N A T U R A L   R E S O U R C E S

Aquatic Resources Program
Habitat Conservation Plan

Covered Species Technical Paper

August 2007

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Doug Sutherland - Commissioner of Public Lands

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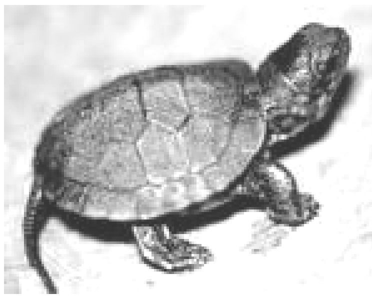

Washington Fish and Wildlife

US Fish and Wildlife Service

Olympic National Sanctuary

Aquatic Resources Program
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1. Introduction

The purpose of this document is to organize information concerning species occurring on state-owned aquatic lands that are considered Endangered, Threatened, of Concern or rare. The document is one of several technical papers developed to assist the Washington State Department of Natural Resources (Washington DNR) Aquatic Resources Program in its development of a Habitat Conservation Plan for state-owned aquatic lands. It Manage habitat in a way that contributes to reducing the risk of species extinction and that contributes to species recovery.

- Protect the long-term interest of the public and state as landowner.
- Minimize state's financial and legal liability.

Additional documents include:

- Potential Covered Activities Technical Paper - Identifies Washington DNR management activities that may cause take of covered species (Washington DNR 2005a).
- Covered Habitat Technical Paper - Identifies the location being evaluated and describes baseline habitat conditions (Washington DNR 2005b).
- Potential Effects and Expected Outcomes Technical Paper - Describes and quantifies the direct and indirect effects of potentially Covered Activities on Covered species and Habitats (Washington DNR 2007).

1-1 Overview of species considered and species categories

1-1.1 DESCRIPTION OF COVERED, EVALUATION, AND WATCH LIST CATEGORIES

When considering species to include in the HCP, Washington DNR followed guidance provided by the ESA and the Services (US Fish and Wildlife Service and NOAA Fisheries 1996), which state that the primary "trigger" for needing an incidental take permit (Section 10(a) of ESA) is whether a species is federally Threatened or Endangered. The Services also encourage the inclusion of unlisted species (proposed and candidate species as a minimum) that are likely to be listed within the foreseeable future or within the life of the permit in order to provide more planning certainty to the permittee in the face of future species listings; and to increase the biological value of the

plan through comprehensive multi-species or ecosystem planning that is proactive in the consideration of the needs of unlisted species.

To determine which species would benefit from multi-species planning and inclusion in a HCP for state-owned aquatic lands, species were assigned to the following three categories:

Covered Species

- Species with 1) sufficient biological information (enough habitat, distribution, status or conservation potential to provide adequate conservation planning) and 2) where conservation measures exist (practical and effective measures that have demonstrated effectiveness to sustain or recover a population) or 3) species for which conservation measures can be easily defined and implemented to support an application for Section 10(a) Incidental Take Permits.

- Species that may not have a great deal of information available for conservation planning (e.g. habitat, distribution, status or conservation potential), but have a close habitat association to other Covered Species and would therefore, benefit sufficiently to support application for a Section 10(a) Permit.

- Species whose listing appears imminent unless conservation measures are instituted that would likely assure their survival and recovery.

Evaluation Species

- Species that require additional information to provide adequate conservation planning or whose conservation measures are not easily defined to support application for a Section 10(a) Permit. As adequate information and corresponding conservation measures are developed related to an Evaluation Species, amendments to the HCP and Incidental Take Permit can be submitted for inclusion into the list of Covered Species.

Watch List Species

- Species that are not considered to be at risk during the ESA planning horizon or do not have adequate information regarding habitat, distribution, status or conservation potential.

Only those species ranked as Covered in the potential effects analysis (Washington DNR 2007) are recommended for inclusion in the HCP and Incidental Take Permit. Evaluation and Watch List Species did not receive recommendations for inclusion because it is either unlikely that the species will be listed in the foreseeable future; that Washington DNR authorized activities have the potential to affect the species; and/or insufficient information exists to assess potential effects and develop conservation measures.

1-1.2 SELECTION OF SPECIES CONSIDERED

The overall strategy for selecting species to consider for inclusion in the HCP was to be all-inclusive of those organisms that could potentially benefit from conservation planning by Washington DNR on state-owned aquatic lands. Categorization was then adjusted throughout the selection process as information on the species, its habitat use, and the potential for interaction with activities authorized by Washington DNR was developed. Conservative assumptions that were inclusive with respect to species habitat use and the potential for activity interactions were used both in selecting species to be considered and in the assignment to initial coverage categories. For example, if existing information about habitat use for a particular life-stage of a species was inconclusive and there was a remote chance that they could have an interaction with activities authorized by Washington DNR, they were put in a category that allowed for additional investigation (Covered or Evaluation Species). Species were moved to more appropriate categories when more in-depth information indicated the species did not meet the initial categorization criteria.

What follows is a more detailed description of the steps and tasks in this iterative process.

Step 1: Preliminary Species List, Categorization and Screening

The first step in developing the preliminary species list was to develop a comprehensive list of potential species (Endangered, Threatened, of Concern, or rare) for inclusion in the species categorization process. The following information was used by Washington DNR to define a preliminary list of approximately 86 “target” species. Details of the species selection chronology is provided in Appendix A.

- Federal, state and Natural Heritage designations.
- Assessment of the probability of Federal listing.
- Occurrence in the planning area.
- Dependence on submerged habitat.
- Vulnerability to activities authorized by Washington DNR.
- Covered in existing HCPs or Recovery Plans.
- Ecosystems utilized and habitat preferences.
- Known threats.
- Informal review and discussion with NOAA Fisheries and US Fish and Wildlife.

A consultant team was brought into the project to do an independent review of the preliminary Washington DNR list and provide assistance in developing a method for gathering additional information and categorizing the species. The consultant team developed more detailed information related to species interaction with, and vulnerability to, activities authorized by Washington DNR; defined appropriate life stages for each species; and examined potential activity categories for interactions (yes/no), as well as a level of confidence for the potential interaction (low/medium/high). The matrix and information regarding potential for interaction is provided in Appendix B.

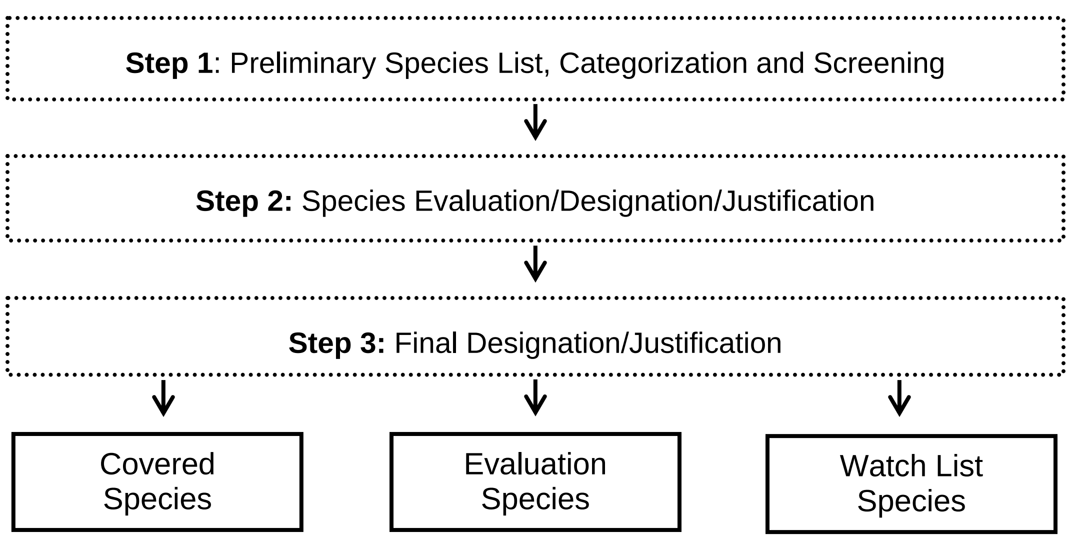
The consultant team then employed a decision matrix for determining preliminary designation of species to be considered for inclusion in the HCP. Table 1.1 is a summary of the preliminary selection criteria used in the matrix and shows that there are two general areas of criteria – the current listing status of the species, and the potential for Washington DNR authorized activities to affect the species. Much of the information developed in Tasks 1 and 2 were applied in the independent preliminary selection criteria (Figure 1.1). Preliminary selection criteria included:

- Species status - current protection status under ESA,
- Species of Concern status (including state-listed),
- Designation as imperiled (state or global),
- Potential interaction with Washington DNR authorized activities, and
- Potential effect of Washington DNR authorized activities.

Table 1.1 - Decision matrix for determining preliminary coverage designation.

Preliminary selection criteria	**Species status – Level that federal ESA protection is warranted**			
Potential affect	**Currently Listed**	**Species of Concern**	**Designated Imperiled**	**Not Designated**
High	Covered Species	Covered Species	Evaluation Species	Evaluation Species
Medium	Evaluation Species	Evaluation Species	Evaluation Species	Watch List Species
Low	Evaluation Species	Evaluation Species	Watch List Species	Watch List Species

Figure 1.1 - Decision process for preliminary designation of species to be considered.



The consultant team gathered information for those factors influencing the continued existence of each species designated as Covered or Evaluation Species in the initial categorization. The focus of information for each species is summarized below:

- Species status,
- Species range,
- Habitat use,
- Population trends,
- Threats warranting ESA listing,
- Potential effect from Washington DNR authorized activities, and
- Justification and recommendation for species designation.

Species distribution data for the state of Washington was also acquired (Appendix C), with the distribution reviewed by independent experts and adjusted if necessary. For those species for which observational data was missing or incomplete, predicted distribution was determined by using habitat type as a surrogate for distribution throughout a species known range. This method provided a conservative estimate of species distribution. In all cases, the best available science was used in determining species distribution.

Following the compilation of distribution data, Washington DNR and the consultant team reviewed and adjusted the initial species designations (Appendix D).

Step 3: Final Designation/Justification

The final recommendations for Covered Species (Table 1.2) was based on the species lifestage and life history information, spatial distribution data, and the result of the Potential Effects Analysis described in the Potential Effects and Expected Outcomes Technical Paper (Washington DNR 2007).

Table 1.2 - Final Covered Species list.

Species			Listing Status	
Group	**Common Name**	***Scientific Name***	**Federal**	**State**
Amphibians & Reptiles	Columbia spotted frog	*Rana luteiventris*	Not listed	Candidate
	Northern leopard frog	*Rana pipiens*	Not listed	Endangered
	Western toad	*Bufo boreas*	Not listed	Candidate
	Western pond turtle	*Clemmys marmorata*	Species of Concern	Endangered
Birds	Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened
	Black tern	*Chlidonias niger*	Species of Concern	Monitored

Species			Listing Status	
Group	**Common Name**	***Scientific Name***	**Federal**	**State**
	California brown pelican	*Pelecanus occidentalis*	Endangered	Endangered
	Common loon	*Gavia immer*	Not listed	Candidate
	Harlequin duck	*Histrionicus histrionicus*	Not listed	Species of Concern
	Marbled murrelet	*Brachyramphus marmoratus*	Threatened	Threatened
	Western snowy plover	*Charadrius alexandrinus nivosus*	Threatened	Endangered
Fish	Bull trout/Dolly Varden	*Salvelinus confluentus*	Threatened	Candidate
	Chinook salmon	*Oncorhynchus tschwytscha*	Endangered/Threatened	Candidate
	Chum salmon	*Onchorhynchus keta*	Threatened	Candidate
	Coastal cutthroat trout	*Oncorhynchus clarki clarki*	Species of Concern	None
	Coho salmon	*Oncorhynchus kisutch*	Concern/Candidate	Not Listed
	Pink salmon	*Oncorhynchus gorbuscha*	Not Listed	Not listed
	Sockeye/Kokanee salmon	*Onchorhynchus nerka*	Endangered/Threatened	Candidate
	Steelhead	*Onchorhynchus mykiss*	Threatened	Candidate
	Green sturgeon	*Acipenser medirostris*	Endangered	Not Listed
	White sturgeon	*Acipenser transmontanus*	Not Listed	Not Listed
Marine Mammal	Southern resident killer whale	*Orcinus orca*	Endangered	Endangered

1-2 References

US Fish and Wildlife Service and NOAA Fisheries. 1996. Habitat Conservation Planning and Incidental Take Permit Processing Handbook.

Washington State Department of Natural Resources. 2005b. Aquatic Resources Program Endangered Species Act Compliance Project, Covered Habitat Technical Paper. Olympia, WA.

Washington State Department of Natural Resources. 2005a. Aquatic Resources Program Endangered Species Act Compliance Project, Potential Covered Activities Technical Paper. Olympia, WA.

Washington State Department of Natural Resources. 2007. Aquatic Resources Program Endangered Species Act Compliance Project, Potential Effects ad Expected Outcomes Technical Paper. Olympia, WA.

2. Covered Species

Covered Species are those species that are proposed for inclusion in Washington DNR's Aquatic Lands HCP. The list includes Threatened or Endangered species, as well as unlisted species that either have similar life histories and habitat requirements to Covered Species, or were determined to have a high likelihood of being listed during the course of a HCP. Covered Species have sufficient biological information (e.g., habitat, distribution, status or conservation potential) to support conservation planning; existing conservation measures that are practical and have demonstrated effectiveness; or they are species for which conservation measures can be easily defined and implemented to support an application for Section 10(a) Incidental Take Permits.

2-1 Amphibians and Reptile

2-1.1 Columbia spotted frog (*Rana luteiventris*)

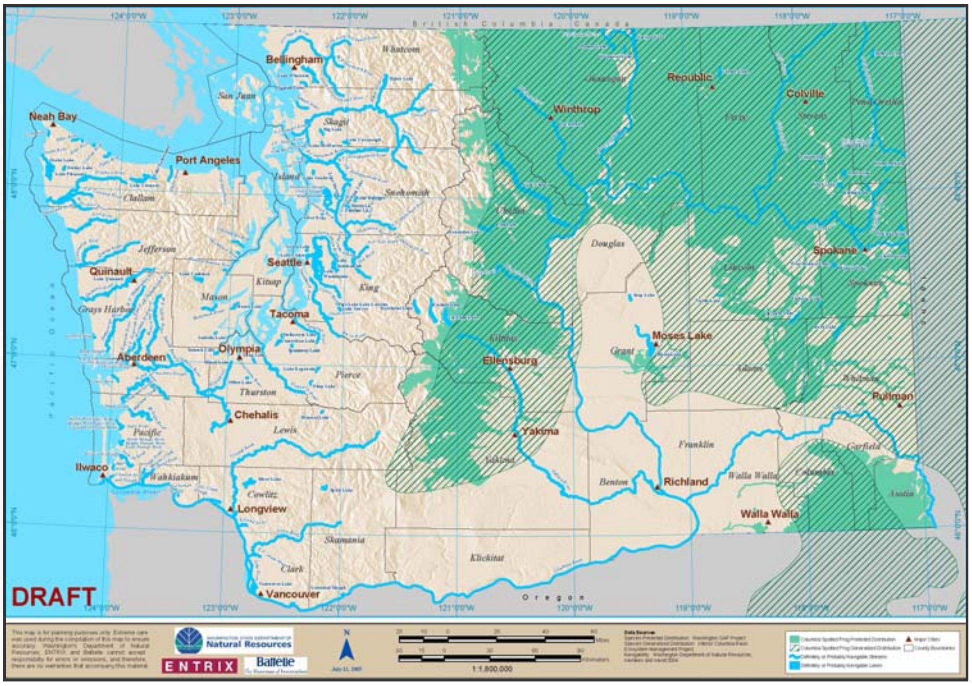
STATUS AND RANK

Entity	Status/Rank
Federal Government	Candidate Species
Washington State	Candidate Species
Natural Heritage Program	G4; S4

RANGE

The historic range of the Columbia spotted frog extends from southern Alaska through British Columbia and western Alberta to Washington, Oregon, Nevada and Utah (Stebbins 1985). Physiographic provinces occupied by this species in Washington include the Okanogan Highlands, the Columbia Basin, and the eastern side of the Cascade Mountains. While populations in the Columbia Basin are small and scattered, this frog is common in the northern and eastern portions of its range in Washington (Hallock and McAllister 2005) (Figure 2.1).

Figure 2.1 – Distribution of the Columbia spotted frog.



HABITAT USE

The Columbia spotted frog is a highly aquatic species that is primarily found in the marshy edges of ponds and lakes, stream pools and other wetlands at elevations from 300 to 2,500 meters (Nussbaum et al.1983; O'Neill et al. 2001; Pilliod et al. 2002). These habitats encompass riverine, palustrine, and lacustrine wetlands, as well as nearshore areas of lakes and rivers.

Adults

Columbia spotted frogs range in size from 5 to 10 centimeters in length and reach sexual maturity between 2 to 6 years of age (NatureServe 2005). The species has a maximum life span of 10 years (B. C. Frogwatch 2001) and is usually found near permanent water (Nussbaum et al. 1983; Stebbins 1985; O'Neill et al. 2001; NatureServe 2005). Adults may move overland between ephemeral and permanent water sources (O'Neill et al. 2001), sometimes covering long distances (Stebbins 1985), with research in Idaho indicating that females move farther from breeding habitats (up to 1,030 meters) than males (less than 200 meters (Pilliod et al. 2002). This frog feeds on insects, mollusks, crustaceans, and spiders (Nussbaum et al.1983; O'Neill et al. 2001).

Spawning, Incubation and Tadpoles

Spawning and incubation occur in the shallow waters of most aquatic habitats occupied by the species, although only slow-moving reaches of riverine habitat are used for this purpose (Nussbaum et al. 1983; O'Neill et al. 2001). Spawning is temperature dependent and generally occurs from March through June (Hallock and McAllister 2005) with egg

masses deposited as free floating clusters (NatureServe 2005). Tadpoles feed on algae and other vegetation, organic debris, and zooplankton (O'Neill et al. 2001). While most tadpoles metamorphose after two to three months, northerly populations or those at higher elevations may overwinter and metamorphose the following year (O'Neill et al. 2001).

Overwintering

This frog hibernates after burrowing into mud at the bottom of ponds and lakes (O'Neill et al. 2001; Pilliod et al. 2002).

POPULATION TRENDS

The Columbia spotted frog is reported to be stable in most of its range (NatureServe 2005). In Washington the frogs are considered a Candidate Species and are monitored due both to population declines in other states and declines in populations of the closely related Oregon spotted frog (Hallock and McAllister 2005).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

The primary threats to this species are the result of changes to hydrology and water quality from anthropomorphic activities, along with fragmentation of wetlands (Hallock and McAllister 2005; Code of Federal Regulations 2004). The Great Basin Distinct Population Segment (southwestern Idaho and eastern Oregon) is a federal Candidate taxon (Code of Federal Regulations 2004).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Over-utilization has not been identified as a major threat to this species.

Disease or Predation

Predation by bullfrogs and non-native fish is a potential threat to this species (Hallock and McAllister 2005). While the extent to which diseases contribute to declines is currently not known, a number of parasites (*Aeromonas hydrophila*, *Ribeiroia ondatrae*, *Batrachochytrium dendrobatidis* and *Saprolegnia ferax*) have been observed in declining amphibian populations in western states (NatureServe 2005).

Adequacy of Existing Regulatory Mechanisms

Because the extent of population declines is uncertain, it is not possible to determine whether regulatory mechanisms are adequate.

Other Factors Affecting Continued Existence

Beaver removal from within the range of the Columbia spotted frog may be detrimental because beaver contribute to the maintenance of wetland conditions important for this frog (Hallock and McAllister 2005). While the depletion of stratospheric ozone and an accompanying increase in ultra-violet B radiation (UVB, wavelength 290 to 320

nanometers) at the earth's surface have been postulated as possible threats to all life stages of amphibians, research has yielded mixed results (Blaustein et al. 1997; Pakhala et al. 2001; Corn and Muths 2002; Diamond et al. 2004).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Because Columbia spotted frogs are closely associated with aquatic habitats, both adults and tadpoles have the potential to be impacted by activities authorized on state-owned aquatic lands. In addition to impacts associated with the construction and maintenance of nearshore structures such as bridges, roads and docks, this species may be affected by localized reductions in water quality from outfalls; loss of habitat from filling of shallow-water areas and armoring; and reductions in vegetated habitat for tadpoles due to increased shading or trampling during construction and maintenance of overwater structures and recreational activities.

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2-1.2 Northern leopard frog (*Rana pipiens*)

STATUS AND RANK

Entity	Status/Rank
Federal Government	Species of Concern
Washington State	Endangered
Natural Heritage Program	G5; S1

RANGE

The northern leopard frog is widely distributed across North America with its historic range extending from Hudson Bay and the Great Slave Lake in Canada, south to Virginia, Nebraska, New Mexico and Arizona. Its east-west extent is from New England to the eastern edges of Washington, Oregon and California, as well as the Central Valley of California (Stebbins 1985; Zeiner et al. 1988).

In Washington, the leopard frog historically occurred in both the Columbia Basin and Okanogan Highlands physiographic provinces. This frog has been reported from the Pend Oreille River, the Potholes Reservoir, and Alder Creek (Klickitat County), as well as the Columbia, Snake, Spokane, and Walla Walla Rivers. While the full elevational range occupied by this species is sea level to 1,457 meters, in Washington it is generally found from 82 meters to 415 meters (O'Neil et al. 2001).

This species has been reported in at least one state-owned river (the Pend Oreille) in the last five years, although this is listed as an unconfirmed sighting. Reports of this frog in the vicinity of Moses Lake in Grant County were on tributary streams and associated wetlands or ponds (Figure 2.2).

Figure 2.2 – Distribution of the northern leopard frog.

HABITAT USE

The northern leopard frog is found in a variety of aquatic habitats, including creeks, rivers, ponds, lakes and marshes from sea level to high into the mountains (Nussbaum et al.1983; Stebbins 1985; Hallock and McAllister 2005). These habitats encompass riverine, palustrine and lacustrine freshwater wetlands, as well as the nearshore areas of lakes and rivers. In Washington, leopard frogs were historically found in valleys at elevations up to 610 meters (McAllister et al. 1999; O'Neil et al. 2001), with most occurrences in the shrub-steppe zones (Hallock and McAllister 2005). Waterbodies occupied by this frog may be situated in grassland, scrubland or forests (Stebbins 1985).

Adults

Northern leopard frogs grow to 5 to 10 centimeters in length and have a maximum life span of approximately 4 years, becoming sexually mature at 2 to 3 years of age (B. C. Frogwatch 2001; NatureServe 2005). While the species is dependent on vegetation as refugia from predators (McAllister et al. 1999), they range widely in a variety of habitats including wet meadows, grassy woodlands, and hay fields (Nussbaum et al.1983; Stebbins 1985). Although little is known about overland movements in Washington (Hallock and McAllister 2005), these frogs migrate to and from breeding ponds (O'Neil et al. 2001), as well as overwintering waterbodies (McAllister et al. 1999). Adults of this species are entirely carnivorous regularly feeding on beetles, flies, ants, Odonata, grasshoppers, and spiders, as well as small vertebrates such as birds, snakes and other frogs (Nussbaum et al. 1983; O'Neil et al. 2001). Young frogs remain at the water's margin, possibly to segregate from larger frogs (McAllister et al.1999).

