I	H	H	I	H	H	I	H	H	I	M	M	I	H	H	I
Pink salmon	H	H	I	H	H	I	H	H	I	H	H	I	M	M	I	H	H	I
Sockeye salmon	H	H	H	H	H	H	H	H	H	H	I	I	M	H	M	H	H	H
Steelhead	H	M	H	H	?	H	H	?	H	H	?	I	M	?	M	H	?	H
Coastal cutthroat trout	H	H	H	H	H	H	H	H	H	H	I	I	M	H	M	H	H	H
Redband trout	H	N	H	H	N	M	H	N	H	H	N	I	M	N	M	H	N	H
Westslope cutthroat trout	H	N	H	H	N	M	H	N	H	H	N	I	M	N	M	H	N	H
Bull trout	H	H	H	H	H	H	H	H	H	H	I	I	M	H	M	H	H	H
Dolly Varden	H	H	H	H	H	H	H	H	H	H	I	I	M	H	M	H	H	H
Pygmy whitefish	H	N	H	H	N	M	H	N	H	H	N	I	M	N	M	H	N	H
Olympic mudminnow	N	N	N	H	N	H	H	N	H	N	N	N	N	N	N	N	N	N
Lake chub	H	N	H	H	N	M	H	N	H	H	N	I	M	N	M	H	N	H
Leopard dace	H	N	H	H	N	M	H	N	H	H	N	I	M	N	M	H	N	H
Margined sculpin	H	N	N	H	N	N	H	N	N	H	N	I	M	N	N	H	N	N
Mountain sucker	H	N	H	H	N	M	H	N	H	H	N	I	M	N	M	H	N	H
Umatilla dace	H	N	H	H	N	M	H	N	H	H	N	I	M	N	M	H	N	H
Pacific lamprey	H	I	H	H	I	M	H	I	H	H	I	I	M	I	M	H	I	H
River lamprey	H	H	H	H	H	M	H	H	H	H	I	I	M	H	M	H	H	H
Western brook lamprey	H	N	H	H	N	M	H	N	H	H	N	I	M	N	M	H	N	H
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N
White sturgeon	H	?	H	H	?	M	H	?	H	H	?	I	M	?	M	H	?	H
Longfin smelt	H	H	N	H	H	N	H	N	N	M	I	N	I	?	N	H	I	N
Eulachon	H	H	N	H	H	N	H	N	N	H	I	N	I	?	N	H	I	N
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Surf smelt	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Pacific herring	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Lingcod	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Pacific cod	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Pacific hake	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Walleye pollock	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Black rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Bocaccio rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Brown rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Canary rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
China rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Copper rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Greenstriped rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Quillback rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Redstripe rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Tiger rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Widow rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Yelloweye rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Yellowtail rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N
Olympia oyster	N	H	N	N	H	N	N	N	N	N	I	N	N	I	N	N	H	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Newcomb's littorine snail	N	H	N	N	H	N	N	H	N	N	H	N	N	N	N	N	L	N
Giant Columbia River limpet	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
Great Columbia River spire snail	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N
California floater (mussel)	H	N	H	H	N	H	H	N	H	H	N	H	H	N	H	H	N	H
Western ridged mussel	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-25. Species- and habitat-specific risk of take for mechanisms of impacts associated with tide gates.

	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**
Chinook salmon	H	H	H	H	H	H	H	H	H	I	I	I	M	H	M	H	H	H
Coho salmon	H	H	H	H	H	H	H	H	H	I	I	I	M	H	M	H	H	H
Chum salmon	H	H	I	H	H	I	H	H	H	I	I	I	M	H	I	H	H	H
Pink salmon	H	H	I	H	H	I	H	H	H	I	I	I	M	H	I	H	H	H
Sockeye salmon	H	H	H	H	H	H	H	H	H	I	I	I	M	H	M	H	H	H
Steelhead	H	H	H	H	?	H	H	?	H	I	?	I	M	?	M	H	M	H
Coastal cutthroat trout	H	H	H	H	H	H	H	H	H	I	I	I	M	H	M	H	H	H
Redband trout	H	N	H	H	N	H	H	N	H	I	N	I	M	N	M	H	N	H
Westslope cutthroat trout	H	N	H	H	N	H	H	N	H	I	N	I	M	N	M	H	N	H
Bull trout	H	H	H	H	H	H	H	H	H	I	I	I	M	H	M	H	H	H
Dolly Varden	H	H	H	H	H	H	H	H	H	I	I	I	M	H	M	H	H	H
Pygmy whitefish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Olympic mudminnow	H	N	H	H	N	H	H	N	H	I	N	I	M	N	M	H	N	H
Lake chub	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Leopard dace	H	N	H	H	N	H	H	N	H	I	N	I	M	N	M	H	N	H
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Mountain sucker	H	N	H	H	N	H	H	N	H	I	N	I	M	N	M	H	N	H
Umatilla dace	H	N	H	H	N	H	H	N	H	I	N	I	M	N	M	H	N	H
Pacific lamprey	H	I	H	H	I	H	H	I	H	I	I	I	M	I	M	H	M	H
River lamprey	H	H	H	H	H	H	H	H	H	I	I	I	M	H	M	H	H	H
Western brook lamprey	H	N	H	H	N	H	H	N	H	I	N	I	M	N	M	H	N	H
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N
White sturgeon	H	?	H	H	?	H	H	?	H	H	?	I	M	?	M	H	?	H
Longfin smelt	H	H	H	H	H	H	H	H	H	I	I	I	I	?	?	H	H	H
Eulachon	H	H	N	M	H	N	H	H	N	I	I	N	I	?	N	H	H	N
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Surf smelt	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Pacific herring	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Lingcod	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Ecosystem Fragmentation			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications		
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine
Pacific cod	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Pacific hake	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Walleye pollock	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Black rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Bocaccio rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Brown rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Canary rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
China rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Copper rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Greenstriped rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Quillback rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Redstripe rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Tiger rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Widow rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Yelloweye rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Yellowtail rockfish	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Olympia oyster	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	H	N
Newcomb's littorine snail	N	H	N	N	H	N	N	H	N	N	H	N	N	N	N	N	L	N
Giant Columbia River limpet	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
California floater (mussel)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Western ridged mussel	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

9.4.5 Habitat Modifications

Habitat modification projects are typically designed with the intent of promoting improvements in habitat conditions for a range of species. Once construction is completed, habitat modifications will not generally impose stressors that result in potential take. This position is predicated on two key assumptions: (1) the project in question has been conceived and designed with proper consideration of the broader ecosystem context in which it will be implemented; and (2) the project is constructed properly and performs as expected.

One exception is beaver dam removal, which is typically intended to address problematic flooding caused by beaver dams and not necessarily to improve habitat conditions. Another exception is woody debris removal, often promoted for the purpose of fish passage, flood protection, and infrastructure protection. These activities are expected to impose stressors that lead to possible take of HCP species.

Construction-related impacts will impose stressors on HCP species that may occur in the affected environment. The magnitude, timing, duration, and frequency of each impact mechanism will vary widely with the project scale and location. The risk of take assessment applies a "worst-case scenario" standard. This assessment is conditioned by the species occurrence and life-history specific uses of habitats. For example, beaver dam removal and in-channel/off-channel habitat creation do not occur in marine and lacustrine environments. Therefore, species and species life-history stages that occur only in these environments will not be exposed to related impact mechanisms and stressors, and there is no resulting risk of take. In contrast, large woody debris removal/placement/modification can occur in any environment type. Therefore, the risk of take in this case must be considered more broadly.

Tables 9-26 through 9-34 identify the risk of take for each of the 52 HCP species by impact mechanism and environment type. The summary risk of take presented in the narrative and the matrices represents the greatest overall risk of take for the category.

9.4.5.1 Beaver Dam Removal/Modifications

The removal or modification of beaver dams in Washington State is not intended to improve habitat conditions; instead, the purpose is to address flooding caused by the beaver dam impoundment or to avoid the potential for catastrophic dam failure with the potential to threaten infrastructure, property, or public health in downstream areas. Beaver dams are a normal constituent of riverine environments in the Pacific Northwest, so removing or modifying them alters natural habitat forming process that HCP species occurring in these environments have adapted to throughout their evolutionary history. Therefore, beaver dam removal would be expected to impose a number of stressors on aquatic species occurring in the affected environment, resulting in a broad potential for risk of take. Beaver dams occur only in riverine environments and associated habitats, so the risk of take resulting from removal applies only to riverine environments.

9.4.5.1.1 Construction Activities

Human activity and equipment operation during dam removal imposes stressors in the form of visual and physical disturbance in the vicinity of the structure. Levels of underwater noise produced by beaver dam removal are uncertain, but given the scale of work and tools used in comparison to known reference values for underwater construction activities, noise levels would not be expected to exceed tolerance thresholds capable of causing injury. Disturbance related to construction would be expected to cause behavioral modification, increased stress, and displacement, and could affect survival, growth, and productivity. This equates to a moderate risk of take.

Once a beaver dam is breached, the impoundment behind the structure will drain. Aquatic species in the impoundment that are trapped in rapidly dewatering habitats face a risk of mortality from stranding, particularly non-motile species and life-history stages. Motile species able to avoid stranding will be rapidly displaced from existing habitats and forced to relocate within disturbed habitat that may present limited foraging opportunities, which could similarly limit survival as well as growth and productivity. These combined stressors equate to a high risk of take for species that utilize beaver dam impoundments.

9.4.5.1.2 Hydraulic and Geomorphic Modifications

Beaver dam removal substantially modifies hydraulic and geomorphic conditions both in the impoundment area and the downstream reach. Following dam removal or modification, open water impoundment and wetland areas upstream of beaver dams will be converted into flowing water environments with unstable channels forming in the impoundment bed. The stream channel in the former impoundment area will seek to find an equilibrium condition. The channel will erode to a stable gradient within the fine sediment bed, creating unstable vertical banks with little or no riparian vegetation to provide root cohesion. These banks will remain in an unstable condition until sufficient erosion and vegetation growth has occurred. This will limit the availability of underbank habitat, and contribute chronic, fine sediment loading to the channel. In systems where sediment loading exceeds transport capacity, the detrimental effects of increased fines on substrate composition may persist for some time. These conditions typically result in poor habitat suitability for HCP species occurring in riverine environments where beaver dam removal is likely to occur, resulting in conditions that are limiting to survival, growth, fitness, and spawning productivity. Species exposed to these stressors face a moderate risk of take.

Beaver dams play an active role in hyporheic exchange in riverine environments. The hydraulic head created by the impoundments has been shown to cause downwelling upstream of the structure, which emerges in downstream areas. This vertical connectivity between surface and groundwater is associated with a number of important ecological processes, including the biogeochemical processing of nutrients and pollutants, and the creation of zones of upwelling that are preferential spawning habitats for salmonids and other species. Consequently, any activity that disrupts vertical connectivity will disrupt these processes, reducing water quality and affecting the availability of suitable habitats. These effects will limit the survival, growth, fitness, and in some cases spawning success. This represents a moderate risk of take for species utilizing these habitats

9.4.5.1.3 Ecosystem Fragmentation

On initial consideration, breaching of beaver dams may appear to improve longitudinal connectivity in riverine systems. Beaver dams represent a potential barrier to fish passage as well as a zone of hydraulic complexity which sequesters sediment, wood, organic material, and water. However, beaver dams are typically semipermeable and do not pose total barriers to fish passage. As a natural feature of the landscape, the hydraulic and structural complexity provided by beaver dams supports a broad array of species during different stages of their life history, including HCP species. The distribution of these features along a longitudinal gradient in riverine ecosystems is an important measure of ecological connectivity, particularly for species such as coho salmon that prefer slow water habitats like beaver ponds for rearing habitat. Altering the longitudinal connectivity of complex, diverse habitats in a riverine environment by draining beaver ponds represents a form of ecosystem fragmentation. Reducing the total area of suitable habitat and increasing the distance between habitat patches limits the abundance and productivity of affected populations, which represents a moderate risk of take.

The draining of beaver dam impoundments eliminates open water habitats and causes the channel system to withdraw from riparian and floodplain areas. Depending on where the stream channel stabilizes in the impoundment area, riparian habitats may be separated from the channel by open ground. This effect fragments the channel from floodplain habitats, reducing the connectivity between terrestrial and aquatic habitats which are highly productive. The reduced availability of these productive habitats may limit survival, growth, and fitness of those species that utilize the affected riverine habitats.

An additional related effect is the vulnerability of disturbed habitats to invasion by exotic plant species. Exposed impoundment beds are likely sites for colonization by invasive species. Once these species become established, they may create a barrier to riparian recovery and a dispersal source for additional colonization. Invasive species may reduce the suitability of floodplain and riparian habitat for refuge, food production, and other ecological functions. These effects would also be considered likely to limit the survival, growth, and fitness of species that utilize the affected riverine habitats.

Collectively, these stressors would be expected to impose a moderate risk of take on those HCP species occurring in the affected area.

9.4.5.1.4 Riparian Vegetation Modifications

Removing beaver dams weakens terrestrial-aquatic linkages, reducing riparian influence on stream channels. Until riparian vegetation can establish after dewatering, there will be reduced vegetation adjacent to the channel and thus decreased direct delivery of organic material to the channel. Impoundments can increase riparian vegetation downstream of the dam by augmenting floodplain groundwater, so removing beaver dams which impound a large cross section of the floodplain can affect downstream riparian functions by altering hyporheic flow.

Fragmented connectivity between the active channel and the riparian zone and reduced riparian productivity in downstream habitats lead to reduction in allochthonous inputs of insects, leaf litter, and LWD. This would reduce habitat suitability and food web productivity, limiting the survival, growth, and fitness of species dependent on the affected environment. This equates to a moderate risk of take.

9.4.5.1.5 Aquatic Vegetation Modifications

Draining beaver dam impoundments converts slack water habitats into flowing water, reducing the amount of habitat suitable for aquatic vegetation. Reduced aquatic vegetation results in the loss of autochthonous production and habitat structure within the affected reach. While these are unique stressors, they are considered to be a component of the broader effects of conversion from slack water to flowing water habitats, and the resulting ecological fragmentation. Therefore, they impose a similar moderate risk of take.

9.4.5.1.6 Water Quality Modifications

The literature on beaver dams and their removal is equivocal with regard to the potential effects on stream temperatures. Beaver dam impoundments are typically shallow, open water habitats that expose greater surface area to solar radiation, and therefore could have higher ambient temperatures on average than open stream channels. Removal of beaver dams may result in reduced stream temperatures which could benefit certain species such as native char that are cold water dependent. However, beaver dam impoundments may also serve moderate water temperatures within optimal ranges for aquatic species that co-evolved with beavers in riverine environments. Applying a worst-case scenario perspective, the removal of or modification of beaver dams is expected to modify stream temperatures unfavorably for the HCP species occurring in these environments, cause avoidance behavior, and otherwise limit the survival, growth, and fitness of exposed species. This equates to a moderate risk of take.

Beaver dam removal or modification mobilizes fine sediments deposited in the impoundment. This will increase suspended sediment levels within the affected area immediately upon dam removal, and for an extended period afterwards as the channel within the former impoundment erodes to a stable configuration. Bank erosion within the impoundment will continue to contribute fine sediment loading during high flow events until riparian vegetation growth provides sufficient root cohesion for bank stability. Short-term increases in suspended sediment loading following beaver dam removal could potentially reach concentrations high enough to cause injury or mortality to sensitive species and life-history stages in downstream environments, which equates to a high risk of take. Chronic sediment loading over time would be expected to alter habitat suitability, affecting foraging opportunities and behavior. These effects are potentially limiting to survival, growth, and fitness, which equates to a moderate risk of take.

Beaver dam impoundments sequester a variety of nutrients and pollutants. Research has demonstrated that the biogeochemical processes that are active in beaver dam impoundments can trap pollutants and render them less toxic. Draining the impoundment removes some portion of this capacity and has been shown to result in the relatively rapid release and transport of stored pollutants and nutrients to downstream environments. A large pulse of nutrients could cause temporary eutrophication that, depending on the nature of the downstream environment, could cause a relatively rapid decrease in dissolved oxygen levels. Acute exposure to nutrients or pollutants has the potential to cause injury or mortality, which represents a high risk of take.

9.4.5.2 Large Woody Debris Placement/Removal/Modifications

LWD projects may involve (1) the placement or repositioning of LWD to improve habitat conditions and the functioning of ecological processes, or (2) the removal of LWD from the aquatic environment to facilitate human uses. This latter type of project occurs most often in riverine environments. In the marine environment, LWD removal from structures such as jetties and breakwaters may interfere with eventual deposition of LWD in the littoral environment.

If LWD placement projects are properly designed for their ecological context, and function as intended, the impact mechanisms associated with the project would not be expected to impose stressors on aquatic species once construction is complete. In contrast, LWD removal projects have been shown to detrimentally affect ecological conditions, resulting in an ongoing risk of take. To assess take from LWD placement and removal, we assumed worst-case scenarios. Because the construction impacts for LWD placement projects are more extensive than those for removal, risk of take from construction activities is based on the stressors imposed by LWD placement. For the remaining impact mechanisms, risk of take is rated based on the effects of LWD removal.

9.4.5.2.1 Construction Activities

Construction of LWD projects may involve driving pilings, heavy equipment operation and materials placement, and work area dewatering. The majority of these activities are temporary in nature, lasting from a few days to several weeks, depending on the size of the project. The risk of take associated with construction activity varies by impact mechanism and is dependent on the project-specific magnitude of that impact mechanism. The risk of take resulting from construction also varies by the type of environment, the life-history stages exposed, and the intent of the project. For example, an engineered logjam in a riverine setting may have significant construction-related impacts but will produce an array of beneficial changes in habitat conditions. The risk of take associated with the project would be limited to those individuals that are in the river during construction. The impact mechanisms associated with beneficial changes in habitat conditions are presumed not to impose stressors leading to risk of take. In contrast, the removal of LWD from a stream system (e.g., to protect infrastructure) would involve impact mechanisms that impose stressors during construction, as well as from adverse changes in habitat characteristics.

The operation of heavy construction equipment and the physical placement or removal of LWD and other related materials imposes stressors in the form of increased underwater noise, as well as physical and visual disturbance. The magnitude of these stressors varies widely, depending on the scale of the project in question and the specific construction measures used. Applying a "worst-case-scenario" perspective, the magnitude of these stressors can be significant. For example, many engineered logjam designs include placement of timber or in some cases steel piles using either impact or vibratory hammers. Sound pressure from pile driving has the potential to cause injury and mortality.

Construction-related bank, channel, and shoreline disturbance could result in localized decreased stream bank and shoreline stability, as well as increased erosion and turbidity. These effects could recur during seasonal high-flow conditions. The risk of take depends on species-specific sensitivity to increased turbidity. More motile fish species experience only temporary behavioral alteration and a low risk of take. Less motile fish life-history stages or sessile invertebrates could experience a high risk of take from decreased survival due to mortality from substrate sedimentation and smothering, as well as decreased growth and fitness due to the effects of high turbidity on foraging success.

Temporary dewatering and fish handling pose a relatively high risk of take. Even with appropriate protocols and experienced field crews, high levels of mortality can result.

9.4.5.2.2 Hydraulic and Geomorphic Modifications

To assess take, we assumed that LWD placement projects are properly designed for the ecosystem context, and that the impact mechanisms imposed will result in beneficial changes in habitat conditions. Therefore, regardless of environment type, these impact mechanisms will produce no stressors and no resulting risk of take.

In contrast, we expect that hydraulic and geomorphic modification caused by LWD removal impose an array of impact mechanisms and related stressors. LWD removal projects in rivers often extensively modify the environment, imposing a number of stressors on those species that use these habitats. Risk of take depends on the size and scale of the project in question, and on species that use the area. The ratings represent the highest potential risk of take associated with LWD removal projects.

In rivers, LWD removal can change channel geometry, flow conditions, and substrate composition. Alteration of any of these habitat components can change the suitability of the habitat for various life-history stages of HCP species. These habitat alterations are essentially permanent and continuous, and can lead to changes in the productivity of the habitat for spawning, forage, rearing, and refuge. In a worst-case scenario, these effects are in turn likely to lead to reduced spawning success as well as reduced survival, growth, and fitness for species and life-history stages dependent on the affected habitat.

In the nearshore marine environment, although specific research data are lacking, anecdotal assessments suggest that LWD can modify local scale hydraulic and geomorphic conditions, affecting habitat structure and the quality and distribution of habitat patches. The risk of take resulting from removing LWD is strongly linked to species-specific dependence on the nearshore environment. Removing LWD can alter wave energy, altering water temperatures and the sorting and transport of sediments, and resulting in a moderate risk of take. Removing LWD can alter longshore transport of sediments, leading to localized alterations in substrate composition and stability, and resulting in a moderate risk of take.

In lacustrine environments, LWD can alter water temperatures, shoreline stability, and the accumulation of allochthonous and autochthonous materials, altering the suitability of nearshore habitats for those species dependent on these habitats, leading to decreased survival, growth, and fitness. This equates to a moderate risk of take for species that are dependent on these habitats during some phase of their life history. Removal of LWD can change the depositional environment by altering nearshore current and wave energy regimes, and by altering longshore sediment transport. This can lead to changes in substrate conditions that may be beneficial or detrimental to individual species. Because substrate composition is an important determinant of community structure in the lacustrine environment, these habitat changes can alter community structure and habitat suitability for those species dependent on the original habitat condition. This equates to a moderate risk of take for species that are dependent on these habitats due to effects on the survival, growth, and productivity of exposed life-history stages.

The hydraulic and geomorphic modifications caused by the removal of LWD from a stream channel can influence and alter groundwater and surface water exchange in the vicinity. This mechanism is generally equated with a moderate to low risk of take for species exposed to this stressor, depending on species-specific, life-history characteristics. Species with a moderate risk of take include those with life-history stages that are dependent on hyporheic exchange for its beneficial effects on water temperature and dissolved oxygen levels. Hyporheic exchange also plays a key role in nutrient cycling and food web productivity in alluvial bed rivers. Projects resulting in significant alteration of hyporheic exchange could adversely affect food web productivity, thereby limiting foraging opportunities for fish and invertebrate species dependent on these types of environments.

9.4.5.2.3 Ecosystem Fragmentation

In riverine systems, LWD removal can result in channel degradation and other forms of hydraulic and geomorphic modification leading to the disconnection of floodplain and off-channel habitats. This poses a moderate risk of take. The removal of LWD reduces the structural complexity of instream habitat, reducing the density and longitudinal distribution of habitat patches and leading to reduced food web productivity and the reduced availability of habitats suitable for those HCP species that occur in these environments. This impact mechanism equates to a moderate risk of take.

Marine and lacustrine environments are not as dominated as riverine environments by the longitudinal transport of water, sediment, and other materials, so the influence of LWD on ecological connectivity is less pronounced. LWD provides cover and organic substrate and has been shown to influence wave energy and sediment deposition in the surrounding environment, and to influence the stability of the boundary between the riparian and littoral zone. The removal of LWD may lead to simplification of the nearshore environment and reduced longshore connectivity of suitable habitat patches, and may alter connectivity along the gradient between the littoral and riparian environment. Reduced longshore connectivity of suitable habitats may lead to increased stress, increased predation risk, and reduced foraging opportunities for juvenile Chinook, chum, and pink salmon, and other species that utilize the nearshore environment during early life-history stages. Exposure to these stressors may limit survival, growth, and fitness, which would equate to a moderate risk of take. Fragmentation of riparian and littoral connectivity may equate to a similar level of risk. For example, LWD accumulations have been shown to promote littoral vegetation growth, and riparian vegetation has been demonstrated to influence incubation success in forage fishes. Alteration of the connectivity between the littoral and riparian zone could affect the suitability of habitats for species such as forage fish and Newcomb's littorine snail that are dependent on these fringing environments.

9.4.5.2.4 Riparian Vegetation Modifications

In riverine environments, LWD placement projects may present riparian impacts if excavation of the bank is necessary to anchor the foundation of an engineered LWD structure. Because restoration of the affected area is typically required as a condition of the HPA permit process, impacts on riparian vegetation are usually intermediate-term in their duration with riparian function returning as the replanted vegetation becomes established. The extent of riparian impacts associated with LWD placement is likely to be limited, and the duration over which the impact mechanism imposes stressors will depend on the time required for the riparian function to recover.

In many riverine projects, LWD removal projects take place from existing infrastructure, such as roadways and bridges, with the intent of providing protection of that infrastructure, and thus do not modify riparian vegetation. In other cases, LWD removal may require the disturbance of intact riparian vegetation to create a construction access point. Hydraulic and geomorphic effects caused by LWD removal may lead to fragmentation of riparian habitat from the aquatic environment, imposing a number of stressors on those HCP species that occur in the affected habitat. The longer term effects of removal projects are a primary consideration in the worst-case scenario based approach to assessing the risk of take. Fish species that are dependent on habitats altered by the removal of LWD are likely to experience decreased spawning success and/or decreased survival, growth, and fitness due to an overall reduction in suitable habitat area. This equates to a moderate risk of take.

In marine environments, LWD placement projects most often take place on exposed beaches. The effects of construction activities during wood placement on riparian vegetation are typically limited. Usually only the construction access point is affected, and riparian disturbance may be further limited if an established access point is used. If existing access points are used, or the project is implemented from a barge or vessel, then the effects of the project on riparian vegetation from construction will be insignificant.

Removal of LWD in marine environments may expose the shoreline to increased wave action, leading to soil erosion and loss of riparian habitat. For many species, the risk of take associated with marine riparian impact mechanisms is unknown because the scientific understanding of the related ecological processes is in its infancy, and the extent to which many marine or anadromous species rely on the nearshore environment during their life history is unclear.

In lacustrine environments, LWD placement projects would not be expected to degrade riparian vegetation conditions outside of construction access points, and these effects would be expected to diminish over time as the site restoration matures. LWD removal projects could expose the shoreline to increased wave energy, encouraging cyclical shoreline erosion that chronically degrades riparian functions over longer time periods. This equates to a moderate risk of take for species with a demonstrable dependence on these habitats because the reduction in suitable habitat area because of reduced survival, growth, and fitness.

9.4.5.2.5 Aquatic Vegetation Modifications

During construction, aquatic vegetation in the footprint of LWD structures can be eradicated or buried by the placement of fill or structural material. After construction of a LWD structure, or the removal or repositioning of LWD, changes in wave energy, circulation patterns, flow and/or current velocities, and substrate composition can lead to adverse or beneficial alterations in aquatic vegetation.

In riverine systems, protected slow-water areas created by LWD placement projects may increase suitable habitat for emergent vegetation. The removal of LWD would be expected to reduce this area, resulting in the loss of aquatic vegetation functions.

9.4.5.2.6 Water Quality Modifications

LWD placement and removal projects have the potential to introduce toxic substances from accidental spills during the project construction phase. This presents a moderate risk of take.

LWD placement and removal projects can increase suspended solids during construction or from bank and channel bed instability caused by channel adjustment following LWD removal projects. The severity of individual stressor exposure will vary depending on the nature of the effect, its magnitude and duration, and the sensitivity of the species and life-history stage exposed. These stressors would induce a moderate risk of take.

In rivers, additions of large wood debris are generally expected to have limited effects on dissolved oxygen conditions. Decreased nutrient retention associated with LWD removal from riverine environments could theoretically impose some eutrophication-related effects on downstream habitats, but the scale of these effects is expected to be insignificant in all but the most extreme cases (e.g., LWD removal projects that cause dewatering of impounded or backwatered areas). LWD placement projects would be expected to increase sequestration of organic material, distributing nutrient cycling more broadly across the riverine landscape. Dissolved oxygen levels in marine or lacustrine environments are not driven by large woody debris. The risk of take associated with changes to dissolved oxygen caused by LWD projects is insignificant.

9.4.5.3 Spawning Substrate Augmentation

Spawning substrate augmentation projects are usually designed to mitigate the loss of spawning suitable substrate caused by hydromodification or other sources of environmental degradation. If these projects are designed properly and are implemented as intended, spawning substrate augmentation is expected to improve the functioning of ecological processes resulting in improved habitat conditions. Therefore, with the exception of construction activities and subsequent channel adjustments, the impact mechanisms associated with this type of project would not be expected to impose ecological stressors, and the related risk of take is limited.

9.4.5.3.1 Construction

Substrate augmentation projects require the use of heavy machinery to place gravel sized material either directly into the stream channel or along the channel bank to allow for passive distribution during flood conditions. Primary impact mechanisms associated with project construction include the in-water operation of heavy equipment and related noise, visual, and physical disturbance, and bank and channel disturbance from equipment use and materials placement. These disturbances equate to a moderate risk of take.

9.4.5.3.2 Hydraulic and Geomorphic Modifications

The expected effects of gravel augmentation on channel geometry include particle sorting that creates diverse substrate patches, creation of exposed bars, increased hydraulic complexity and shear zones, and creation of backwaters and other complex alluvial features. These morphologic changes have been observed to increase the quality, quantity, and diversity of both aquatic habitats and associated terrestrial habitats associated with the stream channel. Gravel augmentation can also have the undesirable effect of filling pools, decreasing the amount of pool habitat available. Properly implemented projects would not be expected to impose stressors on HCP species. Therefore, there is no anticipated risk of take.

Gravel augmentation can temporarily reduce bank instability as the channel adjusts to the presence of the new bed material and as the bed elevation rises. Increased bank stability will reduce sediment import into the channel and subsequent spawning gravel and organism burial, and there would be no related risk of take.

Properly implemented spawning gravel augmentation projects improve the composition and stability of spawning substrates. There is no associated risk of take resulting from sediment changes.

9.4.5.3.3 Ecosystem Fragmentation

Spawning gravel augmentation has the potential to raise the channel bed, affecting surface water elevations and, in turn, the frequency at which side channel, off-channel, and floodplain habitats are activated over a range of flow conditions. Properly implemented projects could lead to increased floodplain and side-channel connectivity in riverine environments. This beneficial result would not lead to a risk of take.

Passive augmentation projects often involve the piling of introduced substrate on bars or other channel features, allowing high flows to recruit the introduced material into the channel. Once sediments are entrained into the channel, temporary low flow barriers may occur under certain circumstances before they are fully distributed. In marine and lacustrine environments, substrate piles may be left for recruitment by wave action and longshore sediment transport. Depending on placement, these substrate piles may locally affect the availability of shallow water habitat until the pile has been fully dispersed and distributed. Therefore, this impact mechanism may result in a temporary reduction in the availability and/or accessibility of suitable habitats. This equates to a moderate risk of take for certain types of gravel augmentation projects.

9.4.5.3.4 Aquatic Vegetation Modifications

Spawning gravel augmentation potentially could result in burial or other physical damage to aquatic vegetation. This would impose a temporary reduction in autochthonous production and alteration of the habitat complexity associated with the vegetation itself. These effects may be short-term or long-term in nature, depending on the degree to which the augmentation project changes the existing substrate characteristics and the sensitivity of the local plant community to this change. From a worst-case scenario perspective, these impact mechanisms could limit the availability of foraging habitat, refuge, and cover, and limit food web productivity by reducing autochthonous production. These stressors would equate to a moderate risk of take for those species and life-history stages dependent on aquatic vegetation in the affected environment type.

9.4.5.3.5 Water Quality Modifications

Substrate augmentation projects temporarily increase suspended sediment loading, equated with a moderate risk of take. Once the project has stabilized, substrate augmentation would be expected to have either a neutral or a potentially beneficial effect on water quality conditions.

The increased hyporheic exchange promoted by substrate augmentation promotes the biogeochemical transformation of nutrients, metals, and other pollutants. Stressors related to pollutant exposure would remain unchanged or would be reduced by gravel augmentation projects; therefore, there is no associated risk of take.

The available research tends to indicate that spawning gravel augmentation increases intergravel DO levels resulting in an improvement in habitat conditions. There is no risk of take.

9.4.5.4 In-Channel/Off-Channel Habitat Creation/Modifications

In-channel and off-channel habitat creation or modification projects are intended to enhance or restore degraded habitat conditions. Properly designed properly and implemented, they improve the functioning of ecological processes, resulting in improved habitat conditions. With the exception of the short-term effects associated with construction activities, the impact mechanisms associated with this type of project would not be expected to impose ecological stressors. Therefore, there will be no associated risk of take once project construction is complete.

9.4.5.4.1 Construction Activities

Construction of in-channel/off-channel habitat creation/modification projects could cause disturbances due to noise, physical and visual disturbance, temporary disturbances to the bank, temporary dewatering and fish handling. Each of these is associated with a moderate risk of take until the system reaches a new equilibrium.