Spawning, Incubation and Tadpoles

Northern leopard frogs spawn from April through June in shallow water emergent or submerged vegetation (O'Neil et al. 2001), with suitable habitat including cattail and sedge marshes and weedy ponds (Nussbaum et al.1983; Zeiner et al. 1988). Egg masses are usually laid in water at depths of less than 65 centimeters (26 inches) in areas exposed to sunlight (McAllister et al.1999) and are generally attached to emergent vegetation (Zeiner et al.1988; McAllister et al. 1999). Leopard frog tadpoles are grazers, developing in shallow nearshore waters (Zeiner et al.1988; McAllister et al.1999), with metamorphosis completed in the summer of the first year (Hallock and McAllister 2005). After metamorphose, young frogs may emigrate from their natal ponds to more permanent waters such as a lake or stream (McAllister et al. 1999).

A set of seven important breeding pond characteristics was defined in a study in Wisconsin. These seven characteristics are: "...1) less than 1.6 kilometers from overwintering sites; 2) 1.5 meters or more deep; 3) emergent vegetation on approximately two-thirds of the circumference of a pond to provide escape from predators; submergent vegetation on approximately half of the surface area to provide cover for escape, a site for attachment of egg masses, and a source of food for tadpoles; 4) a gradual slope to the bottom, which provides a greater area of emergent vegetation, and in turn more cover; 5) open water that is exposed, which will warm ponds faster; 6) areas surrounding the ponds in hay, unmowed pasture, shallow marshes or meadows; and 7) ponds that maintain water most years but dry up periodically and eliminate fish" (McAllister et al. 1999).

Overwintering

Although not all populations of northern leopard frogs hibernate, their activity levels are much reduced during colder weather. Leopard frogs usually overwinter underwater among stones, sunken logs or leaf litter along the bottom of ponds, lakes and streams (McAllister et al.1999; Hallock and McAllister 2005).

POPULATION TRENDS

Although the northern leopard frog is one of the most widely distributed amphibians in North America, recent declines in its populations have been reported throughout its range, including the Pacific Northwest. Museum records for Washington indicate that the leopard frog inhabited at least eighteen general areas in eastern Washington, with many of these areas along the Columbia River and its major tributaries. Since 1992, field surveys have confirmed the presence of this species only in two areas in the state, both of which are in the Crab Creek drainage in Grant County. An additional population on the campus of Washington State University may still be active, although these have probably been liberated from laboratory experiments (McAllister et al.1999).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

The only extant populations in Washington inhabit relatively small areas in a single region, where they are vulnerable to habitat modification (McAllister et al.1999).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Although this species is collected for teaching, research, bait and as human food (Alberta, Naturally 1997), overutilization has not been identified as a major threat in Washington.

Disease or Predation

In addition to being vulnerable to predation by exotic species such as bullfrogs and carp (Hallock and McAllister 2005), leopard frogs may also be negatively impacted by competition with bullfrogs for food and other resources (Witmer and Lewis 2001) Various diseases and parasites (*Aeromonas hydrophila, Ribeiroia ondatrae, Batrachochytrium dendrobatidis and Saprolegnia ferax*) have been observed in declining high-elevation amphibian populations in other states (NatureServe 2005), and bacteria were associated with die-offs of leopard frogs in the Midwest, Canada and Mexico in the 1970s. However, these bacteria have also been found in healthy frogs and neither disease nor predation has been identified as a contributing factor to declines in northern leopard frog populations in Washington (McAllister et al. 1999).

Adequacy of Existing Regulatory Mechanisms

Inadequacy of regulatory mechanisms has not been identified as a major threat.

Other Factors Affecting Continued Existence

Additional threats to the northern leopard frog in Washington include the adverse effects of fertilizers and pesticides (Hallock and McAllister 2005) associated with agricultural areas and pesticides used for mosquito control (Kaufman et al. 2001). If roads are built between breeding ponds and other habitats, large numbers of leopard frogs may be killed by vehicles during migration from breeding to summer and overwintering sites (Merrell 1977). While the depletion of stratospheric ozone and an accompanying increase in ultra-violet B radiation (UVB, wavelength 290 to 320 nanometers) at the earth's surface have been postulated as possible threats to all life stages of amphibians, research has yielded mixed results (Blaustein et al. 1997; Pakhala et al. 2001; Corn and Muths 2002; Diamond et al. 2004).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

In addition to impacts associated with the construction and maintenance of nearshore structures such as bridges, roads and docks, northern leopard frogs may be affected by localized reductions in water quality from outfalls; loss of habitat from filling of shallow-water areas and armoring; and reductions in vegetated habitat for spawning and tadpoles due to increased shading or trampling during construction and maintenance of overwater structures and recreational activities

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2-1.3 Western toad (*Bufo boreas)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	G4; S3

RANGE

The historic range of the western toad extends from southern Alaska through the western United States and Canada into Baja California (Stebbins 1985; O'Neil et al. 2001). The extent of the species east-west range was, and still appears to be, from the Pacific coast to the Rocky Mountains (Stebbins 1985), although the species is currently absent from the Willamette Valley (Nussbaum et al. 1983). In Washington, the western toad historically occurred throughout most of the state, except for the south-central Columbia Basin (Figure 2.3).

HABITAT USE

The western toad is found from sea level to elevations as high as 2,255 meters in the mountains (Stebbins 1985; Martin 2001). Habitats used by this species include many aquatic habitats, grasslands, mountain meadows, woodlands, and forests with loose soils (Nussbaum et al. 1983; Stebbins 1985). This toad is also found in urban habitats, particularly in low-density zones with irrigated landscaping (Ferguson et al. 2001).

Adults

Adult western toads reach lengths of 5 to 14 centimeters and live to be about 10 years of age, with sexual maturity occurring at 2 to 3 years (B. C. Frogwatch 2001). When not breeding, this species is found primarily in terrestrial habitats, including grasslands, scrublands, woodlands, forests, and mountain meadows (Nussbaum et al. 1983; Stebbins 1985; Vander Haegen et al. 2001). Although little appears to be known about the extent of the species movements, females have been observed to move up to 2,600 meters from breeding sites, with the documented movements for males shorter (O'Neill et al. 2001). This toad feeds primarily on insects, but also eats spiders, centipedes, sowbugs, crayfish, and earthworms (Nussbaum et al. 1983; O'Neill et al. 2001). Western toads are

dependent on loose soils for protection from both predators and dehydration, and have also been known to use the burrows of other animals for protection (Vander Haegen et al. 2001).

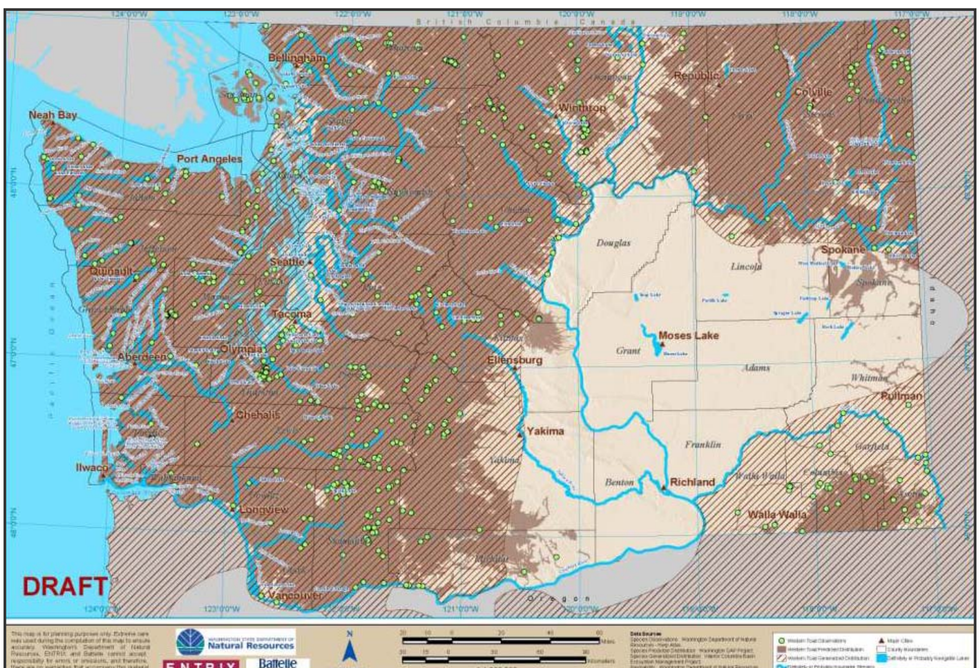
Spawning, Incubation, and Tadpoles

In Washington, spawning and incubation occur in almost any standing water (Zeiner et al. 1988) from February through July in Washington (O'Neill et al. 2001). Strings of eggs are attached to submerged and emergent vegetation (O'Neill et al. 2001) or laid on the sediments directly (Hallock and McAllister 2005) in shallow ponds, lakes, slow-moving reaches of streams, springs, reservoirs, stock ponds, canals, and roadside ditches (Nussbaum et al. 1983; Stebbins 1985; Zeiner et al. 1988). Tadpoles feed on algae and detritus (Nussbaum et al. 1983; O'Neill et al. 2001), undergoing metamorphose during their first summer.

Overwintering

Hibernation typically occurs from November through April, but the extent varies with location and temperature (O'Neill et al. 2001). While some of these toads have been observed to hibernate in terrestrial locations (Nussbaum et al. 1983), little information is available in the general literature regarding western toad hibernation.

Figure 2.3 – Distribution of the western toad



POPULATION TRENDS

Western toad populations are declining in western Washington. Insufficient information exists to evaluate the trend in eastern Washington (O'Neill et al. 2001).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Due to habitat conversion to agricultural, industrial, or other high-density urban use in low-elevation areas of Washington, the range of the western toad has been significantly reduced (Martin 2001). In addition, habitat fragmentation resulting from urban/suburban development has isolated wetlands and riparian habitats from western toad terrestrial habitat, further impacting the species (Ferguson et al. 2001).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Overutilization has not been identified as a major threat to this species.

Disease or Predation

Ravens preying on breeding adults appears to have contributed to the decline of the western toad at certain locations in Oregon (NatureServe 2005). Various diseases and parasites (*Aeromonas hydrophila*, *Ribeiroia ondatrae*, *Batrachochytrium dendrobatidis, Saprolegnia ferax*) have been observed in declining western toad populations in other states (NatureServe 2005) . However, the extent to which diseases contribute to declines is not currently known.

Adequacy of Existing Regulatory Mechanisms

Because the reasons for the decline of the western toad are not fully understood (Sallabanks et al. 2001), existing regulatory mechanisms may be inadequate to reduce further declines.

Other Factors Affecting Continued Existence

While the depletion of stratospheric ozone and an accompanying increase in ultra-violet B radiation (UVB, wavelength 290 to 320 nanometers) at the earth's surface have been postulated as possible threats to all life stages of amphibians, research has yielded mixed results (Blaustein et al. 1997; Pakhala et al. 2001; Corn and Muths 2002; Diamond et al. 2004).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Because adult western toads are primarily terrestrial, potential impacts to this species from activities authorized by Washington DNR are likely restricted to breeding habitats. In addition to impacts associated with the construction and maintenance of nearshore structures such as bridges, roads and docks, this species may be affected by localized reductions in water quality from outfalls; loss of habitat from filling of shallow-water

areas and armoring; reductions in vegetated habitat for tadpoles due to increased shading or trampling during construction and maintenance of overwater structures and recreational activities; habitat fragmentation from barriers such as roads and bridges; and alteration of seasonal inundation regimes as a result of stormwater discharges and/or increases in impervious surfaces.

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2-1.4 Western pond turtle (*Clemmys marmorata (Emys marmorata)*)

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Species of Concern
Washington State	Endangered
Natural Heritage Program	G3, G4; S1

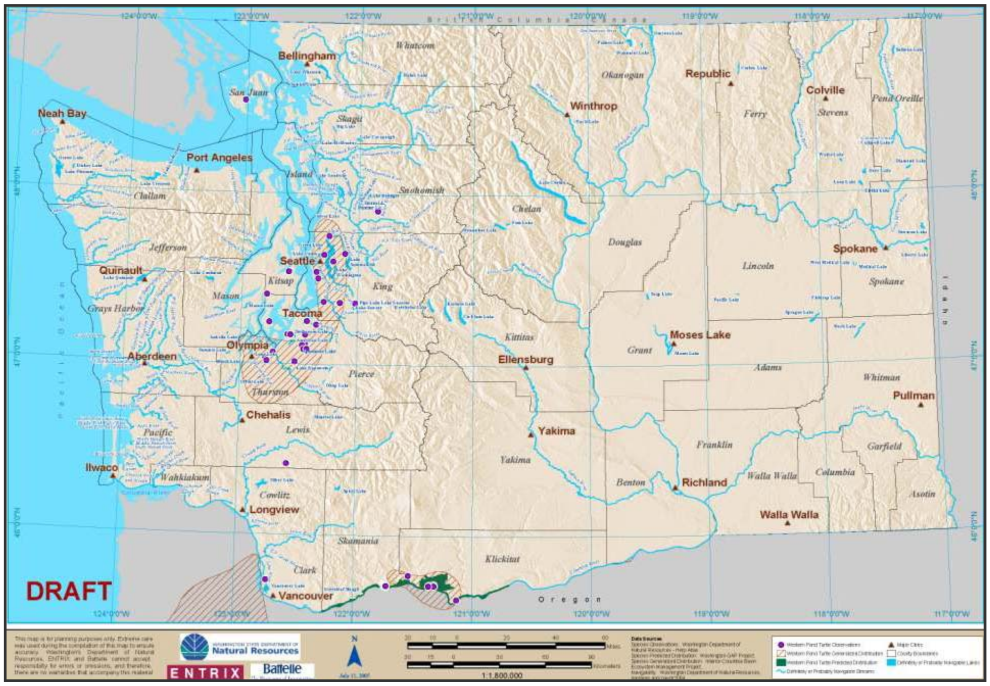
RANGE

The historic range of the western pond turtle extended from Puget Sound south along the Pacific Coast to Baja California (Hays et al.1999), with disjunct populations on the Carson and Truckee Rivers in western Nevada and along the Mojave River in southern California (Holland 1991). Specimens from populations in British Columbia and Idaho (Stebbins 1985) may represent introductions or may be mislabeled (Holland 1991).

Within Washington, pond turtles occurred in the Puget Trough Physiographic Province and in the Columbia River Gorge from sea level up to elevations near 300 meters (Hays et al.1999; Hallock and McAllister 2002), although they occupy higher elevations elsewhere in their range.

Of the four existing Washington populations, two occur naturally in ponds, lakes and small tributaries to the Columbia River in Skamania and Klickitat Counties (Hays et al.1991). The remaining two populations are captive-reared stock released by Washington State Department of Fish and Wildlife (Washington Fish and Wildlife) in the Columbia Gorge and man-made ponds in Pierce County (Hallock and McAllister 2002). These ponds are on lands owned by Washington Fish and Wildlife (Hays et al. 1991). Figure 2.4 shows the distribution of pond turtles in Washington.

Figure 2.4 – Distribution of the western pond turtle.



HABITAT USE

This highly aquatic turtle occurs in riverine, palustrine, and lacustrine habitats, frequenting streams, ponds, lakes and both permanent and ephemeral wetlands (Nussbaum et al. 1983; Stebbins 1985). The species will migrate overland, and may aestivate (a state of dormancy, which slows the metabolism to help conserve water during hot or dry periods) on land during summer months (O'Neil et al. 1983). Because they are cold blooded, pond turtles utilize floating vegetation, cattail mats, logs, rocks, mud flats, and sandbanks for basking (Hays et al. 1999). When the pond turtle occupies large rivers, it is usually found near the banks or in adjacent backwater habitats, where the current is relatively slow and emergent basking sites are abundant (Stebbins 1985; Hays et al. 1999).

A variety of substrates are found in the habitat range used by western pond turtles, including solid rock, boulders, cobbles, gravel, sand, mud, decaying vegetation, and combinations of these (Stebbins 1985; Hays et al. 1999). Vegetative cover used by pond turtles ranges from areas with little or no emergent vegetation to abundant emergent vegetation; sites with no emergent vegetation and abundant submerged vegetation; and disturbed habitats where large mats of algae are the only aquatic vegetation present. Areas with dense shade generally lack basking sites and are unsuitable habitat for pond turtles (Hays et al. 1999).

Nesting

Western pond turtles reach reproductive maturity at over 10 years of age or at a carapace length of 135 to 140 mm (Washington Fish and Wildlife 2005). They nest from May to mid-July, with females burying their eggs in soils with little or no vegetative covering

(Nussbaum et al. 1983; Stebbins 1985; Hays et al. 1999; O'Neil et al. 2001). These turtles usually nest within 100 meters of water, but occasionally will nest up to 400 meters from water (Nussbaum et al. 1983; Hays et al. 1999). In Washington, incubation times are between 90 and 130 days with gender determined by temperature. Western pond turtles have an estimated lifespan of between 50 and 70 years (Washington Fish and Wildlife 2005).

Foraging

Western pond turtles forage in or under water and cannot swallow food without being in water (O'Neil et al. 2001). They are opportunistic feeders, eating of invertebrates (insects, earthworms, mollusks, crayfish), vertebrates (fish, tadpoles, amphibians) and carrion (small mammals, birds, amphibians, reptiles) (Nussbaum et al. 1983; O'Neil et al. 2001).

Overwintering

In Washington, this species overwinters in muddy bottoms of lakes or ponds or in upland habitats adjacent to water bodies (Nussbaum et al. 1983; Hays et al. 1999). Observation of juveniles in one study suggests they overwinter in the water (Hays et al. 1999).

POPULATION TRENDS

Although the western pond turtle used to occur throughout the southern Puget Sound lowlands, only two natural populations remain in Washington. Both of these populations are in the Columbia Gorge (Burke 2004). The western pond turtle is declining throughout its range (Hays et al. 1999).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Alteration and degradation of critical features of aquatic or terrestrial habitats is a major threat to this species. Loss of nests to human activities is an additional major threat to this species (Hallock and McAllister 2002).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Removal from the wild by humans is a major threat to this species (Hallock and McAllister 2002). While commercial exploitation for food may be the cause for the initial decline of western pond turtle populations in Washington, there are currently no known scientific or educational uses for the species.

Disease or Predation

Loss of hatchlings to introduced bullfrogs, loss of nests to predators, and disease and competition from introduced turtles are among the threats to this species (Hallock and McAllister 2002). While information concerning the threat of disease is lacking, in 1990 an unknown disease killed approximately 1/3 of the population in Klickitat County (Washington Fish and Wildlife 2005).

Adequacy of Existing Regulatory Mechanisms

Inadequacy of regulatory mechanisms has not been identified as a major threat to the western pond turtle in Washington.

Other Factors Affecting Continued Existence

No other manmade factors have been identified as a major threat to this species.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Outfalls and discharges associated with wastewater treatment, industrial processes or fish hatcheries may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality and increased potential for the bioaccumulation of pollutants. Roadways, bridges, and docks may result in habitat loss during construction, while stormwater runoff from the structures may increase temperatures as well as concentrations of heavy metals, salts and petroleum products in both the sediments and water column. Additionally, nearshore and transportation related activities (e.g., fill and bank armoring, sediment disturbance, utility line construction) might alter shallow-water lake and stream tributary habitats.

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2-2 Birds

2-2.1 Bald eagle (*Haliaeetus leucocephalus*)

STATUS AND RANK

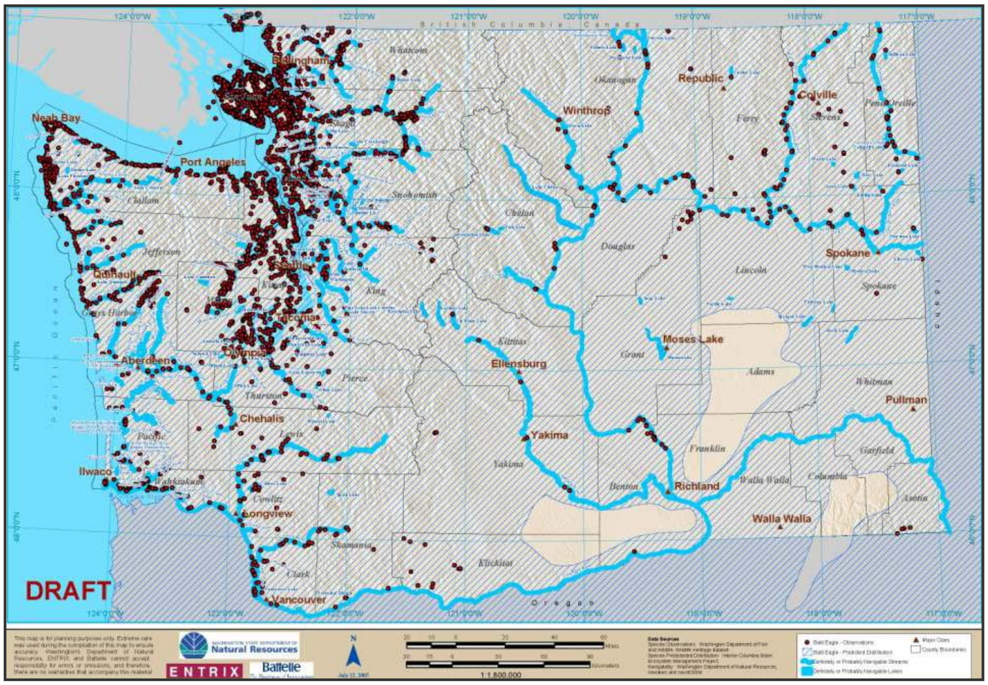
Entity	Status/Rank
US Fish and Wildlife Service	Delisted
Washington State	Delisted
Natural Heritage Program	G5; S4B, S4N

RANGE

Bald eagles are well distributed throughout almost all of North America. They exist in virtually the entire continental United States, including Alaska, Canadian provinces and the northwestern portion of Mexico (Johnsgard 1990). They nest in prominent places overlooking or near water bodies. They are most frequent in winter near coasts or the Mississippi River, and may be locally abundant to prey upon plentiful fish and/or waterfowl.

Nesting bald eagles are much more abundant along the Puget Sound, in coastal areas and the Columbia River estuary than elsewhere in western Washington. In eastern Washington, bald eagle nests are more likely to occur along northeastern waterways (Stinson et al. 2001), although a few widely scattered nests have been recorded on the east slope of the Cascade Mountains and in the Hanford Reach of the Columbia River (Stinson et al. 2001) (Figure 2.5). During winter, eagles generally become less abundant in maritime environments and may become locally abundant throughout the state near substantial salmon spawning areas and winter waterfowl concentrations (Fielder and Starkey 1987; Dunwiddie and Kuntz 2001; Stinson et al. 2001).

Figure 2.5 – Distribution of the bald eagle.



HABITAT USE

Bald eagles nest near large water bodies edged with mature forest (Livingston et al. 1990). They defend territories greater than 10 kilometers^2 that support healthy fish populations and are variably intolerant of disturbance (Johnsgard 1990).

Nesting

In western Washington, breeding home ranges encompass an aquatic foraging area centered around a mature or old growth forest stand within 1.6 kilometers of open water and containing one or more trees large enough to support a nest (Garrett et al. 1993; Livingston et al. 1990; Stinson et al. 2001). Home ranges average 6.8 square kilometers (range 0.7 to 79.9 square kilometers), and include foraging and resting perches, as well as sentinel perches near nests and foraging areas (Watson and Pierce 1998). Foraging for mostly birds and fish occurs in lakes, rivers, bays and marine areas (Watson and Pierce 1998). Adults mature at 5 years of age, lay one to two eggs per clutch, and may survive beyond 20 years of age (Buehler 2000). Nest success can vary widely (Buehler 2000).