9.4.5.4.2 Hydraulic and Geomorphic Modifications

Hydraulic and geomorphic modifications caused by off-channel and side-channel habitat creation are anticipated to improve habitat complexity and increase habitat suitability. Therefore, this impact mechanism category is not expected to impose any stressors on HCP species and there is no related risk of take.

9.4.5.4.3 Ecosystem Fragmentation

Off-channel and side-channel habitat creation will result in increased ecological connectivity and complexity, which will increase the availability and suitability of habitats for HCP species. Therefore, this impact mechanism category is not expected to impose any stressors and there is no related risk of take.

9.4.5.4.4 Riparian Vegetation Modifications

Off-channel and side-channel habitat creation will effectively increase the amount of functional riparian habitat in connection with the active channel, thereby increasing allochthonous inputs, reducing solar radiation exposure and related effects on water temperature, and increasing the buffering capacity. This will increase the availability and suitability of habitats for HCP species. Therefore, this impact mechanism category is not expected to impose any stressors and there is no related risk of take.

9.4.5.4.5 Aquatic Vegetation Modifications

Off-channel and side-channel habitat creation will effectively increase the amount of habitat available for aquatic vegetation growth, thereby increasing autochthonous production, habitat complexity and community structure. This will increase the availability and suitability of habitats for HCP species. Therefore, this impact mechanism category is not expected to impose any stressors and there is no related risk of take.

9.4.5.4.6 Water Quality Modifications

Water quality modifications associated with in-channel and off-channel habitat creation that have the potential to impose stressors on HCP species will occur principally during project construction. The primary water quality related impact mechanism is increased suspended sediments caused by bank and channel disturbance, and the “first flush” effect when the dewatered project areas are first exposed to stream flows. Pollutant loading may also occur as a result of accidental spills from heavy equipment during construction. The related risk of take associated with these impact mechanisms is moderate.

As this type of project becomes functional, increased hyporheic exchange and storage of flood waters in off-channel habitats is likely to provide additional biogeochemical processing capacity that will aid in the sequestration and detoxification of certain forms of pollutants. This effect would be expected to provide beneficial improvements in water quality. This type of project is also expected to improve temperature conditions.

9.4.5.5 Riparian Planting/Restoration/Enhancement

Riparian planting, restoration, and enhancement projects are commonly implemented in conjunction with habitat restoration initiatives or as mitigation for a separate human induced source of habitat degradation. Riparian restoration occurs in riverine, marine, and lacustrine environments and is most typically implemented using manual labor or, in specific circumstances, light machinery. Riparian restoration usually requires only limited disturbance of the bank or shoreline and little or no disturbance of the aquatic environment itself. Once implemented, riparian enhancement projects will generally result in improved riparian function and the related impact mechanisms would not be expected to impose stressors on HCP species. Therefore, the overall risk of take associated is low and is primarily associated with construction for almost all of the HCP species. An exception includes the Newcomb's littorine snail because this species is actually dependent on littoral vegetation and is therefore potentially subject to direct disturbance or injury.

9.4.5.5.1 Construction Activities

Riparian planting may produce construction-related impacts in the form of visual and noise-related disturbance, as well as the disturbance of the stream bank or shoreline. The magnitude of this disturbance is minor in comparison to that produced by the construction of other types of habitat modifications. Because riparian planting takes place primarily out of the water and is short-term in duration, the extent of stressor exposure is limited to short-term behavioral alteration. This equates to a low risk of take for species present in the affected habitat when the activity takes place.

9.4.5.5.2 Hydraulic and Geomorphic Modifications

The immediate effect of riparian enhancement projects on hydraulic and geomorphic conditions is limited. Over time, vegetation growth will consolidate the stream bank or shoreline through root cohesion, thereby increasing stability. As vegetation matures, it will eventually provide a source of LWD recruitment that will have a broad beneficial influence on aquatic habitat. Therefore, riparian vegetation modification impact mechanisms are not expected to impose stressors on the HCP species and there is no related risk of take.

9.4.5.5.3 Ecosystem Fragmentation

The immediate benefits of riparian enhancement projects on ecosystem connectivity are limited, but over time mature vegetation will enhance connectivity by expanding the frequency and distribution of desirable habitat patches. Riparian vegetation modification impact mechanisms are not expected to impose stressors on HCP species, and there is no related risk of take in any environment type.

9.4.5.5.4 Riparian Vegetation Modifications

Riparian enhancement projects are specifically intended to modify the riparian environment for the purpose of providing habitat benefits. These projects are expected to lessen the magnitude of stressors imposed by degraded riparian conditions and will result in no related risk of take in any environment type.

9.4.5.5.5 Aquatic Vegetation Modifications

Riparian enhancement projects are not expected to cause adverse aquatic vegetation modification or to impose any stressors on HCP species. Therefore, there is no associated risk of take in any environment type.

9.4.5.5.6 Water Quality Modifications

Once established, riparian enhancement projects are expected to alter temperature conditions for the benefit of native aquatic species through increased shading and through buffering ambient air temperatures. In riverine environments, these effects will primarily take the form of moderated water temperatures. In both marine and lacustrine environments, increased shading will moderate water temperatures primarily in isolated nearshore shallow water environments. Altered ambient air temperatures and increased shading on marine shorelines will provide additional benefits for sand lance and surf smelt, HCP species that spawn in the upper intertidal zone. Collectively, this is expected to improve habitat suitability in all environment types. Therefore, it will not impose stressors on HCP species and there will be no resulting risk of take.

Riparian enhancement projects have some limited potential to increase sediment loading to the aquatic environment during and immediately following the construction phase. This may occur during manual reworking of the bank or shoreline environment for planting and soil amendment, and exposure to the first high-water or runoff events that follow project completion. In practice, the amount of sediment loading likely to result from riparian enhancement is low relative to that produced by other types of habitat projects because the extent of ground disturbance is generally more limited. With proper project design and BMP implementation, the short-term increase in sediment loading produced by riparian enhancement is not expected to exceed levels sufficient to adversely affect survival, growth, or fitness of HCP species. Therefore, this impact mechanism is equated with a low risk of take.

Once established, riparian enhancement projects are expected to slow the overland flow of stormwater, encouraging infiltration and vegetative filtering. The improved buffering and filtering capacity would be expected to reduce the delivery of pollutants to aquatic ecosystems, and decrease shoreline erosion that contributes to sediment loading. As such, this type of project will not directly produce any pollutant-related stressors, and will reduce the incidence and severity of pollutant loading from other sources. Therefore, no risk of take is anticipated.

9.4.5.6 Wetland Creation/Restoration/Enhancement

Wetland creation, restoration, and enhancement projects enhance or restore degraded habitat conditions. Under the presumption that these projects are designed properly for the surrounding ecological context and are implemented as intended, they would be expected to improve the functioning of ecological processes and to result in improved habitat conditions. Therefore, ecological stressors would only be expected to occur during the short-term period required for construction and the intermediate-term period required for vegetation and site hydrology to mature. The related risk of take resulting from wetland projects would be expected to diminish over time.

9.4.5.6.1 Construction Activities

Under a worst-case scenario, wetland construction effects from large-scale projects could occur within existing aquatic habitat, requiring fish exclusion and dewatering; use heavy machinery for clearing and grading to contour the project area for the desired hydrologic conditions; place LWD, rock, or other materials as habitat structure or components in water level control structures; breach existing hydromodifications to establish connectivity with surface waters; and require extensive revegetation.

Heavy equipment operation in and around riparian areas during wetland construction and the breaching of hydromodifications or other barriers to connect wetlands to surface waters have the potential to impose a number of stressors on the aquatic environment, and equate with a moderate risk of take. Bank, channel, and shoreline disturbance equates to a moderate risk of take. Dewatering and fish handling equates to a moderate risk of take.

9.4.5.6.2 Hydraulic and Geomorphic Modifications

Wetland creation and enhancement projects are typically designed specifically for local hydraulic and geomorphic conditions, often through the reconnection of fragmented floodplain, off-channel habitat, and estuarine habitats. These measures would be expected to improve habitat complexity and increase habitat suitability for a wide range of aquatic and terrestrial species. Therefore, this impact mechanism category is not expected to impose any stressors on HCP species and there is no related risk of take.

9.4.5.6.3 Ecosystem Fragmentation

Wetland creation and enhancement projects are designed to increase ecological connectivity and complexity, increasing the availability and suitability of habitats for HCP species. Therefore, this impact mechanism category is not expected to impose any stressors and there is no related risk of take.

9.4.5.6.4 Riparian Vegetation Modifications

Wetland creation and enhancement projects typically incorporate the preservation and restoration of riparian buffer vegetation, maintaining or increasing the availability and suitability of habitats for HCP species. Therefore, this impact mechanism category is not expected to impose any stressors and there is no related risk of take.

9.4.5.6.5 Aquatic Vegetation Modifications

Wetland creation and enhancement projects will, in most cases, increase the amount of habitat available for aquatic vegetation growth, thereby increasing autochthonous production, habitat complexity and community structure. This will increase the availability and suitability of habitats for HCP species. Therefore, this impact mechanism category is not expected to impose any stressors and there is no related risk of take.

9.4.5.6.6 Water Quality Modifications

The risk of take resulting from wetland creation and enhancement, from temporary increases in suspended sediment, is expected to be moderate.

9.4.5.7 Beach Nourishment/Contouring

Beach nourishment and contouring projects address degraded beach conditions, most often caused by shoreline modification or overwater structures. Under the presumption that these projects are designed properly for the surrounding ecological context and are implemented as intended, beach nourishment would be expected to improve the functioning of ecological processes and result in improved habitat conditions. After a short period of construction activities and subsequent channel adjustments, beach nourishment and contouring would not be expected to impose ecological stressors.

9.4.5.7.1 Construction Activities

Beach nourishment can result in the immediate burial of benthic organisms and aquatic vegetation and, if present, forage fish eggs and the non-motile larvae of certain fish species that are prevalent in the nearshore environment. Impacts on benthic organism diversity and abundance are typically temporary as these communities tend to recover from disturbance quickly. However, this impact mechanism could result in a short-term, localized reduction in foraging opportunities for those species dependent on these prey resources, potentially affecting growth and fitness. This equates to a moderate risk of take. In the case of non-motile HCP species or species life-history stages exposed to this stressor, there is a high likelihood of direct mortality or injury, which equates to a high risk of take.

9.4.5.7.2 Hydraulic and Geomorphic Modifications

Beach nourishment projects directly alter the hydraulic and geomorphic characteristics of the affected shoreline environment. Because they are typically intended to address beach degradation most often caused by shoreline modification projects, properly designed beach nourishment projects either directly or indirectly result in improved hydraulic and geomorphic conditions from a habitat perspective. On this basis, this impact mechanism would generally not be expected to impose stressors on aquatic organisms and there would be no related risk of take. In practice, however, current understanding of marine and lacustrine geomorphology is sufficiently limited to create design uncertainty in site-specific circumstances. On this basis, some risk of take may occur that is difficult to quantify, resulting in an uncertain risk of take.

9.4.5.7.3 Ecosystem Fragmentation

The ability of beach nourishment to reconnect or disconnect pre-existing shoreline communities depends on the nature of the shorelines adjacent to the activity site. If the substrate is significantly different than the shorelines adjacent to it, or if added sediment buries aquatic vegetation, the activity may fragment the alongshore transit of HCP species. Under the basic presumption that the project is properly designed and implemented, these forms of ecosystem fragmentation should not occur. In contrast, beach contouring can moderate the ecological gradient between the littoral and riparian zones, thereby improving ecological connectivity. Properly designed beach nourishment projects should not further degrade or may even improve this impact mechanism and would therefore not impose any related stressors. Accordingly, there will be no related risk of take from this impact mechanism.

9.4.5.7.4 Riparian Vegetation Modifications

Beach nourishment projects do not involve direct modification of the riparian environment, except where necessary to provide access for equipment and materials. In a worst-case scenario, limited riparian disturbance necessary for equipment and materials access may occur. For HCP species with limited dependence on marine or lacustrine riparian vegetation, the resultant effects of this limited disturbance are expected to be insignificant. Some HCP species (e.g., sand lance, surf smelt, Chinook salmon) inhabit littoral fringe areas during life-history stages that are more sensitive to stressor exposure. These species face a moderate risk from the limited and minor resultant effects.

Newcomb's littorine snail is considered an exception. Because this species has a limited distribution and is entirely dependent on shoreline vegetation, any alteration of its habitat would be associated with a high risk of take.

Once established, beach nourishment projects are expected to produce beneficial changes in hydraulic and geomorphic conditions along the shoreline, thereby contributing to preservation and improvement of riparian conditions.

9.4.5.7.5 Aquatic Vegetation Modifications

Beach nourishment projects may in some cases alter aquatic vegetation, leading to localized shifts in food web productivity, possibly affecting foraging opportunities for dependent species and life-history stages. This equates to a moderate risk of take resulting from decreased growth and fitness. Alterations may reduce cover and rearing habitat, equating to a moderate risk of take.

9.4.5.7.6 Water Quality Modifications

Beach nourishment projects could temporarily increase suspended sediments. Motile species and life-history stages exposed to temporary sediment impacts at low occurrence frequency experience only temporary disturbance, behavioral alteration, and low risk of take. Sessile invertebrates or relatively immobile life-history stages may experience decreased survival and reduced foraging opportunities leading to a moderate to high risk of take. Sublethal levels of suspended sediments may affect the foraging success of planktonic herring larvae, leading to decreased foraging success and decreased survival, growth, and fitness.

Beach nourishment projects could introduce toxics through accidental spills from construction equipment. In extreme cases, these effects can include direct mortality. More commonly, chronic, low-level exposure to a variety of contaminants is likely to cause physiological injury and/or contaminant bioaccumulation leading to decreased survival, growth, and fitness. This presents a moderate to high risk of take to species potentially exposed to this stressor, depending on life-history specific sensitivity.

9.4.5.8 Reef Creation/Restoration/Enhancement

Reef creation, restoration, or enhancement projects involve the placement of rock, wood, concrete, metal (e.g., sunken vessel hulls), or other materials on the bottom, creating three dimensional structure that attracts or encourages the settlement of fish, invertebrates, and aquatic vegetation. Ideally, these structures are intended to increase the availability of suitable habitat for fish and invertebrates, leading to increased abundance and productivity. However, the degree to which reefs provide this function versus merely concentrating existing populations without increasing abundance or productivity remains uncertain.

9.4.5.8.1 Construction Activities

Reef construction may result in visual, physical, and noise related disturbance and displacement, injury or mortality. Temporary disturbance and displacement and a decreased ability to sense predators and prey due to auditory masking effects equate to a moderate risk of take. Limited or non-motile species or life-history stages occurring in the project area during materials placement face a high risk of take from physical injury or mortality from burial and mechanical injury.

9.4.5.8.2 Hydraulic and Geomorphic Modifications

Artificial reefs that extend above the wave closure depth can significantly affect nearshore wave energy, current velocities, and circulation patterns, leading to decreased habitat availability, decreased survival, growth, and fitness, and a moderate risk of take. The physical alterations of the shoreline environment that accompany some reef creation projects can cause alterations in sediment supply and substrate conditions through alteration of longshore sediment transport. In conjunction with altered wave energy, this can lead to changes in substrate conditions. This equates to a moderate risk of take.

9.4.5.8.3 Ecosystem Fragmentation

Reefs created in nearshore habitats may alter habitat characteristics. Changes in foraging opportunities and increased predation risk due to increased cover and habitat for predatory fish species may lead to decreased survival, growth, and fitness, which equates to a moderate risk of take. Reefs constructed offshore and below the wave closure depth would be expected to have limited effects on the nearshore environment and would provide beneficial habitat conditions for a variety of HCP species including rockfish, lingcod, and northern abalone. These structures may present little or no risk of take from ecosystem fragmentation.

9.4.5.8.4 Aquatic Vegetation Modifications

Artificial reefs may displace aquatic vegetation, altering autochthonous inputs and habitat complexity/community structure, resulting in a moderate risk of take.

9.4.5.8.5 Water Quality Modifications

Reef creation projects may temporarily increase suspended solids. In general, motile species and life-history stages exposed to temporary sediment impacts at low occurrence frequency experience only temporary disturbance, behavioral alteration, and low risk of take. Sessile invertebrates or relatively immobile life-history stages exposed to increased suspended solids may experience decreased survival and reduced foraging opportunities leading to a moderate risk of take.

Reef creation projects may introduce toxic substances through accidental spills, through the presence of toxic substances in materials used to create the structure (e.g., decommissioned ships), or through resuspension of contaminated sediments during construction if these substances are present in the project area. This effect may continue for some time if the hydraulic effects of the structure induce scouring. In extreme cases, exposure to contaminants can result in direct mortality. More commonly, chronic, low-level exposure to a variety of contaminants can cause physiological injury and/or contaminant bioaccumulation leading to decreased survival, growth, and fitness. This presents a moderate risk of take.

9.4.5.9 Eelgrass and Other Aquatic Vegetation Creation/Enhancement/Restoration

Aquatic vegetation restoration has the least potential for take of any habitat modification. Assuming that the project has been conceived and designed properly for the ecosystem context, augmentation of eelgrass and other types of aquatic vegetation are expected to provide beneficial improvements habitat conditions.

9.4.5.9.1 Construction Activities

Eelgrass and aquatic vegetation enhancement projects are typically implemented by hand or by using nonpowered equipment. Construction-related effects would be low intensity physical and visual disturbance. Because planting success requires careful placement, sessile or non-motile organisms would be at relatively low risk of physical injury when carefully trained staff are used. Therefore, the stressors imposed by construction would be expected to result only in short-term disturbance and behavioral modification, which equates to a low risk of take.

9.4.5.9.2 Hydraulic and Geomorphic Modifications

Properly designed aquatic vegetation enhancement projects would not be expected to impose hydraulic and geomorphic stressors on the aquatic environment, and there is no associated risk of take.

9.4.5.9.3 Ecosystem Fragmentation

Properly designed aquatic vegetation enhancement projects would be expected to improve ecological connectivity by increasing the diversity of habitat patches and improving their distribution. There is no associated risk of take.

9.4.5.9.4 Aquatic Vegetation Modifications

The intention of aquatic vegetation projects is to enhance the ecological functions provided by aquatic vegetation. There is no associated risk of take.

9.4.5.9.5 Water Quality Modifications

Enhancement of eelgrass and other aquatic vegetation has essentially no potential for adverse effects on water quality, with the exception of minor effects during project construction. In the case of eelgrass enhancement, there are often effectively no discernable construction-related effects on water quality. Taking a worst-case scenario perspective, short-term increases in suspended sediment levels may occur during construction-related disturbance from vessel operation and manual or diver labor. This would be expected to result in a low risk of take, predominantly in the form of temporary behavioral effects, for a short-term period. Once vegetation has been established, chronic levels of suspended sediment should decrease as vegetation encourages the settling of fines. Increased dissolved oxygen levels and other beneficial water quality effects would be expected to develop once a successfully implemented eelgrass or aquatic vegetation enhancement project matures. Following project completion, no further risk of take would be expected.

Table 9-26. Species- and habitat-specific risk of take for mechanisms of impacts associated with beaver dam removal.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	H	N	N	H	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Chinook salmon are known to occur in environments where beaver dam removal or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Coho salmon	H	N	N	H	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Coho salmon are known to occur in environments where beaver dam removal or modification may occur, and preferentially select beaver impoundments for juvenile rearing habitat. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Chum salmon	H	N	N	H	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Chum salmon are known to spawn in environments where beaver dam removal or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Pink salmon	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Pink salmon are known to spawn in environments where beaver dam removal or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Sockeye salmon	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Sockeye salmon are known to spawn in environments where beaver dam removal or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Steelhead	H	N	N	H	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Steelhead are known to occur in environments where beaver dam removal or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Coastal cutthroat trout	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Coastal cutthroat trout are known to occur in environments where beaver dam removal or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Westslope cutthroat trout	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Westslope cutthroat and redband trout are known to occur in environments where beaver dam removal or modification may occur. Therefore, these species are vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Redband trout	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	
Bull trout	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Native char occur in rivers and streams where beaver are often abundant, indicating the potential for these species to be exposed to the effects of beaver dam removal or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Dolly Varden	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	
Pygmy whitefish	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	This species spawns in small, cold water tributary streams to rearing lakes. These habitats are potentially within the range of beaver distribution, indicating the potential for exposure to beaver dam removal projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Olympic mudminnow	H	N	N	H	N	N	M	N	N	H	N	N	M	N	N	H	N	N	Primary habitats are wetlands and small, slow-flowing streams, presumably including beaver pond habitats. Therefore, this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Margined sculpin	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages where beaver dam removal or modification has the potential to occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Mountain sucker	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	This species spawns in tributary habitats potentially suitable for beaver dam removal or modification projects. Therefore this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Lake chub	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. These habitats are potentially subject to beaver dam removal or modification projects. Therefore, this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Leopard dace	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east, including smaller rivers and stream systems. Therefore, this species occurs in habitats potentially subject to beaver dam removal or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Umatilla dace	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers. Therefore, this species occurs in habitats potentially subject to beaver dam removal or modification. Therefore, this

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																			species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Western brook lamprey	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Western brook lamprey spend their entire life history in habitats potentially affected by beaver dam removal. Due to its limited motility and dependence on small streams and similar habitats where beaver dams are prevalent, this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
River lamprey	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	Pacific and river lamprey are anadromous species that spawn in habitats potentially affected by beaver dam removal. Ammocoetes burrow into riverine sediments to rear for extended periods and are similarly vulnerable. Freshwater life-history stages of both species are potentially exposed to a range of impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Pacific lamprey	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Green sturgeon distribution in Washington State is restricted to marine waters; therefore, there is no potential for exposure to beaver dam modification and no related risk of take.
White sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The freshwater distribution of White sturgeon in Washington State is restricted to large river environments that are insensitive to the effects of beaver dam removal projects. Therefore there is no related risk of take.
Longfin smelt	H	N	N	H	N	N	H	N	N	N	N	N	H	N	N	N	N	N	The freshwater distribution of longfin smelt is limited to larger river environments that are insensitive to the effects of beaver dam removal, with the possible exception of the Lake Washington population. Spawning habitats for this population may be in river systems where beaver dam removal or modification could occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Eulachon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The freshwater distribution of this species in Washington State is limited to larger river environments that are insensitive to the effects of beaver dam removal. Therefore there is no related risk of take.
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species does not occur in environments where beaver dam removal or modification take place; therefore, there is no related risk of take.
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where beaver dam removal or modification take place; therefore, there is no related risk of take.
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where beaver dam removal or modification take place; therefore, there is no related risk of take.
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species do not occur in environments where beaver dam removal or modification take place; therefore, there is no related risk of take.
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species do not occur in environments where beaver dam removal or modification take place; therefore, there is no related risk of take.
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where beaver dam removal or modification take place; therefore, there is no related risk of take.
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where beaver dam removal or modification take place; therefore, there

	Construction & Maintenance Activities			**Hydraulic and Geomorphic Modifications**			**Riparian Vegetation Modifications**			**Aquatic Vegetation Modifications**			**Water Quality Modifications**			**Ecosystem Fragmentation**			
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Comments**
																			is no related risk of take.
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where beaver dam removal or modification take place; therefore, there is no related risk of take.
Giant Columbia River limpet	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	M	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, indicating the potential for exposure to beaver dam removal projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Great Columbia River spire snail	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	M	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. This species is unlikely to be exposed to the effects of beaver dam removal projects and no effects are expected. In contrast, the great Columbia River spire snail inhabits smaller tributary streams to the Columbia River where exposure to the effects of beaver dam removal is likely. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
California floater (mussel)	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	The western ridged mussel is commonly found in small, clear water tributaries and streams. The California floater mussel is known to occur in the Okanogan River basin (as well as fringing ponds of the Columbia River). The distribution of both species in small to moderate sized rivers and streams indicates the potential for exposure to beaver dam projects. These non-motile species are particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beaver dam removal.
Western ridged mussel	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	H	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-27. Species- and habitat-specific risk of take for mechanisms of impacts associated with large woody debris placement/removal/modification.

	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Comments**
Chinook salmon	H	H	H	H	M	M	N	N	N	M	M	M	M	M	M	M	M	M	Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats. Individuals occurring in spawning, incubation, rearing, and migratory habitats in freshwater, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Coho salmon	H	H	H	H	M	M	N	N	N	M	M	M	M	M	M	M	M	M	Coho salmon occur in riverine, lacustrine, and nearshore marine habitats. Individuals occurring in spawning, incubation, rearing, and migratory habitats in freshwater, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Chum salmon	H	H	I	H	M	I	N	N	I	L	M	I	M	M	I	L	M	I	Chum salmon in Washington State do not use lacustrine habitats and occur in this environment type infrequently. Therefore, the effects of stressor exposure in lacustrine environments are expected to be insignificant. Individuals occurring in spawning, incubation and migratory habitats in freshwater, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Pink salmon	H	H	I	H	M	I	N	N	I	L	M	I	M	M	I	L	M	I	Pink salmon in Washington State do not use lacustrine habitats and occur in this environment type infrequently. Therefore, the effects of stressor exposure in lacustrine environments are expected to be insignificant. Individuals occurring in spawning, incubation and migratory habitats in freshwater, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Sockeye salmon	H	H	H	H	M	M	N	N	N	M	M	M	M	M	M	L	M	M	Sockeye salmon occur in riverine, lacustrine, and nearshore marine habitats, and are particularly dependent on the latter two environment types. Individuals occurring in spawning, incubation, rearing and migratory habitats in freshwater, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Steelhead	H	?	H	H	?	M	M	M	M	M	?	M	M	?	M	M	?	M	Steelhead occur in riverine, lacustrine, and nearshore marine habitats and are particularly dependent on the latter two environment types. As juvenile steelhead are more typically found far from shore in the marine environment, the effects of shading are less clear; therefore, the risk of take in the marine environment is uncertain. Individuals occurring in spawning, incubation, rearing, and migratory habitats in fresh water, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Coastal cutthroat trout	H	H	H	H	M	M	M	M	M	M	M	M	M	M	M	M	M	M	This species is prevalent in rivers, estuaries, and nearshore marine habitats, and also occurs at lesser frequencies in lacustrine habitats (e.g., Lake Washington). It is highly dependent on nearshore marine areas for foraging. Individuals occurring in spawning, incubation, rearing, and migratory habitats in freshwater, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Westslope cutthroat trout	H	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	N	M	These species occur primarily in coldwater streams, small to medium-sized rivers, and lakes. Individuals occurring in spawning, incubation, rearing, and migratory habitats in freshwater, and foraging and rearing habitats in lacustrine waters may be exposed to stressors resulting from LWD placement and removal projects.
Redband trout	H	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	N	M	
Bull trout	H	H	H	H	M	M	N	N	N	L	M	M	M	M	M	L	M	M	Native char occur in riverine, lacustrine, and nearshore marine habitats. Individuals occurring in spawning, incubation, rearing and migratory habitats in freshwater, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Dolly Varden	H	H	H	H	M	M	N	N	N	L	M	M	M	M	M	L	M	M	
Pygmy whitefish	H	N	H	H	N	M	M	N	M	N	N	M	M	N	M	M	N	M	Lakes and smaller lake tributaries are primary habitats used by pygmy whitefish. Individuals occurring in spawning, incubation, rearing and migratory habitats in freshwater, and juvenile migratory habitats in marine waters may be exposed to stressors resulting from LWD placement and removal projects.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. These habitats are not typically suited for LWD placement and removal projects, except in the context of wetland enhancement projects (which are addressed in Table 9-8). Outside of this context this species would not likely be exposed to this type of project and there would be no related risk of take.
Margined sculpin	H	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages. Individuals occurring in spawning, incubation, rearing, and migratory habitats may be exposed to stressors resulting from LWD placement and removal projects.
Mountain sucker	H	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	N	M	This species is commonly found in moderate to large rivers and lakes suitable for LWD placement and removal projects. Individuals occurring in spawning, incubation, rearing, and migratory habitats may be exposed to stressors resulting from LWD placement and removal projects.
Lake chub	H	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	N	M	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. Individuals occurring in spawning, incubation, rearing, and migratory habitats may be exposed to stressors

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																			resulting from LWD placement and removal projects.
Leopard dace	H	N	H	H	N	M	N	N	N	M	N	M	M	N	M	M	N	M	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. Therefore, this species occurs in habitats potentially suitable for LWD placement and removal projects at sensitive life-history stages, including egg incubation. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Umatilla dace	H	N	H	H	N	M	N	N	N	M	N	M	M	N	M	M	N	M	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers (including reservoirs within the Columbia and Snake River systems). Therefore, this species occurs in habitats potentially suitable for LWD placement and removal projects at sensitive life-history stages, including egg incubation. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Western brook lamprey	H	N	H	H	N	M	N	N	N	N	N	N	N	N	N	M	N	M	This species is characterized by isolated breeding populations favoring small streams and brooks. Therefore, this species occurs in habitats potentially suitable for LWD placement and removal projects at sensitive life-history stages, including egg incubation. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
River lamprey	H	H	H	H	M	M	M	?	M	?	?	?	M	M	M	M	M	M	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of rivers to rear for extended periods, potentially years. The non-motile ammocoete life-history stage is more susceptible to acute transient water quality impacts and direct physical disturbance. In their saltwater phase, river lamprey remain close to shore for periods of 10–16 weeks from spring through fall, increasing exposure to stressors in the nearshore environment. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Impact mechanisms affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults, which in turn equates to a moderate risk of take.
Pacific lamprey	H	L	H	H	L	M	M	N	M	?	N	?	M	L	M	M	L	M	Pacific lamprey are anadromous, with migratory corridors extending from marine waters to small tributary streams. Ammocoetes burrow into riverine sediments to rear for extended periods. The non-motile ammocoete life-history stage is more susceptible to acute transient water quality impacts and direct physical disturbance. Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6–40 months and are therefore less likely to be exposed to project-related stressors in the nearshore marine environment. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Impact mechanisms affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults. This in turn equates to a moderate risk of take.
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	Green sturgeon distribution in Washington State is restricted to marine waters; therefore, there is no potential for exposure to LWD placement/removal projects in freshwater and marine environments and no related risk of take. Sensitivity to impact mechanisms resulting from this project type in marine environments is uncertain.
White sturgeon	H	?	H	H	?	M	M	?	M	M	?	M	M	?	M	M	?	M	The freshwater distribution of White sturgeon in Washington State is restricted to large river environments that are insensitive to the effects of LWD placement and removal projects. However, side channel and margin habitats in the Columbia River and lacustrine impoundments used for juvenile rearing may be suitable environments for this project type. Therefore some potential for stressor exposure exists. Sensitivity to impact mechanisms resulting from this project type in marine environments is uncertain.
Longfin smelt	H	I	M	H	I	M	M	I	M	N	I	M	M	I	M	M	I	M	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems potentially suitable for LWD placement or removal projects. Longfin smelt are also located in Lake Washington. Demersal adhesive eggs are vulnerable to acute transient water quality impacts and direct physical effects. Planktonic larvae and juveniles of these species may also be vulnerable to stressor exposure in the nearshore marine environment during early rearing. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Mature juveniles and adults occupy offshore environments and are therefore at less risk of take from these stressors.
Eulachon	H	I	N	H	I	N	M	I	N	N	I	N	M	I	N	M	I	N	

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Pacific sand lance	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	M	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure from marine LWD projects is high. Larvae of both species disperse in nearshore waters for early rearing. These beach-spawning species depend on a narrow range of substrate conditions for suitable spawning habitat, increasing sensitivity to hydraulic and geomorphic effects. Planktonic larvae are also dependent on nearshore current and circulation patterns for rearing survival. Planktonic life-history stages are also incapable of escaping acute water quality impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Surf smelt	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	M	N	
Pacific herring	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	M	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure from hydraulic/geomorphic and aquatic vegetation modifications is high. Planktonic larvae disperse in nearshore waters for early rearing and are dependent on current and circulation patterns for survival, growth, and fitness. Planktonic life-history stages are also incapable of escaping acute water quality impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Lingcod	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are potentially exposed to water quality related impact mechanisms from LWD placement and removal projects. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 and 150 m) and, therefore, have low exposure potential. Larvae disperse and settle in nearshore waters for early rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pacific hake	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	Hake, cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. Therefore, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Larvae disperse and settle in nearshore waters for early rearing, and are dependent on current, wave, and circulation patterns to ensure dispersal to environments favorable for rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pacific cod	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Walleye pollock	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Brown rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. Therefore, rockfish can experience stressor exposure across all life-history stages. Juveniles disperse and settle in nearshore waters for early rearing, and are dependent on current, wave, and circulation patterns to ensure dispersal to environments favorable for rearing. Because they are demersal and relatively immobile once they have settled, juveniles are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Copper rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Greenstriped rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Widow rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Yellowtail rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Quillback rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Black rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
China rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Tiger rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Bocaccio rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Canary rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Redstripe rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	

Species	**Construction & Maintenance Activities**			**Hydraulic and Geomorphic Modifications**			**Riparian Vegetation Modifications**			**Aquatic Vegetation Modifications**			**Water Quality Modifications**			**Ecosystem Fragmentation**			Comments
	Riverine	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	
Yelloweye rockfish	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	
Olympia oyster	N	H	N	N	M	N	N	N	N	N	M	N	N	M	N	N	M	N	This species occurs commonly in shallow water nearshore habitats. This distribution increases risk of stressor exposure and potential for take resulting from water quality modification in the nearshore environment. Because this species is sessile during much of its life-history, it is vulnerable to both short-term construction and water quality related impacts, as well as modification of hydraulic and geomorphic conditions in the nearshore environment. Modification of current, wave, and circulation patterns may also affect larval settlement, influencing survival during this life-history stage. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Northern abalone	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) in depth, but is not found in shallow water habitats where the construction and water quality-related effects of LWD projects are most pronounced.
Newcomb's littorine snail	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	M	N	The Newcomb's littorine snail inhabits *Salicornia* marshes on the littoral fringe. It is intolerant of extended submergence in both fresh and marine water; therefore, it not a true aquatic species. This species will be particularly vulnerable to LWD placement and removal projects in saltmarsh environments, particularly removal projects.
Giant Columbia River limpet	H	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, indicating the potential for exposure to spawning gravel augmentation projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from LWD placement and removal projects.
Great Columbia River spire snail	H	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. Exposure to the effects of spawning gravel augmentation is likely to occur in smaller river systems and streams in habitat by this species. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from LWD placement and removal projects.
California floater (mussel)	H	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	N	M	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake rivers and the mainstems of these systems. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. Therefore, both species may occur in habitats potentially suitable for LWD placement and removal projects. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Habitat accessibility modifications will not directly affect this species; however, indirect effects could occur through direct effects on host-fish.
Western ridged mussel	H	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-28. Species- and habitat-specific risk of take for mechanisms of impacts associated with spawning substrate augmentation.