Migration

Most bald eagles nesting around Puget Sound leave the state in late summer and migrate northward into British Columbia, Canada and as far as southeast Alaska to take advantage of abundant salmon spawning runs, waterfowl concentrations or large mammal carrion (Watson and Pierce 1998). Eagles typically returned to Washington during fall/early winter to reestablish breeding home range boundaries (Watson and Pierce 1998).

Wintering

Bald eagles congregate near abundant food sources during winter; with roost and perch locations within sight of important food sources (Anthony et al. 1983; Garrett et al. 1993). Large trees with minimal disturbance adjacent to open water with abundant fish and waterfowl are often utilized, and foraging is often from riverbanks and prominent nearby perches. Rivers that support substantial spawning salmon often attract wintering bald eagles (Dunwiddie and Kuntz 2001; Fielder and Starkey 1987).

POPULATION TRENDS

Bald eagle populations declined drastically during the 1950s mainly due to organochlorine pesticide (dichlorodiphenyltrichloroethane, or DDT) use. In 1973, populations in the southern United States were listed as Endangered, followed by the listing of the entire population in all 48 contiguous states except for Washington, Oregon, Minnesota, Wisconsin and Michigan in 1976. Populations began to recover following the nationwide ban of DDT use in 1972. The number of bald eagles wintering in eastern Washington climbed from 115 in 1974 to 1975, to a high of 235 in 1980 to 1981 (Fielder and Starkey 1987). Productivity increased throughout the 1980s and 1990s, and the population virtually doubled every 7 to 8 years (64 Code of Federal Regulations Part 128, 1999). The bald eagle was reclassified from federally Endangered to Threatened in 1995 (60 Code of Federal Regulations Paet 133, 1995) and is currently under review for delisting (64 Code of Federal Regulations Part 128, 1999).

Statewide nesting surveys were conducted in Washington from 1980 to 1998. During this time, the population increased about 10 percent annually, reaching a peak of 664 pairs (Stinson et al. 2001). Statewide carrying capacity was estimated at 733 pairs, and the decreasing trend in territory occupancy rates may indicate the population is approaching carrying capacity (Stinson et al. 2001).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Bald eagles are sensitive to human disturbance, and the effects of disturbance have influenced habitat utilization. Boating, aircraft, recreation and logging activity have been documented as influencing bald eagle behavior, distribution, abundance and habitat use (McGarigal et al. 1991; Skagen et al. 1991; Brown and Stevens 1997; Grubb and Bowerman 1997; Gende et al. 1998; Wood 1999; Rodgers and Schwikert 2003). Nest density also decreases with proximity to clearcut logging (Anthony and Isaacs 1989; Gende et al. 1998).

Human presence related to residential development of shoreline habitat has been a great source of disturbance to nesting bald eagles in western Washington, and pedestrian activity near an active bald eagle nest was noted as the only disturbance that resulted in eagles flushing from the nest (Watson et al. 1999). In studies by Anthony et al. (1983) and Garrett et al. (1993), suitable roosts and perches near commercial, residential and industrial areas were avoided by wintering and breeding bald eagles.

Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes

The bald eagle is a national symbol, and utilization of eagles is highly regulated and not known to currently pose a threat to eagle populations. There are no known commercial, recreational, scientific, or educational uses for bald eagles.

Disease or Predation

Disease and predation are not known to be threats to bald eagle populations.

Adequacy of Existing Regulatory Mechanisms

The bald eagle is afforded protection under the Migratory Bird Treaty Act, the Bald Eagle Protection Act and its current Threatened status under the Endangered Species Act. Additionally, Washington bald eagle protection rules require an agreement between landowners and Washington Fish and Wildlife to protect eagle habitat (Stinson et al. 2001). However, this protection is only afforded to occupied habitat. Two thirds of Washington bald eagles nest on private land, and only 10 percent of these are secure without further protection (Stinson et al. 2001), indicating existing regulatory mechanisms may be inadequate for long-term eagle population viability.

Other Factors Affecting Continued Existence

Bioaccumulation of environmental contaminants contributed significantly to the population declines that lead to the initial listing of the bald eagle, and this threat continues to effect populations. Elevated dioxins (tetrachlorodibenzo-p-dioxin, or TCDDs), polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), organochlorine, pesticides and mercury found in young and eggs have been linked to depressed productivity (Elliot et al. 1996; Anthony et al. 1993; Elliot and Norstrom 1998; Donaldson et al. 1999). Residual DDT, dichlorodiphenyldichloroethylene (DDE) and PCBs were linked to thin eggshells in the Columbia River estuary (Anthony et al. 1993) and nest failure in New Jersey (Clark et al. 1998).

Bald eagles are also dependent on locally abundant food sources during fall and winter and as a result their distribution and production has been highly influenced by the availability of fish (Watson et al. 1991; Willson and Halupka 1995; Watson and Pierce 1997). In winter, Skagit River bald eagle distribution has been linked to the run size of spawning chum salmon (*Oncorhynchus keta*) (Dunwiddie and Kuntz 2001; Watson and Pierce 2001) and it is believed that prey abundance may be a limiting factor in bald eagle productivity in Hood Canal (Watson and Pierce 1998).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Bald eagles are likely to be affected by several activities authorized by Washington DNR on state-owned aquatic lands. Roadways, bridges and docks could reduce foraging habitat and disturb roosting or nesting populations. Stormwater runoff from these structures may increase concentrations of pesticides, fertilizers, heavy metals, salts and petroleum products in the sediments and water column, which directly impacts prey

species of bald eagles. Outfalls and discharges associated with aquaculture and industry may cause localized reduction of water quality, which adversely affects the forage fish that comprise much of the bald eagle's diet. Construction and operation of harbors, ports, shipyards, marinas and petroleum and ferry terminals could cause habitat reduction and degradation and increased disturbance, particularly with nesting. These activities could also cause an increased risk of exposure to spilled oil and fuel, which would affect bald eagle survival.

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2-2.2 Black tern (*Chlidonias niger)*

STATUS AND RANK

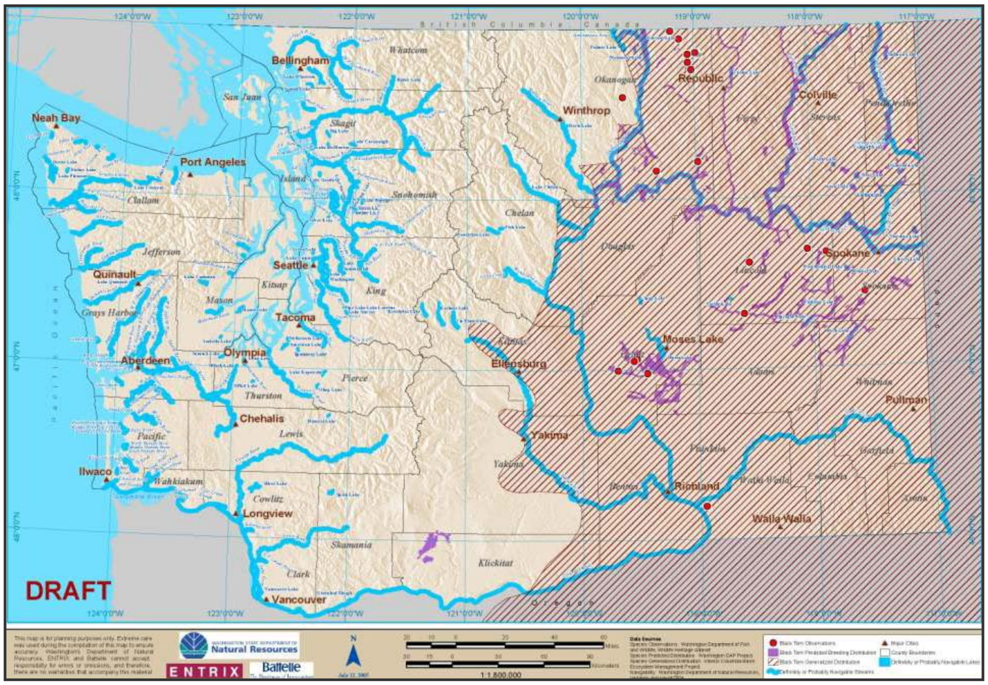
Entity	Status/Rank
US Fish and Wildlife Service	Not Listed
Washington State	Monitored
Natural Heritage Program	G4; S4B, S2N

RANGE

The breeding range for black terns in North America extends from the northern U.S. through central Canada (Dunn and Agro 1995), with breeding populations concentrated in productive wetlands in the prairies of Alberta, Saskatchewan, Manitoba, the Dakotas and Minnesota (Dunn and Agro 1995).

Within Washington State, the birds breed primarily on the east slope of the Cascade Mountains within the Okanogan, Columbia Plateau, Canadian Rockies and Blue Mountains ecoregions (Smith et al. 1997) (Figure 2.6). Black terns winter in marine and marine coastal areas of Central America and northern South America on both the Pacific and Caribbean sides (Dunn and Agro 1995). They leave their nest marshes in early August and aggregate on wetland feeding sites for several weeks. Breeders return to the U.S. and Canada by mid-May. Although flocks can reach tens of thousands, migration usually occurs in small flocks and primarily across inland routes (Dunn and Agro 1995).

Figure 2.6 – Distribution of the black tern.



HABITAT USE

Black terns have a life span of approximately 8 years and reach sexual maturity during their second summer.

Nesting

Semicolonial nests (typically 11 to 50 nests) are constructed on floating substrates in shallow freshwater marshes with emergent vegetation including prairie sloughs, lake margins and occasionally river or island edges. Most nests are on semi-permanent ponds. Nesting marshes across North America (usually 20 hectares) are in open or forested lands up to 1,540 meters elevation (Smith et al. 1997; Dunn and Agro 1995). In northeastern Washington, black terns nest in major river valleys and suitable habitats up to 914 meters in elevation (US Fish and Wildlife 1999). In Washington, eggs are typically laid from May to June. Average clutch size is 2.6 (n=2297) (Dunn and Agro 1995). Hatching occurs from late June to late July with most young fledging from mid-July to late August (Dunn and Agro 1995). Nesting adults forage on insects and small freshwater fish (2.5 to 3.0 centimeters). The proportions of insects to fish in the diet vary with availability (Dunn and Agro 1995).

Migration

During fall and spring migration to and from wintering habitats in Central and South America and breeding habitats in North America, black terns use freshwater lakes, rivers and interior wetlands in the U.S. Although they may concentrate in areas with swarming insects, the relative proportion of insects and fish in their diet highly is variable (Dunn and Agro 1995).

POPULATION TRENDS

The North American Breeding Bird Survey index indicates that throughout its range, nesting black tern populations have followed a continual decreasing trend from the 1960s to the 1990s, which has reduced the total population by 67 percent (Peterjohn and Sauer 1997; Dunn and Agro 1995). A strong positive association between black tern nests and the abundance of ponds in the northern Great Plains indicates that the availability of suitable nesting habitats may have influenced recent population trends (US Fish and Wildlife 1999).

Insufficient information exists to discern trends for the Washington breeding black tern population. Numbers of black terns nesting in the Columbia Basin appeared to decline when invasive plants choked out native emergent vegetation, but then increased in response to vegetation removal (US Fish and Wildlife 1999). Numbers of nesting black terns in Washington increased from the late 1970s to the mid 1990s, following the end of an extended drought (US Fish and Wildlife 1999).

THREATS WARRANTING ESA PROTECTION

Threats to black terns presented below are summarized from Dunn and Agro (1995) and US Fish and Wildlife (1999).

Destruction, Modification, or Curtailment of Habitat or Range

Threats include the loss or degradation of wetlands used for breeding and migration as a result of drainage for agriculture and urban/suburban development. The invasive species purple loosestrife (*Lythrum salicaria*) chokes out native emergent vegetation and can form stands too dense for black tern nesting. Pesticides and piscicides used in agricultural, horticultural, or invasive species control impact insects and fish prey items that are important food sources during nesting and migration.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for black terns.

Disease or Predation

Black terns are susceptible to botulism and internal parasites, but these apparently do not cause significant mortality. Nest predation may limit reproductive success with known predators including: great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), great horned owl (*Bubo virginianus*), mink (*Mustela vision*) and Norway rat (*Rattus norvegicus*). Other potential predators include the common raven (*Corvus corax*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethica*) and long-tailed weasel (*Mustela freneta*).

Adequacy of Existing Regulatory Mechanisms

Current regulations appear to be adequate for the protection of black terns during the breeding period. Wetland nesting habitats have provided some protection by Section 404 of the Clean Water Act, although these regulations will not prevent all wetland losses.

The Wetland Reserve Program offers incentives for the conservation of breeding habitat by providing permanent wetland easements. Current regulations are inadequate for the protection of black terns on their winter range.

Other Factors Affecting Continued Existence

Other natural or manmade factors affecting the continued existence of black terns may include: the periodic decline of the pelagic fish forage base in wintering areas compounded by subsequent overharvest; isolation and fragmentation of nesting and migration habitats due to agriculture or development; and, collisions with power lines, towers and wind turbines during migration. In addition, breeding populations are impacted by human recreational activities such as swimming, fishing, birding, boating or canoeing.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Black tern breeding relies upon freshwater marshes, which may be altered by a number of activities authorized by Washington DNR. Transportation projects such as roadways, bridges, and docks may result in habitat loss during construction, while stormwater runoff from the structures may increase concentrations of heavy metals, salts and petroleum products in wetlands that are known to degrade habitat. Invasive species control projects may disturb nesting behavior and alter utilized habitat. Navigation improvements involving dredging, filling or other alteration of wetlands may result in increased sedimentation and/or the direct loss of organisms and habitat. Sewage or other wastewater outfalls may cause localized reductions in water quality resulting in increased turbidity, eutrophication, decreased habitat quality, and the potential disturbance of nesting colonies.

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2-2.3 Brown pelican (*Pelecanus occidentalis*)

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Endangered
Washington State	Endangered
Natural Heritage Program	G4; S3N

RANGE

There are six recognized subspecies of brown pelican (US Fish and Wildlife 2005a) that collectively range from North America south to Mexico, the West Indies and Caribbean, into to Guyana and Venezuela (Shields 1987) in South America (US Fish and Wildlife 2005b). Three subspecies occur in the United States, with the Caribbean brown pelican (*P. o. occidentalis*) found only in Puerto Rico and the United States Virgin Islands. The eastern brown pelican (*P. o. carolinensis*) occurs from along the Atlantic coast to Florida, Alabama, Louisiana, Mississippi, Texas and in the Barrier Islands (US Fish and Wildlife 2005c), with the California brown pelican occurring in California, Oregon and Washington (US Fish and Wildlife 2005a).

In Washington, the California brown pelican is currently fairly common to locally abundant as a nonbreeding summer and fall visitor on the ocean coast, but is rare in winter and spring (Wahl et al. In Press). The species is very rare in freshwater systems and in the estuaries north and south of the Tacoma Narrows (Wahl et al. In Press). Grays Harbor and Willapa Bay are important roosting areas, with East Sand Island in the Columbia River a more recent roosting site. Most reports are from the Strait of Juan de Fuca south to Point No Point, and less frequently in the San Juan Islands, the southern portion of Georgia Strait, Port Susan and the Central Basin off Seattle. Figure 2.7 illustrates the distribution of brown pelicans in Washington.

HABITAT USE

California brown pelicans breed and nest in colonies on islands in the Gulf of California and along the outer coast from Baja California to West Anacapa and the Santa Barbara Islands in Southern California. Adults typically mature at 3 to 5 years of age and lay three eggs annually during their 4 to 7 year reproductive span (Shields 2002). Fledging rates are around one per nest but vary with food availability (Shields 2002).

Foraging

Nonbreeding California brown pelicans range northward along the Pacific Coast from the Gulf of California to Washington and southern British Columbia (US Fish and Wildlife 2005b). The species forages mainly on surface-schooling fish (Washington Fish and Wildlife 2005) in shallow estuarine and inshore waters, mostly within 10 kilometers (6 miles) of the coast and less often up to 64 kilometers (40 miles) from shore (US Fish and Wildlife 2005d). More than 97 percent of the 32,533 birds surveyed at Grays Harbor from 1971 to 2000 were in the channel or in littoral waters offshore (Wahl et al. In Press).

Roosting

Roosting and loafing sites provide important resting habitat for breeding and nonbreeding California brown pelicans. Important roosting sites include offshore rocks and islands, river mouths with sandbars, breakwaters, pilings and jetties along the Pacific Coast and San Francisco Bay (US Fish and Wildlife 2005b).

Figure 2.7 – Distribution of the brown pelican.

POPULATION TRENDS

The North American Breeding Bird Survey (BBS) index indicates increasing numbers over the whole United States; increasing but highly variable numbers in the Western BBS region and in the Pacific Northwest; and highly variable yet slightly increasing numbers in Oregon and California (Sauer et al. 2004).

Changes in abundance of several marine species off the west coast in the early 1990s were associated with changes in ocean productivity. Record numbers of brown pelicans appeared in the fall of 1997, with more than 300 birds occurring along the Strait of Juan de Fuca and 90 birds estimated in Hood Canal and from Puget Sound south to Olympia. There was one record of California brown pelican occurrence in eastern Washington in October 1997 (Wahl et al. In Press).

Grays Harbor surveys from 1971 to 2000 only recorded single birds in 1977 and 1982, but during the El Niño event of 1983, hundreds came north from California. Numbers were similar for several years, dramatically increased in 1989, and remained at variably high levels through 1998. It was estimated that up to 7,000 birds have occurred along the Washington-Oregon coast in late summer since 1985, and shore counts in the early 1990s peaked at 1,000 birds each in Grays Harbor and Willapa Bay. The most important roost north of California from 1987 to 1997 was in Willapa Bay, where an average 2,178 birds were present during aerial surveys. Birds commuted between there and Grays Harbor, where Whitcomb Island was another important roost prior to channel-dredging and its subsequent disappearance in the 1990s. In 1999, up to 6,000 birds roosted on a sand island in Willapa Bay. Erosion and disturbance there resulted in relocation to surrounding estuaries, with more than 9,000 present at East Sand Island in the Columbia River in 2002 (Wahl et al. In Press).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

The present destruction, modification or curtailment of habitat or range by humans was not identified by the US Fish and Wildlife as being an issue for the California subspecies of the brown pelican (US Fish and Wildlife 1983; 2005a). As with other seabird populations, brown pelicans may be susceptible to human-induced catastrophic events such as oil spills (Anderson et al. 1996). Reproductive success may also be affected by natural catastrophes (e.g., landslides or fires). While this may be a limiting factor in isolated, local situations it is probably of little consequence to long-term population trends (US Fish and Wildlife 1983).

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Brown pelicans are not used for commercial or recreational activities. If scientific or educational use does occur, it is highly regulated.

Disease or Predation

Disease outbreaks (King et al. 1977; Dyer et al. 2002; Norcross and Bolen 2002) in California brown pelicans may result from overcrowding in harbors (US Fish and Wildlife 1983; 2005a). Disease and predation may be limiting factors in isolated, local situations but probably are of little consequence to long-term population trends (US Fish and Wildlife 1983).

Adequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms was not identified by the US Fish and Wildlife as being an issue for the California brown pelican (US Fish and Wildlife 1983; 2005a).

Other Factors Affecting Continued Existence

There are three types of manmade and natural factors that could affect the continued existence of the California brown pelican: pollution (US Fish and Wildlife 1983; 2005a),

human disturbance (US Fish and Wildlife 1983) and weather (US Fish and Wildlife 1983; 2005).

The brown pelican was listed as Endangered in 1970 because of widespread pollutant-related reproductive failures (50 Code of Federal Regulations Part 17, 1970). They are extremely sensitive to bioaccumulation of the pesticide dichlorodiphenyltrichloroethane (DDT), which causes reproductive failure by altering calcium metabolism and thinning eggshells (Jehl 1973). In 1985, brown pelican populations on the Atlantic Coast had recovered enough that they could be removed from the Endangered species list (50 Code of Federal Regulations Part 17, 1985). Although California breeding populations have rebounded since the elimination of DDT use (Anderson and Gress 1983), persistent residues in the coastal environment continue to cause chronic reproductive problems (US Fish and Wildlife 1983, 2005a; Carter et al. 2005) and some California brown pelicans still show relatively high levels of pesticides in their tissues (US Fish and Wildlife 2005a). The California brown pelican is also Threatened by the possibility of oil spills from tanker traffic in the Santa Barbara Channel (Anderson et al. 1996; Carter et al. 2005; US Fish and Wildlife 1983 and 2005).

Breeding populations of the California brown pelican are Threatened by human disturbance in the form of recreation (including fishermen, birders, photographers, educational groups) and military and civilian aircraft noise (US Fish and Wildlife 1983). Human disturbance has been identified as a problem at post-breeding roosts on the central California coast, along with entanglement in hooks and fishing line (US Fish and Wildlife 2005a). Human disturbance may be a limiting factor in isolated, local situations but probably is of little consequence to long-term population trends (US Fish and Wildlife 1983).

California breeding populations and nest productivity may vary dramatically from year to year depending on El Niño events and other climatic changes (US Fish and Wildlife 2005a), and may also be affected by severe storms (US Fish and Wildlife 1983). Weather may be a limiting factor in isolated situations but probably is of little consequence to long-term population trends (US Fish and Wildlife 1983).

California brown pelicans are dependent on northern anchovies (US Fish and Wildlife 1983; 2005a; Washington Fish and Wildlife 2005) and Pacific sardines (US Fish and Wildlife 2005a), both of which have declined (US Fish and Wildlife 2005a). Since about 1974, food availability (Carter 2005) has become the most important limiting factor influencing pelican breeding success (US Fish and Wildlife 1983). However, it is not clear that food availability in nonbreeding resident populations, such as those that occur in the Pacific Northwest, is a limiting factor for the California subspecies (US Fish and Wildlife 1983; 2005a).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

California brown pelicans are likely to be affected by activities authorized by Washington DNR on state-owned aquatic lands. Overwater structures, such as log booms/rafts and docks/wharves may reduce foraging areas. Stormwater runoff may increase concentrations of pesticides, fertilizers, heavy metals, salts and petroleum products in the water column, which directly impacts prey species of the California brown pelican.

Outfalls and discharges associated with aquaculture and industry may cause localized reduction of water quality, which adversely affects forage fish that comprise a large part of the brown pelican's diet. Construction and operation of harbors, ports, shipyards, marinas, petroleum and ferry terminals could increase the risk of exposure to spilled oil and fuel, which could affect brown pelican survival.

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2-2.4 Common loon (*Gavia immer)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Sensitive
Natural Heritage Program	G5; S2B, S4N

RANGE

The breeding range for the common loon extends from Alaska south into Washington and eastward throughout Canada (McIntyre and Barr 1997). The species winters in Pacific coastal waters from the western Aleutian Islands south to Colima, Mexico and from Newfoundland south to Florida and across the Gulf Coast to Veracruz, Mexico (McIntyre and Barr 1997).

Within Washington, common loons nest on lakes and reservoirs in the Okanogan, North Cascades, East Cascades, and Puget Trough ecoregions, while non-nesting birds may be found during the summer throughout the state north of latitude 46º 30'N (Richardson et al. 2000) (Figure 2.8). Their winter distribution includes coastal and inland marine waters in the Northwest Cascade and Puget Trough ecoregions, with a few birds found on interior reservoirs, rivers and lakes (Richardson et al. 2000).

Figure 2.8 – Distribution of the common loon.

HABITAT USE

Common loons reach sexual maturity between 2 and 3 years of age, reaching up to 9 years in age.