	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Comments**
Chinook salmon	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	Chinook salmon are known to occur in environments where spawning gravel augmentation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Coho salmon	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	Coho salmon are known to occur in environments where spawning gravel augmentation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Chum salmon	H	N	N	N	N	N	I	N	N	M	N	N	M	N	N	Chum salmon are known to spawn in environments where spawning gravel augmentation or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Pink salmon	H	N	N	N	N	N	I	N	N	M	N	N	M	N	N	Pink salmon are known to spawn in environments where spawning gravel augmentation or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Sockeye salmon	H	N	N	N	N	N	I	N	N	M	N	N	M	N	N	Sockeye salmon are known to spawn in environments where spawning gravel augmentation or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Steelhead	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	Steelhead are known to occur in environments where spawning gravel augmentation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Coastal cutthroat trout	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	Coastal cutthroat trout are known to occur in environments where spawning gravel augmentation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Westslope cutthroat trout	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	Westslope cutthroat and redband trout are known to occur in environments where spawning gravel augmentation or modification may occur. Therefore, these species are vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Redband trout	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	
Bull trout	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	Native char occur in rivers and streams, indicating the potential for these species to be exposed to the effects of spawning gravel augmentation or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Dolly Varden	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	
Pygmy whitefish	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	This species spawns in small, cold water tributary streams to rearing lakes, indicating the potential for exposure to spawning gravel augmentation projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats used by this species include wetlands and small, slow-flowing streams, environments unsuitable for spawning gravel augmentation. Therefore there is no related risk of take.
Margined sculpin	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages where spawning gravel augmentation or modification has the potential to occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Mountain sucker	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	This species spawns in tributary habitats potentially suitable for spawning gravel augmentation projects. Therefore this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Lake chub	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. These habitats are potentially subject to spawning gravel augmentation or modification projects. Therefore, this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Leopard dace	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east, including smaller rivers and stream systems. Therefore, this species occurs in habitats potentially subject to spawning gravel augmentation or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Umatilla dace	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers. Therefore, this species occurs in habitats potentially subject to spawning gravel augmentation. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Western brook lamprey	H	N	N	N	N	N	?	N	N	M	N	N	M	N	N	Western brook lamprey spend their entire life history in habitats potentially affected by spawning gravel augmentation. Due to its limited motility and dependence on small streams and similar habitats this species is particularly vulnerable to the impact mechanisms, stressors,

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																and related risk of take resulting from spawning gravel augmentation.
River lamprey	H	N	N	N	N	N	?	N	N	M	N	N	M	N	N	Pacific and river lamprey are anadromous species that spawn in habitats potentially affected by spawning gravel augmentation.
Pacific lamprey	H	N	N	N	N	N	?	N	N	M	N	N	M	N	N	Ammocoetes burrow into riverine sediments to rear for extended periods and are similarly vulnerable. Freshwater life-history stages of both species are potentially exposed to a range of impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Green sturgeon distribution in Washington State is restricted to marine waters; therefore, there is no potential for exposure to spawning gravel augmentation and no related risk of take.
White sturgeon	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	The freshwater distribution of white sturgeon in Washington State is restricted to large river environments that are potentially suitable for spawning gravel augmentation. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Longfin smelt	H	N	N	N	N	N	N	N	N	M	N	N	M	N	N	The freshwater distribution of longfin smelt may include river environments where spawning gravel augmentation may be appropriate. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Eulachon	H	N	N	N	N	N	N	N	N	M	N	N	M	N	N	The freshwater distribution of eulachon may include river environments where spawning gravel augmentation may be appropriate. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species does not occur in environments where spawning gravel augmentation takes place; therefore, there is no related risk of take.
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where spawning gravel augmentation takes place; therefore, there is no related risk of take.
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where spawning gravel augmentation takes place; therefore, there is no related risk of take.
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species do not occur in environments where spawning gravel augmentation takes place; therefore, there is no related risk of take.
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species do not occur in environments where spawning gravel augmentation takes place; therefore, there is no related risk of take.
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where spawning gravel augmentation takes place; therefore, there is no related risk of take.
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where spawning gravel augmentation takes place; therefore, there is no related risk of take.
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where spawning gravel augmentation takes place; therefore, there is no related risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Giant Columbia River limpet	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, indicating the potential for exposure to spawning gravel augmentation projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Great Columbia River spire snail	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. Exposure to the effects of spawning gravel augmentation is likely to occur in smaller river systems and streams in habitat by this species. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
California floater (mussel)	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	The western ridged mussel is commonly found in small, clear water tributaries and streams. The California floater mussel is known to occur in the Okanogan River basin (as well as fringing ponds of the Columbia River). The distribution of both species in small to moderate sized rivers and streams indicates the potential for exposure to spawning gravel augmentation projects. These non-motile species are particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting from spawning gravel augmentation.
Western ridged mussel	H	N	N	N	N	N	M	N	N	M	N	N	M	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take? = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-29. Species- and habitat-specific risk of take for mechanisms of impacts associated with in-channel and off-channel habitat creation/modification.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Chinook salmon are known to occur in environments where in-channel/off-channel habitat creation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Coho salmon	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Coho salmon are known to occur in environments where in-channel/off-channel habitat creation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Chum salmon	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Chum salmon are known to spawn in environments where in-channel/off-channel habitat creation or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pink salmon	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Pink salmon are known to spawn in environments where in-channel/off-channel habitat creation or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Sockeye salmon	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Sockeye salmon are known to spawn in environments where in-channel/off-channel habitat creation or modification may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from in-channel/off-channel habitat creation.
Steelhead	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Steelhead are known to occur in environments where in-channel/off-channel habitat creation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Coastal cutthroat trout	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Coastal cutthroat trout are known to occur in environments where in-channel/off-channel habitat creation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Westslope cutthroat trout	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Westslope cutthroat and redband trout are known to occur in environments where in-channel/off-channel habitat creation or modification may occur. Therefore, these species are vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Redband trout	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	
Bull trout	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Native char occur in rivers and streams, indicating the potential for these species to be exposed to the effects of in-channel/off-channel habitat creation or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Dolly Varden	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	
Pygmy whitefish	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	This species spawns in small, cold water tributary streams to rearing lakes, indicating the potential for exposure to in-channel/off-channel habitat creation projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																			habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats used by this species include wetlands and small, slow-flowing streams, environments unsuitable for in-channel/off-channel habitat creation. Therefore there is no related risk of take.
Margined sculpin	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages where in-channel/off-channel habitat creation or modification has the potential to occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Mountain sucker	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	This species spawns in tributary habitats potentially suitable for in-channel/off-channel habitat creation projects. Therefore this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Lake chub	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. These habitats are potentially subject to in-channel/off-channel habitat creation or modification projects. Therefore, this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Leopard dace	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east, including smaller rivers and stream systems. Therefore, this species occurs in habitats potentially subject to in-channel/off-channel habitat creation or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Umatilla dace	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers. Therefore, this species occurs in habitats potentially subject to in-channel/off-channel habitat creation. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Western brook lamprey	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Western brook lamprey spend their entire life history in habitats potentially affected by in-channel/off-channel habitat creation. Due to its limited motility and dependence on small streams and similar habitats this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
River lamprey	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	Pacific and river lamprey are anadromous species that spawn in habitats potentially affected by in-channel/off-channel habitat creation. Ammocoetes burrow into riverine sediments to rear for extended periods and are similarly vulnerable. Freshwater life-history stages of both species are potentially exposed to a range of impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pacific lamprey	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	
Green sturgeon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Green sturgeon distribution in Washington State is restricted to marine waters; therefore, there is no potential for exposure to in-channel and off-channel habitat creation projects and no related risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
White sturgeon	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The freshwater distribution of white sturgeon in Washington State is restricted to large river environments that are potentially suitable for in-channel/off-channel habitat creation. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Longfin smelt	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The freshwater distribution of longfin smelt may include river environments where in-channel/off-channel habitat creation may be appropriate. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Eulachon	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The freshwater distribution of eulachon may include river environments where in-channel/off-channel habitat creation may be appropriate. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pacific sand lance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species do not occur in environments where in-channel/off-channel habitat creation takes place; therefore, there is no related risk of take.
Surf smelt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Pacific herring	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where in-channel/off-channel habitat creation takes place; therefore, there is no related risk of take.
Lingcod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where in-channel/off-channel habitat creation takes place; therefore, there is no related risk of take.
Pacific hake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species do not occur in environments where in-channel/off-channel habitat creation takes place; therefore, there is no related risk of take.
Pacific cod	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Walleye pollock	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Brown rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	These marine species do not occur in environments where in-channel/off-channel habitat creation takes place; therefore, there is no related risk of take.
Copper rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Greenstriped rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Widow rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Yellowtail rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Quillback rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Black rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
China rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Tiger rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Bocaccio rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Canary rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Redstripe rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Yelloweye rockfish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where in-channel/off-channel habitat creation takes place; therefore, there is no related risk of take.
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where in-channel/off-channel habitat creation takes place; therefore, there is no related risk of take.
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where in-channel/off-channel habitat creation takes place; therefore, there is no related risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Giant Columbia River limpet	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, indicating the potential for exposure to in-channel/off-channel habitat creation projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Great Columbia River spire snail	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. Exposure to the effects of in-channel/off-channel habitat creation is likely to occur in smaller river systems and streams inhabited by this species. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
California floater (mussel)	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The western ridged mussel is commonly found in small, clear water tributaries and streams. The California floater mussel is known to occur in the Okanogan River basin (as well as fringing ponds of the Columbia River). The distribution of both species in small to moderate sized rivers and streams indicates the potential for exposure to this project type. These non-motile species are particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with in-channel/off-channel habitat creation. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Western ridged mussel	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-30. Species- and habitat-specific risk of take for mechanisms of impacts associated with riparian planting/restoration/enhancement.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	L	L	L	N	N	N	N	N	N	N	N	N	L	L	L	N	N	N	Chinook salmon are known to occur in environments where riparian planting/restoration/enhancement may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Coho salmon	L	L	L	N	N	N	N	N	N	N	N	N	L	L	L	N	N	N	Coho salmon are known to occur in environments where riparian planting/restoration/enhancement may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Chum salmon	L	L	I	N	N	I	N	N	I	N	N	I	L	L	I	N	N	I	Chum salmon are known to spawn in environments where riparian planting/restoration/enhancement may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pink salmon	L	L	I	N	N	I	N	N	I	N	N	I	L	L	I	N	N	I	Pink salmon are known to spawn in environments where riparian planting/restoration/enhancement may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Sockeye salmon	L	L	L	N	N	N	N	N	N	N	N	N	L	L	L	N	N	N	Sockeye salmon are known to spawn in environments where riparian planting/restoration/enhancement may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from riparian planting/restoration/enhancement.
Steelhead	L	L	L	N	N	N	N	N	N	N	N	N	L	L	L	N	N	N	Steelhead are known to occur in environments where riparian planting/restoration/enhancement may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Coastal cutthroat trout	L	L	L	N	N	N	N	N	N	N	N	N	L	L	L	N	N	N	Coastal cutthroat trout are known to occur in environments where riparian planting/restoration/enhancement may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Westslope cutthroat trout	L	N	L	N	N	N	N	N	N	N	N	N	L	N	L	N	N	N	Westslope cutthroat and redband trout are known to occur in environments where riparian planting/restoration/enhancement may occur. Therefore, these species are vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Redband trout	L	N	L	N	N	N	N	N	N	N	N	N	L	N	L	N	N	N	
Bull trout	L	L	L	N	N	N	N	N	N	N	N	N	L	L	L	N	N	N	Native char occur in rivers and streams, indicating the potential for these species to be exposed to the effects of riparian planting/restoration/enhancement or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Dolly Varden	L	L	L	N	N	N	N	N	N	N	N	N	L	L	L	N	N	N	
Pygmy whitefish	L	N	L	N	N	N	N	N	N	N	N	N	L	N	L	N	N	N	This species spawns in small, cold water tributary streams to rearing lakes, indicating the potential for exposure to riparian planting/restoration/enhancement projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Olympic mudminnow	N	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	Primary habitats used by this species include ponds, wetlands and small, slow-flowing streams. For the purpose of this assessment, these habitats are considered lacustrine, and are potentially suitable for riparian planting/restoration/enhancement projects. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Margined sculpin	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages where riparian planting/restoration/enhancement has the potential to occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Mountain sucker	L	N	L	N	N	N	N	N	N	N	N	N	L	N	L	N	N	N	This species spawns in tributary habitats potentially suitable for riparian planting/restoration/enhancement projects. Therefore this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Lake chub	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. These habitats are potentially subject to riparian planting/restoration/enhancement projects. Therefore, this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Leopard dace	L	N	L	N	N	N	N	N	N	N	N	N	L	N	L	N	N	N	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east, including smaller rivers and stream systems. Therefore, this species occurs in habitats potentially subject to riparian planting/restoration/enhancement or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Umatilla dace	L	N	L	N	N	N	N	N	N	N	N	N	L	N	L	N	N	N	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers. Therefore, this species occurs in habitats potentially subject to riparian planting/restoration/enhancement. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Western brook lamprey	L	N	L	N	N	N	N	N	N	N	N	N	L	N	L	N	N	N	Western brook lamprey spend their entire life history in habitats potentially affected by riparian planting/restoration/enhancement. Due to its limited motility and dependence on small streams and similar habitats this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
River lamprey	L	L	L	N	N	N	N	N	N	N	N	N	L	L	L	N	N	N	Pacific and river lamprey are anadromous species that spawn in habitats potentially affected by riparian planting/restoration/enhancement. Ammocoetes burrow into riverine sediments to rear for extended periods and are similarly vulnerable. Freshwater life-history stages of both species are potentially exposed to a range of impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pacific lamprey	L	I	L	N	N	N	N	N	N	N	N	N	L	I	L	N	N	N	
Green sturgeon	N	L	N	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	Green sturgeon distribution in Washington State is restricted to marine waters, typically in offshore environments. Therefore this species has limited potential for stressor exposure to and related risk of take.
White sturgeon	L	L	L	N	?	N	N	?	N	N	?	N	L	?	L	N	?	N	The freshwater distribution of white sturgeon in Washington State is restricted to large river environments that are potentially suitable for riparian planting/restoration/enhancement. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Longfin smelt	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	The freshwater distribution of longfin smelt may include river environments where riparian planting/restoration/enhancement may be appropriate. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Eulachon	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	The freshwater distribution of eulachon may include river environments where riparian planting/restoration/enhancement may be appropriate. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pacific sand lance	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	These marine species use upper intertidal habitats subject to the effects of marine riparian planting/restoration/enhancement projects. Therefore, some exposure to short-term stressors may occur, resulting in risk of take.
Surf smelt	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Pacific herring	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	This marine species uses lower intertidal habitats subject to the effects of marine riparian planting/restoration/enhancement projects. Therefore, some exposure to short-term stressors may occur, resulting in risk of take.
Lingcod	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	This marine species uses nearshore habitats during larval rearing and may experience exposure to minor stressors resulting from marine riparian planting/restoration/enhancement projects.
Pacific hake	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	These marine species use nearshore habitats during larval rearing and may experience exposure to minor stressors resulting from marine riparian planting/restoration/enhancement projects.
Pacific cod	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Walleye pollock	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Brown rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	These marine species use nearshore habitats during larval rearing and may experience exposure to minor stressors resulting from marine riparian planting/restoration/enhancement projects.
Copper rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Greenstriped rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Widow rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Yellowtail rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Quillback rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Black rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
China rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Tiger rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Bocaccio rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Canary rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Redstripe rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Yelloweye rockfish	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	
Olympia oyster	N	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	This marine species uses nearshore habitats and may experience exposure to minor stressors resulting from marine riparian planting/restoration/enhancement projects.
Northern abalone	N	I	N	N	N	N	N	N	N	N	N	N	N	I	N	N	N	N	This marine species may occur in nearshore habitats and may experience exposure to minor stressors resulting from marine riparian planting/restoration/enhancement projects. However, distribution in deeper waters away from the shoreline limits the severity of stressor exposure to insignificant levels.
Newcomb's littorine snail	N	H	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	This marine species uses a specific type of littoral vegetation (*Salicornia* spp.) as its sole habitat and is limited in distribution to a few discrete locations in Washington State. Therefore, this species will be highly sensitive to adverse effects from riparian vegetation projects that affect its habitat.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Giant Columbia River limpet	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, indicating the potential for exposure to riparian planting/restoration/enhancement projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Great Columbia River spire snail	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. Exposure to the effects of riparian planting/restoration/enhancement is likely to occur in smaller river systems and streams inhabited by this species. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
California floater (mussel)	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	The western ridged mussel is commonly found in small, clear water tributaries and streams. The California floater mussel is known to occur in the Okanogan River basin (as well as fringing ponds of the Columbia River). The distribution of both species in small to moderate sized rivers and streams indicates the potential for exposure to this project type. These non-motile species are particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with riparian planting/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Western ridged mussel	L	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-31. Species- and habitat-specific risk of take for mechanisms of impacts associated with wetland creation/restoration/enhancement.

	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Comments**
Chinook salmon	H	H	H	N	N	N	N	N	N	N	N	N	M	M	M	N	N	N	Chinook salmon are known to occur in environments where wetland creation/restoration/enhancement may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Coho salmon	H	H	H	N	N	N	N	N	N	N	N	N	M	M	M	N	N	N	Coho salmon are known to occur in environments where wetland creation/restoration/enhancement may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Chum salmon	H	H	H	N	N	N	N	N	N	N	N	N	M	M	M	N	N	N	Chum salmon are known to spawn in environments where wetland creation/restoration/enhancement may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pink salmon	H	H	I	N	N	N	N	N	N	N	N	N	M	M	I	N	N	N	Pink salmon are known to spawn in environments where wetland creation/restoration/enhancement may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Sockeye salmon	H	H	H	N	N	N	N	N	N	N	N	N	M	M	M	N	N	N	Sockeye salmon are known to spawn in environments where wetland creation/restoration/enhancement may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from wetland creation/restoration/enhancement.
Steelhead	H	H	H	N	N	N	N	N	N	N	N	N	M	M	M	N	N	N	Steelhead are known to occur in environments where wetland creation/restoration/enhancement may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Coastal cutthroat trout	H	H	H	N	N	N	N	N	N	N	N	N	M	M	M	N	N	N	Coastal cutthroat trout are known to occur in environments where wetland creation/restoration/enhancement may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Westslope cutthroat trout	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	Westslope cutthroat and redband trout are known to occur in environments where wetland creation/restoration/enhancement may occur. Therefore, these species are vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Redband trout	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	
Bull trout	H	H	H	N	N	N	N	N	N	N	N	N	M	M	M	N	N	N	Native char occur in rivers and streams, indicating the potential for these species to be exposed to the effects of wetland creation/restoration/enhancement or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Dolly Varden	H	H	H	N	N	N	N	N	N	N	N	N	M	M	M	N	N	N	
Pygmy whitefish	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	This species spawns in small, cold water tributary streams to rearing lakes, indicating the potential for exposure to wetland creation/restoration/enhancement projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Olympic mudminnow	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	Primary habitats used by this species include ponds, wetlands and small, slow-flowing streams. For the purpose of this assessment, these habitats are considered lacustrine, and are potentially suitable for wetland creation/restoration/enhancement projects. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Margined sculpin	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages where wetland creation/restoration/enhancement has the potential to occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Mountain sucker	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	This species spawns in tributary habitats potentially suitable for wetland creation/restoration/enhancement projects. Therefore this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Lake chub	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. These habitats are potentially subject to wetland creation/restoration/enhancement projects. Therefore, this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Leopard dace	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east, including smaller rivers and stream systems. Therefore, this species occurs in habitats potentially subject to wetland creation/restoration/enhancement or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Umatilla dace	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers. Therefore, this species occurs in habitats potentially subject to wetland creation/restoration/enhancement. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Western brook lamprey	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	Western brook lamprey spend their entire life history in habitats potentially affected by wetland creation/restoration/enhancement. Due to its limited motility and dependence on small streams and similar habitats this species is particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
River lamprey	H	L	H	N	N	N	N	N	N	N	N	N	M	L	M	N	N	N	Pacific and river lamprey are anadromous species that spawn in habitats potentially affected by wetland creation/restoration/enhancement. Ammocoetes burrow into riverine sediments to rear for extended periods and are similarly vulnerable. Freshwater life-history stages of both species are potentially exposed to a range of impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pacific lamprey	H	I	H	N	N	N	N	N	N	N	N	N	M	I	M	N	N	N	
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	L	N	N	?	N	Green sturgeon distribution in Washington State is restricted to marine waters, typically in offshore environments. Therefore this species has limited potential for exposure to wetland enhancement projects in coastal environments, and similarly limited risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
White sturgeon	H	?	H	N	?	N	N	?	N	N	?	N	M	L	M	N	?	N	The freshwater distribution of white sturgeon in Washington State is restricted to large river environments that are potentially suitable for wetland creation/restoration/enhancement. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Longfin smelt	H	N	N	N	N	N	N	N	N	N	N	N	M	L	N	N	N	N	The freshwater distribution of longfin smelt may include river environments where wetland creation/restoration/enhancement may be appropriate. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Eulachon	H	N	N	N	N	N	N	N	N	N	N	N	M	L	N	N	N	N	The freshwater distribution of eulachon may include river environments where wetland creation/restoration/enhancement may be appropriate. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pacific sand lance	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	These marine species use upper intertidal habitats subject to the effects of estuarine and coastal marine wetland restoration/enhancement projects. Therefore, some exposure to short-term stressors may occur, resulting in risk of take.
Surf smelt	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Pacific herring	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	This marine species uses lower intertidal habitats subject to the effects of estuarine and coastal marine wetland restoration/enhancement projects. Therefore, some exposure to short-term stressors may occur, resulting in risk of take.
Lingcod	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	This marine species uses nearshore habitats during larval rearing and may experience exposure to minor stressors resulting from estuarine and coastal marine wetland restoration/enhancement projects.
Pacific hake	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	These marine species use nearshore habitats during larval rearing and may experience exposure to minor stressors resulting from estuarine and coastal marine wetland restoration/enhancement projects.
Pacific cod	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Walleye pollock	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Brown rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	These marine species use nearshore habitats during larval rearing and may experience exposure to minor stressors resulting from estuarine and coastal marine wetland restoration/enhancement projects.
Copper rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Greenstriped rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Widow rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Yellowtail rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Quillback rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Black rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
China rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Tiger rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Bocaccio rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Canary rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Redstripe rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Yelloweye rockfish	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	
Olympia oyster	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	This marine species uses nearshore habitats and may experience exposure to minor stressors resulting from estuarine and coastal marine wetland restoration/enhancement projects.
Northern abalone	N	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	This marine species may occur in nearshore habitats and may experience exposure to minor stressors resulting from estuarine and coastal marine wetland restoration/enhancement projects. However, distribution in deeper waters away from the shoreline

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																			limits the severity of stressor exposure to insignificant levels.
Newcomb's littorine snail	N	H	N	N	N	N	N	H	N	N	N	N	N	N	N	N	N	N	This marine species uses a specific type of littoral vegetation (*Salicornia* spp.) as its sole habitat and is limited in distribution to a few discrete locations in Washington State. Therefore, this species will be highly sensitive to adverse effects from estuarine and coastal marine wetland restoration/enhancement projects that affect its habitat.
Giant Columbia River limpet	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, indicating the potential for exposure to wetland creation/restoration/enhancement projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Great Columbia River spire snail	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. Exposure to the effects of wetland creation/restoration/enhancement is likely to occur in smaller river systems and streams inhabited by this species. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
California floater (mussel)	H	N	H	N	N	N	N	N	N	N	N	N	M	N	M	N	N	N	The western ridged mussel is commonly found in small, clear water tributaries and streams. The California floater mussel is known to occur in the Okanogan River basin (as well as fringing ponds of the Columbia River). The distribution of both species in small to moderate sized rivers and streams indicates the potential for exposure to this project type. These non-motile species are particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with wetland creation/restoration/enhancement. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Western ridged mussel	H	N	N	N	N	N	N	N	N	N	N	N	M	N	N	N	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-32. Species- and habitat-specific risk of take for mechanisms of impacts associated with beach nourishment/contouring.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	N	H	H	N	?	?	N	M	M	N	N	N	N	M	M	N	N	N	Chinook salmon are known to occur in lacustrine and marine environments where beach nourishment/contouring may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Coho salmon	N	H	H	N	?	?	N	M	M	N	N	N	N	M	M	N	N	N	Coho salmon are known to occur in lacustrine and marine environments where beach nourishment/contouring may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Chum salmon	N	H	I	N	?	I	N	M	I	N	N	N	N	M	I	N	N	N	Chum salmon are known to occur in marine environments where beach nourishment/contouring may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pink salmon	N	H	I	N	?	I	N	M	I	N	N	N	N	M	I	N	N	N	Pink salmon are known to occur in marine environments where beach nourishment/contouring may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Sockeye salmon	N	H	H	N	?	?	N	I	M	N	N	N	N	M	M	N	N	N	Sockeye salmon are known to occur in lacustrine and marine environments where beach nourishment/contouring may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from beach nourishment/contouring.
Steelhead	N	H	H	N	?	?	N	I	M	N	N	N	N	M	M	N	N	N	Steelhead are known to occur in lacustrine and marine environments where beach nourishment/contouring may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Coastal cutthroat trout	N	H	H	N	?	?	N	M	M	N	N	N	N	M	M	N	N	N	Coastal cutthroat trout are known to occur in lacustrine and marine environments where beach nourishment/contouring may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Westslope cutthroat trout	N	N	H	N	N	?	N	N	M	N	N	N	N	N	M	N	N	N	Westslope cutthroat and redband trout are known to occur in lacustrine environments where beach nourishment/contouring may occur. Therefore, these species are vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Redband trout	N	N	H	N	N	?	N	N	M	N	N	N	N	N	M	N	N	N	
Bull trout	N	H	H	N	?	?	N	M	M	N	N	N	N	M	M	N	N	N	Native char occur in lacustrine and marine environments, indicating the potential for these species to be exposed to the effects of beach nourishment/contouring or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Dolly Varden	N	H	H	N	?	?	N	M	M	N	N	N	N	M	M	N	N	N	
Pygmy whitefish	N	N	H	N	N	?	N	N	I	N	N	N	N	N	M	N	N	N	This species rears in lakes, indicating the potential for exposure to lacustrine beach nourishment/contouring projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																			improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats used by this species include ponds, wetlands and small, slow-flowing streams. These habitats are unsuitable for beach nourishment/contouring projects. Therefore there will be no risk of take from this project type.
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages. Therefore there is no potential for exposure to this type of project and no related risk of take.
Mountain sucker	N	N	H	N	N	?	N	N	M	N	N	N	N	N	M	N	N	N	This species rears in lacustrine habitats potentially suitable for beach nourishment/contouring projects. Therefore this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Lake chub	N	N	H	N	N	?	N	N	M	N	N	N	N	N	M	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. While unlikely, the lacustrine habitats used by this species could potentially be subject to beach nourishment/contouring projects. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Leopard dace	N	N	H	N	N	?	N	N	M	N	N	N	N	N	M	N	N	N	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east, including smaller rivers and stream systems. While exposure is generally unlikely, this species may occur in lacustrine impoundments potentially subject to beach nourishment/contouring or modification. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Umatilla dace	N	N	H	N	N	?	N	N	M	N	N	N	N	N	M	N	N	N	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers. Therefore, this species occurs in lacustrine impoundments potentially subject to beach nourishment/contouring projects. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Western brook lamprey spend their entire life history in small streams and rivers unsuitable for beach nourishment/contouring. Therefore there is no risk of stressor exposure and no related risk of take.
River lamprey	N	H	H	N	?	?	N	I	M	N	N	N	N	L	M	N	N	N	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of rivers to rear for extended periods, potentially years. The non-motile ammocoete life-history stage is more susceptible to acute transient water quality impacts and direct physical disturbance. In their saltwater phase, river lamprey remain close to shore for periods of 10–16 weeks from spring through fall, meaning there is some potential for exposure to beach nourishment/contouring related stressors in the nearshore environment. Life-history stages exposed to lacustrine beach nourishment/contouring projects face a high risk of take during project construction, while exposure to marine projects produce lesser risk of take because the effects are avoidable. Once established, these projects should result in no risk of take.
Pacific lamprey	N	I	H	N	N	?	N	N	M	N	N	N	N	I	M	N	N	N	Pacific lamprey are anadromous, with migratory corridors extending from marine waters to small tributary streams. Ammocoetes burrow into riverine sediments to rear for extended periods. The non-motile ammocoete life-history stage is more susceptible to acute transient water quality impacts and direct physical disturbance during construction of lacustrine beach nourishment/contouring projects and face high risk of take. In marine waters, Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6–40 months and are therefore face an insignificant potential for exposure to stressors from marine beach nourishment projects. Once established, these projects should result in no risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Green sturgeon	N	?	N	N	?	N	N	?	N	N	N	N	N	?	N	N	N	N	Green sturgeon distribution in Washington State is restricted to offshore marine waters. The potential for exposure to stressors resulting from beach nourishment/contouring is limited to avoidable disturbance and water quality effects. Risk of take is similarly low.
White sturgeon	N	L	H	N	I	?	N	I	M	N	N	N	N	L	M	N	N	N	The freshwater distribution of white sturgeon in Washington State includes lacustrine impoundments that are potentially suitable for beach nourishment/contouring. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Longfin smelt	N	H	H	N	I	?	N	I	M	N	N	N	N	M	M	N	N	N	The freshwater distribution of longfin smelt includes lacustrine environments where beach nourishment/contouring may be appropriate. The marine distribution of this species is primarily limited to offshore habitats so the risk of stressor exposure in these environments is insignificant. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting construction and temporary water quality impacts associated with beach nourishment/contouring in lacustrine environments. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Eulachon	N	H	N	N	I	N	N	I	N	N	N	N	N	M	N	N	N	N	Eulachon distribution in freshwater is limited to river environments unsuitable for beach nourishment/contouring projects. The marine distribution of this species is primarily limited to offshore habitats so the risk of stressor exposure in these environments is insignificant.
Pacific sand lance	N	H	N	N	?	N	N	M	N	N	N	N	N	H	N	N	N	N	These marine species are dependent on littoral beach habitats for spawning, which are directly affected by beach nourishment/contouring are highly likely to occur; therefore, the likelihood of stressor exposure and related risk of take during project construction is high. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Surf smelt	N	H	N	N	?	N	N	M	N	N	N	N	N	H	N	N	N	N	
Pacific herring	N	H	N	N	?	N	N	M	N	N	N	N	N	H	N	N	N	N	This marine species is dependent on littoral beach habitats for spawning which are directly affected by beach nourishment/contouring are likely to occur; therefore, the likelihood of stressor exposure and related risk of take during project construction is high. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Lingcod	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	This marine species occurs in nearshore habitats as rearing larvae and juveniles with limited motility. Therefore, these vulnerable life-history stages may be exposed to stressors from beach nourishment/contouring projects associated with construction and water quality impacts. Exposure to these short-term stressors presents risk of take. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pacific hake	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	These marine species occur in nearshore habitats as rearing larvae and juveniles with limited motility. Therefore, these vulnerable life-history stages may be exposed to stressors from beach nourishment/contouring projects associated with construction and water quality impacts. Exposure to these short-term stressors presents risk of take. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Pacific cod	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Walleye pollock	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Brown rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	These marine species occur in nearshore habitats as rearing juveniles with limited motility. Therefore, this vulnerable life history-stage may be exposed to stressors from beach nourishment/contouring projects associated with construction and water quality impacts. Exposure to these short-term stressors presents risk of take. Once established, these projects will improve habitat conditions and would not be expected to impose ecological stressors; therefore, there will be no related risk of take.
Copper rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Greenstriped rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Widow rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Yellowtail rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Quillback rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Black rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
China rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Tiger rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Bocaccio rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Canary rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Redstripe rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Yelloweye rockfish	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	
Olympia oyster	N	H	N	N	?	N	N	I	N	N	N	N	N	H	N	N	N	N	This marine species occurs in the shallow nearshore marine environments and is non-motile once settled. Therefore, this species could potentially be exposed to impact mechanisms and stressors from beach nourishment projects in the nearshore environment. Limited mobility increases sensitivity to construction and water quality related stressors. Once established, these projects should result in improved habitat conditions and will have no ongoing risk of take.
Northern abalone	N	H	N	N	?	N	N	I	N	N	N	N	N	M	N	N	N	N	This marine species occupies nearshore marine habitats covering a range of depths and is effectively non-motile. Therefore, this species could potentially be exposed to impact mechanisms and stressors from beach nourishment projects. Limited mobility increases sensitivity to construction and water quality related stressors. Once established, these projects should result in improved habitat conditions and will have no ongoing risk of take, with the exception of potential water quality impacts if reef materials include toxic substances with leaching potential.
Newcomb's littorine snail	N	N	N	N	?	N	N	H	N	N	N	N	N	N	N	N	N	N	Newcomb's littorine snail occurs solely in saltmarsh environments unsuitable for beach nourishment. Therefore, there is no potential for stressor exposure and no related risk of take.
Giant Columbia River limpet	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for beach nourishment projects. Therefore there is no potential for stressor exposure and no related risk of take
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. These environments are unsuitable for beach nourishment projects. Therefore there is no risk of stressor exposure and no related risk of take.
California floater (mussel)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The western ridged mussel is commonly found in small, clear water tributaries and streams. The California floater mussel is known to occur in the Okanogan River basin (as well as fringing ponds of the Columbia River). The distribution of both species in small to moderate sized rivers and streams indicates no potential for exposure to beach nourishment projects. Therefore there is no risk of stressor exposure and no related risk of take.
Western ridged mussel	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-33. Species- and habitat-specific risk of take for mechanisms of impacts associated with reef creation.

	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Comments**
Chinook salmon	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	Chinook salmon are known to occur in lacustrine and marine environments where reef creation may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Coho salmon	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	Coho salmon are known to occur in lacustrine and marine environments where reef creation or modification may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Chum salmon	N	H	I	N	M	I	N	M	I	N	M	I	N	M	I	Chum salmon are known to occur in marine environments where reef creation may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Pink salmon	N	H	I	N	M	I	N	M	I	N	M	I	N	M	I	Pink salmon are known to occur in marine environments where reef creation may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Sockeye salmon	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	Sockeye salmon are known to occur in lacustrine and marine environments where reef creation may occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Steelhead	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	Steelhead are known to occur in lacustrine and marine environments where reef creation may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Coastal cutthroat trout	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	Coastal cutthroat trout are known to occur in lacustrine and marine environments where reef creation may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Westslope cutthroat trout	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	Westslope cutthroat and redband trout are known to occur in lacustrine environments where reef creation may occur. Therefore, these species are vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Redband trout	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	
Bull trout	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	Native char occur in lacustrine and marine habitats where reef creation projects may occur. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Dolly Varden	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	
Pygmy whitefish	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	This species rears throughout their juvenile and adult life history in lakes, indicating the potential for exposure to reef creation projects in lacustrine environments. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats used by this species include wetlands and small, slow-flowing streams, environments unsuitable for reef creation. Therefore there is no related risk of take.
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for reef creation; therefore, there is no risk of stressor exposure and no related risk of take.
Mountain sucker	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	This species occurs in lacustrine habitats potentially suitable for reef creation projects. Therefore there is some potential for stressor exposure and related risk of take.
Lake chub	N	N	H	N	N	N	N	N	N	N	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. These habitats are unsuitable for reef creation projects; therefore, there is no potential for stressor exposure and no related risk of take.
Leopard dace	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. Therefore, this species occurs in habitats potentially subject to reef creation or modification. Therefore, this species is vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Umatilla dace	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers. Therefore, this species occurs in lacustrine impoundments potentially subject to reef creation. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Western brook lamprey spend their entire life history in habitats potentially unsuitable for reef creation. Therefore there is no risk of stressor exposure and no related risk of take.
River lamprey	N	H	H	N	M	M	N	?	?	N	M	M	N	M	M	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of rivers to rear for extended periods, potentially years. The non-motile ammocoete life-history stage is more susceptible to acute transient water quality impacts and direct physical disturbance. In their saltwater phase, river lamprey remain close to shore for periods of 10–16 weeks from spring through fall, meaning there is some potential for exposure to beach nourishment/contouring related stressors in the nearshore environment. Life-history stages exposed to lacustrine reef creation projects face a high risk of take during project construction, while exposure to marine projects produce lesser risk of take because the exposed life-history stages have higher motility. Once established, these projects should result in no risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Pacific lamprey	N	H	H	N	M	M	N	?	?	N	M	M	N	M	M	Pacific lamprey are anadromous, with migratory corridors extending from marine waters to small tributary streams. Ammocoetes burrow into riverine sediments to rear for extended periods. The non-motile ammocoete life-history stage is more susceptible to acute transient water quality impacts and direct physical disturbance during construction of lacustrine beach nourishment/contouring projects and face high risk of take. In marine waters, Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6–40 months and are therefore face reduced potential for exposure to stressors from marine reef creation projects. Once established, these projects should result in no risk of take.
Green sturgeon	N	L	N	N	?	N	N	?	N	N	L	N	N	?	N	Green sturgeon distribution in Washington State is restricted to marine waters as foraging adults. Therefore, the potential for stressor exposure is limited to this large, mobile life-history stage.
White sturgeon	N	L	H	N	?	M	N	?	M	N	L	M	N	?	M	The freshwater distribution of white sturgeon in Washington State includes lacustrine environments that are potentially suitable for reef creation, as well as marine habitats where reef creation is likely to occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation. However, sensitivity to stressor exposure in the marine environment is lower because only large motile adults occur in this environment type.
Longfin smelt	M	H	H	N	M	M	N	N	N	N	M	M	N	?	M	The freshwater distribution of longfin smelt includes lacustrine environments (Lake Washington) where reef creation may be appropriate, and marine habitats where reef creation is likely to occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Eulachon	N	H	N	N	M	N	N	N	N	N	M	N	N	?	N	Eulachon occur in marine environments where reef creation is likely to occur. Therefore, this species is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Pacific sand lance	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	These marine species occur in marine environments where reef creation is likely to occur. Therefore, they are potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Surf smelt	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Pacific herring	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	This marine species occurs in marine environments where reef creation is likely to occur. Therefore, it is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Lingcod	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	This marine species occurs in marine environments where reef creation is likely to occur. Therefore, it is potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Pacific hake	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	These marine species occur in marine environments where reef creation is likely to occur. Therefore, they are potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Pacific cod	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Walleye pollock	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Brown rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	These marine species occur in marine environments where reef creation is likely to occur. Therefore, they are potentially vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Copper rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Greenstriped rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Widow rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Yellowtail rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Quillback rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Black rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
China rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Tiger rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Bocaccio rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Canary rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Redstripe rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Yelloweye rockfish	N	H	N	N	M	N	N	M	N	N	M	N	N	M	N	
Olympia oyster	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where reef creation takes place; therefore, there is no related risk of take.
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where reef creation takes place; therefore, there is no related risk of take.
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species does not occur in environments where reef creation takes place; therefore, there is no related risk of take.
Giant Columbia River limpet	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, indicating no potential for exposure to reef creation projects. Therefore, this species is not vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. These environments are unsuitable for reef creation projects; therefore, there is no potential for stressor exposure and no related risk of take.
California floater (mussel)	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	The California floater mussel is known to occur in the Okanogan River basin (as well as fringing ponds of the Columbia River). While unlikely, the distribution of this species in lacustrine impoundments presents the potential for exposure to reef creation projects. This non-motile species would be particularly vulnerable to the impact mechanisms, stressors, and related risk of take resulting from reef creation.
Western ridged mussel	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The western ridged mussel is commonly found in small, clear water tributaries and streams. These environments are unsuitable for reef creation; therefore, there is no risk of stressor exposure and no related risk of take.

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-34. Species- and habitat-specific risk of take for mechanisms of impacts associated with eelgrass and other aquatic vegetation creation/restoration/enhancement.

	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			
Species	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Comments**
Chinook salmon	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	This species occurs in marine and lacustrine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Coho salmon	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	This species occurs in marine and lacustrine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Chum salmon	N	H	I	N	M	I	N	M	I	N	M	I	N	M	I	This species occurs in marine and lacustrine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Pink salmon	N	H	I	N	M	I	N	M	I	N	M	I	N	M	I	This species occurs in marine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Sockeye salmon	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	This species occurs in marine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Steelhead	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	This species occurs in marine and lacustrine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Coastal cutthroat trout	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	This species occurs in marine and lacustrine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Westslope cutthroat trout	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	These species occur in lacustrine habitats where aquatic vegetation restoration/enhancement projects may occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Redband trout	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	
Bull trout	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	These species occur in marine and lacustrine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Dolly Varden	N	H	H	N	M	M	N	M	M	N	M	M	N	M	M	
Pygmy whitefish	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	This species occurs in lacustrine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats used by this species include wetlands and small, slow-flowing streams, environments potentially suitable for emergent vegetation enhancement projects. Therefore some potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for aquatic vegetation enhancement projects; therefore, there is no risk of stressor exposure and no related risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Mountain sucker	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	This species occurs in lacustrine habitats where aquatic vegetation restoration/enhancement projects are likely to occur. Therefore the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Lake chub	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. Occurrence in lacustrine habitats potentially suitable for aquatic vegetation restoration/enhancement projects are likely to occur suggests the potential for stressor exposure exists. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Leopard dace	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. Lacustrine and riverine habitats in the Columbia River could be suitable environments for aquatic vegetation enhancement.
Umatilla dace	N	N	H	N	N	M	N	N	M	N	N	M	N	N	M	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers. Therefore, this species occurs in lacustrine impoundments potentially subject to reef creation. Lacustrine and riverine habitats in the Columbia and Snake rivers could be suitable environments for aquatic vegetation enhancement.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Western brook lamprey spend their entire life history in habitats potentially unsuitable for aquatic vegetation restoration and enhancement projects. Therefore there is no risk of stressor exposure and no related risk of take.
River lamprey	N	H	H	N	M	M	N	?	?	N	M	M	N	M	M	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of rivers to rear for extended periods, potentially years, indicating the potential for exposure to aquatic vegetation enhancement and restoration projects in lakes and estuaries. In their saltwater phase, river lamprey remain close to shore for periods of 10–16 weeks from spring through fall, meaning there is some potential for exposure to aquatic vegetation restoration and enhancement projects in both environment types. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take.
Pacific lamprey	N	I	H	N	N	M	N	I	?	N	I	M	N	N	M	Pacific lamprey are anadromous, with migratory corridors extending from marine waters to small tributary streams. Ammocoetes burrow into riverine and lacustrine sediments to rear for extended periods, indicating the potential for exposure to aquatic vegetation enhancement and restoration projects in lakes. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established these projects would be expected to improve habitat conditions; therefore, there will be no ongoing risk of take. In marine waters, Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6–40 months and are therefore face little potential for exposure to this type of project in the marine environment.
Green sturgeon	N	I	N	N	N	N	N	N	N	N	I	N	N	N	N	Green sturgeon distribution in Washington State is restricted to marine waters as foraging adults. Given the tendency for distribution in offshore waters, the potential for exposure to stressors from this project type is insignificant. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
White sturgeon	N	I	L	N	N	N	N	N	N	N	I	L	N	N	N	The freshwater distribution of white sturgeon in Washington State includes lacustrine environments that are potentially suitable for aquatic vegetation restoration and enhancement projects, as well as marine habitats where this project type is likely to occur. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Given the tendency for distribution in offshore waters, the potential for exposure to stressors from this project type is insignificant. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Longfin smelt	N	I	L	N	N	N	N	N	N	N	I	L	N	N	N	The freshwater distribution of longfin smelt includes lacustrine environments (Lake Washington) where aquatic vegetation restoration and enhancement may be appropriate. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Offshore distribution in marine waters suggests that the potential for stressor exposure and related risk of take from this project type are insignificant. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Eulachon	N	I	N	N	N	N	N	N	N	N	I	N	N	N	N	Eulachon occur in marine environments where reef creation is likely to occur. However, associated are limited in magnitude; therefore, the related risk of take is similarly limited. Offshore distribution in marine waters suggests that the potential for stressor exposure and related risk of take from this project type are insignificant. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Pacific sand lance	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	These marine species occur in marine environments where aquatic vegetation restoration and enhancement projects are likely to occur. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Surf smelt	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Pacific herring	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	This marine species occurs in marine environments where aquatic vegetation restoration and enhancement projects are likely to occur. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Lingcod	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	This marine species occurs in marine environments where aquatic vegetation restoration and enhancement projects are likely to occur. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Pacific hake	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	These marine species occur in marine environments where aquatic vegetation restoration and enhancement projects are likely to occur. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Pacific cod	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Walleye pollock	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Brown rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	These marine species occur in marine environments where aquatic vegetation restoration and enhancement projects are likely to occur. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Copper rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Greenstriped rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Widow rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Yellowtail rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Quillback rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Black rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
China rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Tiger rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Bocaccio rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Canary rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Redstripe rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Yelloweye rockfish	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	
Olympia oyster	N	L	N	N	N	N	N	N	N	N	L	N	N	N	N	This marine species occurs in marine environments where aquatic vegetation restoration and enhancement projects are likely to occur. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Northern abalone	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This marine species occurs in nearshore marine environments, however it is typically distributed in habitats unsuitable for aquatic vegetation restoration and enhancement projects. Therefore there is no potential for stressor exposure and no related risk of take.
Newcomb's littorine snail	N	H	N	N	N	N	N	N	N	N	N	N	N	N	N	This species is dependent on saltmarsh vegetation as its sole habitat. Vegetation restoration and enhancement projects may occur in this environment type, suggesting the potential for direct physical injury or mortality during planting activities. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Giant Columbia River limpet	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep. These habitats are unsuitable for aquatic vegetation restoration and enhancement projects. Therefore there is no potential for stressor exposure and no related risk of take.
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. These habitats are unsuitable for aquatic vegetation restoration and enhancement projects. Therefore there is no potential for stressor exposure and no related risk of take.
California floater (mussel)	N	N	L	N	N	N	N	N	N	N	N	L	N	N	n	The California floater mussel is known to occur in the Okanogan River basin as well as fringing ponds of the Columbia River. The distribution of this species in lacustrine impoundments and fringing pond habitats presents the potential for exposure to aquatic vegetation restoration and enhancement projects. However, associated stressors are limited in magnitude; therefore, the related risk of take is similarly limited. Once established, these projects will result in improved habitat conditions and will produce no ongoing risk of take.
Western ridged mussel	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The western ridged mussel is commonly found in small, clear water tributaries and streams. These habitats are unsuitable for aquatic vegetation restoration and enhancement projects. Therefore there is no potential for stressor exposure and no related risk of take.

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

9.4.6 Marinas and Terminals

Marinas and terminals are very similar to each other, with similar mechanisms of impacts, stressors, and potential risks of take, and so they are treated as one type of activity. Terminals would generally be expected to produce impact mechanisms of greater magnitude and frequency than marinas, but marinas and terminals can vary broadly in scale and activity frequency, and the related impact mechanisms will vary accordingly. A high-volume marine terminal frequented by cargo vessels produces larger and more frequent disturbances than a small recreational marina on a lake. A low-volume ferry terminal serving a lightly populated area will produce less operational and vessel-related disturbance than a large marina supporting a mix of commercial and recreational vessels. Therefore, it is not possible to estimate the risk of take based on facility type alone.

The matrices summarizing the potential risks of take associated with marinas/terminals discuss risks from each mechanism of impact in greater detail than for other types of activities. Tables 9-35 through 9-40 show potential risk of take associated with construction and maintenance, operations and vessel activities, water quality modifications, riparian vegetation modifications, aquatic vegetation modifications, and hydrologic-geomorphic modifications respectively.

9.4.6.1 Construction, Maintenance, and Operation Activities

Impact mechanisms imposed by marinas/terminals will vary in terms of magnitude and to a certain extent in the frequency of disturbance associated with construction and maintenance.

The potential for injury or mortality from pile driving varies depending on piling size and composition, pile driving methods, and site-specific environmental characteristics such as bathymetry, intervening land masses, and substrate composition.

Construction vessel operation results in increased ambient noise levels in and around the project vicinity, disturbance of substrates from anchors, shading cast by the vessels (if they stay in the same place over a longer period of time), grounding of construction vessels, and operational or accidental discharges. The overall risk of take associated construction vessels is considered moderate because of its limited duration and because of timing restrictions that will limit the duration of effects on many HCP species.

Work area dewatering poses a high risk of take of varying levels of severity depending on habitat and species-specific factors.

Marina/terminal development often involves dredging to establish and maintain approach and navigation channels. Dredging activities are typically temporary to short term in duration, lasting from days to weeks, and recur at interannual to decadal frequencies. Stressors associated with dredging include disturbance and the potential for direct injury or mortality from physical entrainment. Many juvenile and most adult fish are sufficiently mobile to avoid entrainment and injury. In combination with timing restrictions, this will limit exposure so that only moderate risk of take will result from disturbance and temporary or permanent displacement. In contrast, eggs, sessile invertebrates, and demersal or planktonic larvae are vulnerable to entrainment, and timing restrictions may not provide protection for all HCP species in all environments.

Once a marina or terminal is constructed, the operation of the facility and related vessel activities will impose a suite of ongoing impact mechanisms on the aquatic environment. Stressors associated with these impact mechanisms vary in nature and severity, but are similar in that they will be essentially permanent in duration and common to continuous in frequency.

Species occurring in larger rivers, estuaries of large rivers, and the marine environment are more likely to be exposed to larger, higher activity facilities. Species occurring only in lakes or smaller rivers will not receive the same type of exposure, as these environments are more suitable for smaller-scale facilities supporting predominantly recreational uses.

Grounding, anchoring, and prop wash are forms of direct disturbance from vessel activity associated with marinas/terminals. The risk of take for is variable, with likelihood of adverse effects dependent on project-specific considerations. In general, the risk of take from stressors associated with grounding, anchoring, and prop wash is low to moderate for species and life-history stages that do not utilize the affected habitat extensively and are mobile and can avoid the stressor with minor behavioral alteration. Species with less mobile life-history stages that are exposed to this stressor may experience a moderate to high potential for take.

Vessel maintenance and operational discharges may degrade water quality through the introduction of potentially toxic substances. The ratings of species-specific risk of take associated with discharges are based on a combination of the general effects of receptor exposure to toxic substances and the duration and frequency of potential exposure resulting from facility operation. Because the associated stressors are likely to occur at a greater frequency over the long term, vessel discharges are generally associated with a high risk of take.

Facility and vessel operation result in permanent alterations to ambient noise levels at frequencies ranging from intermittent to continuous depending on the type of facility involved. The risks of take associated with ongoing noise are greater than that associated with construction because of the longer duration and higher frequency of exposure. Shipping or ferry terminals frequented by large vessels capable of producing high levels of underwater noise would be expected to produce a higher level of risk of take, as the potential for auditory masking, hearing threshold effects, and avoidance behavior are greater. Large marinas frequented by numerous commercial and recreational vessels may also produce considerable ambient noise and related risk of take that are comparable to or exceed smaller shipping terminals. Smaller marinas serving recreational vessels may produce less pronounced effects on ambient noise levels overall, with seasonal peaks in activity punctuated by long periods of less activity. Under a "worst-case scenario" altered ambient noise equates to a high risk of take, with likelihood of adverse effects dependent on project-specific considerations.

Marinas/terminals alter ambient light conditions in the nearshore environment. Daytime shading produced by overwater structures and vessels and nighttime lighting both modify the ambient light environment, forcing behavioral adaptations by fish. Structural shading can also lead to alteration of submerged aquatic vegetation, producing additional impact mechanisms. In marine environments, the diffusion of small bubbles from cavitation and prop wash can also modify the ambient light environment by diminishing light penetration, again resulting in additional impact mechanisms caused by alteration of submerged aquatic vegetation. Risk of take associated with altered ambient light varies by species and environment. Fish species that are exposed to this stressor, particularly in lacustrine and nearshore marine environments, may alter their behavior, with variable effects on survival, growth, and fitness. The sensitivity of invertebrates to altered ambient light conditions is less understood. In a "worst-case scenario" species are generally likely to experience a high risk of take because the habitat alterations associated with altered ambient light conditions, and resulting effects on survival, growth, and fitness, are long term in nature.

9.4.6.1 Hydraulic and Geomorphic Modifications

Marina/terminal projects modify hydraulic and geomorphic conditions, resulting in the imposition of several impact mechanisms and related stressors. Risk of take resulting from these impact mechanisms is strongly linked to species-specific dependence on the nearshore environment.

Alterations to wave energy, current velocities, nearshore circulation patterns, sediment supply and transport, altered substrate composition, and altered freshwater inputs caused by marinas/terminals all equate to a high risk of take in both marine and lacustrine environments.

Altered shoreline and bluff stability can be variable depending on specific design elements of the marina/terminal. Most marinas/terminals armor the shoreline, increasing shoreline and bluff stability locally, as well as possibly decreased stability elsewhere through alteration of wave energy. In other cases, unmitigated vegetation alteration may decrease shoreline stability. Changes are associated with a high risk of take.

Permitting of marinas/terminals implicitly authorizes the development of some amount of associated impervious surface. Runoff from these surfaces that is not detained or infiltrated will alter peak flows entering the receiving body and, in theory, could result in localized alteration of hydraulic conditions. In reality, however, the larger water bodies suitable for marina and terminal development are insensitive to the relatively small amount of impervious surface area created by this type of facility. These types of water bodies are considered flow control exempt by the Washington State Departments of Ecology and Transportation (WSDOT 2006c), meaning that for regulatory purposes they are considered insensitive to the effects of flow perturbation imposed by impervious surfaces. Flow effects in flow control exempt water bodies are not considered a source of take for ESA consultation purposes (WSDOT 2006d), meaning that the risk of take is considered insignificant and discountable. Therefore, the risk of take resulting from this stressor will be insignificant.

9.4.6.2 Riparian Vegetation Modifications

The nature and scale of riparian vegetation modifications depend on the size and design of the individual project in combination with site-specific conditions. The majority of riparian vegetation modifications associated with marinas and terminals involves permanent conversion to an armored shoreline using bulkheads or some similar structure.

In marine and lacustrine environments, risk of take from marina/terminal projects' effects on riparian vegetation is strongly linked to species-specific dependence on the nearshore environment and riparian functions. For many species, the risk of take associated with marine riparian impact mechanisms is unknown because scientific understanding of the related ecological processes is in its infancy, and the extent to which many marine or anadromous species rely on the nearshore environment during their life history is unclear.

In riverine environments, marina/terminal projects are limited to the lower reaches of larger river systems in virtually all circumstances, meaning that they are located in a position on the river continuum where allochthonous inputs from riparian vegetation are less important to overall food web productivity. The loss of allochthonous production from riparian vegetation modification at the scale of a typical terminal or marina project is likely to have an insignificant effect on food web productivity and foraging opportunities. In a worst-case scenario, a large marina shipping terminal project could alter a large amount of riparian area, leading to a localized reduction in allochthonous inputs in a relatively enclosed circulation environment. However, these effects are not expected to be significant relative to the broader effects on habitat suitability imposed by the activity.

If riparian vegetation is removed and not replaced with armoring, bank stability may decrease. Such changes are associated with a high risk of take.

9.4.6.3 Aquatic Vegetation Modifications

Both the construction and operation of marinas/terminals can result in aquatic vegetation modifications. During construction, vegetation in the structural footprint of the project will be eradicated or buried by the placement of fill or structural material. After construction, vegetation growth and persistence can be affected by changes in ambient light conditions caused by vessel and structural shading.

In marine environments, changes in wave energy, flow and/or current velocities, and substrate composition can also lead to alteration of the vegetation community, shifts in the food web, and altered habitat complexity. This results in a high risk of take. In riverine and lacustrine environments, aquatic vegetation is a relatively minor component of the habitat structure. Aside from native emergent vegetation confined to a relatively narrow range of depths, the majority of aquatic vegetation species in lake systems are invasive exotic species. But for species that depend on native aquatic vegetation, alterations caused by marinas/terminals result in a high risk of take.

9.4.6.1 Water Quality Modifications

The size of the facility, its operation and maintenance requirements, and the intensity of vessel traffic determine stressor intensity from water quality modifications.

Increased suspended solids from marina or terminal operations and maintenance result in a low risk of take for motile species and a moderate risk of take for non-motile species.

Dredging, grounding and anchoring, pile driving, and other activities can result in the resuspension of previously contaminated sediments. Depending on the nature and concentration of the contaminant and the duration of exposure, the toxic substances in contaminated sediments can cause a range of adverse effects in exposed species. These effects may include physiological injury and/or contaminant bioaccumulation leading to decreased survival, growth, and fitness. This presents a moderate risk of take.

Construction and operation of marinas/terminals presents multiple pathways for the introduction of a range of toxic substances to the aquatic environment. Depending on the nature and concentration of the contaminant, toxic substance exposure can cause a range of adverse effects in exposed species. In extreme cases, these effects can include direct mortality. More commonly, chronic, low-level exposure to a variety of contaminants is likely to cause physiological injury and/or contaminant bioaccumulation leading to decreased survival, growth, and fitness. This presents a moderate risk of take.

Dissolved oxygen levels could be reduced near marinas/terminals. In extreme circumstances, nutrient-rich discharge from shipboard sanitary systems or ballast water may cause temporary or short-term decreases in dissolved oxygen levels. A large decrease in aquatic vegetation may limit photosynthetic production of oxygen, but the likelihood of this effect substantially decreasing dissolved oxygen levels is quite limited. In general, the likelihood of decreased dissolved oxygen occurring as a direct or indirect result of marina/terminal development is low. Fish species that are highly mobile will generally be able to avoid adverse effects, translating to a low risk of take. Sessile invertebrates and less mobile life-history stages could experience direct mortality as a result of low levels of dissolved oxygen, equating to moderate or even high risk of take depending on species-specific life history. However, because of the low likelihood of occurrence, the overall risk of take associated with this stressor is considered low for all species.

Curing concrete in water or operational discharges and accidental spills of acidic or caustic materials may lead to alteration of normal pH levels. In general, alterations to pH will be limited to low-frequency events that are temporary to short term in duration. Fish species that are highly mobile will generally be able to avoid adverse effects through behavioral avoidance, translating to a low risk of take. In contrast, sessile invertebrates and less mobile life-history stages could experience direct mortality as a result of exposure, equating to high risk of take.

Creosote-treated wood is expected to present a moderate risk of take, in part because it is no longer frequently installed. WACs 220-110-060 and -224 prohibit the use of creosote- and pentachlorophenol-treated wood in lakes; therefore, exposure to this stressor will not occur in most lacustrine habitats for new projects. There is some uncertainty about potential exposure in lacustrine environments because the applicability of this statute to reservoirs (which are functionally similar to lacustrine environments) is not clear. ACZA and CCA type C treated wood is expected to present a high risk of take.

Marinas/terminals have some amount of associated impervious surface. Runoff from these surfaces that is not detained and treated or infiltrated transports toxic substances and contaminated sediments to the aquatic environment, creating a new permanent stressor of temporary to short-term duration, occurring at common frequencies with seasonal peaks. Depending on the nature and concentration of the transported contaminants, stormwater-related toxic substances can cause a range of adverse effects on exposed species. In extreme cases, these effects can include direct mortality. More commonly, chronic, low-level exposure to a variety of contaminants is likely to cause physiological injury and/or contaminant bioaccumulation leading to decreased survival, growth, and fitness. This presents a high risk of take.

Table 9-35. Species- and habitat-specific risk of take for mechanisms of impact associated with marina/terminal construction and maintenance activities.