Nesting

Common loons generally nest on clear, oligotrophic lakes with complex rocky shorelines, numerous bays, deep inlets, numerous islands, floating bogs and fish (McIntyre and Barr 1997). In Washington State, common loons have been recorded nesting on lakes and reservoirs ranging from less than 1 to 32 square kilometers and 3 to 91 meters deep. Preferred nesting sites are on island or shoreline edges within 1.5 meters of water, sheltered from winds, and positioned to allow a view of the pairs' territory. Nesting sites usually include screening vegetation (McIntyre and Barr 1997). Common loons often nest on small islands or floating bog mats, but these birds will also use mainland shorelines (Richardson et al. 2000). The species breeds in the summer, with females laying 1 to 3 eggs each year and chicks hatching within 29 days on average. Non-nesting or failed nesting loons are also found within similar habitats during the summer throughout the state north of latitude 46º 30'N (Richardson et al. 2000). Common loons forage primarily on fish between 10 and 70 grams in size, other aquatic vertebrates, some invertebrates and occasionally vegetation (McIntyre and Barr 1997).

Migration

Prior to their migration during April and again in late October to early December, this species aggregates on low-gradient valley rivers and in littoral or limnetic zones of larger lakes and reservoirs. These staging areas are concentrated in habitats that combine abundant food with shelter from wind-generated waves (McIntyre and Barr 1997).

Wintering

Common loons winter primarily inshore along coastal marine waters, over shoals and in sheltered bays, inlets and channels, with some individuals on fresh water lakes, reservoirs and low-gradient valley rivers. Winter distributions are variable but are related to the abundance of forage fish, stability of the forage base, protection from storm exposure, and turbidity (Spitzer 1995). Adults are flightless during a few weeks in mid-winter (February) and are therefore vulnerable to environmental disturbances (McIntyre and Barr 1997). In Washington, an estimated 2,890 ± 1,278 (95 percent confidence interval) use Puget Sound and the Strait of Juan de Fuca during winter (Richardson et al. 2000).

POPULATION TRENDS

The worldwide population of common loons is estimated at 500,000 to 700,000, with numbers decreasing across the southern portion of their range during the early to mid-twentieth century and increasing range wide from1969 to 1989 (McIntyre and Barr 1997).

Nest surveys in Washington State documented an average of 3 nests per year during the 1980s and 8 nests per year during the 1990s, but these surveys were not consistent or comprehensive (Richardson et al. 2000). Non-breeding common loons are known from over 140 different locations on lakes, reservoirs and rivers during the summer. Fourteen to 36 loons occurred in the Puget Sound area during July 1992 to 1998 (Richardson et al. 2000), roughly 10 percent of the winter population in Puget Sound. Surveys in Puget Sound indicate that the wintering population was in the low thousands based on counts of 100 to 200 birds/survey in the early 1990s, with an apparent unexplained increase to 375 to 500 birds/survey in the late 1990s (Richardson et al. 2000). Winter surveys in northwestern Washington indicate inconsistent population trends, illustrating either increasing trends of 43 to 64 percent or a decreasing trend of 17 percent from the late 1970s to the early 2000s (Bower 2003).

THREATS WARRANTING ESA PROTECTION

Threats to common loons presented below are summarized from McIntyre and Barr (1997), Richardson et al. (2000) and Lewis et al. (1999).

Destruction, Modification, or Curtailment of Habitat or Range

Such threats include the loss or degradation of the following: 1) lake or reservoir shoreline habitats for breeding; 2) coastal areas for wintering; 3) the degradation of nesting habitat due to lake and reservoir water level fluctuations; 4) the reduction or elimination of forage fish and invertebrates due to rotenone used in invasive species management; and 5) habitat degradation from oil and fuel spills in breeding or wintering habitats.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for common loons.

Disease or Predation

Diseases include avian botulism and fungal infections of the respiratory tract. Nest predation occurs in response to disturbance from boaters and fishermen. Predation from the introduction of, or increase in, nest predators such as crows and ravens, gulls, coyotes, raccoons, skunks, mink and weasels and bald eagles is a concern to common loon populations.

Adequacy of Existing Regulatory Mechanisms

Nest sites are subject to human disturbance from recreational activities and shoreline developments. Oil spills have contributed to mortality during the past 20 years, despite regulations, because common loon nesting habitats are not protected.

Other Factors Affecting Continued Existence

Common loons are at risk from entanglement or entrapment and drowning in fish gill nets, and the ingestion of toxicants–lead from fishing gear, mercury and organochlorines.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Common loons rely upon freshwater marshes, which may be altered by a number of activities authorized by Washington DNR. Transportation projects such as roadways, bridges, and docks may result in habitat loss during construction, while stormwater runoff from the structures may increase concentrations of heavy metals, salts and petroleum products in wetlands that are known to degrade habitat. Invasive species control projects may disturb nesting behavior and alter utilized habitat. Navigation improvements involving dredging, filling or other alteration of wetlands may result in increased sedimentation and/or the direct loss of organisms and habitat. Sewage or other wastewater outfalls may cause localized reductions in water quality resulting in increased turbidity, eutrophication, decreased habitat quality, and the potential disturbance of nesting.

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2-2.5 Harlequin duck (*Histrionicus histrionicus)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Not Listed
Natural Heritage Program	G4; S2B, S3N

RANGE

There are two separate breeding ranges for harlequin ducks in North America - western North America, from the Brooks Range in Alaska south to Oregon, and inland to Wyoming; and eastern North America, in Labrador, Newfoundland and Quebec. Wintering harlequin ducks use the Pacific coast from the Aleutian Islands in Alaska to Northern California and the Atlantic coast from Newfoundland south to Massachusetts.

Within Washington, an estimated 400 harlequin duck pairs nest on fast-flowing streams of inland watersheds or estuarine sites (Robertson and Goudie 1999) (Figure 2.9). Nesting birds are found throughout the Olympic and Cascade Ranges, the Pacific Northwest Coast and in northeastern Washington. Although there are questions surrounding the observances, they may also occur in the southeastern corner of Washington in the Blue Mountains ecoregion (Lewis and Kraege 2004). An estimated 3,000 harlequin ducks winter in northern Puget Sound, northern Hood Canal, the Strait of Juan de Fuca, San Juan Islands and along the outer coast (Robertson and Goudie 1999; Lewis and Kraege 2004). Many birds that nest in Washington, molt and winter in the Strait of Georgia, British Columbia, while some harlequins that molt and winter in Washington nest in interior British Columbia, Alberta, Idaho, Wyoming and Montana (Smith and Smith 2003; Lewis and Kraege 2004).

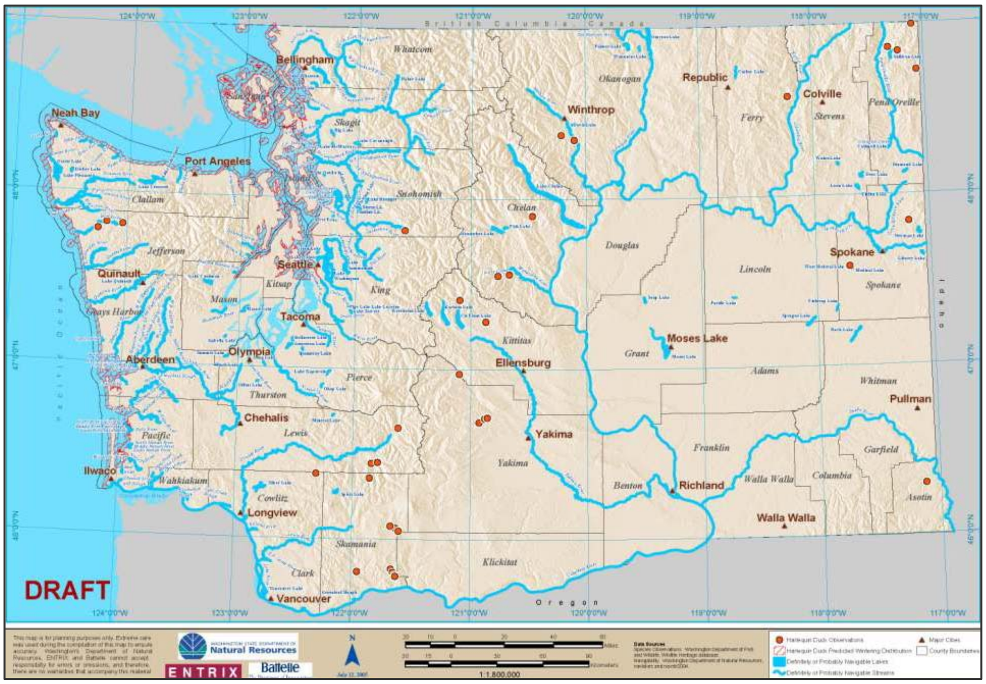
HABITAT USE

Nesting

Harlequin ducks have a life span of approximately 10 years (Robertson and Goudie 1999) and reach reproductive maturity at between the ages of 2 and 3 for females and males respectively. Females typically lay between 5 and 7 eggs in the spring and independently incubate them for 27 to 30 days (Seattle Audubon 2002). Harlequin ducks generally nest during mid April through August on the ground along fast-flowing streams in riparian, sub-alpine or coastal habitats with cobble to boulder size substrate and vegetated banks (Robertson and Goudie 1999; Lewis and Kraege 2004). Preferred habitat includes streams with low acidity, high invertebrate density, steep banks, vegetation cover along stream banks, with braided channels and small islands and gravel and sand bars (Robertson and Goudie 1999). Pairs may also use lakes, offshore islands and mainland

coasts, as well as nesting in tree cavities and cliff faces (Robertson and Goudie 1999). Within several weeks after hatch, hens with broods move to low-gradient streams with adequate supplies of aquatic insect larvae (Roberton and Goudie 1999, Lewis and Kraege 2004). Harlequin ducks are attracted to areas with high prey densities, such as lake outlets, and streams where trout, salmon and suckers lay eggs. They feed on larval and adult midges (Chironomidae), black flies (Simuliidae), caddis flies (Tricoptera), stone flies (Plecoptera), and mayflies (Ephemeroptera) and on fish roe (Robertson and Goudie 1999).

Figure 2.9 – Distribution of the harlequin duck.



Migration

Prior to spring migration (mid-March through May), many harlequin ducks aggregate at Pacific herring (*Clupea pallasi*) spawning locations (Vermeer et al. 1997), although it is unclear if these aggregations are pre-migratory staging or simply a response to an abundant food source. Harlequin ducks aggregate along banks or near gravel bars of low-gradient valley rivers before they move upstream to riffle-pool reaches to nest (Robertson and Goudie 1999). Fall migration occurs from late June through mid September.

Wintering

In Washington, harlequin ducks are found in shallow (1 meter) water usually over eelgrass (*Zostera* spp.) and kelp communities and occasionally over sandy beaches or mudflats. Winter distributions are variable but are related to the abundance of available intertidal and subtidal invertebrate forage species with crustaceans (*Hemigrapsus* and *Pagarus*), amphipods, isopods (*Idotea* spp.) and barnacles (*Balanus* spp.) as the most plentiful food items. This species will also forage on molluscs such as snails (*Lacuna*

spp.), periwinkles (*Littorina* spp), limpets (*Collisella* spp. and *Notocmaea* spp.), chitons (*Tonicella* spp. *Mopalia* spp.), blue mussel (*Mytilus edulis*) and fish such as small scuplins (Cottidae) and gunnels (Pholidae) (Gaines and Fitzner 1987, Vermeer 1983). Males and non-breeding females are flightless during late July to mid August and breeding females are flightless during September with some breeding females molting as late as October and early November (Robertson and Goudie 1999).

POPULATION TRENDS

In western North America, the upward estimate for the population of harlequin ducks, based on numbers wintering in the Strait of Georgia, Washington, Prince Williams Sound and the Aleutian Islands, Alaska is approximately 206,000 birds (Robertson and Goudie 1999). While wintering populations in the Strait of Georgia may have declined since 1994 (Robertson and Goudie 1999; Smith and Smith 2003), winter surveys in northwestern Washington indicate an increasing population trend from the late 1970s to the early 2000s (Bower 2003).

THREATS WARRANTING ESA PROTECTION

The threats to harlequin ducks presented below are summarized from Robertson and Goudie (1999) and Lewis and Kraege (2004).

Destruction, Modification, or Curtailment of Habitat or Range

Threats include: 1) the loss or degradation of stream habitats for breeding and coastal areas for molting and wintering; 2) degradation of nesting habitat due to logging and mining activities; 3) reduction of invertebrate forage in nesting habitats due to habitat degradation from altered stream flows and silt deposition; 4) reduction in invertebrate abundance in nesting habitats due to rotenone used in invasive species management; 5) disturbance in nesting and brood-rearing habitats from fishing, boating, rafting and research activities; 6) molting and wintering habitat degradation from shoreline development, aquaculture, algae-harvesting and oil and fuel spills; and 7) disturbance in molting and wintering habitats due to boat traffic.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

This species may be unsustainably harvested through sport or subsistence hunting.

Disease or Predation

Harlequin ducks are likely susceptible to diseases afflicting other sea ducks. Nest predation occurs, particularly in response to disturbance from boaters and fishermen. Predation occurs on adults, eggs and young, especially females and ducklings, by bald eagles (*Haliaeetus leucocephalus*), common ravens (*Corvus corax*), hawks (*Buteo* spp.), great horned owls (*Bubo virginianus*), river otters (*Lutra canadensis*), mink (*Mustela vision*) and martin (*Martes americana*).

Adequacy of Existing Regulatory Mechanisms

Harlequin duck nesting habitats are protected by their status as a Priority Habitat Species in Washington, but because females and young show fidelity to nesting sites, the species may not re-colonize restored habitats. Harlequin ducks consistently use the same molting locations, which may also be protected due to their Priority Habitat Species status. However, the location and level of use for molting areas may not be well described. Existing regulatory mechanisms may be inadequate to protect the species.

Other Factors Affecting Continued Existence

Other factors include ingestion of plastics; bioaccumulation of heavy metals and polycyclic aromatic hydrocarbons from creosote piers and/or diesel soot; contaminated food supplies leading to reduced survival and reproduction; and losses due to entanglement or entrapment and drowning in fish gill-nets.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Harlequin ducks rely upon riverine, estuarine, and marine habitats which may be altered by a number of activities authorized by Washington DNR. Transportation projects such as roadways, bridges, and docks may result in habitat loss during construction, while stormwater runoff from the structures may increase concentrations of heavy metals, salts and petroleum products in wetlands that are known to degrade habitat. Invasive species control projects may disturb nesting behavior and alter utilized habitat. Navigation improvements involving dredging, filling or other alteration of wetlands may result in increased sedimentation and/or the direct loss of organisms and habitat. Sewage or other wastewater outfalls may cause localized reductions in water quality resulting in increased turbidity, eutrophication, decreased habitat quality, and the potential disturbance of nesting. Construction and operation of harbors, ports, shipyards, marinas, petroleum and ferry terminals could cause habitat reduction and degradation, increased disturbance and increased risk of exposure to spilled oil and fuel, which would affect harlequin ducks survival and productivity.

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2-2.6 Marbled murrelet (*Brachyramphus marmoratus)*

STATUS AND RANK

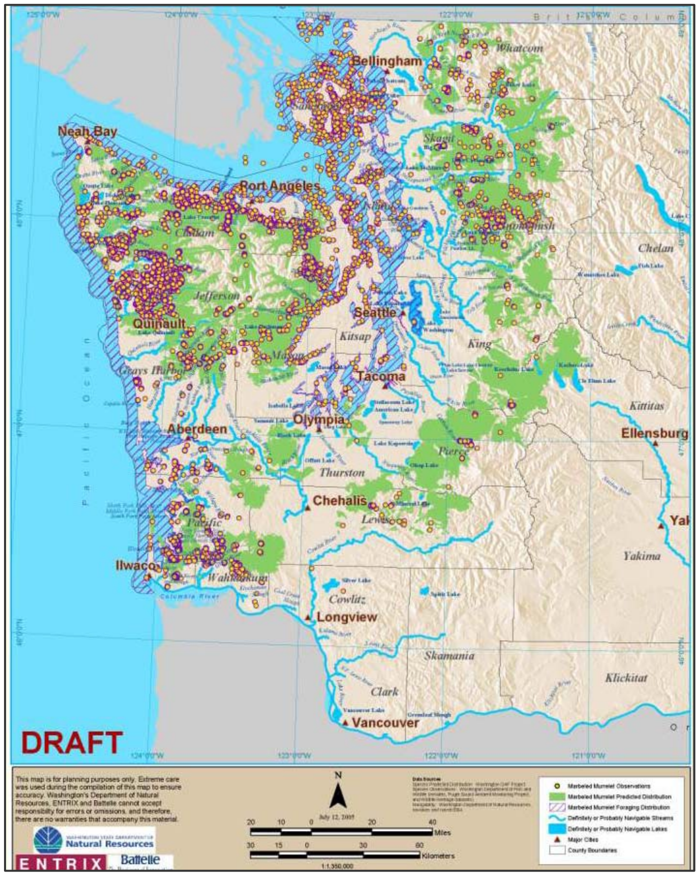
Entity	Status/Rank
US Fish and Wildlife	Threatened
Washington State	Threatened
Natural Heritage Program	G3, G4; S3

RANGE

An estimated 300,000 marbled murrelets range from the Aleutian Islands in Alaska to central California, where they nest on the ground or in old-growth or mature trees generally within 80 kilometers of the coast (Nelson 1997). About 90 percent of the marbled murrelet population occurs in Alaska, with the remaining 10 percent in British Columbia (6.5 percent), Washington (0.8 percent), Oregon (1.9 percent) and California (0.8 percent) (Nelson 1997). Ground nesting occurs primarily from the Aleutian Islands to Kodiak Island in Alaska, with murrelets nesting mainly in trees from Kodiak Island to the southern extent of their range in California (Nelson 1997). Breeding and non-breeding birds use coastal marine waters for foraging and may be found within 5 kilometers of the shoreline (Nelson 1997).

In Washington, the birds mainly occur in northern Puget Sound and the northern Pacific Coast (Speich and Wahl 1995) (Figure 2.10). At-sea distributions are both temporally and spatially variable, with a general eastward shift in abundance from the Strait of Juan de Fuca to Puget Sound and the San Juan Islands during the fall and winter, with British Columbia populations moving south to Puget Sound (Speich and Wahl 1995). Abundance decreases with increasing distance from the shoreline and there is a tendency for juvenile birds to remain closer to shore than adults (Speich and Wahl 1995).

Figure 2.10 – Distribution of the marbled murrelet.



HABITAT USE

Nesting

In Washington marbled murrelets nest primarily in Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Picea sitchensis*) trees greater than 76 centimeters in diameter at breast height (US Fish and Wildlife 1997). Nests found in Washington were generally 34 meters above the ground on a 29 centimeter diameter limb of a large (60 meter tall, 150 centimeter diameter at breast height) conifer tree with two landing pads and 60 percent moss cover (US Fish and Wildlife 1997). The average age of forest stands supporting marbled murrelet nests in the Pacific Northwest was 522 years (US Fish and Wildlife 1997). Stands were generally 206 hectares, low elevation conifers, 324 trees per hectare with multiple canopy layers and snags (US Fish and Wildlife 1997).

Critical nesting habitat units contain two primary constituent elements: 1) individual trees with potential nesting platforms; and 2) forested areas within 0.8 kilometers of individual trees with potential nesting platforms, and a canopy height of at least one-half the site-potential tree height (US Fish and Wildlife 1997). Although no marine habitats have been designated as critical, marbled murrelets spend most of their lives in the marine

environment, generally within about 2 kilometers of the shoreline (US Fish and Wildlife 1997).

Marbled murrelets reach sexual maturity at 2 years and breed in the early spring. Most eggs are laid between April and July. Females lay only one egg that is incubated for approximately 30 days by both adults (US Fish and Wildlife 1997). During the breeding season, small schooling fish such as Pacific sandlance (*Ammodytes hexapterus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), surf smelt (*Hypomesus pretiosus*) and shiner perch (*Cymatogaster aggregata*) are consumed (Nelson 1997). Additionally they feed on rockfish (Sebastes spp.) and a host of marine invertebrates such as squid and shrimp. They may also feed on salmon (*Onchorhynchus* spp.) in freshwater lakes during the summer (Nelson 1997). Distribution and abundance during foraging may be influenced by distance from the nest (usually <20 kilometers) as well as physical and biological processes related to prey concentration such as upwelling, outflow of large rivers, shelves at mouths of inlets, shallow banks, rip currents, tidal eddies and kelp beds (Nelson 1997).

Marbled murrelets generally forage in protected coastal and nearshore waters including bays, inlets, fjords, lagoons and coves with most birds diving within 50 meters of the water surface 2 to 5 kilometers from shore (Thomson 1997) and may aggregate where Pacific herring are spawning (Speich and Wahl 1989).

Wintering

Generally, marbled murrelets move from the outer coastal areas to protected waters such as Puget Sound during winter (Nelson 1997). During winter, the birds are distributed farther from shore in the Strait of Juan de Fuca and long the outer coast, but they are also more abundant (Thompson 1997). Dominant winter prey includes euphausiids (*Thysanoessa* spp., *Euphausia pacifica* (krill)), mysids (*Achanthomysis* spp., *Neomysis* spp.), gammarid amphipods (*Atylus tridens*), smelt and herring, but marbled murrelets also feed on rockfish (*Sebastes* spp), squid and shrimp (Nelson 1997). Marbled murrelets may also occur on freshwater lakes during winter, where they feed on salmonids (Nelson 1997).

POPULATION TRENDS

Although marbled murrelets were considered common or abundant throughout Washington, Oregon and California during the early 1900s, they are now rare (Nelson 1997; US Fish and Wildlife 1997, 2004). Marine surveys from 1972 to 1993 indicate a population decline on the order of 4 percent per year in Washington (Speich and Wahl 1995), while surveys from 1996 to 1999 indicate no evidence of change (US Fish and Wildlife 2004). Populations in Washington appeared to increase during 2000, 2001 and 2002, but survey variability was high and trends are not significant (Huff 2003). Low reproduction rates across Washington, Oregon and California, as measured by nest success and the ratio of juveniles to adults, indicate that the marbled murrelet population in these areas is not reproductively stable (US Fish and Wildlife 2004).

THREATS WARRANTING ESA PROTECTION

Threats to marbled murrelets and designated critical nesting habitat presented below are summarized from US Fish and Wildlife (2004), McShane et al. (2004), Nelson (1997) and US Fish and Wildlife (1997).

Destruction, Modification, or Curtailment of Habitat or Range

Harvest of old-growth forests in the Washington, Oregon and California range of the marbled murrelet is the main cause of population decline. While the rate of annual habitat loss has declined, however the historic loss and modification of habitat has not been offset by the development of new habitat.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for marbled murrelets.

Disease or Predation

Nest failure rates due to predation are 68 to 100 percent and key factors related to nest failure include proximity to humans, abundance of avian predators, and proximity and type of forest edge. Nest predators take both eggs and chicks and include common ravens (*Corvus corax*), common crows (*Corvus brachyrynchos*), Steller's jays (*Cyanocitta stelleri*), gray jays (*Perisoreus canadensis*) and hawks (*Accipiter* spp.). Predators of adult and juvenile marbled murrelets include peregrine falcons (*Falco peregrinus*), bald eagles (*Haliaeetus leucocephalus*) and western gulls (*Larus occidentalis*).

Adequacy of Existing Regulatory Mechanisms

The adequacy of regulatory mechanisms has improved with federal and state listings as a Threatened species and implementation of the Northwest Forest Plan and Habitat Conservation Plans on private lands. Birds are still taken as by-catch in drift net and gill net fisheries, indicating that existing regulatory mechanisms may be inadequate to protect marbled murrelets.