Species	Pile Driving			Construction Vessel Operation			Channel/Work Area Dewatering			Navigation/ Maintenance Dredging			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	H	H	H	M	M	M	H	H	H	M	M	M	This species has a complex and variable life history depending on race. In general, Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors.
Coho salmon	H	H	H	M	M	M	H	H	H	M	L	M	This species has a complex and variable life history depending on race. In general, coho salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure.
Chum salmon	H	H	I	M	M	I	H	H	I	M	M	I	Chum salmon in Washington State do not use lacustrine habitats suitable for marina/terminal development. Therefore, stressor exposure will not occur in lacustrine environments. Chum may spawn in the lower reaches of large river environments (e.g., the Columbia River) and may therefore be subject to temporary effects of maintenance dredging on spawning habitat, as well as juvenile and adult exposure during migration. Juvenile chum salmon are dependent on nearshore marine habitats and are therefore subject to stressor exposure from marina/terminal development in these environments.
Pink salmon	H	H	I	M	M	I	H	H	I	M	M	I	Pink salmon in Washington State do not use lacustrine habitats. Therefore, stressor exposure will not occur in lacustrine environments. This species is dependent on nearshore marine habitats for juvenile rearing and migrates through the mainstems and estuaries of larger river systems potentially suitable for marina/terminal development. As such, this species may potentially experience related stressor exposure.
Sockeye salmon	H	H	H	M	M	M	H	H	H	M	L	M	This species is highly dependent on lacustrine environments for juvenile rearing. Most spawning behavior occurs in smaller rivers and streams that are not suitable for marina development. However, some populations spawn in nearshore lacustrine habitats, creating increased risk of stressor exposure at sensitive egg and alevin life-history stages. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridor. Avoidance of impacts on juvenile sockeye in lacustrine environments is difficult due to year-round residence.
Steelhead	H	L	H	L	L	M	H	L	H	M	L	M	Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats, so the risk of take associated with activities in these habitat types is unknown.
Coastal cutthroat trout	H	H	H	L	L	M	H	H	H	M	M	M	This species is prevalent in estuaries and large rivers and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for marina/terminal development. Migratory behavior and residence timing are variable. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure.
Westslope cutthroat trout	I	N	H	I	N	M	I	N	H	I	N	M	These species occur primarily in coldwater streams and small to medium sized rivers, and in lakes. Occurrence in larger rivers suitable for marina/terminal development is unlikely.
Redband trout	I	N	H	I	N	M	I	N	H	I	N	M	
Bull trout	H	H	H	M	M	M	H	H	H	M	M	M	Spawning by these species occurs in habitats that are generally unsuitable for marina/terminal development. Therefore, spawning, egg incubation, and early rearing will not be directly affected by these activities. Most effects will occur from development in riverine migratory corridors, as well as riverine, lacustrine, and marine foraging habitats used by mature juveniles and adults.
Dolly Varden	H	H	H	M	M	M	H	H	H	M	M	M	
Pygmy whitefish	N	N	H	N	N	M	N	N	H	N	N	M	Lakes and smaller lake tributaries are primary habitats used by this species. Whitefish do not occur in larger rivers suitable for marina/terminal development; therefore, stressor exposure will only occur in lacustrine environments.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. Species does not occur in larger rivers or lakes suitable for marina/terminal development.
Margined sculpin	N	N	•	N	N	•	N	N	•	N	N	•	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for marina/terminal development.
Mountain sucker	H	N	H	L	N	M	H	N	H	M	N	M	This species is commonly found in large rivers and lakes suitable for marina and potentially terminal development.
Lake chub	I	N	I	N	N	I	I	N	I	I	N	I	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens Counties that are generally unsuitable for marina/terminal development. Therefore, the likelihood of stressor exposure is considered discountable.
Leopard dace	H	N	H	M	N	M	H	N	H	M	N	M	This species has been reported in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in habitats potentially suitable for marina/terminal development at sensitive life-history stages, including egg incubation.
Umatilla dace	H	N	H	M	N	M	H	N	H	M	N	M	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake Rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for marina/terminal development at sensitive life-history stages, including egg incubation.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	This species is characterized by isolated breeding populations favoring small streams and brooks, which are unsuitable environments for marina development. Therefore, marina/terminal development will have no-effect on this species.
River lamprey	H	H	H	?	?	?	H	H	H	H	M	H	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of larger rivers to rear for extended periods, potentially years. In their saltwater phase, river lamprey remain close to shore for periods of 10 to 16 weeks from spring through fall. They are therefore susceptible to dredging and dewatering impacts. Sound sensitivity of primitive fishes such as lamprey is currently a data gap, so the potential effects of this stressor are unknown. This life-history makes this species particularly

Species	Pile Driving			Construction Vessel Operation			Channel/Work Area Dewatering			Navigation/ Maintenance Dredging			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
													sensitive to dredging and dewatering in lakes and rivers, as well as in the nearshore marine environment. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Pacific lamprey	H	H	H	?	I	?	H	I	H	H	L	H	Pacific lamprey are anadromous with migratory corridors that cross estuaries and mainstems of larger river systems suitable for marina/terminal development. Ammocoetes burrow into riverine sediments to rear for extended periods. They are therefore susceptible to dredging and dewatering impacts in freshwater environments. Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6 to 40 months. Sound sensitivity of primitive fishes such as lamprey is currently a data gap, so the potential effects of this stressor are unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Green sturgeon	N	H	N	N	?	N	N	L	N	N	M	N	In Washington, white sturgeon are found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington. Although this species is considered anadromous, some populations in the Columbia River may be reproducing successfully in some impoundments. Sturgeon eggs are demersal and adhesive. Larval sturgeon are essentially planktonic and rear in quiet backwaters of the large rivers and lakes where they are transported by currents following emergence. These life-history stages are therefore sensitive to dewatering, dredging, and other direct impacts. Green sturgeon fisheries occur in the Columbia River below Bonneville Dam, Willapa Bay, and Grays Harbor. Individuals are also occasionally caught incidentally in small coastal bays and the Puget Sound. Sturgeon are wide ranging in marine waters. Dependence on nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in nearshore habitats.
White sturgeon	H	H	H	L	?	L	H	L	H	M	M	M	
Longfin smelt	H	H	N	M	M	N	H	H	H	H	H	H	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems, which are preferred areas for marina development. Demersal adhesive eggs are vulnerable to short-term dewatering and dredging impacts. Adults, eggs, and larvae are vulnerable to impacts from pile driving. Planktonic larvae and juveniles of these species may also be vulnerable to stressor exposure in the nearshore marine environment during early rearing. Mature juveniles and adults are found in offshore environments.
Eulachon	H	H	N	M	M	N	H	H	N	H	H	N	
Pacific sand lance	N	H	N	N	M	N	N	H	N	N	H	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high.
Surf smelt	N	H	N	N	M	N	N	H	N	N	H	N	
Pacific herring	N	H	N	N	M	N	N	H	N	N	H	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure is high.
Lingcod	N	H	N	N	M	N	N	H	N	N	H	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are subject to impacts from dewatering and dredging. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 to 150 m) and therefore have less exposure potential. Temporary disturbance while brooding may increase risk of egg predation. Low mobility larvae settle in nearshore areas, increasing risk of take from dredging and dewatering.
Pacific hake	N	H	N	N	M	N	N	H	N	N	H	N	Hake, cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Larvae and smaller juveniles of all three species may be at higher risk of dredging entrainment due to limited mobility.
Pacific cod	N	H	N	N	M	N	N	H	N	N	H	N	
Walleye pollock	N	H	N	N	M	N	N	H	N	N	H	N	
Brown rockfish	N	H	N	N	M	N	N	H	N	N	H	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Planktonic larvae and demersal juveniles are particularly vulnerable to dewatering and fish handling, as well as dredging activities.
Copper rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Greenstriped rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Widow rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Yellowtail rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Quillback rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Black rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
China rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Tiger rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Bocaccio rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Canary rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Redstripe rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Yelloweye rockfish	N	H	N	N	M	N	N	H	N	N	H	N	
Olympia oyster	N	?	N	N	M	N	N	H	N	N	H	N	Olympia oysters are found in intertidal and subtidal environments potentially subject to dredging and dewatering impacts. Exposure to these impact mechanisms could lead to direct mortality or injury. Sound sensitivity of this species is currently a data gap, and the effects of related stressors are unknown.
Northern abalone	N	?	N	N	M	N	N	H	N	N	H	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) depth. This distribution

Species	Pile Driving			Construction Vessel Operation			Channel/Work Area Dewatering			Navigation/ Maintenance Dredging			Comments
	Riverine	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	
													increases risk of stressor exposure and potential for take from dewatering and dredging activities. The effect of underwater noise on mollusks is a data gap so the potential for take related to this stressor is unknown.
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	This species inhabits a narrow band of upper littoral zone habitat above MHHW and is therefore not exposed to stressors resulting from in-water construction activities.
Giant Columbia River limpet	?	N	N	?	N	?	?	N	N	I	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for marina/terminal development. As such, there is essentially no likelihood of stressor exposure and therefore no potential for take resulting from these activities. The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. This distribution likely limits exposure to navigational dredging. Exposure to work area dewatering is possible, but sensitivity to this stressor is a data gap so the potential for take is unknown. The effects of underwater noise on mollusks are currently a data gap so the potential for take related to this stressor is unknown.
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	
California floater (mussel)	?	N	?	?	N	?	H	N	H	H	N	H	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake River and the mainstems of these systems. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. As such, both species may occur in habitats suitable for marina/terminal development. This distribution presents risk of stressor exposure and potential for take, particularly from dewatering and dredging activities. Exposure to dewatering can cause mortality in both species. The effect of underwater noise on mollusks is currently a data gap so the potential for take related to this stressor is unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Western ridged mussel	?	N	N	?	N	N	H	N	N	H	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-36. Species- and habitat-specific risk of take for mechanisms of impact associated with marina/terminal facility operation and vessel activities.

Species	Grounding, Anchoring, and/or Prop Wash			Vessel Maintenance and Operational Discharges			Increased or Altered Ambient Noise Levels			Ambient Light Modifications			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	H	H	H	H	H	H	L	L	L	L	H	H	This species has a complex and variable life history depending on race. In general, Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Ambient light modification is a recognized stressor for this species in nearshore marine and lacustrine environments.
Coho salmon	H	H	H	H	M	H	L	L	L	L	?	H	This species has a complex and variable life history depending on race. In general, coho salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Ambient light modification is a likely source of risk of take for this species in nearshore lacustrine environments and may also pose risk of take in marine environments. However, as juvenile coho salmon are more typically found farther from shore, the effects of shading are less clear; therefore, the risk of take in the marine environment is uncertain.
Chum salmon	H	H	I	H	H	I	L	L	I	L	H	I	Chum salmon in Washington State do not use lacustrine habitats suitable for marina/terminal development. Therefore, stressor exposure will not occur in lacustrine environments. Chum may spawn in the lower reaches of large river environments (e.g., the Columbia River) and may therefore be subject to facility and vessel operational effects dredging on spawning habitat, in addition to juvenile and adult exposure during migration. Juvenile chum salmon are dependent on nearshore marine habitats, and are therefore subject to stressor exposure from marina/terminal development in these environments. Ambient light modification is a recognized stressor for this species, resulting in a moderate risk of take from chronic behavioral alteration.
Pink salmon	H	H	I	H	H	I	L	L	I	L	H	I	Pink salmon in Washington State do not use lacustrine habitats. Therefore, stressor exposure will not occur in lacustrine environments. This species is dependent on nearshore marine habitats for juvenile rearing and migrates through the mainstems and estuaries of larger river systems potentially suitable for marina/terminal development. As such, this species may potentially experience related stressor exposure.
Sockeye salmon	H	L	H	H	H	H	L	L	L	L	?	H	This species is highly dependent on lacustrine environments for juvenile rearing. Most spawning behavior occurs in smaller rivers and streams that are not suitable for marina development. However, some populations spawn in nearshore lacustrine habitats, creating increased risk of stressor exposure at sensitive egg and alevin life-history stages. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridor. Avoidance of impacts on juvenile sockeye in lacustrine environments is difficult due to year-round residence. Ambient light modification is a likely source of risk of take for this species in nearshore lacustrine environments and may also pose risk of take in marine environments. However, as juvenile sockeye salmon are more typically found farther from shore, the effects of shading are less clear; therefore, the risk of take in the marine environment is uncertain.
Steelhead	H	L	H	H	H	H	L	L	L	L	?	H	Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats, so the risk of take associated with activities in these habitat types is unknown. Ambient light modification is a potential source of take for this species in nearshore lacustrine environments and may also pose risk of take in marine environments. However, as juvenile steelhead are more typically found farther from shore, the effects of shading are less clear; therefore, the risk of take in the marine environment is uncertain.
Coastal cutthroat trout	H	H	H	H	H	H	L	L	L	H	H	H	This species is prevalent in estuaries and large rivers and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for marina/terminal development. Migratory behavior and residence timing are variable. Spawning and juvenile rearing activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Ambient light modification is a likely source of risk of take for this species in nearshore marine environments, based on similar sensitivity of other salmonid species in these environments.
Westslope cutthroat trout	I	N	H	I	N	H	I	N	L	I	N	H	These species occur primarily in coldwater streams, small to medium-sized rivers, and in lakes. Occurrence in larger rivers suitable for marina/terminal development is unlikely. Ambient light modification is a likely source of risk of take for these species in nearshore lacustrine environments, based on similar sensitivity of other salmonid species in these environments.
Redband trout	I	N	H	I	N	H	I	N	L	I	N	H	
Bull trout	H	H	H	H	H	H	L	L	L	?	?	?	Spawning by these species occurs in habitats that are generally unsuitable for marina/terminal development. Therefore, spawning, egg incubation, and early rearing will not be directly affected by these activities. Most effects will occur from development in riverine migratory corridors, as well as riverine, lacustrine, and marine foraging habitats used by mature juveniles and adults. Sensitivity to this stressor in lacustrine environments is a data gap. However, char in lakes are typically found in deeper water.
Dolly Varden	H	H	H	H	H	H	L	L	L	?	?	?	
Pygmy whitefish	N	N	H	N	N	H	N	N	L	N	N	?	Lakes and smaller lake tributaries are primary habitats used by this species. Whitefish do not occur in larger rivers suitable for marina/terminal development; therefore, stressor exposure will only occur in lacustrine environments.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. Species does not occur in larger rivers or lakes suitable for marina/terminal development.

Species	Grounding, Anchoring, and/or Prop Wash			Vessel Maintenance and Operational Discharges			Increased or Altered Ambient Noise Levels			Ambient Light Modifications			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for marina/terminal development.
Mountain sucker	H	N	H	H	N	H	M	N	M	?	N	?	This species is commonly found in large rivers and lakes suitable for marina and potentially terminal development. Sensitivity of this species to ambient light modification is currently a data gap; therefore, the potential for take resulting from this stressor is unknown.
Lake chub	N	N	N	N	N	N	N	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens Counties that are generally unsuitable for marina/terminal development.
Leopard dace	H	N	H	H	N	H	M	N	M	?	N	?	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in habitats potentially suitable for marina/terminal development at sensitive life-history stages, including egg incubation.
Umatilla dace	H	N	H	H	N	H	M	N	M	?	N	?	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake Rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for marina/terminal development at sensitive life-history stages, including egg incubation.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	This species is characterized by isolated breeding populations favoring small streams and brooks, which are unsuitable environments for marina development. Therefore, marina/terminal development will have no-effect on this species.
River lamprey	H	H	H	H	H	H	?	?	?	?	I	?	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of larger rivers to rear for extended periods, potentially years. In their saltwater phase, river lamprey remain close to shore for periods of 10 to 16 weeks from spring through fall. They are therefore susceptible to injury or mortality from grounding, anchoring, and prop wash. Sensitivity to ambient noise and light modification in lamprey is currently a data gap so the potential effects of these stressors are unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Pacific lamprey	H	I	H	H	L	H	?	?	?	?	?	?	Pacific lamprey are anadromous, with migratory corridors that cross estuaries and mainstems of larger river systems suitable for marina/terminal development. Ammocoetes burrow into riverine sediments to rear for extended periods. They are therefore susceptible to injury or mortality from grounding, anchoring, and prop wash. Sensitivity to ambient noise and light modification in lamprey is currently a data gap so the potential effects of these stressors are unknown. Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6 to 40 months. Sound sensitivity of primitive fishes such as lamprey is currently a data gap so the potential effects of this stressor are unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Green sturgeon	N	L	N	N	H	N	N	?	N	N	?	N	In Washington, white sturgeon are found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington. Although this species is considered anadromous, some populations in the Columbia River may be reproducing successfully in some impoundments. Sturgeon eggs are demersal and adhesive. Larval sturgeon are essentially planktonic and rear in quiet backwaters of the large rivers and lakes where they are transported by currents following emergence. These life-history stages are therefore sensitive to grounding, anchoring, and other direct impacts. Individuals are occasionally caught incidentally in small coastal bays and the Puget Sound. Sturgeon are wide ranging in marine waters. Green sturgeon fisheries occur in the Columbia River below Bonneville Dam, Willapa Bay, and Grays Harbor. Dependence on nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in nearshore habitats. Sensitivity to ambient noise and light modification in primitive fishes like sturgeon is currently a data gap so the potential effects of these stressors are unknown.
White sturgeon	H	L	H	H	H	H	?	?	?	?	?	?	
Longfin smelt	H	L	H	H	H	H	L	H	H	?	?	?	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems, which are preferred areas for marina development. Adults, eggs, and larvae are vulnerable to impacts from vessel anchoring and grounding, and other operational impacts. Planktonic larvae and juveniles of these species may also be vulnerable to stressor exposure in the nearshore marine environment during early rearing. Mature juveniles and adults occupy offshore environments and are therefore not at risk of take from marina/terminal related impact mechanisms until they return to nearshore and riverine environments for spawning. Smelt sensitivity to ambient light modification is a data gap; therefore, the risk of take from this stressor is uncertain.
Eulachon	H	L	N	H	H	N	L	H	N	?	?	N	
Pacific sand lance	N	H	N	N	H	N	N	L	N	N	?	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high. Smelt and sand lance sensitivity to ambient light modification is a data gap; therefore, the risk of take resulting from this stressor is uncertain.
Surf smelt	N	H	N	N	H	N	N	L	N	N	?	N	
Pacific herring	N	H	N	N	H	N	N	H	N	N	H	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure is high. Sensitivity of spawning habitat and incubating eggs from vessel grounding, anchoring, and prop wash is high, meaning that there is high risk of take resulting from this stressor. Herring display demonstrable sensitivity to vessel noise, meaning that risk of take from ambient noise modification is likely.
Lingcod	N	H	N	N	H	N	N	H	N	N	H	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are subject to impacts from vessel ground, anchoring and prop wash, and other operational impact mechanisms. Adults may occur anywhere from the intertidal zone to depths

Species	Grounding, Anchoring, and/or Prop Wash			Vessel Maintenance and Operational Discharges			Increased or Altered Ambient Noise Levels			Ambient Light Modifications			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
													of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 to 150 m) and therefore have less exposure potential. Temporary disturbance while brooding may increase risk of egg predation. Low-mobility larvae settle in nearshore areas, increasing risk of take from grounding, anchoring, and prop wash. Lingcod sensitivity to ambient light modification is a data gap, meaning the risk of take resulting from this stressor is unknown.
Pacific hake	N	H	N	N	H	N	N	H	N	N	?	N	Hake, cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Low-mobility larvae settle in nearshore areas, increasing risk of take from grounding, anchoring, and prop wash. The sensitivity of these species to ambient light modification is a data gap, meaning the risk of take resulting from this stressor is unknown.
Pacific cod	N	H	N	N	H	N	N	H	N	N	?	N	
Walleye pollock	N	H	N	N	H	N	N	H	N	N	?	N	
Brown rockfish	N	H	N	N	H	N	N	H	N	N	?	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Demersal larvae are vulnerable to injury and mortality from grounding, anchoring, and prop wash. The sensitivity of these species to ambient light modification is a data gap, meaning the risk of take resulting from this stressor is unknown.
Copper rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Greenstriped rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Widow rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Yellowtail rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Quillback rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Black rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
China rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Tiger rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Bocaccio rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Canary rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Redstripe rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Yelloweye rockfish	N	H	N	N	H	N	N	H	N	N	?	N	
Olympia oyster	N	H	N	N	H	N	N	H	N	N	?	N	This species occurs commonly in shallow nearshore habitats. This distribution increases risk of stressor exposure and potential for take from grounding and anchoring activities. The effect of underwater noise and ambient light modification on mollusks is a data gap; therefore, the related risk of take is unknown.
Northern abalone	N	H	N	N	H	N	N	H	N	N	?	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) depth. This distribution increases risk of stressor exposure and potential for take from grounding and anchoring activities. The effect of underwater noise and ambient light modification on mollusks is a data gap; therefore, the related risk of take is unknown.
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	This species inhabits a narrow band of upper littoral zone habitat above MHHW and is therefore not exposed to stressors resulting from marina/terminal operation.
Giant Columbia River limpet	H	N	N	H	N	N	?	N	?	?	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for marina/terminal development. As such, there is essentially no likelihood of stressor exposure and therefore no potential for take resulting from these activities. The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. This distribution may increase exposure to anchoring and prop wash. The effect of ambient light and noise modification on mollusks is currently a data gap so the potential for take related to this stressor is unknown.
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	
California floater (mussel)	H	N	H	H	N	H	?	N	?	?	N	?	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake River and the mainstems of these systems. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. As such, both species may occur in habitats suitable for marina/terminal development. This distribution presents risk of stressor exposure and potential for take, particularly from grounding, anchoring, and prop wash. The effect of ambient light and noise modification on mollusks is currently a data gap so the potential for take related to this stressor is unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Western ridged mussel	H	N	N	H	N	N	?	N	N	?	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-37. Species- and habitat-specific risk of take for mechanisms of impact associated with water quality modifications caused by marinas/terminals.

Species	Increased Suspended Solids			Resuspension of Contaminated Sediments			Introduction of Toxic Substances			Altered pH			Altered Dissolved Oxygen			Use of Creosote-Treated Wood			Use of ACZA and CCA Type C Treated Wood			Increased Stormwater and Nonpoint Source Pollution			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	M	M	M	M	M	M	M	M	M	L	L	L	L	L	L	M	H	N	M	M	M	M	M	M	This species has a complex and variable life history depending on race. In general, Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors.
Coho salmon	M	M	M	M	M	M	M	M	M	L	L	L	L	L	L	M	H	N	M	M	M	M	M	M	This species has a complex and variable life history depending on race. In general, coho salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure.
Chum salmon	M	M	I	M	M	I	M	M	I	L	L	I	L	L	I	M	H	N	M	M	I	M	M	I	Chum salmon in Washington State do not use lacustrine habitats suitable for marina/terminal development. Therefore, stressor exposure will not occur in lacustrine environments. Chum may spawn in the lower reaches of large river environments (e.g., the Columbia River). As such, in addition to migratory juveniles and adults, spawning habitats may therefore be exposed to water quality related stressors. Juvenile chum salmon are dependent on nearshore marine habitats and are therefore subject to stressor exposure from marina/terminal development in these environments.
Pink salmon	M	M	I	M	M	I	M	M	I	L	L	I	L	L	I	M	H	N	M	M	I	M	M	I	Pink salmon in Washington State do not use lacustrine habitats. Therefore, stressor exposure will not occur in lacustrine environments. This species is dependent on nearshore marine habitats for juvenile rearing and migrates through the mainstems and estuaries of larger river systems potentially suitable for marina/terminal development. As such, this species may potentially experience related stressor exposure.
Sockeye salmon	M	M	M	M	M	M	M	M	M	L	L	M	L	L	L	M	H	N	M	M	M	M	M	M	This species is highly dependent on lacustrine environments for juvenile rearing. Most spawning behavior occurs in smaller rivers and streams that are not suitable for marina development. However, some populations spawn in nearshore lacustrine habitats, creating increased risk of stressor exposure at sensitive egg and alevin life-history stages. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridor. Avoidance of impacts on juvenile sockeye in lacustrine environments is difficult due to year-round residence.
Steelhead	M	M	M	L	M	M	M	M	M	L	L	L	L	L	L	M	M	N	M	M	M	M	M	M	Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats, so the risk of take associated with activities in these habitat types is unknown. As juvenile steelhead are more typically found farther from shore, the effects of shading are less clear; therefore, the risk of take in the marine environment is uncertain.
Coastal cutthroat trout	M	M	M	M	M	M	M	M	M	L	L	L	L	L	L	M	M	N	M	M	M	M	M	M	This species is prevalent in estuaries and large rivers and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for marina/terminal development. Migratory behavior and residence timing are variable. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure.
Westslope cutthroat trout	I	N	M	I	N	M	I	N	M	I	N	L	I	N	L	I	N	N	I	N	L	I	N	M	These species occur primarily in coldwater streams, small to medium-sized rivers, and lakes. Occurrence in larger rivers suitable for marina/terminal development is unlikely.
Redband trout	I	N	M	I	N	M	I	N	M	I	N	L	I	N	L	I	N	N	I	N	L	I	N	M	
Bull trout	M	M	M	L	M	M	M	M	M	L	L	L	L	L	L	M	M	N	M	M	M	M	M	M	Spawning by these species occurs in habitats that are generally unsuitable for marina/terminal development. Therefore, spawning, egg incubation, and early rearing will not be directly affected by these activities. Most effects will occur from development in riverine migratory

Species	Increased Suspended Solids			Resuspension of Contaminated Sediments			Introduction of Toxic Substances			Altered pH			Altered Dissolved Oxygen			Use of Creosote-Treated Wood			Use of ACZA and CCA Type C Treated Wood			Increased Stormwater and Nonpoint Source Pollution			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Dolly Varden	M	M	M	L	M	M	M	M	M	L	L	L	L	L	L	M	M	N	M	M	M	M	M	M	corridors, as well as in riverine, lacustrine, and marine foraging habitats used by mature juveniles and adults. However, char in lakes are typically found in deeper water.
Pygmy whitefish	N	N	M	N	N	M	N	N	M	N	N	L	N	N	L	N	N	N	N	N	M	N	N	M	Lakes and smaller lake tributaries are primary habitats used by this species. Whitefish do not occur in larger rivers suitable for marina/terminal development; therefore, stressor exposure will only occur in lacustrine environments.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. Species does not occur in larger rivers or lakes suitable for marina/terminal development.
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for marina/terminal development.
Mountain sucker	M	N	M	M	N	M	M	N	M	M	N	M	L	N	L	M	N	N	M	N	N	M	N	M	This species is commonly found in large rivers and lakes suitable for marina and potentially terminal development.
Lake chub	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens Counties that are generally unsuitable for marina/terminal development.
Leopard dace	M	N	M	M	N	M	M	N	M	M	N	M	L	N	L	M	N	N	M	N	M	M	N	M	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in habitats potentially suitable for marina/terminal development at sensitive life-history stages, including egg incubation.
Umatilla dace	M	N	M	M	N	M	M	N	M	M	N	M	L	N	L	M	N	N	M	N	M	M	N	M	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake Rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for marina/terminal development at sensitive life-history stages, including egg incubation.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This species is characterized by isolated breeding populations favoring small streams and brooks, which are unsuitable environments for marina development. Therefore, marina/terminal development will have no-effect on this species.
River lamprey	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	N	M	M	M	M	M	M	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of larger rivers to rear for extended periods, potentially years. This nonmobile life-history stage is more susceptible to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. In their saltwater phase, river lamprey remain close to shore for periods of 10 to 16 weeks from spring through fall, increasing exposure to stressors in the nearshore environment. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Pacific lamprey	M	L	M	M	L	M	M	L	M	M	L	M	M	L	M	M	L	N	M	L	M	M	L	M	Pacific lamprey are anadromous with migratory corridors that cross estuaries and mainstems of larger river systems suitable for marina/terminal development. Ammocoetes burrow into riverine sediments to rear for extended periods. This nonmobile life-history stage is more susceptible to acute transient water quality impacts, such as reduced dissolved oxygen or altered pH. Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6 to 40 months and are therefore less likely to be exposed to project-related stressors in the nearshore marine environment. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.

Species	Increased Suspended Solids			Resuspension of Contaminated Sediments			Introduction of Toxic Substances			Altered pH			Altered Dissolved Oxygen			Use of Creosote-Treated Wood			Use of ACZA and CCA Type C Treated Wood			Increased Stormwater and Nonpoint Source Pollution			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Green sturgeon	N	L	N	N	M	N	N	M	N	N	L	N	N	L	N	N	M	N	N	M	N	N	M	N	In Washington, white sturgeon are found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington. Although this species is considered to be anadromous, populations in the Columbia River may be reproducing successfully in some impoundments. Sturgeon eggs are demersal and adhesive. Larval sturgeon are essentially planktonic and rear in quiet backwaters of the large rivers and lakes where they are transported by currents following emergence. These life-history stages are therefore potentially exposed to water quality related impact mechanisms from marinas/terminals. Their relative lack of mobility increases sensitivity to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Sturgeon are wide ranging in marine waters. Green sturgeon fisheries occur in Columbia River below Bonneville Dam, Willapa Bay, and Grays Harbor. Individuals are also occasionally caught incidentally in small coastal bays and the Puget Sound. Dependence on nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in nearshore habitats.
White sturgeon	H	L	H	M	M	M	M	M	M	H	L	H	H	L	H	M	M	M	M	M	M	M	M	M	
Longfin smelt	H	L	H	M	M	M	M	M	M	H	L	H	M	L	M	M	M	M	M	M	N	M	M	M	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems, which are preferred areas for marina development. Demersal adhesive eggs are vulnerable to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Planktonic larvae and juveniles of these species may also be vulnerable to stressor exposure in the nearshore marine environment during early rearing. Mature juveniles and adults occupy offshore environments and are therefore at less risk of take from these stressors.
Eulachon	H	L	N	M	M	N	M	M	N	M	L	N	M	L	N	M	M	N	M	M	N	M	M	N	
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	M	N	N	M	N	N	M	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high. Larvae of both species disperse in nearshore waters for early rearing. Because they are essentially planktonic, larvae are vulnerable to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Larvae are also visual feeders. Increased turbidity can reduce foraging success, leading to decreased growth and productivity.
Surf smelt	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	M	N	N	M	N	N	M	N	
Pacific herring	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure is high. Larvae disperse in nearshore waters for early rearing. Because they are essentially planktonic, larvae are vulnerable to acute transient water quality impacts such as reduced dissolved or altered pH. Larvae are also visual feeders. Increased turbidity can reduce foraging success, leading to decreased growth and productivity.
Lingcod	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	M	N	N	M	N	N	M	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are potentially exposed to water quality related impact mechanisms from marinas/terminals. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 to 150 m) and therefore have less exposure potential. Temporary disturbance while brooding may increase risk of egg predation. Larvae disperse and settle in nearshore waters for early rearing. Because they are demersal and relatively immobile, larvae are vulnerable to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Larvae are also visual feeders. Increased turbidity can reduce foraging success, leading to decreased growth and productivity.

Species	Increased Suspended Solids			Resuspension of Contaminated Sediments			Introduction of Toxic Substances			Altered pH			Altered Dissolved Oxygen			Use of Creosote-Treated Wood			Use of ACZA and CCA Type C Treated Wood			Increased Stormwater and Nonpoint Source Pollution			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Pacific hake	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	M	N	N	M	N	N	M	N	Hake, cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Because they are demersal and relatively immobile, larvae are vulnerable to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Larvae are visual feeders. Increased turbidity can reduce foraging success, leading to decreased growth and productivity.
Pacific cod	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	M	N	N	M	N	N	M	N	
Walleye pollock	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	M	N	N	M	N	N	M	N	
Brown rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Because they are demersal and relatively immobile, larvae are vulnerable to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Larvae are also visual feeders. Increased turbidity can reduce foraging success, leading to decreased growth and productivity.
Copper rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Greenstriped rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Widow rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Yellowtail rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Quillback rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Black rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
China rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Tiger rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Bocaccio rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Canary rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Redstripe rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Yelloweye rockfish	N	H	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	M	N	
Olympia oyster	N	H	N	N	H	N	N	H	N	N	M	N	N	L	N	N	M	N	N	M	N	N	M	N	This species occurs commonly in shallow water nearshore habitats. This distribution increases risk of stressor exposure and potential for take resulting from water quality modification in the nearshore environment. Because this species is sessile at all live-history stages, it is vulnerable to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Increased turbidity may reduce foraging success of this filter feeding species, leading to decreased growth and productivity.
Northern abalone	N	H	N	N	H	N	N	H	N	N	M	N	N	L	N	N	M	N	N	M	N	N	M	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) depth. Because this species is sessile at all life-history stages, it is vulnerable to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Increased turbidity may affect algal growth, reducing available forage.
Newcomb's littorine snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This species inhabits a narrow band of upper littoral zone habitat above MHHW and is therefore not directly exposed to water quality-related stressors resulting from marina/terminal operation.
Giant Columbia River limpet	M	N	M	M	N	M	H	N	H	H	N	H	L	N	L	M	N	M	M	N	M	M	N	M	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for marina/terminal development. As such, there is essentially no likelihood of stressor exposure and therefore no potential for take resulting

Species	Increased Suspended Solids			Resuspension of Contaminated Sediments			Introduction of Toxic Substances			Altered pH			Altered Dissolved Oxygen			Use of Creosote-Treated Wood			Use of ACZA and CCA Type C Treated Wood			Increased Stormwater and Nonpoint Source Pollution			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	from these activities. The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. The distribution of this species presents the possibility of stressor exposure. However, because it lives in lotic habitats, water quality effects will by nature be transitory, meaning that exposure to acute events will be temporary. Their sessile nature makes behavioral avoidance impossible, however, increasing the duration of acute exposure and potential for physiological injury.
California floater (mussel)	H	N	H	M	N	M	H	N	H	H	N	H	M	N	M	H	N	N	H	N	M	H	N	H	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake River and the mainstems of these systems. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. As such, both species may occur in habitats suitable for marina/terminal development. Because they occur primarily in lotic habitats, water quality effects will by nature be transitory, meaning that exposure to acute events will be temporary. Their sessile nature makes behavioral avoidance impossible, however, increasing the duration of acute exposure and potential for physiological injury. Toxicity of copper, ammonia, and chlorine has been demonstrated in closely related species. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Western ridged mussel	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	H	N	N	H	N	N	M	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-38. Species- and habitat-specific risk of take for mechanisms of impact associated with riparian vegetation modifications caused by marina/terminal development.