Other Factors Affecting Continued Existence

Continued survival and recovery of this species is complicated by low productivity due to high nest failure rates and continuing mortality due to oil spills and gill-net entanglement mortality. These factors may be exacerbated by marine climate change, which has reduced marine productivity in waters adjacent to nesting areas.

In Puget Sound, the Columbia River and Grays Harbor area, marbled murrelets are particularly vulnerable to acute and chronic exposure to oil and other marine pollutants. These factors lead to death or reduced reproduction in marbled murrelets because of their extensive use of nearshore waters and their proximity to onshore oil facilities, tanker ports, industrial developments and shipping routes. Marine circulation changes (El Niño Southern Oscillation) may result in the reduced abundance and quality of prey species, and precipitate changes in food availability, predation pressure, or distribution of productive marine habitats (upwelling, tidal fronts).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Marbled murrelets rely upon estuarine and marine habitats which may be altered by a number of activities authorized by Washington DNR. Transportation projects such as roadways, bridges, and docks may result in habitat loss during construction, while stormwater runoff from the structures may increase concentrations of heavy metals, salts and petroleum products that are known to degrade habitat. Sewage or other wastewater outfalls may cause localized reductions in water quality resulting in increased turbidity, eutrophication, decreased habitat quality, and the potential disturbance of nesting. Construction and operation of harbors, ports, shipyards, marinas, petroleum and ferry terminals could cause habitat reduction and degradation, increased disturbance and increased risk of exposure to spilled oil and fuel, which would affect marbled murrelet survival and productivity. Offshore overwater structures such as log booms, rafts, floats and breakwaters may reduce habitat availability. Boathouses, slips/berths, wharves and docks also reduce habitat availability and add disturbance from vessel traffic. Nearshore activities that cause sediment disturbance, increase contamination or cause additional disturbance such as sand and gravel mining, dredge spoil removal and disposal and aquaculture may cause habitat degradation, reduction in forage availability and displacement due to disturbance.

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2-2.7 Western snowy plover (*Charadrius alexandrinus nivosus)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife	Threatened
Washington State	Endangered
Natural Heritage Program	G4; S1

RANGE

While the snowy plover (*Charadrius alexandrinus*) occurs throughout the Americas, Europe, Africa and Asia (Page et al. 1995b), the western subspecies (*C. a. nivosus*) breeds only along the Pacific Coast of the United States and Mexican, and into the inland West. The Pacific Coast distinct population segment of the western snowy plover breeds from Damon Point, Washington, to Bahia Magdalena, Baja California, Mexico, with most occurring from San Francisco Bay southward (Page et al. 1991; Palacios et al. 1994; 66 Code of Federal Regulations Part 157, 2001).

Only members of the Pacific Coast population of western snowy plovers occur in Washington (Page et al. 1995b), and they occur during all parts of the year (Richardson 1995). Historically, breeding snowy plovers were found on at least five areas in western Washington; however, there are now only three known active breeding grounds: Damon Point/Oyhut Wildlife Area in Grays Harbor County, along with Midway Beach and Ledbetter Point/Gunpowder Sands in Pacific County (Richardson 1995; 64 Code of Federal Regulations Part 234, 1999). All three breeding sites have been proposed as critical habitat units in addition to Copalis Spit in Grays Harbor County, an unoccupied area that has been identified for possible inclusion for the critical habitat designation (69 Code of Federal Regulations Part 242, 2004). No nesting has been documented within eastern Washington, although several individuals have been observed there since 1967 (Richardson 1995) (Figure 2.11).

Figure 2.11 – Distribution of the western snowy plover.

HABITAT USE

Pacific Coast western snowy plovers prefer flat, sandy areas with little or no vegetative cover, such as that found on barrier beaches, playas (dry lake beds), salt flats and to a lesser extent, other beach types (Wilson-Jacobs and Meslow 1984; Palacios et al. 1994). The species has an average life span of approximately 3 years, reaching sexual maturity at 1 year of age (Page et al. 1995b).

Nesting

Western snowy plovers nest primarily above the high tide line on coastal beaches, sand spits, dune-backed beaches, sparsely-vegetated dunes; along beaches at creek and river mouths; and salt pans at lagoons and estuaries. They will nest secondarily at bluff-backed beaches, dredge spoil piles, salt-pond levees, dry salt ponds and river bars (Palacios et al. 1994; Powell 2001). Nesting on beaches in Oregon usually begins in April and May, but may continue into July (Wilson-Jacobs and Meslow 1984). Nesting time was similar in California with eggs usually hatching after an incubation period of slightly less than one month (Warriner et al. 1986). Fledging occurs after a nestling period that lasts about 31 days, during which time the male attends to the chick (Warriner et al. 1986). Most snowy plover will breed following their first year of life, and will typically lay two to three clutches of three eggs annually (Page et al. 1995b).

Winter

Both coastal and interior breeding snowy plovers winter along the Pacific Coast and in the Gulf of California (Page et al. 1995a; Powell et al. 2002), and preferred habitats include beaches, man-made salt ponds, estuarine sand and mud flats (Page et al. 1995b).

POPULATION TRENDS

The estimated United States breeding population of coastal western snowy plovers in 1988 to 1989 for the Pacific Coast states was about 1,900 birds, down from an estimated 2,300 birds during 1977 through 1980 (Page et al. 1991). Winter populations in San Diego County from 1995 through 1999 were similar to counts in 1984 and 1986, although the employed survey methods limit direct comparison (Powell et al. 2002).

Up to eight pairs nested at Damon Point between 1979 and 1989 (Page et al. 1991) and in 1993, three of four nests successfully hatched chicks, with six of the ten chicks fledged (Richardson 1995). In 1994, six adults and four nests were recorded (Richardson 1995). At Ledbetter Point, annual nesting ranged from 4 to 12 pairs from 1979 to 1989 and in 1993 and 1994 (Page et al. 1991; Richardson 1995). Beginning in 1998, intensive nesting surveys were conducted at Damon Point, Ledbetter Point, and a recent colony discovered on Midway Beach. Increasing nesting activity and high reproductive success during 2004 may indicate a small population not in decline in Washington.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Commercial and residential development and construction of jetties, parks and marinas have resulted in the loss of snowy plover habitat (Palacios et al. 1994; Richardson 1995). Snowy plovers are also sensitive to disturbance, and human activity increases related to development of beach areas has reduced breeding success and winter habitat use (Warriner et al. 1986; Ruhlen et al. 2003, Lafferty 2001). The introduction of non-native beach grasses has been shown to exclude nesting in previously utilized areas, reduce prey abundance, and increase mammalian nest predator abundance (Neuman et al. 2004, Slobodchikoff and Doyen 1977).

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Although historically snowy plovers and their eggs have been collected for museum and private collections, protection is currently afforded under the Endangered Species Act and the Migratory Bird Treaty Act.

Disease or Predation

Intentional stabilization of dunes using European beach grass has resulted in succession of other plant species that in turn increased the abundance of mammalian nest predators (Richardson 1995). Predation has contributed to nest failure (Warriner et al. 1986; Powell et al. 2002).

Adequacy of Existing Regulatory Mechanisms

Newly accreted tidelands are often utilized by nesting snowy plovers, yet jurisdiction and/or ownership may not be easily determined without a court decision due to a "moving-boundary" theory of land ownership (Richardson 1995). The potential also exists for disturbance of nesting snowy plovers in Washington due to difficulties in managing beach recreationalists across boundaries of several management agencies (Jensen, Personal communication. March 4, 2005).

Other Factors Affecting Continued Existence

Although there are no other recognized natural or manmade factors affecting these plovers in Washington, the definition of populations within this species is currently being debated, and the outcome could influence the recognition of distinct populations and the listing status.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Western snowy plovers are likely to be affected by activities authorized by Washington DNR on state-owned aquatic lands. Overwater structures, such as docks/wharves and breakwaters, may reduce foraging areas. Roadways, bridges and docks could reduce foraging habitat and disturb roosting or nesting populations. Construction and operation of harbors, ports, shipyards, marinas and petroleum and ferry terminals could cause habitat reduction and degradation and increased disturbance. These activities could also cause an increased risk of exposure to spilled oil and fuel, which would affect western snowy plover survival.

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2-3 Fish

2-3.1 Bull trout/Dolly Varden (*Salvelinus confluentus)*

Bull trout are members of the *Salvelinus* genus and are taxonomically very similar to Dolly Varden (*Salvelinus malma).* In fact, bull trout were not widely recognized as a distinct species until 1978 (Cavender 1978). While it is difficult to distinguish between bull trout and Dolly Varden using morphometric techniques, it is possible to distinguish between the two using genetic techniques. The ranges for these two similar species overlap in Washington (Washington Fish and Wildlife 2000).

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife	Threatened
Washington State	Candidate Species
Natural Heritage Program	G3; SNR

RANGE

Bull trout occur from the headwaters of the Yukon River in Alaska to the Klamath basin in Oregon (Dunham et. al 2003). While the southern range of bull trout was much broader during the last major ice age and extended as far south as the McCloud River (Cavendar 1978), the species currently occurs in numerous sub-basins in the interior Columbia with their range extending into parts of Montana, Idaho (the Wood River) Nevada (the Jarbridge River), and Canada (Bond 1992). The U.S. Fish and Wildlife Service recognizes five distinct population segments within the coterminous United States: 1) Coastal-Puget Sound; 2) St. Mary-Belly River; 3) Klamath River; 4) Columbia River; and 5) Jarbridge River. Bull trout are widely distributed in the state of Washington (Figure 2.12) and the overall range is likely similar to the historical range (Washington Fish and Wildlife 2000). The state of Washington currently recognizes 80 bull trout /Dolly Varden stocks.

Figure 2.12 – Distribution of bull trout/Dolley Varden.

HABITAT USE

Adult

Bull trout may live to 15 years of age (Donald and Alger 1992) and exhibit resident, fluvial, adfluvial, and anadromous life history forms. Resident bull trout utilize small headwater streams for all of their life-stages and may reside within a few hundred meters of where they were born. Resident fish tend to be small as adults (15 to 30 centimeters in length) and do not attain the greater lengths exhibited by other life history forms. Bull trout that exhibit the fluvial life history form typically spawn in small tributaries and, after a short period of rearing, individuals move into larger streams where most growth and maturation occurs. Similarly, adfluvial bull trout utilize small headwater streams for spawning and early rearing (1 to 3 years) but migrate to lakes for growth and maturation. Anadromous bull trout utilize small streams for spawning and rearing and then migrate to the more productive nearshore marine and estuarine wetland ecosystems for growth and maturation. The life history strategies exhibited by bull trout are very flexible and individual fish may not only adopt more than one strategy during the course of a lifetime, but they may alternate strategies from year to year.

Bull trout require cold, clean water and although they are generally absent when temperatures rise above 18° Celsius, they have been observed in lakes with temperatures up to 20° Celsius (Donald and Alger 1992). Increased stream temperatures are believed to negatively impact 11 of 34 subpopulations in the Coastal Puget Sound population segment (Department of Interior 1999).

Spawning/Incubation/Emergence

Spawning migrations for fluvial, adfluvial, and anadromous bull trout may begin as early as April and during these migrations bull trout likely occur in nearly all of the ecosystems and habitats under consideration in this project. Spawning typically occurs in small headwater streams (Meehan and Bjornn 1991) and in some cases, the distance between foraging areas and spawning areas is known to exceed 160 kilometers (e.g., the Skagit River).

Bull trout are iteroparous (capable of spawning more than once) with spawning occurring in the late summer and fall in water temperatures between 5° and 9° Celsius. Similarly to other salmonids, bull trout prefer spawning in substrates consisting of clean loose gravel. Depending on the size of the individual, a female may deposit between 100 and 10,000 eggs (Meehan and Bjornn 1991). Egg development is dependent on temperature and as much as six months may pass between spawning and emergence (Meehan and Bjornn 1991).

Rearing/Outmigration

Bull trout typically rear in their natal streams for two to four years, although resident fish may remain in these streams for their entire lives. Young-of-the-year bull trout utilize low velocity habitats such as side channels and the lateral margins of streams (Wydoski and Whitney 2003), feeding primarily on aquatic invertebrates and fish eggs. While the resident form of this species may subsist entirely on insects, migratory forms become increasingly piscivorous with increasing size.

Fluvial and adfluvial bull trout typically migrate out of their natal streams between 2 and 4 years of age and occupy a wide range of freshwater habitat types including small, high gradient and high elevation streams; large, low gradient and low elevation streams; and the littoral zones of lakes. Bull trout diet in lakes is highly variable and may consist of invertebrates (e.g., chironomidae, ephemeroptera, trichoptera, amphipods) and fish (e.g., mountain whitefish [*Prosopium williamsoni*], lake whitefish [*Coregonus clupeaformis*], kokanee [*Oncorhynchus nerka*]), depending on prey availability and competitive pressures (Donald and Alger 1992).

Anadromous bull trout migrate to saltwater between 2 and 4 years of age, although individuals as young as age-1 and as old as age-7 have been captured as outmigrants (Goetz et al. 2004). Approximately 84 percent of bull trout outmigrants captured in northern Puget Sound were age-3 fish (Goetz et al. 2004).

Bull trout in the nearshore ecosystem rely upon estuarine wetlands and favor irregular shorelines with unconsolidated substrates over rocky (consolidated) habitat types (Goetz 2004). Juveniles may rear within estuarine wetlands and tidally influenced distributary channels (Goetz et al. 2004), while sub adult bull trout have been observed utilizing tidal sloughs in the Chehalis River and tidally influenced floodplain areas of Puget Sound (US Fish and Wildlife 2004). The distribution of bull trout in the nearshore ecosystem is thought to be dependent upon the abundance and distribution of prey items such as sand lance (*Ammodytes hexapterus*), juvenile salmonids (*Oncorhynchus* spp.), surf smelt (*Hypomesus pretiosus*), and pacific herring (*Clupea pallasi*). Bull trout are opportunistic feeders, and diet appears to vary seasonally with the availability of prey items (Goetz et al. 2004).

Anadromous bull trout originating in the Skagit River tend to grow larger than their fluvial counterparts because marine habitats are more productive and provide better foraging opportunities. Age-5 anadromous fish were, on average, nearly 80 millimeters longer than age-5 fluvial bull trout. The larger size of anadromous fish is thought to confer several reproductive advantages including the development of larger and more numerous eggs. Bull trout tend to use the nearshore ecosystem during the spring and late summer months, but do not forage exclusively in the marine environment. Individuals have been observed to migrate hundreds of kilometers through the nearshore ecosystem, to forage in different river basins (Goetz et al. 2004). These basin to basin migrations are difficult to document and are not currently well understood.

POPULATION TRENDS

Although little is known about the historic abundance of bull trout, current population segments are geographically isolated from each other due to natural and anthropogenic barriers. In 1998 the Washington Department of Fish and Wildlife evaluated 80 bull trout / Dolly Varden stocks within the state of Washington and found that 17 percent were "healthy", 3 percent were "depressed", and 8 percent were "critical", with the status of the remaining 72 percent "unknown" (Washington Fish and Wildlife 2000). Of the stocks whose status was known, 63 percent were rated as healthy.

THREATS WARRANTING ESA PROTECTION

The following threats were listed as reasons for the decline of bull trout populations by US Fish and Wildlife in their 2004 Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*).

Destruction, Modification, or Curtailment of Habitat or Range

Activities that lead to higher water temperatures, such as removal of riparian vegetation and some forest management practices, can effect bull trout survival. Dams and water diversions can impose migration barriers and degrade downstream habitats. Eutrophication caused by high nutrient levels in fertilizers from agriculture, fish hatchery, lumber mill runoff and urban/suburban areas may also negatively affect this species by decreasing the dissolved oxygen concentration in the water.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Sport fishing can lead to the overharvest of bull trout. The accidental bycatch of bull trout most likely occurs from sport anglers, commercial, and tribal fishers targeting other salmonid species. There are no known scientific or educational uses for bull trout.

Disease or Predation

Although juvenile bull trout likely serve as forage fish for larger trout and salmon, insufficient information exists to determine whether disease or predation are current threats to bull trout survival. It is important to note that small, isolated populations can be highly sensitive to disease or an increase in predation from native or species.

Adequacy of Existing Regulatory Mechanisms

Due to similarities in morphology, life history requirements, and habitat utilization for bull trout and Dolly Varden, the state of Washington has developed a single management plan for both species (Washington Fish and Wildlife 2000). The illegal harvest of bull trout does occur in portions of their habitat and may impact local populations. These fish are especially vulnerable to poaching during their pre-spawning aggregations or while on their spawning grounds. The remoteness of these locations makes enforcement of existing regulations difficult.

Other Factors Affecting Continued Existence

Bull trout are known to hybridize with the non-native brook trout (*Salvelinus fontinalis*) where their populations overlap and may therefore be at risk through hybridization. In addition, brook trout seem to adapt better than bull trout in degraded or warmer stream habitats and as a result are believed to out-compete bull trout in these areas (US Fish and Wildlife 2004). Dams, culverts, tide gates and other water diversion structures also impact bull trout and contribute to fragmentation of migratory corridors, isolation of fish populations, and the elimination of historical habitats. These structures have been identified as barriers to fish migrations throughout the bull trout's range.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Bull trout are likely to be affected by a variety of activities authorized by Washington DNR on state-owned riverine, estuarine, and nearshore marine areas. In addition to providing a refuge for salmon predators, overwater structures frequently reduce or prevent the growth vegetated habitat by preventing the transmission of light. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality, and potential bioaccumulation of pollutants. Construction of roads and bridges may result in increased sedimentation during construction, as well as increase temperature and pollutant loads from stormwater runoff during operation. Dredging, fill, shoreline armoring, and sand and gravel mining may either remove habitat or prevent the formation of habitat, or alter sediment loads, thereby decreasing habitat through increased scour or deposition. Aquaculture operations may result in disease transmission, decreased dissolved oxygen levels and genetic dilution. They may also impact salmon through the increases in nitrogenous waste and the introduction of chemicals such as anti-foulants, pesticides and antibiotics.

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2-3.2 Chinook salmon (*Oncorhynchus tshawytscha)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	
Lower Columbia River	Threatened
Middle Columbia River Spring-Run	Not Listed
Puget Sound	Threatened
Snake River Fall-Run	Threatened
Snake River Spring-Run	Threatened
Upper Columbia River Fall-Run	Not Listed
Upper Columbia River Spring-Run	Endangered
Washington Coast	Not Listed
Washington State	
Lower Columbia River	Candidate Species
Puget Sound	Candidate Species
Snake River Fall-Run	Candidate Species
Snake River Spring-Run	Candidate Species
Upper Columbia River Spring-Run	Candidate Species
Washington Coast	Not Listed

Entity	Status/Rank
Natural Heritage Program	
Lower Columbia River	G5, T2Q; SNR
Puget Sound	G5, T2Q; SNR
Snake River Fall-Run	G5, T2Q; SNR
Snake River Spring-Run	G5, T2Q; SNR
Upper Columbia River Spring-Run	G5, T2Q; SNR
Washington Coast	G5, T2Q; SNR

RANGE

The historical range of Chinook salmon included most of the North Pacific Ocean from California to Alaska, through the Aleutian Islands and into Siberia. This species probably inhabited most rivers and larger streams in Washington, Oregon and California. Some populations now considered extinct, are believed to have migrated hundreds of miles inland to spawn in tributaries of the Upper Columbia River and the Snake River (Healey 1991; Meehan 1991; Myers et al. 1998; Wydoski and Whitney 2003).

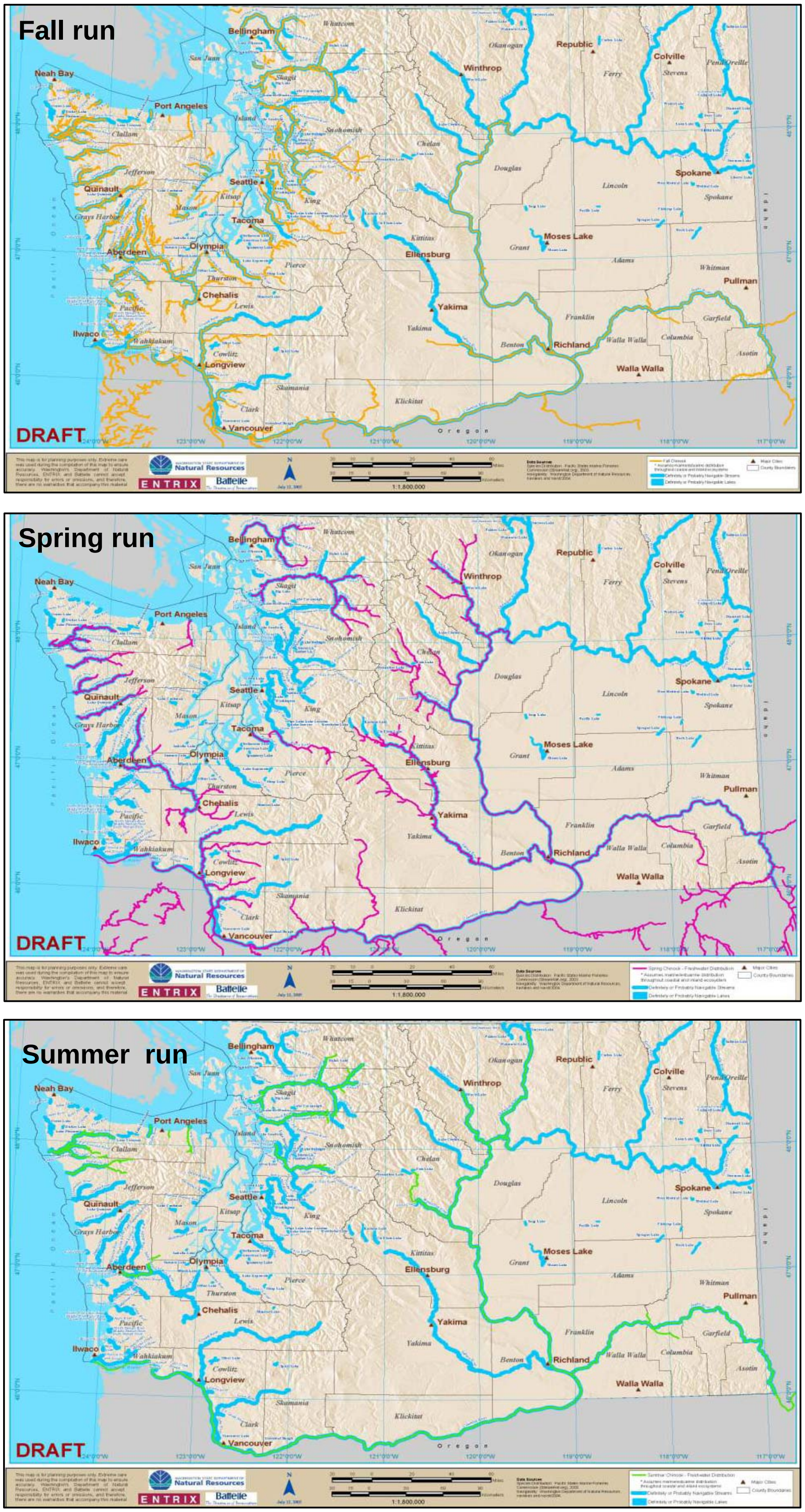
Currently, Chinook salmon are found in the rivers and streams of Puget Sound, including Hood Canal and the Strait of Juan de Fuca, the Pacific coast, and the Columbia River and its tributaries (Wydoski and Whitney 2003). Degradation and loss of habitat in the headwaters of many Washington rivers now limits their spawning range (Wydoski and Whitney 2003). Some landlocked populations occur in Lake Washington, Lake Cushman and Lake Roosevelt (Wydoski and Whitney 2003) (Figure 2.13).