Species	Altered Riparian Shading and Ambient Air Temperature Regime			Altered Stream Bank and Shoreline Stability			Altered Allochthonous Inputs			Altered Habitat Complexity			Altered Surface Water-Groundwater Exchange, or Freshwater Input			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	I	H	H	H	H	H	I	H	H	H	H	H	H	H	H	This species has a complex and variable life history depending on race. In general, Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Marinas/terminals in riverine environments will be developed in habitats where modification of riparian vegetation will have little influence on water temperatures or food web productivity as a whole. Modification of riparian habitat will also most likely involve permanent conversion to an armored state, meaning that effects on bank stability will be minimal.
Coho salmon	I	H	H	H	H	H	I	H	H	H	H	H	H	H	H	This species has a complex and variable life history depending on race. In general, coho salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure.
Chum salmon	I	H	I	H	H	I	I	H	I	H	H	I	H	H	I	Chum salmon in Washington State do not use lacustrine habitats suitable for marina/terminal development. Therefore, stressor exposure will not occur in lacustrine environments. Chum may spawn in the lower reaches of large river environments (e.g., the Columbia River) and may therefore be subject to temporary effects of riparian modification on spawning habitat, in addition to juvenile and adult exposure during migration. Juvenile chum salmon are dependent on nearshore marine habitats and are therefore subject to stressor exposure from marina/terminal development in these environments.
Pink salmon	I	H	I	H	H	I	I	H	I	H	H	I	H	H	I	Pink salmon in Washington State do not utilize lacustrine habitats. Therefore, stressor exposure will not occur in lacustrine environments. This species is dependent on nearshore marine habitats for juvenile rearing and migrates through the mainstems and estuaries of larger river systems potentially suitable for marina/terminal development. As such, this species may potentially experience related stressor exposure.
Sockeye salmon	I	H	H	H	H	H	I	H	H	H	H	H	H	H	H	This species is highly dependent on lacustrine environments for juvenile rearing. Most spawning behavior occurs in smaller rivers and streams that are not suitable for marina development. However, some populations spawn in nearshore lacustrine habitats, creating increased risk of stressor exposure at sensitive egg and alevin life-history stages. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridor. Avoidance of impacts on juvenile sockeye in lacustrine environments is difficult due to year-round residence.
Steelhead	I	?	H	H	?	H	I	?	H	H	?	H	H	L	H	Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats, so the risk of take associated with activities in these habitat types is unknown.
Coastal cutthroat trout	I	H	H	H	H	H	I	H	H	H	H	H	H	H	H	This species is prevalent in estuaries and large rivers and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for marina/terminal development. Migratory behavior and residence timing are variable. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure.
Westslope cutthroat trout	I	N	H	I	N	H	I	N	H	I	N	H	I	N	H	These species occur primarily in coldwater streams, small to medium-sized rivers, and lakes. Occurrence in larger rivers suitable for marina/terminal development is unlikely.
Redband trout	I	N	H	I	N	H	I	N	H	I	N	H	I	N	H	
Bull trout	I	H	H	H	H	H	I	H	H	H	H	H	H	?	H	These species spawn in habitats that are generally unsuitable for marina/terminal development. Therefore, spawning, egg incubation, and early rearing will not be directly affected by these activities. Most effects will occur from development in riverine migratory corridors, as well as in riverine, lacustrine, and marine foraging habitats used by mature juveniles and adults.
Dolly Varden	I	H	H	H	H	H	I	H	H	H	H	H	H	?	H	
Pygmy whitefish	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	Lakes and smaller lake tributaries are primary habitats used by this species. Whitefish do not occur in larger rivers suitable for marina/terminal development; therefore, stressor exposure will only occur in lacustrine environments.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. Species does not occur in larger rivers or lakes suitable for marina/terminal development.
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for marina/terminal development.
Mountain sucker	I	N	H	I	N	H	H	N	H	H	N	H	H	N	H	This species is commonly found in large rivers and lakes suitable for marina and potentially terminal development.
Lake chub	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens Counties

Species	Altered Riparian Shading and Ambient Air Temperature Regime			Altered Stream Bank and Shoreline Stability			Altered Allochthonous Inputs			Altered Habitat Complexity			Altered Surface Water-Groundwater Exchange, or Freshwater Input			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																that are generally unsuitable for marina/terminal development.
Leopard dace	I	N	H	H	N	H	I	N	H	H	N	H	?	N	?	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in habitats potentially suitable for marina/terminal development.
Umatilla dace	I	N	H	H	N	H	I	N	H	H	N	H	?	N	?	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake Rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for marina/terminal development.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This species is characterized by isolated breeding populations favoring small streams and brooks, which are unsuitable environments for marina development. Therefore, marina/terminal development will have no-effect on this species.
River lamprey	I	?	?	H	H	H	I	?	?	H	H	H	?	?	?	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of larger rivers to rear for extended periods, potentially years. They are therefore susceptible to changes in stream bank stability with the potential to affect bottom sediments. In their saltwater phase, river lamprey remain close to shore for periods of 10 to 16 weeks from spring through fall. The dependence of this species on riparian vegetation and freshwater inflow in lacustrine and marine environments is a data gap, so the potential risk of take associated with these stressors is unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Pacific lamprey	I	I	?	H	I	H	I	I	H	H	I	H	?	?	?	Pacific lamprey are anadromous, with migratory corridors that cross estuaries and mainstems of larger river systems suitable for marina/terminal development. Ammocoetes burrow into riverine sediments to rear for extended periods. They are therefore susceptible to changes in stream bank stability with the potential to affect bottom sediments. Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6 to 40 months. The dependence of this species on riparian vegetation and freshwater inflow in lacustrine and marine environments is a data gap, so the potential risk of take associated with these stressors is unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Green sturgeon	N	I	N	N	H	N	N	I	N	N	L	N	N	?	N	In Washington, white sturgeon are found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington. Although this species is considered anadromous, populations in the Columbia River may be reproducing successfully in some impoundments. Larval sturgeon are essentially planktonic and rear in quiet backwaters of the large rivers and lakes where they are transported by currents following emergence. Green sturgeon fisheries occur in Columbia River below Bonneville Dam, Willapa Bay, and Grays Harbor. Sturgeon eggs are demersal and adhesive. These life-history stages are therefore potentially exposed to riparian modification impact mechanisms. Adults are occasionally caught incidentally in small coastal bays and Puget Sound. Sturgeon are wide ranging in marine waters. Dependence on nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in nearshore habitats.
White sturgeon	I	I	H	H	H	H	I	I	H	H	L	H	H	?	H	
Longfin smelt	I	I	N	H	I	H	I	I	H	H	I	H	?	?	?	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems, which are preferred areas for marina development. Demersal adhesive eggs are vulnerable to short-term dewatering and dredging impacts. Adults, eggs, and larvae may be exposed to riparian modification impact mechanisms in marine and riverine environments. Planktonic larvae and juveniles of these species may also be vulnerable to stressor exposure in the nearshore marine environment during early rearing, particularly suspended sediments from decreased bank stability, which may decrease foraging success for these visual feeders. Dependence on freshwater inflow is a data gap, so the related risk of take resulting from this stressor is unknown. Mature juveniles and adults are found in offshore environments and are not exposed to these stressors.
Eulachon	I	I	N	H	I	N	I	I	N	H	I	N	?	?	N	
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high. Egg survival is demonstrably affected by modification of riparian shading and ambient temperature regime, and by alteration of freshwater inflow. Larvae and juveniles are highly dependent on the habitat complexity and productivity of the nearshore environment for rearing, and changes in habitat complexity and allochthonous inputs affecting food web productivity are likely to affect growth and fitness. Changes in stream bank and shoreline stability may affect the suitability of spawning substrate, and increased suspended sediments may affect foraging success of visual feeding larvae.
Surf smelt	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	

Species	Altered Riparian Shading and Ambient Air Temperature Regime			Altered Stream Bank and Shoreline Stability			Altered Allochthonous Inputs			Altered Habitat Complexity			Altered Surface Water-Groundwater Exchange, or Freshwater Input			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Pacific herring	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure is high. Larvae and juveniles are highly dependent on the habitat complexity and productivity of the nearshore environment for rearing, and changes in habitat complexity and allochthonous inputs affecting food web productivity are likely to affect growth and fitness. Changes in stream bank and shoreline stability may increase suspended sediments, affecting egg incubation and the foraging success of visual feeding larvae.
Lingcod	N	I	N	N	H	N	N	H	N	N	H	N	N	H	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are therefore potentially exposed to riparian modification impact mechanisms. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 to 150 m) and therefore have less exposure potential. Larvae and juveniles are highly dependent on the habitat complexity and productivity of the nearshore environment for rearing, and changes in habitat complexity and allochthonous inputs affecting food web productivity are likely to affect growth and fitness. Changes in stream bank and shoreline stability may increase suspended sediments, affecting egg incubation and the foraging success of visual feeding larvae.
Pacific hake	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	Hake, Pacific cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae and juveniles may experience stressor exposure. Larvae and juveniles are highly dependent on the habitat complexity and productivity of the nearshore environment for rearing, and changes in habitat complexity and allochthonous inputs affecting food web productivity are likely to affect growth and fitness. Changes in stream bank and shoreline stability may increase suspended sediments, affecting egg incubation and the foraging success of visual feeding larvae.
Pacific cod	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Walleye pollock	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Brown rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Larvae and juveniles are highly dependent on the habitat complexity and productivity of the nearshore environment for rearing, and changes in habitat complexity and allochthonous inputs affecting food web productivity are likely to affect growth and fitness. Changes in shoreline stability may increase suspended sediments, affecting egg incubation and the foraging success of visual feeding larvae.
Copper rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Greenstriped rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Widow rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Yellowtail rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Quillback rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Black rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
China rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Tiger rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Bocaccio rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Canary rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Redstripe rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Yelloweye rockfish	N	I	N	N	H	N	N	H	N	N	H	N	N	?	N	
Olympia oyster	N	L	N	N	H	N	N	L	N	N	H	N	N	H	N	While the influence of shading and buffer on lower intertidal zone is limited, Olympia oyster growth and fitness may benefit from thermal extremes in some cases. In contrast, sedimentation demonstrably affects survival, growth and fitness in this species. Dependence on allochthonous inputs is currently a data gap. Habitat complexity and groundwater inflow affect habitat suitability for larval settlement and development, as well as juvenile and adult survival.
Northern abalone	N	I	N	N	H	N	N	I	N	N	I	N	N	I	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) depth. Subtidal distribution generally limits exposure to riparian modification impact mechanisms and related stressors. For example, riparian shading will have effectively no influence on this species. In contrast, sedimentation resulting from decreased shoreline stability may extend into the subtidal zone, affecting foraging success. Exposure to other stressors resulting from these impact mechanisms is insignificant, given the subtidal distribution of this species. Therefore, these impact mechanisms are expected to have no effect.
Newcomb’s littorine snail	N	H	N	N	H	N	N	N	N	N	H	N	N	?	N	This species inhabits a narrow band of upper littoral zone vegetation above MHHW and is therefore directly exposed to riparian

Species	Altered Riparian Shading and Ambient Air Temperature Regime			Altered Stream Bank and Shoreline Stability			Altered Allochthonous Inputs			Altered Habitat Complexity			Altered Surface Water-Groundwater Exchange, or Freshwater Input			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																vegetation modification where it is known to occur. Because this species is largely terrestrial, it is unaffected by alteration in allochthonous inputs and groundwater inputs.
Giant Columbia River limpet	I	N	I	I	N	I	L	N	L	H	N	H	?	N	?	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for marina/terminal development. As such, there is essentially no likelihood of stressor exposure and therefore no potential for take resulting from these activities. The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. Dependence of this species on groundwater inputs is a data gap, so the risk of take from this stressor is unknown.
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
California floater (mussel)	I	N	I	H	N	H	I	N	I	H	N	H	H	N	H	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake River and the mainstems of these systems. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. As such, both species may occur in habitats suitable for marina/terminal development. The localized influence of riparian vegetation on temperature conditions in these larger river systems is limited. Dependence of these species on groundwater inputs is a data gap, so the risk of take from this stressor is unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Western ridged mussel	I	N	N	H	N	N	I	N	N	H	N	N	H	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-39. Species- and habitat-specific risk of take for mechanisms of impact associated with aquatic vegetation modifications caused by marinas and terminal development and operation.

Species	Altered Autochthonous Production			Altered Habitat Complexity			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	L	H	H	L	H	H	This species has a complex and variable life history depending on race. In general, Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors.
Coho salmon	L	H	H	L	H	H	This species has a complex and variable life history depending on race. In general, coho salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure.
Chum salmon	I	H	I	I	H	I	Chum salmon in Washington State do not use lacustrine habitats suitable for marina/terminal development. Therefore, stressor exposure will not occur in lacustrine environments. Chum migrate through and in some cases may spawn in the lower reaches of large river environments and may therefore be exposed to aquatic vegetation modification impact mechanisms. Juvenile chum salmon are dependent on nearshore marine habitats and are therefore subject to stressor exposure from marina/terminal development in these environments.
Pink salmon	I	H	I	I	H	I	Pink salmon in Washington State do not use lacustrine habitats. Therefore, stressor exposure will not occur in lacustrine environments. This species is dependent on nearshore marine habitats for juvenile rearing, and migrates through the mainstems and estuaries of larger river systems potentially suitable for marina/terminal development. As such, this species may potentially experience related stressor exposure.
Sockeye salmon	I	?	H	L	?	H	This species is highly dependent on lacustrine environments for juvenile rearing. Most spawning behavior occurs in smaller rivers and streams that are not suitable for marina development. Alteration of lacustrine aquatic vegetation may affect survival, growth and fitness of rearing juveniles. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridor.
Steelhead	L	?	H	L	?	H	Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats, so the risk of take associated with activities in these habitat types is unknown.
Coastal cutthroat trout	L	H	H	L	H	H	This species is prevalent in estuaries and large rivers, and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for marina/terminal development. Migratory behavior and residence timing are variable.
Westslope cutthroat trout	I	N	H	I	N	H	These species occur primarily in coldwater streams, small to medium-sized rivers, and lakes. Occurrence in larger rivers suitable for marina/terminal development is unlikely.
Redband trout	I	N	H	I	N	H	
Bull trout	L	H	H	L	H	H	Spawning by these species occurs in habitats that are generally unsuitable for marina/terminal development. Therefore, spawning, egg incubation, and early rearing will not be directly affected by these activities. Most effects will occur from development in riverine migratory corridors, and in riverine, lacustrine, and marine foraging habitats used by mature juveniles and adults. Predominant riverine habitats do not support extensive aquatic vegetation.
Dolly Varden	L	H	H	L	H	H	
Pygmy whitefish	N	N	H	N	N	H	Lakes and smaller lake tributaries are primary habitats used by this species. Whitefish do not occur in larger rivers suitable for marina/terminal development, therefore stressor exposure will only occur in lacustrine environments.
Olympic mudminnow	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. Species does not occur in larger rivers or lakes suitable for marina/terminal development.
Margined sculpin	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for marina/terminal development.
Mountain sucker	M	N	M	H	N	H	This species is commonly found in large rivers and lakes suitable for marina and potentially terminal development.
Lake chub	N	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens Counties that are generally unsuitable for marina/terminal development.
Leopard dace	H	N	H	H	N	H	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in habitats potentially suitable for marina/terminal development.
Umatilla dace	H	N	H	H	N	H	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake Rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for marina/terminal development.
Western brook lamprey	N	N	N	N	N	N	This species is characterized by isolated breeding populations favoring small streams and brooks, which are unsuitable environments for marina development. Therefore, marina/terminal development will have no-effect on this species.
River lamprey	?	?	?	?	?	?	Dependence of this species on aquatic vegetation is a data gap; therefore, the risk of take associated with these stressors is unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Pacific lamprey	?	?	?	?	?	?	Dependence of this species on aquatic vegetation is a data gap; therefore, the risk of take associated with these stressors is unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Green sturgeon	N	?	N	N	?	N	Dependence on aquatic vegetation in freshwater environments and nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in nearshore habitats.
White sturgeon	H	?	H	H	?	H	
Longfin smelt	I	I	H	I	I	H	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems, which are preferred areas for marina development. This species has limited freshwater residence time and is not dependent on aquatic vegetation during adult, egg, and larval life-history stages. Rearing larvae in nearshore marine areas may be dependent on habitat complexity and food web productivity.
Eulachon	I	I	N	I	I	N	
Pacific sand lance	N	H	N	N	H	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for

Species	Altered Autochthonous Production			Altered Habitat Complexity			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Surf smelt	N	H	N	N	H	N	spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high. Planktonic larvae rear in nearshore areas and are dependent on food web productivity and habitat complexity of these environments.
Pacific herring	N	H	N	N	H	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on aquatic vegetation in nearshore habitats for spawning, and egg incubation, meaning that the likelihood of stressor exposure is high. Planktonic larvae rear in nearshore areas and are dependent on food web productivity and habitat complexity of these environments.
Lingcod	N	H	N	N	H	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are therefore potentially exposed to aquatic vegetation modification impact mechanisms. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 to 150 m) and therefore have less exposure potential. Planktonic larvae and demersal juveniles rear in nearshore areas and are dependent on food web productivity and habitat complexity of these environments.
Pacific hake	N	H	N	N	H	N	Hake, cod, and Pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Planktonic larvae and demersal juveniles rear in nearshore areas and are dependent on food web productivity and habitat complexity of these environments.
Pacific cod	N	H	N	N	H	N	
Walleye pollock	N	H	N	N	H	N	
Brown rockfish	N	H	N	N	H	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Planktonic larvae and demersal juveniles rear in nearshore areas and are dependent on food web productivity and habitat complexity of these environments.
Copper rockfish	N	H	N	N	H	N	
Greenstriped rockfish	N	H	N	N	H	N	
Widow rockfish	N	H	N	N	H	N	
Yellowtail rockfish	N	H	N	N	H	N	
Quillback rockfish	N	H	N	N	H	N	
Black rockfish	N	H	N	N	H	N	
China rockfish	N	H	N	N	H	N	
Tiger rockfish	N	H	N	N	H	N	
Bocaccio rockfish	N	H	N	N	H	N	
Canary rockfish	N	H	N	N	H	N	
Redstripe rockfish	N	H	N	N	H	N	
Yelloweye rockfish	N	H	N	N	H	N	
Olympia oyster	N	H	N	N	H	N	Alteration of aquatic vegetation may affect the productivity of the nearshore food web, leading to reduced growth and fitness of larval, juvenile and adult Olympia oyster.
Northern abalone	N	?	N	N	I	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) depth. While this species feeds on intertidal and subtidal algal biomass and could be affected by altered autochthonous production, but the level of dependence is a data gap and effects are unknown. Alteration of habitat complexity may alter the suitability and productivity of larval settlement habitat, leading to effects on survival, growth, and fitness of this species.
Newcomb's littorine snail	N	N	N	N	N	N	This species inhabits a narrow band of upper littoral zone habitat above MHHW and is therefore not exposed to stressors resulting from these impact mechanisms.
Giant Columbia River limpet	H	N	H	?	N	?	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for marina/terminal development. As such, there is essentially no likelihood of stressor exposure and therefore no potential for take resulting from these activities. The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. The dependence of this species on allochthonous inputs from riparian vegetation is unknown. However, being substrate feeding species dependent on functional nutrient cycling, activities that affect allochthonous production may cause at least some risk of take. The effect of diminished habitat complexity due to aquatic vegetation modification on this species is a data gap; therefore, the associated risk of take is unknown.
Great Columbia River spire snail	N	N	N	N	N	N	
California floater (mussel)	H	N	H	?	N	?	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake River and the mainstems of these systems. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. As such, both species may occur in habitats suitable for marina/terminal development. However, being filter feeding species dependent on functional nutrient cycling, activities that affect autochthonous production may cause at least some risk of take. The effect of diminished habitat complexity due to aquatic vegetation modification on this species is a data gap; therefore, the associated risk of take is unknown. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Western ridged mussel	H	N	N	?	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-40. Species- and habitat-specific risk of take for mechanisms of impact associated with hydraulic and geomorphic modifications caused by marinas/terminals.

	Altered Channel Geometry	Altered Flow Velocity	Altered Wave Velocities		Altered Current Velocities		Altered Nearshore Circulation Patterns		Altered Sediment Supply		Altered Substrate Composition			Altered Surface Water Groundwater Exchange, or Freshwater Input			Addition of Impervious Surface			
Species	**Riverine**	**Riverine**	**Marine**	**Lacustrine**	**Marine**	**Lacustrine**	**Marine**	**Lacustrine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Comments**
Chinook salmon	H	H	H	H	H	H	H	H	H	H	H	H	H	H	?	H	I	I	I	This species has a complex and variable life history depending on race. In general, Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Migrating adults and migrating and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased juvenile growth and fitness.
Coho salmon	H	H	H	H	H	H	H	H	H	H	H	H	H	H	?	H	I	I	I	This species has a complex and variable life history depending on race. In general, coho salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for marina/terminal development and may experience exposure to related stressors. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Migrating adults and migrating and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased juvenile growth and fitness.
Chum salmon	H	H	H	I	H	I	H	I	H	I	H	H	I	H	?	I	I	I	I	Chum salmon in Washington State do not use lacustrine habitats suitable for marina/terminal development. Therefore, stressor exposure will not occur in lacustrine environments. Chum may spawn in the lower reaches of large river environments (e.g., the Columbia River) and may therefore be exposed to impact mechanisms from hydraulic and geomorphic modification during spawning as well as during juvenile and adult migration. Juvenile chum salmon are dependent on nearshore marine habitats, and are therefore subject to stressor exposure from marina/terminal development in these environments. Migrating adults and migrating and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased juvenile growth and fitness.
Pink salmon	H	H	H	I	H	I	H	I	H	I	H	H	I	H	?	I	I	I	I	Pink salmon in Washington State do not use lacustrine habitats. Therefore, stressor exposure will not occur in lacustrine environments. This species is dependent on nearshore marine habitats for juvenile rearing, and migrates through the mainstems and estuaries of larger river systems potentially suitable for marina/terminal development. As such, this species may potentially experience related stressor exposure. Migrating adults and migrating and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased juvenile growth and fitness.
Sockeye salmon	H	H	H	H	H	H	H	H	H	H	H	H	H	H	?	H	I	I	I	This species is highly dependent on lacustrine environments for juvenile rearing. Most spawning behavior occurs in smaller rivers and streams that are not suitable for marina development. However, some populations spawn in nearshore lacustrine habitats, creating increased risk of stressor exposure at sensitive egg and alevin life-history stages. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridor. Migrating adults and migrating and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all

Species	Altered Channel Geometry	Altered Flow Velocity	Altered Wave Velocities		Altered Current Velocities		Altered Nearshore Circulation Patterns		Altered Sediment Supply		Altered Substrate Composition			Altered Surface Water Groundwater Exchange, or Freshwater Input			Addition of Impervious Surface			Comments
	Riverine	Riverine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																				environment types, experiencing decreased survival, decreased spawning fitness, and decreased juvenile growth and fitness.
Steelhead	H	H	?	H	?	H	?	H	?	H	H	?	H	H	?	H	I	I	I	Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats, so the risk of take associated with activities in these environment types is unknown. Migrating adults and migrating and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased juvenile growth and fitness.
Coastal cutthroat trout	H	H	H	H	H	H	H	H	H	H	H	H	H	H	?	H	I	I	I	This species is prevalent in estuaries and large rivers, and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for marina/terminal development. Migratory behavior and residence timing are variable. Spawning activity typically occurs in habitats that are not suitable for terminal and marina development; therefore, eggs and alevins will not experience stressor exposure. Migrating adults and migrating and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased juvenile growth and fitness.
Westslope cutthroat trout	I	I	N	H	N	H	N	H	N	H	H	N	H	H	N	H	I	N	I	These species occur primarily in coldwater streams, small to medium-sized rivers, and lakes. Occurrence in larger rivers suitable for marina/terminal development is unlikely.
Redband trout	I	I	N	H	N	H	N	H	N	H	H	N	H	H	N	H	I	N	I	These species occur primarily in coldwater streams, small to medium-sized rivers, and in lakes. Occurrence in larger rivers suitable for marina/terminal development is unlikely.
Bull trout	H	H	H	H	H	H	H	H	H	H	H	H	H	H	?	H	I	I	I	Spawning by these species occurs in habitats that are generally unsuitable for marina/terminal development. Therefore, spawning, egg incubation, and early rearing will not be directly affected by these activities. Most effects will occur from development in riverine migratory corridors, as well as in riverine, lacustrine, and marine foraging habitats used by mature juveniles and adults. Migrating adults, migrating and rearing juveniles, and foraging adults in marine habitats are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased juvenile growth and fitness.
Dolly Varden	H	H	H	H	H	H	H	H	H	H	H	H	H	H	?	H	I	I	I	
Pygmy whitefish	N	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	H	N	I	Lakes and smaller lake tributaries are primary habitats used by this species. Whitefish do not occur in larger rivers suitable for marina/terminal development; therefore, stressor exposure will only occur in lacustrine environments. This species is sensitive to alteration of hydraulic and geomorphic conditions in lacustrine environments.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. Species does not occur in larger rivers or lakes suitable for marina/terminal development.
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for marina/terminal development.
Mountain sucker	H	H	N	H	N	H	N	H	N	H	H	N	H	H	N	H	I	N	I	This species is commonly found in large rivers and lakes suitable for marina and potentially terminal development. Adults and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all

Species	Altered Channel Geometry	Altered Flow Velocity	Altered Wave Velocities		Altered Current Velocities		Altered Nearshore Circulation Patterns		Altered Sediment Supply		Altered Substrate Composition			Altered Surface Water Groundwater Exchange, or Freshwater Input			Addition of Impervious Surface			Comments
	Riverine	Riverine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																				environment types, experiencing decreased survival, decreased spawning fitness, and decreased growth and fitness.
Lake chub	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens Counties that are generally unsuitable for marina/terminal development.
Leopard dace	H	H	N	H	N	H	N	H	N	H	H	N	H	H	N	H	I	N	I	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in habitats potentially suitable for marina/terminal development. Adults and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased growth and fitness.
Umatilla dace	H	H	N	H	N	H	N	H	N	H	H	N	H	H	N	H	I	N	I	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake Rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for marina/terminal development. Adults and rearing juveniles are sensitive to alterations in hydraulic and geomorphic conditions in all environment types, experiencing decreased survival, decreased spawning fitness, and decreased growth and fitness.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This species is characterized by isolated breeding populations favoring small streams and brooks, which are unsuitable environments for marina development. Therefore, marina/terminal development will have no-effect on this species.
River lamprey	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	I	I	I	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of larger rivers to rear for extended periods, potentially years. In their saltwater phase, river lamprey remain close to shore for periods of 10 to 16 weeks from spring through fall. They are therefore susceptible to alteration of riverine, lacustrine, and nearshore marine environments caused by hydraulic and geomorphic modification. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Pacific lamprey	H	H	L	H	L	H	L	H	L	H	H	L	H	H	L	H	I	I	I	Pacific lamprey are anadromous, with migratory corridors that cross estuaries and mainstems of larger river systems suitable for marina/terminal development. Ammocoetes burrow into riverine sediments to rear for extended periods. They are therefore susceptible to hydraulic and geomorphic modifications in riverine and lacustrine environments. Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6 to 40 months. While some exposure to nearshore habitat conditions altered by hydraulic and geomorphic modification is possible, the dependence on these habitats is low so the associated risk of take is also believed to be low. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.

Species	Altered Channel Geometry	Altered Flow Velocity	Altered Wave Velocities		Altered Current Velocities		Altered Nearshore Circulation Patterns		Altered Sediment Supply		Altered Substrate Composition			Altered Surface Water Groundwater Exchange, or Freshwater Input			Addition of Impervious Surface			Comments
	Riverine	Riverine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Green sturgeon	N	N	?	N	?	N	?	N	?	N	N	?	N	N	?	N	N	I	N	In Washington, white sturgeon are found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington. Although this species is considered anadromous, populations in the Columbia River may be reproducing successfully in some impoundments. Sturgeon eggs are demersal and adhesive. Larval sturgeon are essentially planktonic and rear in quiet backwaters of the large rivers and lakes where they are transported by currents following emergence. These life-history stages are therefore sensitive to altered riverine and lacustrine habitat conditions caused by hydraulic and geomorphic modification. Green sturgeon fisheries occur in Columbia River below Bonneville Dam, Willapa Bay, and Grays Harbor. Individuals are also occasionally caught incidentally in small coastal bays and Puget Sound. Sturgeon are wide ranging in marine waters. Dependence on nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in these habitats.
White sturgeon	H	H	?	H	?	H	?	H	?	H	H	?	H	H	?	H	I	I	I	
Longfin smelt	H	H	H	H	H	H	H	H	I	H	H	I	N	?	?	?	I	I	N	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems, which are preferred areas for marina development. Demersal adhesive eggs are sensitive to altered riverine habitat conditions caused by hydraulic and geomorphic modification. Planktonic larvae and juveniles of these species may also be vulnerable to stressor exposure in the nearshore marine environment during early rearing. These life-history requirements translate to risk of take resulting from riverine and marine habitat alteration caused by hydraulic and geomorphic modification. Mature juveniles and adults are found in offshore environments.
Eulachon	H	H	H	N	H	N	H	N	I	N	H	I	N	?	?	N	I	I	N	
Pacific sand lance	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high. Dependence on shoreline and nearshore habitats for spawning and rearing means that these species are sensitive to habitat alterations caused by hydraulic and geomorphic modification.
Surf smelt	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Pacific herring	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure is high. Dependence on nearshore habitats for spawning and rearing means that this species is sensitive to habitat alterations caused by hydraulic and geomorphic modification.
Lingcod	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are therefore exposed to impact mechanisms associated with hydraulic and geomorphic modification. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 to 150 m) and therefore have less exposure potential. Temporary disturbance while brooding may increase risk of egg predation. Dependence on nearshore habitats for rearing means that this species is sensitive to habitat alterations caused by hydraulic and geomorphic modification.

Species	Altered Channel Geometry	Altered Flow Velocity	Altered Wave Velocities		Altered Current Velocities		Altered Nearshore Circulation Patterns		Altered Sediment Supply		Altered Substrate Composition			Altered Surface Water Groundwater Exchange, or Freshwater Input			Addition of Impervious Surface			Comments
	Riverine	Riverine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Pacific hake	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	Hake, cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Dependence on nearshore habitats for rearing means that these species are sensitive to habitat alterations caused by hydraulic and geomorphic modification.
Pacific cod	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Walleye pollock	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Brown rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Dependence on nearshore habitats for rearing means that these species are sensitive to habitat alterations caused by hydraulic and geomorphic modification.
Copper rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Greenstriped rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Widow rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Yellowtail rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Quillback rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Black rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
China rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Tiger rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Bocaccio rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Canary rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Redstripe rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Yelloweye rockfish	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	
Olympia oyster	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	Dependence on nearshore habitats throughout this species' life history means that it is sensitive to habitat alterations caused by hydraulic and geomorphic modification. These impact mechanisms are likely to result in effects on survival, growth, and productivity across veliger, juvenile, and adult life-history stages.
Northern abalone	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) depth. Dependence on nearshore habitats throughout much of this species' life history means that it is sensitive to habitat alterations caused by hydraulic and geomorphic modification.
Newcomb's littorine snail	N	N	H	N	H	N	H	N	H	N	N	H	N	N	H	N	N	I	N	This species inhabits a narrow band of upper littoral zone habitat above MHHW. Hydraulic and geomorphic modification of nearshore habitats can result in alteration of upper intertidal habitat characteristics, leading to indirect risk of take on this species.
Giant Columbia River limpet	H	H	N	H	N	H	N	H	N	H	H	N	H	?	N	?	I	N	I	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for marina/terminal development. As such, there is essentially no likelihood of stressor exposure

Species	Altered Channel Geometry	Altered Flow Velocity	Altered Wave Velocities		Altered Current Velocities		Altered Nearshore Circulation Patterns		Altered Sediment Supply		Altered Substrate Composition			Altered Surface Water Groundwater Exchange, or Freshwater Input			Addition of Impervious Surface			Comments
	Riverine	Riverine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	and therefore no potential for take resulting from these activities. The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. This species is sensitive to alterations in hydraulic and geomorphic conditions in riverine and lacustrine habitats, leading to decreased survival, growth, and fitness.
California floater (mussel)	H	H	N	H	N	H	N	H	N	H	H	N	H	H	N	H	I	N	I	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake River and the mainstems of these systems. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. As such, both species may occur in habitats suitable for marina/terminal development. These species are sensitive to alterations in hydraulic and geomorphic conditions in riverine and lacustrine habitats, leading to decreased survival, growth, and fitness. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Western ridged mussel	H	H	N	N	N	N	N	N	N	N	M	N	N	M	N	N	I	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

9.4.7 Shoreline Modifications

Shoreline modifications include jetties, breakwaters, groins, and bank barbs.