HABITAT USE

The life history of Chinook salmon is typical of Pacific salmon in general, whereby spawning occurs in freshwater habitats, and juveniles rear in freshwater for a period of time before migrating to salt water, where they mature and spend several years before returning to their natal streams to spawn. However, the variety of life-history types among Chinook salmon makes their habitat requirements especially complex.

Chinook are generally divided into three categories based on when they return to freshwater—spring run (March to May), summer run (June and July) and fall run (August and September (Wydoski and Whitney 2003). All Chinook spawn in the fall with the spring runs spawning first in headwater streams, followed by summer Chinook in tributary mouths and fall types in mainstem tributaries (Wydoski and Whitney 2003). This species also exhibits one of two life-history types, or races: the stream-type and the ocean-type (Myers et al. 1998). Stream-type Chinook tend to spend one or more years in freshwater environments as juveniles prior to migrating to saltwater as smolts. Ocean-type Chinook spend between 3 months and 1 year in freshwater before smolting and migrating to estuarine or nearshore areas in saltwater. Ocean-type Chinook are more dependent on estuarine habitats to complete their life history than any other species of salmon (Healey 1991).

Figure 2.13 – Distribution of Chinook salmon.



Adult

Chinook are the largest of the Pacific salmon with an average length of approximately 1 meter and weights ranging from 1 to 56 kilograms (Wydoski and Whitney 2003), and tend to spawn in large river systems (Meehan 1991). The species spends between 2 and 6 years at sea prior to returning to fresh water to spawn, but this time varies between stocks and also depends somewhat on ocean conditions (Meehan 1991; Wydoski and Whitney 2003). Similarly to other salmonids, Chinook spawn in cold, highly oxygenated water (Healey 1991). Spring Chinook are especially dependent on high water quality and good access to spawning areas as they move upstream during periods of lower flow and hold in rivers for extended periods of time before spawning. Adult spring Chinook salmon tend to prefer deep, cool "holding pools" with woody debris, over-hanging vegetation and undercut banks to protect them from predators (Healey 1991). Chinook generally feed on invertebrates, but become more piscivorous with age (Healey 1991), feeding on sandlance, sticklebacks, crab larvae and small herring while at sea (Healey 1991).

Spawning/Incubation/Emergence

In Washington, Chinook spawn using sites with escape cover, such as logs, undercut banks and deep pools (Meehan 1991) and dominated by large gravel or cobble that is between 2.5 and 15 centimeters (1 and 6 inches) in diameter (Healey 1991). Although adults usually die soon after spawning, females may guard a redd from 4 to 25 days before dying (Healey 1991). Chinook, like other salmonids, will often use areas where other salmon have spawned earlier in the year (Meehan 1991).

While the length of time it takes for eggs to hatch is heavily dependent on water temperature, Chinook eggs generally hatch between 90 and 150 days after deposition. Optimal temperature for incubation is between 7 and 10° Celsius and although eggs hatch sooner in warmer water, the young fish are smaller and generally have lower survival rates (Healey 1991). After hatching, the developing Chinook will typically remain in the gravel for several months prior to emergence (Healey 1991). Newly emerged fry move to shallow, protected areas of the stream, usually seeking out pools formed by large woody debris, where they establish and defend feeding areas(Meehan 1991).

Rearing/Out-Migration

Juvenile Chinook may spend from 3 months to 2 years in freshwater after emergence and before migrating to estuarine areas as smolts. Younger juveniles generally seek out covered areas with lower flow near the edges of stream and river channels, moving to higher velocity, midstream areas as they mature (Healey 1991). Young-of-the-year feed primarily on larval and adult aquatic insects, such as mayflies, caddisflies and chironomids, as well as terrestrial insects (ants, spiders, beetles), earthworms, and crustaceans (Healey 1991).

Ocean type juveniles are typically the result of fall and summer run spawning events and begin slowly moving downstream shortly after they emerge from the redds (Wydoski and Whitney 2003). However, stream-type juveniles over-winter in freshwater for at least 1 year, beginning their downstream migration in the spring of the following year (Wydoski and Whitney 2003). Stream-type juveniles in systems with higher percentages of large woody debris show higher over-winter survival (Murphy et al. 1986). Juvenile Chinook

have also shown a preference for seasonally inundated floodplain areas in larger river systems (Sommer et al. 2001).

At the time of saltwater entry, stream-type (yearling) smolts are much larger than their ocean-type (sub-yearling) counterparts, and do not rely heavily on estuaries for rearing, moving offshore relatively quickly. In contrast ocean-type Chinook typically migrate to estuaries within 3 months of emergence, averaging about 50 to 70 millimeters and make extensive use of estuarine and nearshore habitat for rearing (Healey 1991).

POPULATION TRENDS

Catch records for Washington's Chinook have fluctuated cyclically within the last 30 years, but reached record-low levels during the early 1990s. In general, Chinook populations throughout the Pacific Northwest are considered depressed from historical levels. The National Oceanic and Atmospheric Administration (NOAA) Fisheries recognizes 17 Evolutionarily Significant Units (ESUs) for Chinook, several of which are located within Washington State (Myers et al. 1998).

Washington Coast ESU

This ESU includes the coastal basins north of the mouth of the Columbia River to, but not including, the Elwha River. Long-term trends for most populations in this ESU have been upward; however, several smaller populations are experiencing sharply downward trends. Fall-run populations are predominant and tend to be at a lower risk than spring or summer runs. Hatchery production is significant in the southern portion of this ESU, whereas the majority of the populations in the northern portion of the ESU have minimal hatchery influence (Myers et al. 1998).

Puget Sound ESU

The Puget Sound ESU contains coastal basins of the eastern part of the Strait of Juan de Fuca, Hood Canal and Puget Sound. This region includes the Elwha River and extends to the Nooksack River basin and the United States-Canadian border. Total abundance in this ESU is relatively high; however, much of this production is hatchery-derived. Both long- and short-term trends in abundance are predominantly downward, and several populations are exhibiting severe short-term declines, with spring-run Chinook throughout this ESU depressed. NOAA Fisheries has expressed concerned that the high level of hatchery production may be masking more severe underlying trends in abundance. In many areas, spawning and rearing habitats are severely degraded and migratory access has been restricted or eliminated (Myers et al. 1998).

Lower Columbia River ESU

The Lower Columbia River ESU contains tributaries to the Columbia River from the mouth of the Columbia River to, but not including, the Klickitat River. While abundance in this ESU is relatively high, the majority of the fish appear to be hatchery-produced. The fall Chinook salmon run in the Lewis River appears to be the only healthy, naturally occurring population in this ESU and both long- and short-term trends in abundance for the ESU are negative, some severely so. The numbers of naturally spawning spring runs are so low that NOAA Fisheries was unable to identify any healthy, native, spring-run populations. The pervasive influence of hatchery fish in almost every river in this ESU

and the degradation of freshwater habitat suggest that many naturally spawning populations are not able to replace themselves (Myers et al. 1998).

Middle Columbia River ESU

The Middle Columbia River ESU includes tributaries to the Columbia River from the Klickitat River Basin upstream to include the Yakima River Basin, excluding the Snake River Basin. Chinook abundance in the ESU has declined considerably from historical levels, but appears to be relatively stable during recent years. Natural production accounts for most of the escapement in the Yakima and Deschutes River basins. Habitat degradation, especially due to agricultural practices, affects most of the rivers in this ESU (Myers et al. 1998).

Upper Columbia River ESU

The Upper Columbia River Fall- and Summer-Run Chinook ESU contains tributaries to the Columbia River upstream of the confluence of the Snake and Columbia Rivers to the Chief Joseph Dam. Chinook abundance in this ESU is quite high, although naturally spawning Chinook salmon in the Hanford Reach are responsible for the vast majority of the production. NOAA Fisheries was concerned about the recent decline in summer-run populations in this ESU and the apparent increase in the contribution of hatchery return to total escapement. It was unclear whether, under current conditions, the naturally spawning summer-run Chinook salmon populations are self-sustaining (Myers et al. 1998).

The Upper Columbia River Spring-Run Chinook ESU includes tributaries to the Columbia River upstream from the Yakima River to the Chief Joseph Dam. Chinook abundance in this ESU has been generally low. At least six populations of spring-run Chinook salmon in the ESU have been extirpated, and almost all remaining naturally spawning populations have fewer than 100 spawners. Hydroelectric and irrigation dams have blocked access to much historical habitat and directly impeded adult and smolt migrations. NOAA Fisheries concluded that this ESU is currently at risk of extinction (Myers et al. 1998).

Snake River ESU

The Snake River Fall-Run ESU contains tributaries to the Columbia River from the Dalles Dam to the confluence of the Snake and Columbia Rivers, including the Snake River Basin. Although historically, the Snake River component of this ESU was the predominant source of production, the current 5-year average for Snake River fall-run Chinook salmon is about 500 adults with dams blocking access to most of the historic spawning habitat and migration corridors. Snake River fall-run Chinook salmon are currently listed as a Threatened species, with NOAA Fisheries concluding that the newly defined Deschutes River population is likely to become in danger of extinction in the foreseeable future (Myers et al. 1998).

The Snake River Spring- and Summer-Run ESU includes tributaries to the Snake River upstream of the Snake and Columbia Rivers' confluence. Recent abundance of the naturally spawning population for this ESU has averaged about 2,500 fish, compared with historical levels of approximately 1.5 million. Both long- and short-term trends are

negative for all populations. A number of populations have been extirpated in this ESU, primarily due to dam construction (Myers et al. 1998).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Habitat degradation and loss, in freshwater, estuarine and marine systems is thought to be a significant contributing factor to Chinook population declines in Washington and throughout the Pacific Northwest region (Myers et al. 1998). Habitat degradation and loss has been linked to timber harvest activities, agriculture and grazing, and urbanization (Stouder et al.1997). Hydroelectric dams and irrigation withdrawals have also been linked to the decline of Chinook populations, especially those in the Lower Columbia River (Stouder et al. 1997). Increases in siltation can lead to increased embryo mortality as a result of smothering and may also lead to decreased juvenile survival by shifting food webs to less favorable prey (Meehan 1991).

Over-Utilization for Commercial, Recreational, Scientific or Educational Purposes

Fishing pressure from commercial and recreational sources has been identified as a contributing factor in the decline of Chinook populations (Stouder et al.1997).

Disease or Predation

Neither disease nor predation has been identified as significant threats to the species as a whole (Stouder et al.1997).

Adequacy of Existing Regulatory Mechanisms

Regulatory mechanisms are in place, including management plans for specific river drainages. However, it is not clear that these measures have been effective in protecting wild Chinook populations. In addition, the implications of hatchery fish on native populations are not fully known. Current harvest regulations also may not be adequate to protect wild stocks. Finally, it is not clear whether current regulations governing land-use activities (timber harvest, agriculture and urban/suburban development) will be adequate to prevent further habitat degradation or loss.

Other Factors Affecting Continued Existence

Chinook salmon have been identified as a Threatened or Endangered species in Washington primarily because of degradation or loss of habitat, overharvest and pressure from hatchery stocks (NOAA Fisheries 2005). Fish-passage barriers have long been a problem for Chinook, which often utilize upper tributaries to spawn. Additionally, unfavorable climatic conditions during the last several years may have negatively impacted marine survivability for Chinook.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Chinook are likely to be affected by a variety of activities authorized by Washington DNR on state-owned rivers, estuaries and nearshore marine areas. Overwater structures frequently reduce or prevent the growth vegetated habitat by preventing the transmission of light and provide a refuge for salmon predators. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality and increased potential for the bioaccumulation of pollutants. The construction of roads and bridges may result in increased sedimentation during construction, and may increase temperature and pollutant loads from stormwater runoff during operation. Pollutants that are harmful to salmonids and present in stormwater runoff and outfalls include but are not limited to hormones, PCBs, heavy metals, salts, and petroleum products. Aquaculture operations may result in disease transmission, decreased dissolved oxygen levels and genetic dilution. They may also impact salmon through the increases in nitrogenous waste and the introduction of chemicals such as antifoulants, pesticides and antibiotics.

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2-3.3 Chum salmon (*Oncorhynchus keta*)

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	
Columbia River	Threatened
Hood Canal Summer-run	Threatened
Pacific Coast	Not Listed
Puget Sound / Strait of Georgia	Threatened
Washington State	
Hood Canal Summer-run	Candidate Species
Lower Columbia	Candidate Species
Natural Heritage Program	
Hood Canal Summer-run	G5; S3
Lower Columbia River-run	G5; S3
Northwest Anadromous	G5; S3

RANGE

Chum salmon have the most extensive distribution of all Pacific salmon, with their western reach encompassing Korea, Japan and Russia, including the Arctic coast. The eastern portion of their range includes California, Oregon, Washington and Alaska including the Arctic coast (Salo 1991; Wydoski and Whitney 2003). Previous studies have found that North American chum salmon migrate throughout the North Pacific Ocean and Bering Sea but are not commonly found west of the mid-Pacific Ocean (Neave et al.1976; Salo 1991). Although little is known regarding their ocean distribution, maturing individuals that return to Washington streams have primarily been found in the Gulf of Alaska. Chum salmon are rarely found in northern California and southern Oregon (Kostow 1995; Johnson et al.1997).

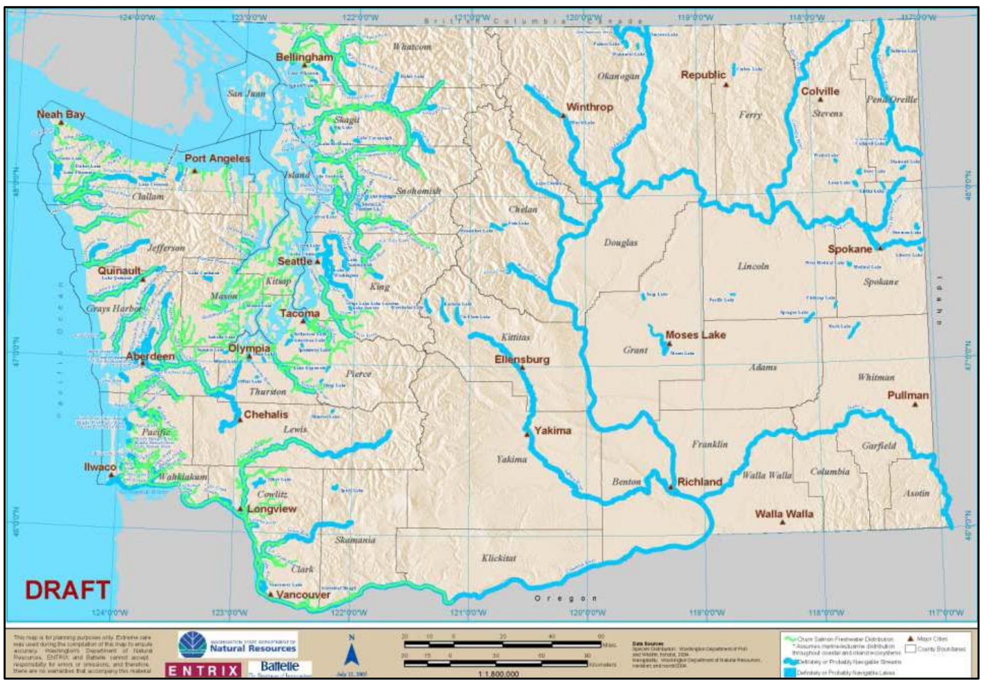
In Washington, chum salmon are usually found in the rivers and streams of the Washington coast, Hood Canal, Strait of Juan de Fuca and Puget Sound. In the Columbia River Basin, their range does not extend above the Dalles Dam and they are rarely found above Bonneville Dam (Wydoski and Whitney 2003) (Figure 2.14). NOAA Fisheries recognizes 72 separate stocks of chum salmon within Washington State. The stocks are divided into 4 evolutionarily significant units (ESUs) including Puget Sound / Strait of Georgia, Hood Canal Summer-run, Pacific Coast and Columbia River (Johnson et al. 1997).

HABITAT USE

Adult

In Washington, chum salmon rear in the ocean for the majority of their adult lives until they reach maturity (Salo 1991; Wydoski and Whitney 2003). The species maintain a variety of life history strategies that exhibit regional differences in age and size at maturity. Chum salmon mature between the ages of 2 and 6, with adults having an average lifespan of 4 years (Wydoski and Whitney 2003; Froese and Pauly 2004). In size and weight, chum salmon are second only to Chinook salmon, reaching up to 108 centimeters in length and 20.8 kilograms in weight. While little information exists regarding the high seas habitat usage of regionally specific stocks, chum salmon are distributed across the North Pacific Ocean and Bering Sea during offshore marine rearing. Upon reaching maturity, adults begin their homeward migration between May and June, entering coastal streams from June to November (Neave et al. 1976).

Figure 2.14 – Distribution of chum salmon.



Spawning/Incubation/Emergence

Chum salmon are anadromous (maturing in saltwater and spawning in freshwater) and semelparous (i.e. they perish after spawning). Summer-run chum salmon enter Washington streams from June to August, spawning between mid-September and mid-October while fall run chum return from September to November, spawning between November and December (Johnson et al.1997).

Chum salmon usually spawn in low elevation reaches because they are unable to negotiate riverine blockages or falls due to reduced swimming ability compared to other salmonids. However, in rivers that offer low gradients and relatively few obstacles such

as the Yukon River in Alaska and the Skagit River in Washington, they can migrate more than 2,500 kilometers and 170 kilometers upstream respectively (Johnson et al. 1997). Chum salmon typically spawn in channel types that include low gradient valleys, riffle pools and plane beds.

Spawning behavior for chum is similar to other salmon. Females select, prepare and guard their redd while engaging in constant territorial competition for the best locations, while males compete for breeding opportunities (Quinn 2005). A variety of features determine optimal redd sites, including water depth and velocity, gravel type and the presence of riparian vegetation for cover. It has been suggested that chum salmon have developed specific spawning habitat requirements because they often co-occur with pink salmon. Females typically avoid the slowest water, due to its inability to flush siltation and provide oxygen throughout the redd (Quinn 2005). Although water velocity criteria vary globally in Washington, Johnson (1971) found that 80 percent of spawning sites had velocities between 21.3 centimeters and 83.8 centimeters per second. The average water depth for chum salmon redds is approximately 0.5 meters (Quinn 2005), with the redds located in substrates ranging from medium gravel to bedrock strewn with boulders (Scott and Crossman 1973). Substrate that lacks excessive sedimentation is particularly important because it provides adequate flow of cold oxygenated water. While bed elements need to be large enough to protect the eggs from scouring events, egg burial ability dictates the maximum size of the gravel particles. In northern climates, where water levels can decrease in spawning areas with freezing temperatures, the presence of upwelling groundwater has been suggested as one of the most important habitat requirements for redd site selection (Reub 1990).

In North America, chum salmon produce between 2,000 and 3,600 eggs per female (Johnson et al. 1997), with alevin / fry survival rates positively correlated with egg size (Quinn 2005). Egg size is extremely important because most of the lifetime mortality occurs during incubation in the redd (Quinn 2005). Since egg development is dependent on temperature, high water temperatures can decrease the amount of hatching time by 1.5 to 4.5 months. In Washington, the time required to hatch varies from approximately 86 to 182 days, depending on location (Salo 1991).

Rearing/Outmigration

Chum spend little time rearing in freshwater, with fry beginning their downstream migration shortly after hatching to rear in estuarine environments. In Washington, the fry migrate downstream from late January through June with migration peaking between April and June. Cues that dictate the timing of downstream migration include spawning date, stream temperature during incubation, fry length and condition, brood class strength, food availability, stream hydromorphology, distance to the estuary, and physiological changes in fry and day length (Salo 1991). In addition to chum fry being smaller than other salmon species, they usually migrate shorter distances and school less closely. Chum fry lack an obvious hiding response to disturbances, and as a consequence congregate toward the shade of waterweeds and riparian vegetation for refuge from predators (Salo 1991). Although there is little information concerning feeding behavior during downstream migration, chum fry have been observed to feed intensely upon chironomid and mayfly larvae, as well as other aquatic insects (Salo 1991).

Since marine survival greatly depends on size and chum fry arrive in estuaries earlier than most salmon, juvenile chum reside in estuaries longer than most other anadromous species (Healey 1982; Wydoski and Whitney 2003; Quinn 2005). Estuarine wetlands are critical to chum salmon survival because they provide high prey abundance, an area of gradual transition from fresh to salt water, and an area with turbid water, shading, and vegetation to serve as refuge from predators and high temperatures (Quinn 2005).

Juveniles enter nearshore estuarine wetlands between February and May, with a peak in late-March to early-May (Simenstad et al. 1982), rearing in productive and shallow eelgrass beds until they reach 45 to 60 millimeters in length and move offshore. Juvenile habitat usage may be in part due to possible overlap with returning adult chum salmon (Hood Canal summer-run) which may feed upon juveniles (Johnson et al. 1997). Returning chum salmon adults are joined by juvenile coho (*Oncorhynchus kisutch*), cutthroat trout (*Oncorhynchus clarki*), and aquatic birds as major predators of chum juveniles in estuarine wetlands. In addition to predation, causes of mortality in estuaries include cold temperatures, extreme changes in water flow, habitat degradation, disease, as well as interspecific and exotic species competition (Johnson et al. 1997).

Generally, juveniles feed upon epibenthic crustaceans, with larger juveniles found farther offshore preying on terrestrial insects, copepods, amphipods and other zooplankton (Simenstad et al. 1982). It has been suggested that departure from estuarine wetlands into marine environments is connected to prey abundance and offshore migration may occur when nearshore prey availability becomes low. It may also occur when juveniles are large enough to feed on larger offshore zooplankton (Simenstad 1982; Salo 1991).

While little is known regarding residence time in estuaries, juveniles begin their seaward migrations in April, with larger fish leaving before smaller, lighter fish. The young fish migrate northward through Puget Sound to the Strait of Georgia an have been observed along the coast of Washington and the west coast of Vancouver Island by mid-May. Studies by Hartt and Dell in 1986 found that in their first year in the ocean, chum salmon tended to stay within 36 kilometers of the shore.

POPULATION TRENDS

Information regarding population trends is largely lacking for chum salmon in Washington and elsewhere. Of the 72 recognized chum stocks in the state, Washington Fish and Wildlife considers only Chambers Creek summer-run to be extinct (Washington Fish and Wildlife et al. 1993). It is important to note that the report does not recognize historic extinctions. Half of the 18 stocks with an unknown status are from the West Coast of the Olympic Peninsula and the Strait of Juan de Fuca. Only two stocks are listed as critical, with three considered depressed, and the remaining 48 listed as healthy (Johnson et al. 1997).

Puget Sound / Strait of Georgia ESU

For the past 30 years, commercial harvest has been increasing, with the bulk of the catch recorded from the Puget Sound / Strait of Georgia ESU. While not all of the 38 stocks in this ESU had sufficient data for analysis, of those that did 10 had negative population trends and 23 positive trends. Estimates from 1997 indicated that there are over 1.5 million adults in this population and that the overall was increasing (Johnson et al. 1997).

Hood Canal summer-run ESU

Although the population trend for the Hood Canal summer-run chum salmon ESU has been decreasing for the past 30 years, escapement in some streams showed large increases in 1995 to 1996. Commercial fishing by tribal and non-tribal fishermen has historically targeted chum salmon in Hood Canal, which may have contributed to declining populations. Although chum are commonly caught as non-targeted bycatch, exploitation rates for summer run chum have been drastically reduced since 1991 from closures of the coho salmon and Chinook salmon fisheries (Washington Fish and Wildlife 1996).