Tables 9-41 through 9-43 identify the risk of take for each of the 52 HCP species by impact mechanism and environment type. The summary risk of take presented in the narrative and the matrices represents the greatest overall risk of take for the category.

9.4.7.1 Construction and Maintenance Activities

Construction and maintenance of shoreline modification projects involve a diverse array of activities, including driving pilings, placement of materials, construction vessel operation, maintenance dredging, and work area dewatering. The majority of these activities are temporary in nature, lasting from a few days to several weeks. Some mechanisms may produce a high risk of individual take due to their intensity, while others may result in a low risk of take due to their limited magnitude and duration.

The risk of take associated with construction activity is dependent on the scale of the project and the type of environment where it is implemented. For example, a large jetty project at a river mouth may have a significant impact on the nearshore and estuarine environment, but the risk of take associated with the structure would be limited to those species and individual life-history stages that occur in those habitat types. Breakwaters are typically developed in marine and lacustrine habitats and would only occur in the largest of rivers, specifically the Columbia River, with sufficient open water to allow the formation of wind-driven waves, or supporting vessel traffic producing wakes large enough to cause bank erosion. The distribution of these project types limits the potential for related stressor exposure to the species and life-history stages that occur in these environments. For example, bull trout would be exposed to jetty and breakwater related stressors during subadult and adult life-history stages, but the egg, alevin, and juvenile stages would not, as they occur in upriver environments that are not suitable for jetties or breakwaters.

In contrast, groins and bank barbs are commonly placed in marine, riverine, and lacustrine environments, and are often used in smaller streams and rivers, so the range of species and life-history stages exposed to stressors from these project types is much broader. Species such as the western brook lamprey and the Columbia River spire snail are limited in distribution to free-flowing rivers and streams inappropriate for jetties and breakwaters, so these species will be exposed to only to stressors related to groins or bank barbs.

9.4.7.1.1 Noise

Jetties, breakwaters, or groins may incorporate structural pilings. Project scale and location determine the piling material types and placement methods. The potential for injury or mortality from the noise generated by pile driving varies depending on piling size and composition, pile driving methods, and site-specific environmental characteristics such as bathymetry, intervening land masses, and substrate composition. Applying a worst-case scenario perspective, pile driving must be associated with a high risk of take due to the potential for injury or mortality for the majority of HCP species experiencing possible exposure. Equipment operation and materials placement results in increased ambient noise levels in and around the project vicinity, resulting in a moderate risk of take due to their short-term duration.

9.4.7.1.2 Channel/Work Area Dewatering

Channel or work area dewatering is often required for groin and bank barb construction. Dewatering is not commonly used in jetty and breakwater construction due to the large scale of these structures and the environments where they are typically constructed. Channel and work area dewatering poses a high risk of take.

9.4.7.1.3 Construction and Maintenance Dredging

Development of shoreline modification structures may involve dredging during construction and maintenance. Groins and bank barb structures often extend below the substrate surface, requiring dredging to excavate the foundation (although these activities are usually conducted within a dewatered exclusion area). Dredging activities are typically temporary to short-term in duration, lasting from days to weeks, with maintenance recurring at interannual to decadal frequencies. Stressors associated with dredging include direct disturbance and the potential for injury or mortality from physical entrainment. The potential for take associated with this stressor varies by species and life-history stage, ranging from a moderate risk of take (e.g., from limited exposure to disturbance and displacement) to a high risk (e.g., exposure to entrainment resulting in injury and/or mortality). Many juvenile and most adult fish are sufficiently motile to avoid entrainment and injury. In combination with timing restrictions, this will limit exposure so that only a low to moderate risk of take results from activity-related disturbance and temporary displacement. Fish eggs and demersal larvae and the HCP invertebrate species are effectively nonmotile and therefore are vulnerable to entrainment. These life stages and species would face a high risk of take.

Dredging causes increased suspended solids (turbidity), altered substrate composition, and changes in bathymetry that alter habitat suitability and potentially alter wave energy, current, and circulation patterns. In specific cases, dredging may also result in the resuspension of contaminated sediments. These stressors are associated with a moderate to high risk of take.

9.4.7.2 Hydraulic and Geomorphic Modifications

Shoreline modifications create structures perpendicular to the direction of water flow, inherently involving modification of the hydraulic and geomorphic conditions in the project vicinity, and the subsequent imposition of a number of impact mechanisms and related stressors on the aquatic environment. The nature and scale of hydraulic and geomorphic modification, and the associated risk of take, vary by project type and scale. Jetties, by virtue of their size and location, typically have the most significant effects. Impacts from breakwaters may manifest differently than those from jetties, because breakwaters are typically oriented parallel to the shore, while jetties are oriented perpendicularly. In the absence of other shoreline structures, breakwaters are less prone to interrupt alongshore drift, thereby having lesser effects on substrate conditions. Groins and bank barbs have effects similar to jetties, but more limited in scale because these structures are usually far less extensive and intrusive.

Jetties, breakwaters, and groins and bank barbs all could be built in marine and lacustrine environments, although few lakes in Washington are suitable locations for jetties. The associated risk of take is strongly linked to the potential distribution of the structures, the size and scale of the project, and species-specific dependence on the nearshore environment. Changes to wave energy, current velocities, circulation patterns, sediment supply, and substrate composition caused by shoreline modifications are associated with a high risk of take for species that are dependent on nearshore marine or lacustrine habitats during some phase of their life history. Alteration of groundwater inputs would be expected to cause a corresponding alteration in the distribution of desirable habitat features and availability for species dependent on the nearshore environment. This equates to a moderate to high risk of take for species with demonstrable dependence on these habitats because freshwater inputs will likely still occur; however, they will be modified, resulting in a potential reduction in suitable habitat area, which in turn will lead to reduced survival, growth, and fitness.

Breakwaters and groins and bank barbs could be located in riverine environments. Jetties, which are typically placed at river mouths where they enter the ocean or large lakes, are considered not to affect the riverine environment, with no risk of take. Breakwaters are most likely to be placed in large rivers where wind-driven waves or boat wakes are sufficiently large to warrant these structures to protect marinas, boat launches, or other infrastructure. Groins and bank barbs are used in a broad array of river environments, from small mountain streams to large river mainstems. Therefore, the range of HCP species and life-history stages that could be exposed to breakwater-related stressors in riverine environments is limited, whereas effectively all riverine species and life-history stages could be exposed to stressors resulting from groins and bank barbs. Changes to channel geometry, flow conditions, substrate composition, and groundwater-surface water exchange from shoreline modifications equate to a high risk of take for species with exposure to these impact mechanisms.

9.4.7.1 Ecosystem Fragmentation

9.4.7.1.1 Habitat Loss and Fragmentation

In marine and lacustrine environments, jetties and groins and bank barbs (depending on their scale and location) present significant potential for habitat loss and fragmentation. The magnitude of fragmentation and the related risk of take are driven by the scale of the project in question, with larger projects having the most potential for adverse effects.

By design, jetties are intended to accelerate the flow of water from river mouths into open ocean waters, thereby keeping shallow bar areas from forming. As a consequence, they can alter bathymetric, and circulation patterns in the nearshore environment. In estuaries, they can also alter salinity and tidal exchange. These changes can alter habitat conditions and potentially eliminate desirable habitat types. Habitats in the physical footprint of the structure are permanently lost as a result of construction. Due to their perpendicular orientation to the shore, jetties and groins and bank barbs present a physical barrier to the migration of many species. For example, many salmonid species typically migrate as juveniles in shallow water along the shoreline. These structures effectively force these individuals to migrate around the structure into deeper water where predation risk and foraging opportunities are less favorable to survival. Because jetties are typically larger in size, these effects are more pronounced. Because breakwaters are constructed offshore, typically parallel to the shoreline, they present less of a barrier to migration overall.

9.4.7.1.2 Altered Wave Energy, Current, and Circulation Patterns

In marine and lacustrine environments, jetties, breakwaters, groins, and bank barbs can alter wave energy, current, and circulation patterns in the nearshore and offshore environment. These effects can in many cases result in habitat fragmentation through various pathways. Alteration of these habitat characteristics may render productive habitats less suitable for a given species or, in the case of organisms with a planktonic life-history stage, may hinder the dispersal and retention of eggs and larvae in areas suitable for rearing. Collectively, this can result in take through long-term effects on survival, growth, and fitness of affected populations, which equates to a high risk of take for exposed species.

In riverine environments, particularly those with higher velocity flows, groins and bank barbs often cause localized changes in river geomorphology. In addition to the loss of habitat area within the structural footprint, these structures can concentrate and accelerate river flows, causing localized channel downcutting that can lead to a lowering of mean water surface and the consequent fragmentation of side channels and other floodplain habitats. This hydraulic and geomorphic effect is most prevalent in higher gradient reaches with sufficient velocity to transport bedload, and less prevalent in the lower gradient depositional reaches of large river mainstems. Therefore, this effect is not as likely to occur as a result of breakwater development. Many HCP species depend on floodplain habitats during one or more life-history stages, or depend on host species with these requirements. Loss of access to these habitat types represents take.

9.4.7.1.3 Loss of LWD Recruitment

In marine and lacustrine environments, placement of shoreline modification structures can alter the transport of drift wood to beaches. Many large jetties and breakwaters are intentionally cleared of driftwood accumulations for maintenance purposes, which may further limit the potential for recruitment to nearby beach areas. Groins and bank barbs may similarly alter the transport of woody material along the shoreline.

In riverine environments, placement of shoreline modifications, particularly groins and bank barbs, can alter the transport of LWD, limiting recruitment to downstream environments. The magnitude of this effect is expected to be less pronounced with breakwaters due to their orientation parallel to flow in riverine environments, as well as their typical location in higher order mainstem reaches.

Shorelines with limited LWD recruitment potential due to natural conditions or existing riparian vegetation modifications may become increasingly starved of LWD.

9.4.7.2 Riparian Vegetation Modifications

The development of shoreline modification projects in many cases involves the modification of riparian vegetation in the project area. Because jetties and groins and bank barbs are most typically oriented perpendicular to the shoreline, the extent of riparian impacts during construction and the amount of habitat permanently modified will be relatively minor in comparison to activities such as bank protection.

Breakwaters are not expected to result in any riparian vegetation related stressors, as these structures have no onshore component intersecting the riparian environment. Breakwaters are constructed primarily from barges or floating platforms accessed from established landings. Therefore, effectively no riparian vegetation modification is associated with breakwaters, and no risk of take is expected.

Since jetties are not built in rivers, they do not affect riverine riparian vegetation. In marine and lacustrine environments, the onshore component of jetties results in both short-term and effectively permanent modification of riparian vegetation. Because the onshore component of jetties is relatively small in comparison to the overall footprint of the structure, and the majority of these structures are away from shore and oriented perpendicular to the shoreline, the overall magnitude of riparian vegetation modification in most cases will be relatively limited. The related risk of take is expected to be low for most species due to the limited area affected.

Groins and bank barbs can occur in marine, lacustrine, or riverine environments, and so can affect riparian vegetation in each of these environments. The riparian footprint is typically limited, as groins and bank barbs are oriented perpendicular to the shoreline. However, because a groin or bank barb project often incorporates a series of several structures, the resulting short-term to intermediate-term construction impacts can be fairly extensive, affecting a larger riparian footprint. While the risk of take from groins and bank barbs resulting from riparian vegetation modification is low, the number of individuals affected may potentially be larger in cases where the affected riparian footprint is more extensive.

9.4.7.2.1 Altered Riparian Shading and Altered Ambient Air Temperature Regime

In marine and lacustrine environments, the risk of take from altered riparian shading is low. The perpendicular orientation of jetties, groins, and bank barbs to the shoreline reduces the effects of riparian vegetation modifications on shading. Jetties have no associated risk of take in riverine environments, because jetties are not built in rivers.

Breakwaters have no onshore components and therefore have no effects on riparian conditions, and they will impose no related risk of take from modifications to shading.

In larger river systems, altered temperatures due to changes in riparian vegetation may not be measurable, and the resulting risk of take discountable. In smaller streams, stream temperature effects related to groins and bank barbs may influence local habitat suitability and by, extension affect the survival, growth, and fitness of exposed species and life-history stages.

9.4.7.2.2 Altered Shoreline, Bluff, and Streambank Stability

Depending on site-specific conditions, modifications of marine and lacustrine riparian vegetation can lead to physical alteration of the shoreline and bluff instability. In the context of shoreline modification projects, this effect is expected to be small because the onshore footprint of these structures is limited. In addition, the structure itself will stabilize the shoreline where vegetation has been removed. However, unmitigated vegetation alteration may lead to localized decreases in shoreline stability and cyclical erosion. Where this impact mechanism occurs, it would be expected to alter shoreline habitat conditions and habitat suitability for species dependent on the nearshore environment during some portion of their life history. This equates to a low risk of take for species with demonstrable dependence on these habitats because the reduction in suitable habitat area caused by these impact mechanisms will lead to reduced survival, growth, and fitness.

No associated risk of take is anticipated for breakwaters because these structures do not have an onshore component.

In riverine environments, groins and bank barbs are typically intended to increase local bank stability. In the worst-case scenario, however, riparian vegetation modification associated with a permitted project could result in decreased stream bank and shoreline stability, as well as increased erosion and turbidity. These effects are localized and predominant during seasonal high-flow conditions. The risk of take associated with this stressor varies depending on species-specific sensitivity to increased turbidity. In general, more motile fish species experience only temporary behavioral alteration and low risk of take. In contrast, less motile fish life-history stages or sessile invertebrates could experience a high risk of take from decreased survival due to substrate sedimentation and smothering, as well as decreased growth and fitness due to the effects of high turbidity on foraging success.

9.4.7.2.3 Altered Allochthonous Inputs

Because the footprint of jetties, groins, and bank barbs within marine and lacustrine riparian areas is limited, the extent of alterations to allochthonous inputs is likely to be low. This equates to a low risk of take for species with demonstrable dependence on these habitats. No associated risk of take is anticipated for breakwaters because these structures do not have an onshore component.

In riverine environments, the impact from alterations to allochthonous inputs varies depending on the scale of the groin or barb project and its position in the watershed. Allochthonous inputs are more important to food web productivity in small streams, and less important in large rivers. A groin project near the mouth of a large river will produce lower-magnitude stressors related to allochthonous inputs than a series of bank barbs in a small, higher elevation stream. In smaller streams, a localized reduction in food web productivity might result, leading to decreased foraging opportunities, decreased overall habitat suitability, and decreased growth and fitness. This equates to a high risk of take for a range of HCP species that are dependent on riverine rearing conditions due to the long-term nature of the effect.

9.4.7.2.4 Altered Habitat Complexity

Because the footprint of jetties, groins, and bank barbs within the marine and lacustrine riparian area is limited, the extent of effects related to altered habitat complexity is likely to be low. This equates to a low risk of take for species with demonstrable dependence on these habitats. No associated risk of take is anticipated for breakwaters because these structures do not have an onshore component.

In riverine environments, fish species that are dependent on habitats potentially affected by altered habitat complexity from groin and bank barb development are likely to experience decreased spawning success and/or decreased survival, growth, and fitness due to an overall reduction in suitable habitat area. This equates to a high risk of take, which applies broadly across all species exposed to the stressor.

9.4.7.2.5 Altered Freshwater Inputs

Because the footprint of jetties, groins, and bank barbs within the riparian area of marine, lacustrine, and riverine environments is limited, the extent of alterations to freshwater input due to removing riparian vegetation is likely to be low. This equates to a low risk of take for species with demonstrable dependence on these habitats. No associated risk of take is anticipated for breakwaters because these structures do not have an onshore component.

9.4.7.3 Aquatic Vegetation Modifications

Shoreline modification projects can result in aquatic vegetation modification through the alteration or elimination of vegetation in the construction footprint, as well as the subsequent effects of the structure on hydraulic and geomorphic conditions. During construction, vegetation in the structural footprint of the project can be eradicated or buried by the placement of fill or structural material. After construction, changes in wave energy, circulation patterns, flow and/or current velocities, and substrate composition can also alter the vegetation community. The nature and scale of aquatic vegetation modification are dependent on the size and design of the individual project in combination with site-specific conditions.

Submerged aquatic vegetation (including eelgrass, kelp, and other forms of marine algae) is an important component of the marine littoral ecosystem relied upon by many species during critical life-history stages.
Aquatic vegetation is a relatively minor component of the ecological structure of riverine and lacustrine systems in Washington State. Aside from native emergent vegetation confined to a relatively narrow range of depths, the majority of aquatic vegetation species in rivers and lakes are invasive species. Thus, the risk of take resulting from modifying freshwater aquatic vegetation is relatively minor in comparison to the marine environment. In riverine systems, protected slow-water areas created by groins and bank barbs may increase suitable habitat for emergent vegetation.

Alteration of aquatic vegetation imposes impact mechanisms on the nearshore environment in the form of changes in autochthonous production and altered habitat complexity.

9.4.7.3.1 Altered Autochthonous Production

Alteration of marine littoral vegetation caused by shoreline development projects may in some cases lead to localized shifts in food web productivity, possibly affecting foraging opportunities for dependent species and life-history stages. This equates to a high risk of take resulting from decreased growth and fitness.

Modification of the submerged aquatic vegetation community in lakes and rivers can lead to decreased primary and secondary productivity, which in turn may affect overall food web productivity in the nearshore environment. In systems where the aquatic vegetation community is an important component of food web productivity, this can lead to a high risk of take through indirect effects on foraging success, growth, and fitness of species and life-history stages that depend on forage in the nearshore environment.

9.4.7.3.2 Altered Habitat Complexity

In marine environments, alterations of the submerged aquatic vegetation community through reduction in aerial extent or conversion to other habitat types (e.g., conversion of eelgrass habitat to algae and kelp) can reduce the productivity of these habitats for dependent life-history stages. This equates to a high risk of take for species dependent on these habitats through reduced survival, spawning success, or growth and fitness.

Submerged aquatic vegetation provides habitat structure in lacustrine and riverine environments, creating vertical dimension and overhead cover. Alteration of habitat complexity can decrease the availability of suitable rearing habitat for species and life-history stages dependent on the nearshore environment, leading to increased predation risk and increased competition for suitable space, leading to effects on survival, growth, and fitness. This equates to a high risk of take for species dependent on aquatic vegetation functions in these environments.

9.4.7.4 Water Quality Modifications

The size of the shoreline modification structure, its construction and maintenance requirements, and the level of associated development and activity determine the extent of water quality modifications. To assess the risk of take associated with these facilities, a “worst-case scenario” approach is taken, with consideration of the scale of the structure and related water quality effect that a given species is likely exposed to in each environment.

9.4.7.4.1 Altered Temperature

Shoreline modifications have the potential to alter temperature conditions through the hydraulic and geomorphic mechanisms they impose. Shoreline modification structures can alter waves, currents, and circulation patterns in marine and lacustrine environments, leading to increased stratification. In riverine environments, groins and bank barbs can slow water flows in the lee of the structures, creating slow water areas prone to stratification and elevated temperature conditions.

These effects can be magnified when stratified areas experience decreased shading due to modification of shading riparian vegetation, which may occur in association with jetties, groins, and bank barbs. However, because these structures are typically oriented perpendicular to the shoreline and their onshore footprint is small, the extent of vegetation modification is usually limited, and these effects are small.

Modification of temperature conditions can change the suitability of nearshore habitats. This may in turn affect the survival, growth, and fitness of HCP species that use the affected habitats. Because these effects are essentially permanent, they must be associated with a high risk of take.

9.4.7.4.2 Suspended Solids and Turbidity

Increased suspended solids can result from several different impact mechanisms. The severity of this stressor varies depending on its magnitude, duration, and frequency, as well as the sensitivity of the species and life-history stage exposed.

9.4.7.4.3 Dissolved Oxygen

There are limited pathways through which shoreline modification projects can lead to alterations in surface water dissolved oxygen levels that are not implicitly addressed by other impact mechanisms. A primary area of concern related to the effects of shoreline modifications in marine and lacustrine environments is their potential to alter wave energy, current, and circulation patterns sufficiently to change stratification, isolating biochemical oxygen demand (BOD) and contributing to eutrophication. In extreme circumstances, this could lead to eutrophication-driven DO depletion in affected habitats. This effect equates to a high risk of take from changes in DO conditions in these environment types, due to the effectively permanent nature of the change in habitat conditions that shoreline modifications impose. These effects would not be anticipated in riverine environments due to the continuous, unidirectional flow path imposed by riverine environments.

Other potential causes of altered DO conditions include inputs of nutrient-rich discharge from construction vessel sanitary systems or ballast water that could cause temporary or short-term decreases in dissolved oxygen levels. A large decrease in aquatic vegetation may limit photosynthetic production of oxygen, but the likelihood of this effect substantially decreasing dissolved oxygen levels is quite limited. In general, the likelihood of this stressor occurring as a direct or indirect result of a shoreline modification project is low.

9.4.7.4.4 Nutrient and Pollutant Loading

Shoreline modification projects present multiple pathways for the introduction of a range of toxic substances to the aquatic environment, primarily through construction activities and, in some cases, the use of treated wood materials in the structure. Shoreline modification projects may also indirectly encourage pollutant and nutrient loading by supporting the development of additional infrastructure. Depending on the nature and concentration of the contaminant, toxic substance exposure can cause a range of adverse effects in exposed species. In extreme cases, these effects can include direct mortality (e.g., exposure of immobile rockfish larvae in the demersal microlayer). More commonly, chronic, low-level exposure to a variety of contaminants is likely to cause physiological injury and/or contaminant bioaccumulation, leading to decreased survival, growth, and fitness. This presents a moderate risk of take to species potentially exposed to this stressor.

9.4.7.4.5 Altered pH Levels

There are limited pathways through which shoreline modification projects can lead to alterations in surface water pH. A primary pathway is the in-water curing of concrete and discharge of concrete leachate to surface waters. Operational discharges and accidental spills of acidic or caustic materials may also lead to the alteration of normal pH levels. In general, this stressor is limited to low-frequency events that are temporary to short-term in duration. Fish species that are highly motile are generally able to avoid adverse effects through behavioral avoidance, equating to a low risk of take. In contrast, sessile invertebrates and less motile life-history stages could experience direct mortality as a result of exposure, equating to a high risk of take depending on species-specific life history.

9.4.7.4.6 Treated Wood Pollution

Creosote-treated wood was often used historically in shoreline modification projects and other structures in marine and freshwater environments. This substance is still permitted in some circumstances. Creosote is a wood preservative with a complex formula composed of more than 150 toxic chemical substances. The Hydraulic Code prohibits use of creosote- and pentachlorophenol-treated wood in lakes; therefore, exposure to this stressor exposure will not occur in most lacustrine habitats. There is some uncertainty about potential exposure in lacustrine environments because the applicability of this statute to reservoirs is not clear.

Prohibitions on the use of creosote, pentachlorophenol, and other wood preservatives have prompted the development of alternatives. ACZA and CCA type C are alternative wood preservatives that are less toxic than prohibited materials but are still effective against undesirable invertebrates. These substances, which slowly leach out of treated wood over time, are toxic to other forms of aquatic life than the intended target species and also have the potential to bioaccumulate.

These substances are expected to produce a moderate risk of take for species potentially exposed to this stressor. It is worthwhile to note, however, that this treated wood poses greater potential for chronic exposure as leaching of toxics occurs over extended periods.

Table 9-41. Species- and habitat-specific risk of take for mechanisms of impacts associated with jetties.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	N	H	H	N	H	H	N	L	L	N	H	L	N	H	H	N	H	H	This species has a complex and variable life history depending on race. In general, Chinook salmon occur in marine and lacustrine habitats suitable for jetty development and are thereby potentially exposed to stressors resulting from related impact mechanisms. Spawning activity typically occurs in habitats that are not suitable for jetties; therefore, stressor exposure will only occur during migratory life-history stages at transitional locations between marine or lacustrine and riverine habitats. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.
Coho salmon	N	H	H	N	H	H	N	L	L	N	H	L	N	H	H	N	H	H	This species has a complex and variable life history depending on race. In general, coho salmon occur in lacustrine and nearshore marine habitats suitable for jetty development and may experience exposure to related stressors. Spawning activity typically occurs in habitats that are not suitable for jetties; therefore, stressor exposure will only occur during migratory life-history stages at transitional locations between marine or lacustrine and riverine habitats. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.
Chum salmon	N	H	I	N	H	I	N	L	I	N	H	I	N	H	I	N	H	I	Chum salmon in Washington State do not use lacustrine habitats suitable for jetty development. Therefore, likelihood of stressor exposure in lacustrine environments is considered discountable. Juvenile chum salmon are dependent on nearshore marine habitats and are therefore subject to stressor exposure from jetty development in these environments. Spawning activity typically occurs in habitats that are not suitable for jetties; therefore, stressor exposure will only occur during migratory life-history stages at transitional locations between marine and riverine habitats. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.
Pink salmon	N	H	I	N	H	I	N	L	I	N	H	I	N	H	I	N	H	I	Pink salmon in Washington State do not use lacustrine habitats. Therefore, likelihood of stressor exposure in lacustrine environments is considered discountable. This species is dependent on nearshore marine habitats for juvenile rearing and migrates through the mainstems and estuaries of larger river systems potentially suitable for jetty development. Spawning activity typically occurs in habitats that are not suitable for jetties; therefore, stressor exposure will only occur during migratory life-history stages at transitional locations between marine and riverine habitats. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.
Sockeye salmon	N	H	H	N	H	H	N	L	L	N	H	H	N	H	H	N	H	H	This species is highly dependent on lacustrine environments for juvenile rearing. Most spawning behavior occurs in smaller rivers and streams that are not suitable for jetty development. However, some populations spawn in nearshore lacustrine habitats, creating increased risk of stressor exposure at sensitive egg and alevin life-history stages. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridor. Avoidance of impacts on juvenile sockeye in lacustrine environments is difficult due to year-round residence. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.
Steelhead	N	H	H	N	?	H	N	?	L	N	?	L	N	?	H	N	?	H	Spawning activity typically occurs in habitats that are not suitable for jetty development; therefore, eggs and alevins will not experience stressor exposure. Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats, so the level of take associated with activities in these habitat types is less certain but is conservatively presumed to occur. As juvenile steelhead are more typically found farther from shore, the effects of shading are less clear; therefore, the risk of take in the marine environment is uncertain.
Coastal cutthroat trout	N	H	H	N	H	H	N	L	L	N	H	L	N	H	H	N	H	H	This species is prevalent in estuaries and large rivers (although it also occurs in Lake Washington) and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for jetty development. Migratory behavior and residence timing are variable. Spawning activity typically occurs in habitats that are not suitable for jetties; therefore, stressor exposure will only occur during migration between marine or lacustrine and riverine habitats and adult foraging in the marine and estuarine environment. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.
Westslope cutthroat trout	N	N	H	N	N	H	N	NA	L	N	NA	H	N	NA	H	N	NA	H	These species occur primarily in coldwater streams and small to medium-sized rivers unsuitable for jetty development. Rearing juveniles and adults do occur in lacustrine environments, creating some potential for

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Redband trout	N	N	H	N	N	H	N	NA	L	N	NA	H	N	NA	H	N	NA	H	stressor exposure. As a consequence, there is effectively no risk of take in riverine environment types, while exposure in lacustrine environments may result in a moderate (from project effects on habitat quality and quantity) to high (from project construction) risk of take.
Bull trout	N	H	H	N	H	H	N	L	L	N	H	L	N	H	H	N	H	H	Spawning activity typically occurs in habitats that are not suitable for jetties; therefore, stressor exposure will only occur during migratory life-history stages at transitional locations between marine or lacustrine and riverine habitats. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment. Most effects would occur from development in nearshore marine migratory corridors, as well as lacustrine and marine foraging habitats used by mature juveniles and adults. However, bull trout in lakes are typically (but not exclusively) found in deeper water, limiting the potential for direct stressor exposure.
Dolly Varden	N	H	H	N	H	H	N	L	L	N	H	L	N	H	H	N	H	H	
Pygmy whitefish	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	Lakes and smaller lake tributaries are primary habitats used by this species. Stressor exposure will only occur in lacustrine environments. This species faces high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the lacustrine environment.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. Species does not occur in the marine environment or lakes suitable for jetty development. Therefore, stressor exposure will not occur and there is effectively no risk of take.
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for jetty development. Therefore, stressor exposure will not occur and there is effectively no risk of take.
Mountain sucker	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	This species is commonly found in large lakes potentially suitable for jetty development. Stressor exposure is likely to occur in these environments during the juvenile and adult life-history stages. This species faces high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the lacustrine environment.
Lake chub	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties that are unsuitable for jetty development. Therefore, stressor exposure will not occur and there is effectively no risk of take.
Leopard dace	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in reservoir habitats potentially suitable for jetty development at sensitive life-history stages, including egg incubation. This species faces high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the lacustrine environment.
Umatilla dace	N	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for jetty development at sensitive life-history stages, including egg incubation. This species faces high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the lacustrine environment.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This species is characterized by isolated breeding populations favoring small streams and brooks, which are unsuitable environments for jetty development. There is effectively no risk of take.
River lamprey	N	H	H	N	H	H	N	?	?	N	?	?	N	H	H	N	H	H	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of larger rivers to rear for extended periods, potentially years. The ammocoete life-history stage is potentially exposed to a range of impact mechanisms resulting from jetty development in lacustrine environments. In their saltwater phase, river lamprey remain close to shore for periods of 10–16 weeks from spring through fall, increasing exposure to stressors in the nearshore environment. Impact mechanism effects affecting the abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults.
Pacific lamprey	N	I	H	N	I	H	N	I	?	N	I	?	N	I	H	N	I	H	Pacific lamprey are anadromous with migratory corridors that cross estuaries and mainstems of larger river systems suitable for jetty development. Ammocoetes burrow into riverine sediments to rear for extended periods. The ammocoete life-history stage is more susceptible to a range of impact mechanisms resulting from jetty development in lacustrine environments. In the marine environment Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6–40 months and are therefore less likely to be

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																			exposed to project-related stressors. Therefore, the moderate to high risk of take associated with structure-related habitat alteration and construction activities, respectively, applies primarily to lacustrine habitat. Impact mechanisms in marine and lacustrine environments that affect the abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults. This in turn equates to a moderate risk of take.
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	In Washington, white sturgeon are found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington. Although this species is considered to be anadromous, populations in the Columbia River may be reproducing successfully in some impoundments. Sturgeon eggs are demersal and adhesive. Larval sturgeon are essentially planktonic and rear in quiet backwaters of the large rivers and lakes where they are transported by currents following emergence. These life-history stages are therefore potentially exposed to jetty-related impact mechanisms in lacustrine environments. Their relative lack of mobility increases sensitivity to a range of impact mechanisms. Sturgeon are wide ranging in marine waters. Green sturgeon occur in Washington State only as adults in marine waters, with fisheries occurring in the Willapa Bay, and Grays Harbor. Individuals are also occasionally caught incidentally in small coastal bays and the Puget Sound. Dependence on nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in nearshore habitats.
White sturgeon	N	?	H	N	?	H	N	?	L	N	?	?	N	?	H	N	?	H	
Longfin smelt	N	H	H	N	H	H	N	L	?	N	I	?	N	H	H	N	H	H	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems. Planktonic larvae and juveniles of these species may also be vulnerable to jetty-related stressor exposure in the nearshore marine environment during early rearing. Mature juveniles and adults occupy offshore environments and are therefore at less risk of take from these stressors. Similar to other species' exposure profiles, life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. The Lake Washington population of longfin smelt rears and forages in the lacustrine environment throughout the larval, juvenile, and nonspawning adult portion of its life history and is subject to the effects of jetties in this water body.
Eulachon	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	H	N	
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high. Larvae of both species disperse in nearshore waters for early rearing. These beach-spawning species depend on a narrow range of substrate conditions for suitable spawning habitat, increasing sensitivity to hydraulic and geomorphic effects. Planktonic larvae are also dependent on nearshore current and circulation patterns for rearing survival. Planktonic life-history stages are also incapable of escaping acute water quality impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Surf smelt	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Pacific herring	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure from hydraulic and geomorphic, and aquatic vegetation modifications is high. Planktonic larvae disperse in nearshore waters for early rearing and are dependent on current and circulation patterns for survival, growth, and fitness. Planktonic life-history stages are also incapable of escaping acute water quality impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Lingcod	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are potentially exposed to stressors resulting from jetty related impact mechanisms. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 and 150 m) and therefore have less exposure potential. Temporary disturbance while brooding may increase risk of egg predation. Larvae disperse and settle in nearshore waters for early rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pacific hake	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	Hake, cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Pacific cod	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Larvae disperse and settle in nearshore waters for early rearing, and are dependent on current, wave, and circulation patterns to ensure dispersal to environments favorable for rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Walleye pollock	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Brown rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Juveniles disperse and settle in nearshore waters for early rearing, and are dependent on current, wave, and circulation patterns to ensure dispersal to environments favorable for rearing. Because they are demersal and relatively immobile once they have settled, juveniles are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Copper rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Greenstriped rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Widow rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Yellowtail rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Quillback rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Black rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
China rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Tiger rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Bocaccio rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Canary rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Redstripe rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Yelloweye rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Olympia oyster	N	H	N	N	H	N	N	H	N	N	I	N	N	H	N	N	I	N	This species occurs commonly in shallow water nearshore habitats. This distribution increases risk of stressor exposure and potential for take resulting from water quality modification in the nearshore environment. Because this species is sessile during much of its life history, it is vulnerable to both short-term construction and water quality related impacts, as well as modification of hydraulic and geomorphic conditions in the nearshore environment. Modification of current, wave, and circulation patterns may also affect larval settlement, influencing survival during this life-history stage. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Northern abalone	N	H	N	N	H	N	N	I	N	N	I	N	N	H	N	N	I	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) in depth. Because this species has low mobility, it is more sensitive to a variety of impact mechanisms potentially resulting from jetty development, including construction and water quality effects. Being planktonic spawners, the species' spawning productivity is dependent on current and circulation patterns. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Newcomb's littorine snail	N	H	N	N	H	N	N	H	N	N	I	N	N	M	N	N	?	N	The Newcomb's littorine snail inhabits *Salicornia* marshes on the littoral fringe. It is intolerant of extended submergence in both fresh and marine water; as such, it not a true aquatic species. Therefore, the potential for exposure to most stressors from jetty-related impact mechanisms is minimal. Exceptions include alteration of riparian vegetation affecting this vegetation community. Risk of take for this species is similarly limited, with the exception of a moderate risk of take resulting from potential effects on marine littoral vegetation, and low risk of take associated with behavioral avoidance of water quality degradation. It is important to note, however, that suitable habitats for these species do not typically occur in locations suitable for jetty development; therefore, the likelihood of stressor exposure in general is considered to be limited.
Giant Columbia River limpet	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for jetty development. As such, there is essentially no likelihood of stressor exposure and therefore no potential for take resulting from these activities. The giant Columbia River limpet is known to occur

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. These environments are likewise not suitable for jetty development. As such, there is effectively no risk of take resulting from jetty-related stressor exposure.
California floater (mussel)	N	N	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N	H	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake rivers and the mainstems of these systems in flowing water environments unsuitable for jetty development. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes, the latter being suitable for jetties. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Habitat accessibility modifications will not directly affect these species; however, indirect effects could occur through direct effects on host fish.
Western ridged mussel	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

1 **Table 9-42. Species- and habitat-specific risk of take for mechanisms of impacts associated with breakwaters.**

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	H	H	H	H	H	H	L	H	H	H	H	H	L	H	H	This species has a complex and variable life history, depending on race. In general, Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for breakwater development and are thereby potentially exposed to stressors resulting from related impact mechanisms. Spawning activity typically occurs in habitats that are not suitable for breakwaters. Therefore, stressor exposure will only occur during migratory life-history stages in the lower reaches of large rivers, and lacustrine and marine environments. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.
Coho salmon	H	H	H	H	H	H	L	H	H	H	H	H	L	H	H	This species has a complex and variable life history, depending on race. In general, coho salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for breakwater development and may experience exposure to related stressors. Spawning activity typically occurs in habitats that are not suitable for breakwaters. Therefore, stressor exposure will only occur during migratory life-history stages in the lower reaches of large rivers, and lacustrine and marine environments. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.
Chum salmon	H	H	I	H	H	I	L	H	I	H	H	I	L	H	I	Chum salmon in Washington State do not use lacustrine habitats suitable for breakwater development. Therefore, stressor exposure will not occur in lacustrine environments. Chum may spawn in the lower reaches of large river environments (e.g., the Columbia River). As such, in addition to migratory juveniles and adults, spawning habitats may be exposed to stressors resulting from breakwater-related impact mechanisms. Juvenile chum salmon are dependent on nearshore marine habitats and are therefore subject to stressor exposure from breakwater development in these environments.
Pink salmon	H	H	I	H	H	I	L	H	I	H	H	I	L	H	I	Pink salmon in Washington State do not use lacustrine habitats. Therefore, stressor exposure will not occur in this environment type. This species is dependent on nearshore marine habitats for juvenile rearing and migrates through the mainstems and estuaries of larger river environments potentially suitable for breakwater development. As such, this species may potentially be exposed to stressors resulting from related impact mechanisms. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Sockeye salmon	H	H	H	H	H	H	L	H	H	H	H	H	L	H	H	This species is highly dependent on lacustrine environments for juvenile rearing. Most spawning behavior occurs in smaller rivers and streams that are not suitable for breakwater development. However, some populations spawn in nearshore lacustrine habitats, creating increased risk of stressor exposure at sensitive egg and alevin life-history stages. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridors. Avoidance of impacts on juvenile sockeye in lacustrine environments is difficult due to year-round residence. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Steelhead	H	H	H	H	?	H	L	?	H	H	H	H	L	?	H	Spawning activity typically occurs in habitats that are not suitable for breakwater development; therefore, eggs and alevins will not experience stressor exposure. Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats, so the level of take associated with activities in these habitat types is less certain, but is conservatively presumed to occur. As juvenile steelhead are more typically found farther from shore, the effects of shading are less clear; therefore, the risk of take in the marine environment is uncertain. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Coastal cutthroat trout	H	H	H	H	H	H	L	H	H	H	H	H	L	H	H	This species is prevalent in estuaries and large rivers (although it also occurs in Lake Washington) and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for breakwater development. Migratory behavior and residence timing are variable. Spawning activity typically occurs in habitats that are not suitable for breakwaters; therefore, stressor exposure will only occur during juvenile rearing adult foraging. These life-history stages face high risk of take during the construction of these structure types, and moderate risk of take from the effects of the structure on the migratory environment.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Westslope cutthroat trout	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	These species occur primarily in coldwater streams, small to medium-sized rivers, and lakes. Occurrence in estuaries of larger rivers suitable for breakwater development is highly unlikely; therefore, the risk of take associated with these structures is considered discountable. Stressor exposure in lacustrine environments is possible, however. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Redband trout	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	
Bull trout	H	H	H	L	H	H	L	H	H	H	H	H	L	H	H	Spawning by these species occurs in habitats that are generally unsuitable for breakwater development. Therefore, spawning, egg incubation, and early rearing will not be directly affected by these activities. Most effects will occur from development in riverine migratory corridors, as well as in riverine, lacustrine, and marine foraging habitats used by mature juveniles and adults. However, bull trout in lakes are typically (but not exclusively) found in deeper water, limiting the potential for direct stressor exposure. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Dolly Varden	H	H	H	L	H	H	L	H	H	H	H	H	L	H	H	
Pygmy whitefish	N	N	H	N	N	H	N	N	H	N	N	H	N	N	H	Lakes and smaller lake tributaries are primary habitats used by this species. Whitefish do not occur in larger rivers suitable for breakwater development; therefore, stressor exposure will only occur in lacustrine environments. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. Species does not occur in larger rivers or lakes suitable for breakwater development. Therefore, stressor exposure will not occur and there is effectively no risk of take.
Margined sculpin	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages unsuitable for breakwater development. Therefore, stressor exposure will not occur and there is effectively no risk of take.
Mountain sucker	H	N	H	H	N	H	H	N	H	H	N	H	L	N	H	This species is commonly found in large rivers and lakes suitable for breakwater development. Stressor exposure is likely to occur across all life-history stages. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Lake chub	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties that are unsuitable for breakwater development. Therefore, stressor exposure will not occur, and there is effectively no risk of take.
Leopard dace	H	N	H	H	N	H	H	N	H	H	N	H	L	N	L	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in habitats potentially suitable for breakwater development at sensitive life-history stages, including egg incubation. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Umatilla dace	H	N	H	H	N	H	H	N	H	H	N	H	L	N	L	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for breakwater development at sensitive life-history stages, including egg incubation. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Western brook lamprey	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	This species is characterized by isolated breeding populations favoring small streams and brooks, which are unsuitable environments for breakwater development. There is effectively no risk of take.
River lamprey	H	H	H	H	H	H	?	?	?	H	H	H	L	H	L	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries and lower reaches of larger rivers to rear for extended periods, potentially years. The ammocoete life-history stage is more susceptible to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. In their saltwater phase, river lamprey remain close to shore for periods of 10–16 weeks from spring through fall, increasing exposure to stressors in the nearshore environment. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Impact mechanisms affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults, which in turn equates to a moderate

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																risk of take.
Pacific lamprey	H	I	H	H	I	H	?	I	?	H	I	H	L	I	L	Pacific lamprey are anadromous, with migratory corridors that cross estuaries and mainstems of larger river systems suitable for breakwater development. Ammocoetes burrow into riverine sediments to rear for extended periods. The ammocoete life-history stage is more susceptible to acute transient water quality impacts, such as reduced dissolved oxygen or altered pH. Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6–40 months and are therefore less likely to be exposed to project-related stressors in the nearshore marine environment. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Impact mechanisms affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults. This in turn equates to a moderate risk of take.
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	In Washington, white sturgeon are found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington. Although this species is considered anadromous, populations in the Columbia River may be reproducing successfully in some impoundments. Sturgeon eggs are demersal and adhesive. Larval sturgeon are essentially planktonic and rear in quiet backwaters of the large rivers and lakes where they are transported by currents following emergence. These life-history stages are therefore potentially exposed to water quality related impact mechanisms from breakwaters. Their relative lack of mobility increases sensitivity to acute transient water quality impacts such as reduced dissolved oxygen or altered pH. Sturgeon are wide ranging in marine waters. Green sturgeon occur in Washington State only as adults in marine waters, with fisheries occurring in Willapa Bay and Grays Harbor. Individuals are also occasionally caught incidentally in small coastal bays and the Puget Sound. Dependence on nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in nearshore habitats and the related risk of take.
White sturgeon	H	?	H	H	?	H	H	?	H	H	?	H	H	?	H	
Longfin smelt	H	H	H	H	H	H	I	I	H	H	H	H	H	H	H	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems potentially suitable for breakwater development. Demersal adhesive eggs are vulnerable to acute transient water quality impacts, such as reduced dissolved oxygen or altered pH. Planktonic larvae and juveniles of these species may also be vulnerable to stressor exposure in the nearshore marine environment during early rearing. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Mature juveniles and adults occupy offshore environments and are therefore at less risk of take from these stressors. The Lake Washington population of longfin smelt rears and forages in the lacustrine environment throughout the larval, juvenile, and nonspawning adult portion of its life history and is subject to the effects of breakwaters in this water body.
Eulachon	H	H	N	H	H	N	I	I	N	H	H	N	H	H	N	
Pacific sand lance	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high. Larvae of both species disperse in nearshore waters for early rearing. These beach-spawning species depend on a narrow range of substrate conditions for suitable spawning habitat, increasing sensitivity to hydraulic and geomorphic effects. Planktonic larvae are also dependent on nearshore current and circulation patterns for rearing survival. Planktonic life-history stages are also incapable of escaping acute water quality impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Surf smelt	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Pacific herring	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure from hydraulic/geomorphic and aquatic vegetation modifications is high. Planktonic larvae disperse in nearshore waters for early rearing and are dependent on current and circulation patterns for survival, growth, and fitness. Planktonic life-history stages are also incapable of escaping acute water quality impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Lingcod	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are potentially exposed to water quality related impact mechanisms from breakwaters. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																m), but are most prominent between 330 and 500 ft (100 and 150 m) and, therefore, have less exposure potential. Temporary disturbance while brooding may increase risk of egg predation. Larvae disperse and settle in nearshore waters for early rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pacific hake	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Hake, cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Larvae disperse and settle in nearshore waters for early rearing, and are dependent on current, wave, and circulation patterns to ensure dispersal to environments favorable for rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pacific cod	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Walleye pollock	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Brown rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Juveniles disperse and settle in nearshore waters for early rearing, and are dependent on current, wave, and circulation patterns to ensure dispersal to environments favorable for rearing. Because they are demersal and relatively immobile once they have settled, juveniles are vulnerable to short-term construction and water quality related impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Copper rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Greenstriped rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Widow rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Yellowtail rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Quillback rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Black rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
China rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Tiger rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Bocaccio rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Canary rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Redstripe rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Yelloweye rockfish	N	H	N	N	H	N	N	H	N	N	H	N	N	H	N	
Olympia oyster	N	H	N	N	H	N	N	I	N	N	H	N	N	I	N	This species occurs commonly in shallow water nearshore habitats. This distribution increases risk of stressor exposure and potential for take resulting from water quality modification in the nearshore environment. Because this species is sessile during much of its life-history, it is vulnerable to both short-term construction and water quality related impacts, as well as modification of hydraulic and geomorphic conditions in the nearshore environment. Modification of current, wave, and circulation patterns may also affect larval settlement, influencing survival during this life-history stage. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Northern abalone	N	H	N	N	H	N	N	I	N	N	H	N	N	I	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) in depth. Because this species has low mobility, it is more sensitive to a variety of impact mechanisms potentially resulting from breakwater development, including construction and water quality effects. Being planktonic spawners, spawning productivity is dependent on current and circulation patterns. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Newcomb's littorine snail	N	N	N	N	H	N	N	N	N	N	L	N	N	?	N	The Newcomb's littorine snail inhabits *Salicornia* marshes on the littoral fringe. It is intolerant of extended submergence in both fresh and marine water; as such, it not a true aquatic species. Therefore, the potential for exposure to most stressors from breakwater-related impact mechanisms is minimal, as these offshore structures have limited effects on littoral vegetation. This is particularly true for *Salicornia* marshes, which predominantly occur in low-energy environments less subject to the effects of breakwaters on wave energy.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
																The only potential risk of take associated with breakwater development is from temporary water quality effects. This risk is rated as low.
Giant Columbia River limpet	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	The great Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for breakwater development. As such, there is essentially no likelihood of stressor exposure and, therefore, no potential for take resulting from these activities. The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. These environments are generally not suitable for breakwater development. There is no risk of take for either species.
Great Columbia River spire snail	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
California floater (mussel)	H	N	H	H	N	H	I	N	I	H	N	H	L	N	L	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake rivers. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. Only the latter species occurs in habitats suitable for breakwater development. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Habitat accessibility modifications will not directly affect this species; however, indirect effects could occur through direct effects on host-fish.
Western ridged mussel	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

Table 9-43. Species- and habitat-specific risk of take for mechanisms of impacts associated with groins and bank barbs.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Chinook salmon	H	H	H	H	H	H	L	L	L	L	H	H	H	H	H	H	H	H	This species has a complex and variable life history, depending on race. In general, Chinook salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for groin or bank barb development and are thereby potentially exposed to stressors resulting from related impact mechanisms across all life-history stages. Bank barb development in smaller streams may affect spawning adults, eggs, and alevins. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Coho salmon	H	H	H	H	H	H	L	L	L	L	H	H	H	H	H	H	H	H	This species has a complex and variable life history, depending on race. In general, coho salmon occur in riverine, lacustrine, and nearshore marine habitats suitable for groin or bank barb development and may experience exposure to related stressors across all life-history stages. Bank barb development in smaller streams may affect spawning adults, eggs, and alevins. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Chum salmon	H	H	I	H	H	I	L	L	I	L	H	I	H	H	I	H	H	I	Chum salmon in Washington State do not use lacustrine habitats in any significant fashion. Therefore, the likelihood of stressor exposure in lacustrine environments is considered discountable. Chum may spawn in the lower reaches of large river environments (e.g., the Columbia River). As such, in addition to migratory juveniles and adults, spawning habitats may be exposed to stressors resulting from groin or bank barb related impact mechanisms. Juvenile chum salmon are dependent on nearshore marine habitats and are therefore subject to stressor exposure from groin or bank barb development in these environments. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pink salmon	H	H	I	H	H	I	L	L	I	L	H	I	H	H	I	H	H	I	Pink salmon in Washington State do not use lacustrine habitats. Therefore, stressor exposure will not occur in this environment type and the likelihood of stressor exposure in lacustrine environments is considered discountable. This species is dependent on nearshore marine habitats for juvenile rearing and migrates through and spawns in the mainstems and estuaries of larger river systems potentially suitable for groin or bank barb development. As such, this species may potentially be exposed to stressors resulting from related impact mechanisms. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Sockeye salmon	H	H	H	H	H	H	L	L	L	L	H	H	H	H	H	H	H	H	This species is highly dependent on lacustrine environments for juvenile rearing, and most spawning behavior occurs in smaller rivers and streams that are also suitable for groin or bank barb development. Lake spawning populations also face risk of stressor exposure at sensitive egg and alevin life-history stages in lacustrine environments. Migrating juveniles and adults may experience stressor exposure in larger rivers and reservoirs along their migratory corridors. Bank barb development in smaller streams may affect spawning adults, eggs, and alevins. Avoidance of impacts on juvenile sockeye in lacustrine environments is difficult due to year-round residence. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Steelhead	H	?	H	H	?	H	L	?	L	L	?	H	H	?	H	H	?	H	Steelhead have a lesser but uncertain level of dependence on nearshore marine habitats; the level of take associated with activities in these habitat types is less certain, but is conservatively presumed to occur. Bank barb development in smaller streams may affect spawning adults, eggs, and alevins. As juvenile steelhead are more typically found farther from shore, the effects of shading are less clear; therefore, the risk of take in the marine environment is uncertain. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Coastal cutthroat trout	H	H	H	H	H	H	L	L	L	L	H	H	H	H	H	H	H	H	This species is prevalent in estuaries and large rivers and is highly dependent on nearshore marine areas for foraging. These habitats are suitable for groin or bank barb development. Migratory behavior and residence timing are variable. Bank barb development in smaller streams may affect spawning adults, eggs, and alevins. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Westslope cutthroat trout	N	N	H	H	N	H	N	N	L	N	N	H	N	N	H	N	N	H	These species occur primarily in coldwater streams, small to medium-sized rivers, and lakes. Bank barb development in smaller streams may affect spawning adults, eggs, alevins, and rearing juveniles. Groin development in moderate-sized rivers may have similar effects across all life-history stages. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Redband trout	N	N	H	H	N	H	N	N	L	N	N	H	N	N	H	N	N	H	
Bull trout	H	H	H	H	H	H	L	L	L	L	H	H	H	H	H	H	H	H	Most effects will occur from development in riverine migratory corridors, as well as in riverine, lacustrine, and marine foraging habitats used by mature juveniles and adults, which are all potential sites for groin or bank barb development. In lakes, however, char are typically found in deeper water, limiting the potential for direct stressor exposure. Bank barb development in smaller streams may affect spawning adults, eggs, and alevins. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Dolly Varden	H	H	H	H	H	H	L	L	L	L	H	H	H	H	H	H	H	H	
Pygmy whitefish	H	N	H	H	N	H	L	N	L	H	N	H	H	N	H	H	N	H	Lakes and smaller lake tributaries are primary habitats used by this species. These environments are suitable for groin or bank barb development, meaning that this species may be exposed to stressors from related impact mechanisms across all life-history stages. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Olympic mudminnow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Primary habitats are wetlands and small, slow-flowing streams. These environments are generally not suitable for groin or bank barb development. Therefore, there is essentially no likelihood of stressor exposure and effectively no risk of take.
Margined sculpin	H	N	H	H	N	H	L	N	L	H	N	H	H	N	H	H	N	H	Primary habitats are located in smaller tributary streams of the Walla Walla and Tucannon River drainages. While generally remote, these streams are potentially suitable for groin or bank barb development. Therefore, stressor exposure may occur across all life-history stages. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Mountain sucker	H	N	H	H	N	H	L	N	L	H	N	H	H	N	H	H	N	H	This species is commonly found in large rivers and lakes suitable for groin or bank barb development. Stressor exposure is likely to occur across all life-history stages. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Lake chub	H	N	H	H	N	H	L	N	L	H	N	H	H	N	H	H	N	H	The known distribution of this species in Washington State is limited to small streams and lakes in Okanogan and Stevens counties. These habitats may be suitable for groin or bank barb development, presenting the potential for stressor exposure across all life-history stages. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Leopard dace	H	N	H	H	N	H	L	N	L	H	N	H	H	N	H	H	N	H	This species has been reported to occur in the Columbia and Cowlitz River systems west of the Cascade Range, and in the Columbia River mainstem to the east. As such, this species occurs in habitats potentially suitable for groin or bank barb development at sensitive life-history stages, including egg incubation. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Umatilla dace	H	N	H	H	N	H	L	N	L	H	N	H	H	N	H	H	N	H	This species has been reported to occur in the Columbia, Yakima, Okanogan, Similkameen, Kettle, Colville, and Snake rivers (including reservoirs within the Columbia and Snake River systems). As such, this species occurs in habitats potentially suitable for groin or bank barb development at sensitive life-history stages, including egg incubation. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	**Riverine**	**Marine**	**Lacustrine**	
Western brook lamprey	H	N	I	H	N	I	L	N	I	H	N	I	H	N	I	H	N	I	This species is characterized by isolated breeding populations favoring small streams and brooks. This species is particularly vulnerable to impact mechanisms resulting from bank barb development, and experiences exposure to related stressors across all life-history stages. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Occurrence in lacustrine habitats is extremely rare; therefore, the likelihood of stressor exposure and the related potential for take in this environment type are considered discountable.
River lamprey	H	H	H	H	H	H	L	?	?	?	?	?	H	H	H	H	H	H	River lamprey are commonly found in nearshore areas of rivers and some lake systems. Lamprey ammocoetes burrow into sediments in quiet backwaters of lakes and nearshore areas of estuaries, and lower reaches of larger rivers to rear for extended periods, potentially years. This nonmobile life-history stage is more susceptible to acute construction-related impacts and longer term alteration of habitat suitability due to hydraulic and geomorphic modifications, as well as other changes in habitat complexity. In their saltwater phase, river lamprey remain close to shore for periods of 10–16 weeks from spring through fall, increasing exposure to stressors in the nearshore environment. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Impact mechanism effects affecting the abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults. This equates to a moderate risk of take.
Pacific lamprey	H	I	H	H	I	H	L	I	?	?	I	?	H	I	H	H	I	H	Pacific lamprey are anadromous, with migratory corridors that cross estuaries and mainstems of larger river systems suitable for groin or bank barb development. Ammocoetes burrow into riverine sediments to rear for extended periods. This nonmobile life-history stage is more susceptible to acute construction-related impacts, and longer term alteration of habitat suitability due to hydraulic and geomorphic modifications and other changes in habitat complexity. Pacific lamprey occupy epipelagic habitats away from the nearshore environment for periods ranging from 6–40 months and are therefore less likely to be exposed to project-related stressors in the nearshore marine environment. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Impact mechanism effects affecting abundance of host fish may lead to indirect effects on growth and fitness of transforming adults and adults. This equates to a moderate risk of take.
Green sturgeon	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	N	?	N	In Washington, white sturgeon are found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound, and Lake Washington. Although this species is considered anadromous, populations in the Columbia River may be reproducing successfully in some impoundments. Sturgeon eggs are demersal and adhesive. Larval sturgeon are essentially planktonic and rear in quiet backwaters of the large rivers and lakes where they are transported by currents following emergence. This less mobile life-history stage is more susceptible to acute construction-related impacts and longer term alteration of habitat suitability due to hydraulic and geomorphic modifications, as well as other changes in habitat complexity. Sturgeon are wide ranging in marine waters. Green sturgeon fisheries occur in the Columbia River below Bonneville Dam, Willapa Bay, and Grays Harbor. Individuals are also occasionally caught incidentally in small coastal bays and the Puget Sound. Dependence on nearshore marine habitats is unknown, as is the potential for exposure to stressors occurring in nearshore habitats. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
White sturgeon	H	?	H	H	?	H	L	?	L	H	?	H	H	?	H	H	?	H	
Longfin smelt	H	H	H	H	H	H	L	I	L	I	I	H	H	H	H	H	H	H	Eulachon and longfin smelt spawn in the lower reaches of moderate to large river systems potentially suitable for groin or bank barb development. Spawning habitat suitability may be adversely affected by construction and longer term modifications of habitat suitability from hydraulic and geomorphic modifications or other changes in habitat complexity. Planktonic larvae and juveniles of these species may also be vulnerable to stressor exposure in the nearshore marine environment during early rearing. Mature juveniles and adults occupy offshore environments and are therefore at less risk of take from these stressors. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Eulachon	H	H	N	H	H	N	L	L	N	I	I	N	H	H	N	H	H	N	
Pacific sand lance	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	Surf smelt and sand lance populations are widespread and ubiquitous in Puget Sound, the Strait of Juan de Fuca, and the coastal estuaries of Washington. They are dependent on shoreline habitats for spawning and are prevalent in the nearshore environment, meaning that the likelihood of stressor exposure is high. Larvae

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Surf smelt	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	of both species disperse in nearshore waters for early rearing. These beach-spawning species depend on a narrow range of substrate conditions for suitable spawning habitat, increasing sensitivity to hydraulic and geomorphic effects. Planktonic larvae are also dependent on nearshore current and circulation patterns for rearing survival. Planktonic life-history stages are also incapable of escaping acute water quality impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pacific herring	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	Pacific herring are common throughout the inland marine waters of Washington, particularly in protected bays and shorelines used for spawning. This species is dependent on nearshore habitats for spawning, egg incubation, and larval rearing, meaning that the likelihood of stressor exposure from hydraulic/geomorphic and aquatic vegetation modifications is high. Planktonic larvae disperse in nearshore waters for early rearing and are dependent on current and circulation patterns for survival, growth, and fitness. Planktonic life-history stages are also incapable of escaping acute water quality impacts. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Lingcod	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	Larval lingcod settle in nearshore habitats for juvenile rearing, favoring habitats with freshwater inflow and reduced salinities, and are potentially exposed to water quality related impact mechanisms from groins and bank barbs. Adults may occur anywhere from the intertidal zone to depths of approximately 1,560 ft (475 m), but are most prominent between 330 and 500 ft (100 and 150 m) and, therefore, have less exposure potential. Temporary disturbance while brooding may increase risk of egg predation. Larvae disperse and settle in nearshore waters for early rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction impacts and longer term impacts from hydraulic and geomorphic modifications, as well as other changes in habitat complexity. Changes in wave energy, current, and circulation patterns may adversely affect larval settlement in areas favorable for development. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pacific hake	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	Hake, cod, and pollock spawn in nearshore areas and estuaries, and their planktonic larvae settle in nearshore areas for rearing. Larval Pacific cod settle in nearshore areas associated with eelgrass. Larval pollock settle in nearshore areas at depths as shallow as 33 ft (10 m) for juvenile rearing and are commonly associated with eelgrass algae. As such, spawning adults, eggs, larvae, and juveniles may experience stressor exposure. Larvae disperse and settle in nearshore waters for early rearing, and are dependent on current, wave, and circulation patterns to ensure dispersal to environments favorable for rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction impacts and longer term impacts from hydraulic and geomorphic modifications, as well as other changes in habitat complexity. Changes in wave energy, current, and circulation patterns may adversely affect larval settlement in areas favorable for development. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Pacific cod	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Walleye pollock	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Brown rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	Rockfish are ovoviviparous species that release their planktonic larvae in open water, depending on favorable currents and circulation patterns to carry them into nearshore habitats where they settle for rearing as demersal juveniles. Many species remain in the vicinity of the nearshore environment as they grow into adulthood. As such, rockfish can experience stressor exposure across all life-history stages. Juveniles disperse and settle in nearshore waters for early rearing and are dependent on current, wave, and circulation patterns to ensure dispersal to environments favorable for rearing. Because they are demersal and relatively immobile, larvae are vulnerable to short-term construction impacts and longer term impacts from hydraulic and geomorphic modifications, as well as other changes in habitat complexity. Changes in wave energy, current, and circulation patterns may adversely affect larval settlement in areas favorable for development. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Copper rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Greenstriped rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Widow rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Yellowtail rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Quillback rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Black rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
China rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Tiger rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Bocaccio rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Canary rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	

Species	Construction & Maintenance Activities			Hydraulic and Geomorphic Modifications			Riparian Vegetation Modifications			Aquatic Vegetation Modifications			Water Quality Modifications			Ecosystem Fragmentation			Comments
	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	Riverine	Marine	Lacustrine	
Redstripe rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Yelloweye rockfish	N	H	N	N	H	N	N	L	N	N	H	N	N	H	N	N	H	N	
Olympia oyster	N	H	N	N	H	N	N	L	N	N	I	N	N	H	N	N	I	N	This species occurs commonly in shallow water nearshore habitats. This distribution increases risk of stressor exposure and potential for take resulting from water quality modification in the nearshore environment. Because this species is sessile during much of its life history, it is vulnerable to both short-term construction-related impacts, as well as modification of hydraulic and geomorphic conditions in the nearshore environment. Modification of current, wave, and circulation patterns may also affect larval settlement, influencing survival during this life-history stage. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Northern abalone	N	H	N	N	H	N	N	L	N	N	I	N	N	H	N	N	I	N	While increasingly rare due to depressed population status, this species occurs commonly in nearshore habitats less than 33 ft (10 m) in depth. Because this species has low mobility, it is more sensitive to a variety of impact mechanisms potentially resulting from development associated with groins and bank barbs, including construction and water quality effects. Being planktonic spawners, this species' spawning productivity is dependent on current and circulation patterns. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Newcomb's littorine snail	N	H	N	N	H	N	N	H	N	N	N	N	N	L	N	N	?	N	The Newcomb's littorine snail inhabits *Salicornia* marshes on the littoral fringe. It is intolerant of extended submergence in both fresh and marine water; as such, it not a true aquatic species and the potential for exposure to most stressors from groin or bank barb related impact mechanisms is minimal. Exceptions include alteration of riparian vegetation affecting this vegetation community in the direct footprint of these structures, as well as hydraulic and geomorphic modifications. Life-history stages exposed to construction activities face a high risk of take (from direct mortality or injury), while the effects of the structure on the environment are likely to result in a moderate to low risk of take.
Giant Columbia River limpet	H	N	N	H	M	N	L	N	N	L	N	N	H	N	N	?	N	N	The Columbia River spire snail is typically found in smaller streams in water less than 5 inches deep, environments unsuitable for development of groins and bank barbs. The giant Columbia River limpet is known to occur in the Hanford Reach of the Columbia River and other moderate to large river environments in the state, typically in shallow, flowing water environments with cobble and boulder substrates. These environments are suitable for groin or bank barb development so there is a risk of stressor exposure. These species are dependent on flowing water and therefore will not experience stressor exposure from related impact mechanisms in lacustrine environments. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take.
Great Columbia River spire snail	H	N	N	H	N	N	L	N	N	L	N	N	H	N	N	?	N	N	
California floater (mussel)	H	N	H	H	M	H	L	N	L	L	N	L	H	N	H	H	N	H	The western ridged mussel is predominantly found in the larger tributaries of the Columbia and Snake rivers and the mainstems of these systems. The California floater occurs in shallow muddy or sandy habitats in larger rivers, reservoirs, and lakes. As such, both species may occur in habitats potentially suitable for groin or bank barb development and have potential for stressor exposure from all related impact mechanisms. Life-history stages exposed to construction activities face a high risk of take, while the effects of the structure on the environment are likely to result in a moderate risk of take. Habitat accessibility modifications will not directly affect this species; however, indirect effects could occur through direct effects on host-fish. This equates to a moderate risk of take.
Western ridged mussel	H	N	N	H	M	N	L	N	N	L	N	N	H	N	N	H	N	N	

Risk of Take Ratings: **H** = High, **M** = Moderate; **L** = Low; **I** = Insignificant or Discountable; **N**= No Risk of Take; **?** = Unknown Risk of Take.
Shaded cells indicate environment types in which the species in question does not occur; therefore, there is no risk of take from the impact mechanism in question.

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