Columbia River ESU

Although historical estimates place the Columbia River run in the hundreds of thousands, for the past 50 years, yearly returns have averaged in the thousands (NOAA Fisheries 2003). Although 2002 saw a dramatic increase in the abundance of returning adults in this ESU, in 2003 NOAA Fisheries concluded that Columbia River chum salmon are either likely to become Endangered or in danger of extinction (NOAA Fisheries 2003).

Pacific Coast ESU

Due to the broad geographic area of this ESU abundance data is generally lacking and it is difficult to estimate population trends. However, population estimates indicate that the stock is holding at approximately 150,000 adults in the Pacific Coast ESU (Johnson et al. 1997).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Freshwater, estuarine and marine habitat loss or degradation is thought to be the primary reason for declining chum salmon populations. Similarly to ocean-type Chinook, chum's dependence on estuaries for fry and juvenile rearing leaves them more susceptible to the loss of estuarine habitat than other Pacific salmonids. On average, 18 to 64 percent of estuarine habitat in Washington has been lost (Simenstad et al. 1982; Hutchinson 1989) to diking, channelization, dredging and filling, road building and/or industrialization (Johnson et al. 1997). Excessive sediment loading from gravel mining and dredging can result in increased embryo mortality by decreasing the flow of oxygenated water to the eggs while in gravel. The removal of woody debris from rivers, streams and estuaries to improve navigability, decrease channel meander, and aesthetically improve "views" has resulted in a significant loss of refuge from predators and may increase scour from high flow events caused by water releases from dams and flooding. Bank armoring impacts juveniles by removing refuge from predators found with undercut banks, log snags, and streamside vegetation. The loss of streamside vegetation also leads to increased temperatures that can be detrimental to chum as well as decreases in terrestrial insect prey sources. In addition, bank armoring also alters substrate, which can lead to declines in eelgrass and kelp beds, which provide important habitat and prey sources for chum salmon. Point source and non-point source pollution can have deleterious effects on food web assemblages in freshwater, estuarine and marine habitat. Since chum salmon utilize the lower reaches of rivers, hydropower development may not be a significant concern

for the species, but eggs and young may still be at risk from water level fluctuation related to dam and water diversions.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Chum salmon are targeted for recreational, sport and commercial fisheries, and have historically been subject to overfishing. This is particularly true in the lower Columbia where harvest levels may have reached up to 80 percent of the yearly runs. Although the existing fishery is highly regulated, recreational, sport and commercial fisheries continue to present a threat to the continued existence of chum salmon. Because oceanic harvest cannot differentiate between summer runs and fall runs, it may continue to put summer runs at risk. Additionally, chum salmon are often caught as bycatch.

Disease or Predation

Genetic dilution and increased risk of disease transmission from hatcheries have been recently cited as concerns for chum salmon populations (Johnson et al. 1997). Similar concerns have been raised for exotic introductions of Atlantic salmon through the practice of net-pen fish farming. Atlantic salmon aquaculture may also cause extremely high sea lice (*Lepeophtheirus salmonis*) infestation rates in chum salmon (Morton et al. 2004). Because net pen farms may offer suitable overwintering habitat for sea lice, and chum salmon are small during their nearshore life stage, sea lice infection may cause excessively high mortality for chum salmon (Morton et al. 2004). Disease from sea lice infection includes skin erosion and hemorrhaging that can result in lethal bacterial infections, fungal infections and osmoregulatory failure (Wootten et al. 1982).

Adequacy of Existing Regulatory Mechanisms

Chum salmon may be at risk due to the inadequacy of existing regulatory mechanisms governing land-use activities (timber harvest, agriculture, and urban/suburban development) and continued habitat loss and/or degradation. Furthermore, water quality regulations may also be inadequate to protect chum from the negative effects of pollution. Although regulations are in place regarding specific geographical harvest and hatchery rebuilding plans, recreational, sport, and commercial fisheries still may pose a threat to the existence of chum salmon. Current harvest regulations may not be adequate to protect these fish. It is also unclear whether current regulations surrounding hatchery based fishery enhancement and rebuilding efforts will protect the genetic integrity of wild chum salmon runs.

Other Factors Affecting Continued Existence

In addition to hybridization and increased risk of disease, displacement by and competition for prey resources with hatchery-reared and introduced fish species may also impact chum. In addition, shifts in ocean climate, such as warming and cooling phases caused by the Pacific Decadal Oscillation and the El Nino Southern Oscillation can be detrimental to chum salmon populations. For instance, it has been suggested that early ocean period mortality rates for chum salmon are positively correlated with high sea surface temperatures caused by warming events in coastal Washington (Mueter et al. 2005). Drought periods that create low water flows may dewater eggs or strand juveniles. Summer run chum salmon may be particularly at risk from cyclical drought

due to their entrance in streams during times of exceptionally low flows, resulting in greatly reduced access to suitable spawning habitat.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Chum are likely to be affected by a variety of activities authorized by Washington DNR on state-owned rivers, estuaries and nearshore marine areas. Overwater structures frequently reduce or prevent the growth of vegetated habitat by preventing the transmission of light and provide a refuge for salmon predators. Dredging, fill, shoreline armoring, and sand and gravel mining may either remove habitat or prevent the formation of habitat, or alter sediment loads, thereby decreasing habitat through increased scour or deposition. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality, and increased potential for the bioaccumulation of pollutants. The construction of roads and bridges may result in increased sedimentation during construction, and may increase temperature and pollutant loads from stormwater runoff during operation. Pollutants that are harmful to salmonids and present in stormwater runoff and outfalls include but are not limited to hormones, PCBs, heavy metals, salts, and petroleum products. Aquaculture operations may result in disease transmission, decreased dissolved oxygen levels and genetic dilution. They may also impact salmon through the increases in nitrogenous waste and the introduction of chemicals such as antifoulants, pesticides, and antibiotics.

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Wydoski, R.S. and R.L. Whitney. 2003. Inland Fishes of Washington. University of Washington Press. Seattle, Washington.

2-3.4 Coastal cutthroat trout (*Oncorhynchus clarki clarki)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Species of Concern
Washington State	Not Listed
Natural Heritage Program	G4, T4; SNR

RANGE

Coastal cutthroat trout are distributed along the western coast of North America from the Kenai Peninsula in Alaska to the Eel River in California with their inland distribution typically limited to less than 150 km from the coast (Behnke 1992). NOAA Fisheries (Johnson et al. 1999) recognized 6 Evolutionarily Significant units in the contiguous United States: 1) Puget Sound; 2) Olympic Peninsula; 3) Southwestern Washington; 4) Upper Willamette River; 5) Oregon Coast; and 6) Southern Oregon/California. The distribution of coastal cutthroat trout within the state of Washington includes large rivers and small tributaries of the Columbia River up to the Bonneville Dam and drainage basins on the west side of the Cascade Mountains, including the Olympic Peninsula (Figure 2.15). The state of Washington currently recognizes 40 stock complexes - groups that typically occur in a limited geographic area and are believed to be closely related (Wydoski and Whitney 2003).

Figure 2.15 – Distribution of coastal cutthroat.

HABITAT USE

Adult

Coastal cutthroat trout exhibit resident, fluvial, adfluvial, and anadromous life history forms. Resident coastal cutthroat trout utilize small headwater streams for all of their life-stages and may reside within a few hundred meters of where they were born. Resident fish tend to be small as adults (15 to 30 centimeters in length), with anadromous individuals living to 10 years of age and attaining lengths of 43 to 48 centimeters (17 to 19 inches) (Pauley et al. 1988).

Spawning/Incubation/Emergence

The timing of coastal cutthroat spawning migrations vary widely depending on life history form, age, stock characteristics, and geography (Behnke 1992), and may occur from July through January. This species spawns in small tributaries with total drainage areas of less than 13 square kilometers (Pauley et. al 1988) typically spawning upstream of areas used by steelhead trout and coho salmon for spawning. Although coastal cutthroat trout are iteroparous (repeat spawners), many anadromous fish do not spawn upon their first return to freshwater (Pauley et. al 1988). Anadromous, adfluvial, and resident stocks in Lake Washington appear to have segregated the time at which spawning occurs (December through May) and may be reproductively isolated (Wydoski and Whitney 2003). Substrates selected for spawning typically range in size between 0.1 and 30 centimeters.

Egg development is dependent on temperature, and 10^{o} to 11^{o} Celsius is considered optimal (Pauley et al 1988; Johnson et al 1999), with incubation lasting 6 to 7 weeks. The success rate for incubation to emergence has been shown to decrease with increasing percentage of fine sediments in the interstitial spaces of the gravel.

Rearing/Outmigration

Coastal cutthroat trout typically rear in their natal streams for up to 2 years, occupying streams with gradients ranging between approximately 2 to 9.7 percent (Moore and Gregory 1998a; Connolly and Hall 1999). Resident fish may remain in these streams for their entire life while migratory fish move out to larger rivers, lakes and estuaries.

Young-of-the-year utilize low velocity habitats such as side channels and the lateral margins of streams. Moore and Gregory (1989a and 1989b) found that fry and juvenile fish in stream reaches with an abundance of velocity refuges attained larger sizes than fish in reaches with less cover. While fry and juvenile cutthroat trout are typically found in velocity refuges within shallow-faster habitat units, adult cutthroat trout prefer to reside in deeper pools with slower velocities. Young fish feed primarily on aquatic invertebrates but are opportunistic and will utilize other food sources such as terrestrial invertebrates, zooplankton and fish eggs (Pauley et al 1988). Resident cutthroat trout may subsist entirely on insects while their migratory counterparts become increasingly piscivorous with increasing size.

Adfluvial coastal cutthroat trout may use both littoral and limnetic habitats and feed openly in the water column in the absence of predatory and competitive pressures (Wydoski and Whitney 2003). Fluvial and adfluvial coastal cutthroat trout typically

migrate out of their natal streams between 1 and 4 years of age (Wydoski and Whitney 2003), with most migrating to saltwater during the spring at 2 to 4 years of age (Meehan and Bjornn 1991). In Washington, 97 to100 percent of out-migrants were ages 2 and 3 (Wydoski and Whitney 2003). Because these fish spawn high in the tributaries they are likely to encounter virtually all of the riverine, lake, and wetland habitat types identified in this analysis.

Coastal cutthroat trout forage in estuarine wetlands, as well as nearshore coastal and inland waters, and typically occur in water less than 3 meters in depth (Pauley et al. 1988). Available information indicates that this species occurs at river deltas, distributary channels, and along shallow shorelines (Pauley et al. 1988, Johnson et al. 1999) thus demonstrating some preference for unconsolidated habitats. Although this review did not find evidence of the use of consolidated and neritic habitat use in the marine environment, evidence from freshwater lakes indicates that this behavior cannot be ruled out.

While evidence suggests that coastal cutthroat trout rarely occur in waters greater than 3 meters deep (Pauley et al. 1988), the species has been captured by fishing vessels up to 80 kilometers (55 miles) off the Oregon/Washington coast (Wydoski and Whitney 2003). Little is currently known about habitat utilization in the offshore ecosystem and although it is widely believed that the species does not overwinter at sea, the possibility cannot currently be ruled out.

POPULATION TRENDS

Coastal cutthroat trout stocks in Washington, Oregon and California appear to be declining (Johnson et al 1999) whereas stocks in Alaska and British Columbia are apparently stable (Wydoski and Whitney 2003). As part of the 2000 coastal cutthroat trout salmonid stock inventory, the Washington Department of Fish and Wildlife determined that 2 percent of the stocks within the state were healthy, 18 percent were depressed, and the status of 80 percent of the stocks were unknown (Washington Fish and Wildlife 2000).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Since cutthroat trout spawn in small headwater streams they are particularly susceptible to forest management practices that directly or indirectly alter water temperature, decease dissolved oxygen, increase fine sediment loads, alter the amount of woody debris, or remove riparian vegetation. Dams and water diversions can impose migration barriers and degrade downstream habitats as well. Eutrophication caused by high nutrient levels in fertilizers from agriculture, fish farm waste, lumber mill runoff and urban/suburban areas may also negatively affect this species by decreasing the dissolved oxygen concentration in the water.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Coastal cutthroat trout are a popular gamefish in both freshwater and marine environments. While sport fishing can lead to the overharvest of cutthroat, angling restrictions have resulted in increased population size (Washington Fish and Wildlife 2000). The accidental bycatch of cutthroat trout most likely occurs from sport anglers, commercial, and tribal fishers targeting other salmonid species.

Disease or Predation

Although juvenile cutthroat trout likely serve as forage fish for larger trout and salmon, insufficient information exists to determine that disease or predation is a current threat to cutthroat trout survival. However it is important to note that small, isolated populations can be highly sensitive to disease events or an increase in predation rates from native or introduced predators.

Adequacy of Existing Regulatory Mechanisms

The illegal harvest of cutthroat trout does occur in portions of their habitat and may impact local populations. These fish are especially vulnerable to poaching during their pre-spawning aggregations or while on their spawning grounds. The remoteness of these locations makes enforcement of existing regulations difficult.

Other Factors Affecting Continued Existence

Dams, culverts, tide gates, and other water diversion structures have been identified as barriers to fish migrations throughout the cutthroat trout's range and have led to the fragmentation of migratory corridors, isolation of fish populations, and the elimination of historical habitats. Cutthroat may also be at risk due to hybridization with rainbow trout (*Oncorhynchus mykiss*) in parts of its range where their populations overlap (Behnke 1992). Behnke (1992) hypothesizes that the two species are unable to resist crossbreeding in streams with limited niche diversity and limited space for physical separation.

POTENTIAL EFFECTS FOR WASHINGTON DNR AUTHORIZED ACTIVITIES

Cutthroat trout are likely to be affected by a variety of activities authorized by Washington DNR on state-owned aquatic rivers, estuaries, and nearshore marine areas. In addition to providing a refuge for salmon predators, overwater structures frequently reduce or prevent the growth of vegetated habitat by preventing the transmission of light. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality, and potential bioaccumulation of pollutants. Construction of roads and bridges may result in increased sedimentation during construction, as well as increase temperature and pollutant loads from stormwater runoff during operation. Dredging, fill, shoreline armoring, and sand and gravel mining may either remove or prevent the formation of habitat, or alter sediment loads, thereby decreasing habitat through increased scour or deposition. Aquaculture operations may result in disease transmission, decreased dissolved oxygen

levels and genetic dilution. They may also impact salmon through the increases in nitrogenous waste and the introduction of chemicals such as anti-foulants, pesticides and antibiotics.

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2-3.5 Coho salmon (*Oncorhynchus kisutch)*

STATUS AND RANK

National Oceanic and Atmospheric Administration (NOAA) Fisheries recognizes six ESUs for Coho. Three of these ESUs, Central California, Southern Oregon/Northern California Coasts and Oregon Coasts, were listed as Threatened under the Endangered Species Act (ESA) in October 1996, May 1997 and August 1998, respectively. The three ESUs located in Washington are not currently listed as Endangered or Threatened under the ESA.

Entity	Status/Rank
NOAA Fisheries)	
Lower Columbia River & SW Washington	Species of Concern
Puget Sound & Strait of Georgia	Candidate Species
Olympic Peninsula	Not Listed
Washington State	
Lower Columbia River & SW Washington	Not listed
Puget Sound & Strait of Georgia	Not listed
Natural Heritage Program	
Lower Columbia River & SW Washington	G4, T2Q; SNR
Puget Sound & Strait of Georgia	G4; S3
Olympic Peninsula	G4, T2Q; SNR

RANGE

Coho salmon were historically distributed throughout the North Pacific Ocean from central California to Alaska, through the Aleutian Islands, and from Russia south to Japan. This species probably inhabited most of the coastal streams in Washington, Oregon and Central and Northern California. Some populations, now considered extinct, are believed to have migrated hundreds of miles inland to spawn in tributaries of the Upper Columbia River in Washington and the Snake River in Idaho (Groot and Margolis 1991; Nehlsen et al. 1991; Weitkamp et al. 1995; Wydoski and Whitney 2003). Coho salmon have also been introduced worldwide, becoming naturalized in many areas such as the Great Lakes.

There are believed to be 90 distinct stocks in Washington (Wydoski and Whitney 2003) with populations occurring throughout Puget Sound, Hood Canal, the Strait of Juan de Fuca, the Olympic Peninsula and the Columbia River Basin (Figure 2.16)

HABITAT USE

While the life history of coho salmon is typical of Pacific salmon, this species is found in a broader diversity of habitats than any of the other native anadromous salmonids, including headwater streams, small coastal creeks, and tributaries of major rivers (Meehan 1991).

Adult

Most Coho spend between 1 and 2 years in the ocean before returning to spawn, although some males mature after only 5 to 7 months (Wydoski and Whitney 2003). At maturity coho weigh between 3 and 6 kilograms, with lengths ranging between 0.5 and 0.75 meters (Wydoski and Whitney 2003). Adult coho feed on invertebrates but become more piscivorous as they grow larger (Groot and Margolis 1991) commonly eating sand lance (*Ammodytes hexapterus*), sticklebacks (Gasterosteidae), crab larvae and small herring (*Clupea pallasii)* (Groot and Margolis 1991).

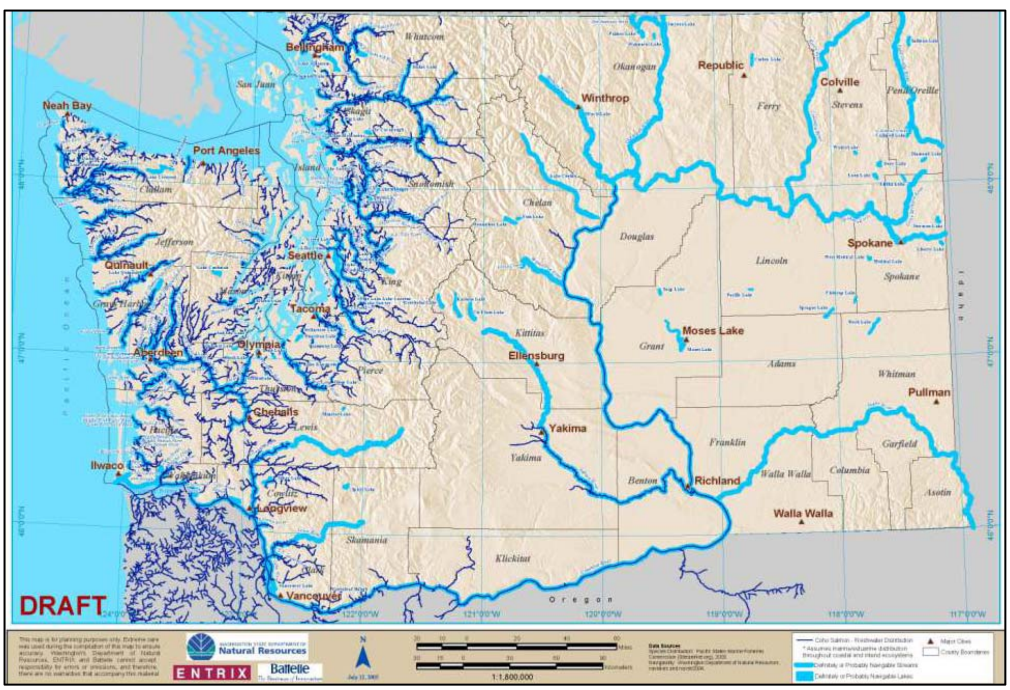
Spawning/Incubation/Emergence

Although the timing is often unique for each run, in Washington coho generally return to freshwater environments beginning in August. Spawning occurs from September through January with the adults entering freshwater earliest moving the farthest upstream (Groot and Margolis 1991; Meehan 1991, Wydoski and Whitney 2003). Spawning behavior and requirements are similar to other salmonids, with females laying eggs in gravel areas free of heavy sedimentation with adequate flow and cool, clear water. Although adults usually die soon after spawning, escape cover, such as logs, undercut banks and deep pools for spawning adults are also important (Meehan 1991).

The length of time it takes for eggs to hatch and egg survival are heavily dependent on water temperature. In hatcheries, coho eggs usually hatch after about 30 to 40 days at a temperature of 10° Celsius. Eggs hatch sooner in warmer water, but the young fish are smaller and generally have lower survival rates. If the temperature goes too high, eggs will not hatch at all (Groot and Margolis 1991).

After hatching, the developing coho will typically remain in the gravel for around 3 months prior to emergence (Groot and Margolis 1991) obtaining nutrients from a yolk sack attached to their body. Upon emergence, fry move to shallow, protected areas of the stream, usually seeking pools formed by large woody debris or boulders (Hartman 1965) where they establish and defend feeding areas (Meehan 1991). These pools generally include structural components such as undercut banks and root masses, that not only provide cover from predators but shelter the fry from seasonal changes in flow and temperature (Meehan 1991). Coho fry feed primarily on aquatic insects, such as mayflies, caddisflies and chironomids, but also utilize terrestrial insects and earthworms (Groot and Margolis 1991).

Figure 2.16 – Distribution of coho salmon.



Rearing/Out-Migration

Coho generally rear in freshwater between 12 and 18 months, exhibiting a strong preference for structurally complex cover (McMahon and Hartman 1989) with off-channel pools for protection from high winter flows (Nickelson et al. 1992) Bustard and Narver (1975a, b) found that beaver ponds were an important overwintering area for juvenile coho, with a survival rate of roughly twice that of the entire stream system.

Out-migration begins in the spring, with the young moving rapidly through estuaries and out to sea. As smolts begin the ocean phase of their life, they usually travel through most, if not all, of the marine environments, including estuaries, nearshore habitat, and open ocean. During this time, coho tend to utilize the coastal waters, moving as far north as the Gulf of Alaska (Groot and Margolis 1991).

POPULATION TRENDS

Catch records for coho have fluctuated cyclically in the past 30 years, but reached record low levels during the early 1990s (Johnson et al. 1997). In general, coho populations throughout the region are considered depressed from historic levels. In 1995, NOAA Fisheries named 6 ESUs for coho in the Pacific Northwest (Weitkamp et al. 1995). Of these, the 3 ESUs located in California and Oregon are considered to be in danger of extinction. The 3 ESUs located in Washington could become Threatened or Endangered in the future. The Puget Sound and Lower Columbia River/Southwest Washington ESUs are currently considered Candidates for listing as Threatened or Endangered under the Endangered Species Act. Although NOAA Fisheries could not reach a definite conclusion regarding the relationship of Clackamas River late-run coho salmon to the historic lower Columbia River ESU, they did conclude that the run is native and a remnant of the lower Columbia River ESU. It was determined that the stock was not currently in danger of extinction but could become so in the foreseeable future (Johnson et al. 1991).

Lower Columbia River/Southwest Washington ESU

Uncertainty about the affect of artificial propagation on the ancestry of the runs in this ESU prevented NOAA Fisheries from reaching a definite conclusion regarding the relationship between coho salmon in that area and the historical Lower Columbia River and Southwest Washington ESU (Weitkamp et al. 1995).

Puget Sound ESU

For the Puget Sound ESU, NOAA Fisheries is concerned that if present trends continue, this ESU is likely to become Endangered in the foreseeable future. Although current population abundance is likely near historical levels and recent trends in overall population abundance have not been downward, there is substantial uncertainty relating to several of the risk factors including: widespread and intensive artificial propagation, high harvest rates, extensive habitat degradation, a recent dramatic decline in adult size, and unfavorable ocean conditions (Weitkamp et al. 1995).

Olympic Peninsula ESU

Although there is continuing cause for concern about habitat destruction and hatchery practices within the Olympic Peninsula ESU, NOAA Fisheries concluded that there is sufficient native, natural, self-sustaining production of coho salmon that this ESU is not in danger of extinction and is not likely to become Endangered in the foreseeable future unless conditions change substantially (Weitkamp et al. 1995).

THREATS WARRANTING ESA PROTECTION

Because juvenile coho can spend a significant portion of their lives in rivers and streams, they are particularly susceptible to human-induced changes in water quality or habitat degradation. In addition, adult spawning habitat is also subject to the negative impacts of land-use activities. Improper forest management, poor agricultural or grazing practices, or urban/suburban development can result in the loss or damage of critical coho spawning and rearing habitat. Common problems include modification of the natural hydrologic regime, non-point source pollution, and physical habitat destruction. Finally, adults and juveniles are affected by the presence of physical barriers to migration, including blocking culverts, dams and water-diversion structures, as well as by high temperatures or low-flow barriers.

Destruction, Modification, or Curtailment of Habitat or Range

Habitat degradation and loss in freshwater, estuarine, and marine systems is thought to be a significant contributing factor to coho population declines in Washington and throughout the Pacific Norwest region (Weitkamp et al. 1995). Habitat degradation and loss has been linked to timber-harvest activities, agriculture and grazing and urbanization (Stouder et al. 1997). Hydroelectric dams and irrigation withdrawals have also been linked to the decline of coho populations, especially those in the Lower Columbia River (Johnson et al. 1991).

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Commercial and recreational fishing have been identified as a contributing factor in the decline of coho populations (Stouder et al. 1997).

Disease or Predation

Neither disease nor predation has been identified as a significant threat to the species as a whole (Stouder et al. 1997).

Adequacy of Existing Regulatory Mechanisms

Geographically based harvest regulations that attempt to differentiate between hatchery and wild coho have been enacted, but it is not clear that these measures have been effective in protecting wild coho populations. It is also not clear whether current regulations governing land-use activities (timber harvest, agriculture and urban/suburban development) will be adequate to prevent further habitat degradation or loss.

Other Factors Affecting Continued Existence

Fish-passage barriers have long been a problem for coho, which often spawn in upper tributaries. Additionally, unfavorable climatic conditions during the last several years may have had a negative impact on marine survivability for coho.

POTENTIAL EFFECTS FROM AUTHORIZED WASHINGTON DNR ACTIVITIES

Coho in the marine environment are not likely to be significantly affected by activities authorized by Washington DNR in saltwater environments because of their limited use of nearshore habitats. The areas of greatest concern are activities authorized in state-owned riverine habitat systems. Overwater structures provide a refuge for salmon predators and can destroy or prevent the formation of complex fry refuge habitat and alter food-web dynamics. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality and increased potential for the bioaccumulation of pollutants. The construction of roads and bridges may cause increased sedimentation during construction, and may increase temperature and pollutant loads from stormwater runoff during operation. Aquaculture operations may result in disease transmission, decreased dissolved oxygen levels and genetic dilution. They may also impact salmon through the increases in nitrogenous waste and the introduction of chemicals such as antifoulants, pesticides and antibiotics.

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2-3.6 Pink Salmon (*Oncorhynchus gorbuscha)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Not Listed
Natural Heritage Program	G5; S2

RANGE

Pink salmon are the most abundant species of salmon and are found throughout the north Pacific, including northern Asia. The North American range is from the Sacramento River in northern California, north to the Bering Strait, and east to the MacKenzie River in northern British Columbia, though spawning is rare south of the Columbia River (Wydoski and Whitney 2003). They are most common from central Alaska south to the Fraser River in British Columbia (Quinn 2005).

Thirteen stocks of pink salmon have been identified in Washington, with actively spawning populations occurring in the Nooksack, Skagit, Stillaguamish, Snohomish, Skykomish, Snoqualmie, Puyallup, Nisqually, Hamma Hamma, Duckabush, Dosewallops, Dungeness and Elwha Rivers (Wydoski and Whitney 2003). Pink salmon have been reported in other systems (e.g., Bogachiel River, Lake Washington), but these are considered strays, not spawning populations (Wydoski and Whitney 2003) (Figure 2.17).

Figure 2.17 – Distribution of pink salmon.

HABITAT USE

Adult

Pink salmon, the smallest of the Pacific salmon, mature and spawn on a two-year cycle. In Washington, pink salmon spawn only in odd years except for the Snohomish River, which has both odd and even-year spawners (Wydoski and Whitney 2003). This species is an opportunistic, generalized feeder, foraging on a variety of forage fish (herring, sandlance), crustaceans (crab larvae, copepods, amphipods, euphausiids), ichthyoplankton and zooplankton (Heard 1991). Adults range in length from 0.3 to 0.75 meters with weights averaging almost 2 kilograms (Wydoski and Whitney 2003) and spend a little over a year in the open ocean before returning to spawn.

Spawning/Incubation/Emergence

Spawning migrations occur between mid-June and late October, although in Washington they are most common during August and September (Hard et al. 1996; Wydoski and Whitney 2003). Arrival time of pink salmon can vary within the same river system, causing an early and late run (Hard et al. 1996).

It is rare for Pink salmon to make extended spawning runs like other species of salmon, and spawning generally occurs near river mouths or a short distance upstream in rivers with fast-flowing current (Wydoski and Whitney 2003). Unlike many other salmonids, pink salmon will spawn in rivers with substantial amounts of silt from glacial runoff such as the Nisqually and Nooksack (Hard et al. 1996). Some researchers have linked the timing of this species spawning runs to water temperature and tidal/current conditions in the nearshore bays and estuaries of the fishes natal rivers (Heard 1991). Spawners may remain in local bays for up to a month before migrating into the river, it is believed that this delay allows for full gonadal development (Heard 1991). Although intertidal spawning is known to occur, it is not common in Washington (Hard et al. 1996).

Pink salmon spawning behavior is similar to that of other salmonids, with females generally digging redds in riffles with small- to medium-sized gravel, though they may also use the tail-ends of pools (Wydoski and Whitney 2003). The incubation period for this species is approximately five months, with emergence taking place between late January and April and peaking during March and April (Hard et al. 1996). As egg development is highly dependent upon water temperature, the time periods for incubation and emergence timing vary from year to year (Wydoski and Whitney 2003). After the eggs hatch, the alevins may remain in the interstitial spaces of the gravel for several months (Heard 1991), with the fry emerging from the gravel at about 30 millimeters in length and fully prepared for migration to saltwater (Quinn 2005).

Rearing/Out-migration

Pink salmon migrate downstream almost immediately after emergence and if the distance to saltwater is short, the migration may occur in one night (Heard 1991). The species spends very little time in estuarine environments, moving quickly to marine nearshore habitats where they grow rapidly, feeding on small crustaceans, such as euphausiids, amphipods and cladocerans (Hard et al. 1996). Prey may be benthic or pelagic in nature, though foraging usually occurs in the water column in nearshore areas, along beaches or shorelines with complexity (Heard 1991). Juveniles form schools in estuaries for several months during the summer before moving offshore by late summer or early fall (Hart et al. 1996; Wydoski and Whitney 2003). Some Puget Sound populations spend their entire marine life in marine nearshore habitats (Hard et al. 1996).

POPULATION TRENDS

According to Hart et al. (1996), pink salmon populations are relatively healthy in the state of Washington, with the exception of rivers along the Strait of Juan de Fuca. The Elwha River population is thought to be extinct and the Dungeness River stocks are considered depressed as a result of heavy flooding in 1979 and 1980 (Hart et al. 1996). Both anthropogenic and natural disturbances have profound impacts on this species due to their strict two-year life cycle (Heard 1991).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Because pink salmon spawn and incubate in rivers and streams, they are particularly susceptible to human-induced changes in water quality and/or habitat degradation. Spawning habitat is particularly subject to the negative impacts from land-use activities such as logging, agriculture, grazing practices, and urban/suburban development. Common problems include modification of flow regimes, non-point source pollution and physical habitat destruction. Additional impacts to pink salmon populations may result from habitat loss as a result of physical barriers to migration (i.e. blocked culverts, dams, water-diversion structures); high temperatures and low flows; and natural events, such as landslides or flood-induced changes.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Pink salmon account for over 50 percent of the commercial salmon harvest on the west coast (Wydoski and Whitney 2003) and while there is some indication that escapement has declined in British Columbia, over-utilization has not been identified as a threat to Washington populations (Hard et al. 1996).

Disease or Predation

Atlantic salmon aquaculture may cause extremely high sea lice (*Lepeophtheirus salmonis*) infestation rates in pink salmon (Morton et al. 2004). Because net pen farms may offer suitable overwintering habitat for sea lice, and pink salmon are small during their nearshore life stage, sea lice infection may result in the high mortality of pink salmon (Morton et al. 2004). Disease from sea lice infection includes skin erosion and hemorrhaging that can result in lethal bacterial infections, fungal infections and osmoregulatory failure (Wootten et al. 1982). Pink salmon are common prey items for marine mammals in the Gulf of Alaska and are also eaten by Pacific halibut, though consumption rates don't appear to have a major impact on the population (Heard 1991).

Adequacy of Existing Regulatory Mechanisms

Few regulatory mechanisms exist for pink salmon. Where the species overlaps with Chinook and summer chum salmon, such as in some of the Puget Sound rivers and in Hood Canal, it is protected by regulatory mechanisms related to those species status as Threatened or Endangered under ESA.

Other Factors Affecting Continued Existence

Habitat destruction is the most pressing concern for all salmon species. Their unique and diverse habitat requirements make them especially susceptible to disturbance. Pink salmon make heavy use of nearshore marine areas along Puget Sound and Hood Canal, and alteration of this zone may impede their rearing and migration.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Pink salmon may be affected by a variety of activities authorized by Washington DNR on state-owned rivers, estuaries and nearshore marine areas. Like other salmonids, they experience high rates of mortality during incubation, and disturbances, such as increased siltation, high or low water velocities and volumes, or increased temperatures may further impede successful emergence. Nearshore areas are thought to be of high importance for pink salmon and activities that result in the removal of eelgrass or decreased benthic production, such as the construction and operation of over-water structures or shoreline armoring modifications may reduce their ability to forage and/or migrate. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality and increased potential for the bioaccumulation of pollutants. The construction of roads and bridges may cause increased sedimentation during construction, and may increase temperature and pollutant loads from stormwater runoff during operation. Aquaculture operations may result in disease transmission, decreased dissolved oxygen levels and genetic dilution. They may also impact salmon through the increases in nitrogenous waste and the introduction of chemicals such as antifoulants, pesticides and antibiotics.

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2-3.7 Sockeye salmon (*Oncorhynchus nerka)*

STATUS AND RANK

See glossary for listing and ranking definitions and criteria.

FEDERAL STATUS (US FISH AND WILDLIFE, NOAA FISHERIES)

Entity	Status/Rank
NOAA Fisheries	
Baker River	Not Listed
Lake Pleasant	Not Listed
Lake Wenatchee	Not Listed
Okanogan River	Not Listed
Ozette Lake	Threatened
Quinault Lake	Not Listed
Snake River	Endangered
Washington State	
Ozette Lake	Candidate Species
Snake River	Candidate Species
Natural Heritage Program	
Ozette Lake	G5, T2Q; SNR
Snake River	G5, T1Q; SNR

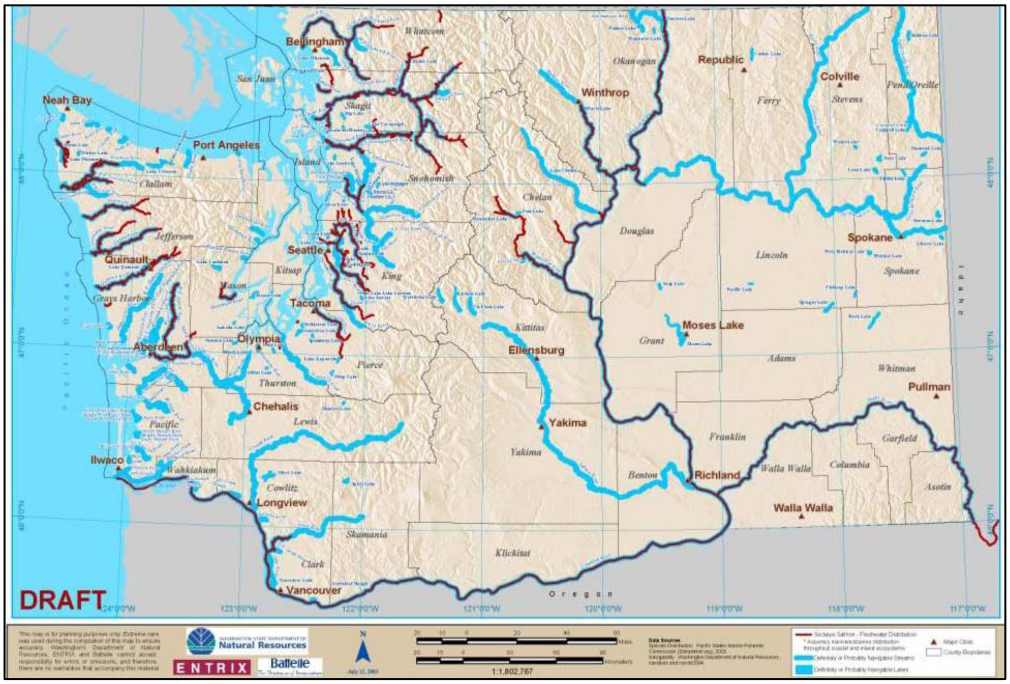
RANGE

The historical range of sockeye salmon is thought to be close to their current range (Burgner 1991; Gustafson et al. 1997; Wydoski and Whitney 2003). The species naturally occurs from Alaska though British Columbia and into Washington and Idaho, as far south as the Columbia River system. Sockeye occur in an anadromous and a land-locked form, which is referred to as kokanee.

The Washington Department of Fish and Wildlife recognizes nine sockeye salmon stocks in the state, with the two largest runs occurring in Lake Washington (three stocks) and the Columbia River (two stocks). Sockeye are found throughout the state in the Snake, Okanogan, Lake Wenatchee, Lake Quinault, Lake Ozette, Baker River, Lake Pleasant and Big Bear Creek drainages. The landlocked form of sockeye (Kokanee) occurs in many lakes throughout Washington, with some of the larger populations in Banks and

Loon Lakes in eastern Washington, and Lake Whatcom and Lake Washington-Sammamish in western Washington (Wydoski and Whitney 2003) (Figure 2.18).

Figure 2.18 – Distribution of sockeye/kokanee salmon.



HABITAT USE

Adult

Sockeye is one of the most complex of any Pacific salmon species because of its variable freshwater residency (1 to 3 years), and because the species has several different forms. While most sockeye are anadromous and spawn in rivers or lakes, some remain in freshwater throughout their life span (Wydoski and Whitney 2003). Anadromous forms stay at sea for 2 to 4 years, reaching a maximum length of 83 centimeters and weighing between 1.5 and 3.5 kilograms at maturity, whereas landlocked forms are generally smaller (lengths 20 to 40 centimeters) (Wydoski and Whitney 2003). Adult diet varies by life form, with ocean populations being generally piscivorous and landlocked forms consuming zooplankton and aquatic and terrestrial insects (Wydoski and Whitney 2003)

Spawning/Incubation/Emergence

Sockeye salmon exhibit the greatest diversity in selection of spawning habitat, river entry timing and the duration of holding in lakes prior to spawning among the Pacific salmon. Although the species typically spawns in inlet or outlet tributaries of a nursery lake, they may also spawn in 1) suitable habitat between lakes; 2) along the shore of nursery lakes on tributary outwash fans or submerged beaches where groundwater upwelling occurs; 3) along beaches where the gravel or rocky substrate is free of fine sediment and the eggs can be oxygenated by wind-driven circulation; or 4) in mainstem rivers without juvenile lake-rearing habitat (Burgner 1991).

Adult sockeye salmon home precisely to their natal stream or lake habitat (Hanamura 1966; Quinn 1984; Quinn et al. 1987), with stream fidelity thought to be adaptive, ensuring that juveniles will encounter a suitable nursery lake. Spawning begins as early as August, with some stocks spawning into February. Similarly to other salmonids, sockeye require well-oxygenated riffles with egg and alevin survivals dependent on clean spawning gravels and low-to-moderate winter stream flows.

The species adaptation to utilizing lacustrine environments for both adult spawning and juvenile rearing has resulted in the evolution of complex timing for incubation, fry emergence, spawning and adult lake entry that often involves intricate patterns of adult and juvenile migration and orientation not seen in other Oncorhynchus species (Burgner 1991).

At a constant temperature of 10° Celsius, sockeye salmon had the longest incubation period to 50 percent hatch of five salmon species tested. Benefits of inter-gravel incubation include protection from predation, freezing, fluctuating flows and desiccation. Survival during incubation is influenced by environmental conditions, the degree of crowding during spawning (Burgner 1991), the type of gravel in which eggs are laid, and the gravel's permeability to water (Burgner 1991).

Rearing/Out-migration

Sockeye migrate downstream to the deep waters of nursery lakes upon emergence from spawning sites, at a size of approximately 25 to 32 millimeters (1.0 to 1.26 inches). At this small size, sockeye fry are vulnerable to predation by other fishes and birds, and survivals can be lowered substantially by aggregations of predators. Cool, clean water is essential for the survival of sockeye during freshwater rearing, with water temperatures greater than 20° Celsius impairing growth rates if adequate food is not available (Meehan 1991). Higher growth rates not only reduce the species vulnerability to predators, but also have a direct affect on survival rates of anadromous forms (Washington Fish and Wildlife 2005).

Growth influences the duration of stay in the nursery lake and is influenced by intra- and inter-specific competition, food supply, water temperature, thermal stratification, migratory movements to avoid predation, lake turbidity and by the length of the growing season. Lake residence time is usually greater the farther north a nursery lake is located. In Washington and British Columbia, lake residence is normally 1 or 2 years, whereas in Alaska, some fish may remain 3, or rarely 4, years in the nursery lake prior to smoltification (Burgner 1991).

Juvenile sockeye typically rear for 1 to 3 years in lake habitats, with anadromous forms out-migrating, and Kokanee continuing their lake residency and becoming sexually mature at ages 2 to 3 years (Wydoski and Whitney 2003). The offspring of riverine spawners generally rear for 1 to 2 years in lower slow-velocity sections of rivers (river-type), although some populations migrate to estuarine environments after a few months in their natal stream (sea-type) (Burgner 1991). Out-migrating lake-type sockeye typically migrate to the estuary between 1 and 3 years of age (Burgner 1991).

Juvenile sockeye salmon spend the first part of their marine lives in estuarine and nearshore areas adjacent to their natal streams, although their residence time in these

areas may be the shortest for any of the salmon species. Smolt migration begins in late April, with southern stocks migrating earliest. Northward migration of juveniles to the Gulf of Alaska occurs in a band relatively close to shore, and offshore movement of juveniles occurs in late autumn or winter. Sockeye salmon prefer cooler ocean conditions than do other Pacific salmon (Burgner 1991).

POPULATION TRENDS

Catch records for sockeye have fluctuated cyclically during the last 30 years, but reached record low levels during the last decade (Stouder et al. 1997). In general, sockeye populations throughout the region are considered depressed from historic levels. NOAA Fisheries has identified seven individual ESUs for sockeye in Washington (Gustafson et al. 1997), with two of these ESUs considered to be in danger of or Threatened with extinction (Snake River and Ozette Lake).

THREATS WARRANTING ESA PROTECTION

Because juvenile sockeye can spend a significant portion of their lives in rivers, streams and lakes, they are particularly susceptible to human-induced degradation of water quality and habitat. In addition, adult spawning habitat is also subject to the negative impacts of land-use activities such as logging, agricultural, grazing, and urban/suburban development. Common problems include modification of the natural hydrologic regime, non-point-source pollution and physical habitat destruction. Finally, adults and juveniles are affected by the presence of physical barriers to migration, including blocking culverts, dams, water-diversion structures and low-flow barriers, as well as by high temperatures.

Destruction, Modification, or Curtailment of Habitat or Range

Habitat degradation and loss in freshwater, estuarine and marine systems is thought to be a significant contributing factor to sockeye population declines throughout the Pacific Northwest region. Of particular concern is lakeshore development or other human activities that degrade lake ecosystems that support sockeye and/or Kokanee populations (Gustafson et al. 1997). Habitat degradation and loss has been linked to timber-harvest activities, agriculture and grazing, and urbanization (Stouder et al. 1997). Hydroelectric dams and irrigation withdrawals have also been linked to the decline of salmon populations in general, especially those in the Columbia River Basin (Stouder et al. 1997).

Channelization and bank armoring reduces the amount, quality and diversity of sockeye spawning areas by narrowing and deepening the stream channel. Those sockeye that spawn on lakeshores need access to undisturbed, shallow-water shorelines and clean gravels with upwelling ground water (Washington Fish and Wildlife 2005).

The erosion and downstream movement of spawning gravels is a major cause of egg and alevin losses, and severe flooding can cause mortalities exceeding 90 percent. Land-use practices and natural events that introduce substantial amounts of silt into spawning streams affect sockeye inter-gravel survivals by reducing the permeability of the gravel, which can affect the survival of incubating eggs and alevins by interfering with the delivery of oxygenated water and the removal of metabolic wastes.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Fishing pressure (commercial and recreational) has been identified as a contributing factor in the decline of sockeye populations (Gustafson et al. 1997). Although catch records have been used to manage sockeye abundance throughout the Pacific Northwest, the inherent geographic and genetic variability of the harvest composition may result in the over harvesting of specific stocks.

Disease or Predation

Neither disease nor predation has been identified as a significant threat to the species as a whole (Stouder et al. 1997). However, predation on migrating sockeye salmon fry varies considerably with spawning location (lakeshore beach, creek, river or spring area). Sockeye salmon fry mortality due to predation by other fish species and birds can be extensive during downstream and upstream migration to nursery lake habitat and is only partially reduced by the nocturnal migratory movement of some fry populations (Burgner 1991).

Adequacy of Existing Regulatory Mechanisms

Existing regulatory mechanisms attempt to differentiate between hatchery and wild stock harvests, and include geographic regulations such as specific river drainages. However, it is not clear that these measures have been effective in protecting sockeye and Kokanee populations. In addition, current harvest regulations also may not be adequate to protect these fish. Finally, it is not clear whether current regulations governing land-use activities (timber harvest, agriculture and urban/suburban development) will be adequate to prevent further habitat degradation or loss.

Other Factors Affecting Continued Existence

Fish-passage barriers are a potential problem for sockeye and Kokanee, which often utilize lake tributaries to spawn. Additionally, unfavorable climatic conditions during the last several years may have negatively affected marine survivability for sockeye.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Sockeye and Kokanee populations are likely to be affected by activities authorized by Washington DNR on state-owned riverine, lake and nearshore-estuarine systems. Outfalls may increase eutrophication, siltation and water temperature warming in cold, oligotrophic, deepwater lake habitats. Over-water structures (e.g., boat ramps/launches, jetties) may alter shallow-water habitats. Nearshore and transportation related activities (e.g., fill and bank armoring, sediment disturbance, utility line construction) could alter shallow-water lake and stream tributary habitats. Aquaculture operations may cause disease transmission, decreased dissolved oxygen levels and genetic dilution. They may also impact salmon through the increases in nitrogenous waste and the introduction of chemicals such as antifoulants, pesticides and antibiotics.

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2-3.8 Steelhead (*Oncorhynchus mykiss)*

STATUS AND RANK

Steelhead trout have been identified as Threatened or Endangered in Washington primarily because of habitat degradation or loss, along with overharvesting and competitive pressures from hatchery stocks (NOAA Fisheries 1996). The National Oceanic and Atmospheric Administration Fisheries recognizes 15 ESUs of steelhead, several of which occur in Washington. See glossary for listing and ranking definitions and criteria.

FEDERAL STATUS (NOAA FISHERIES 2005)

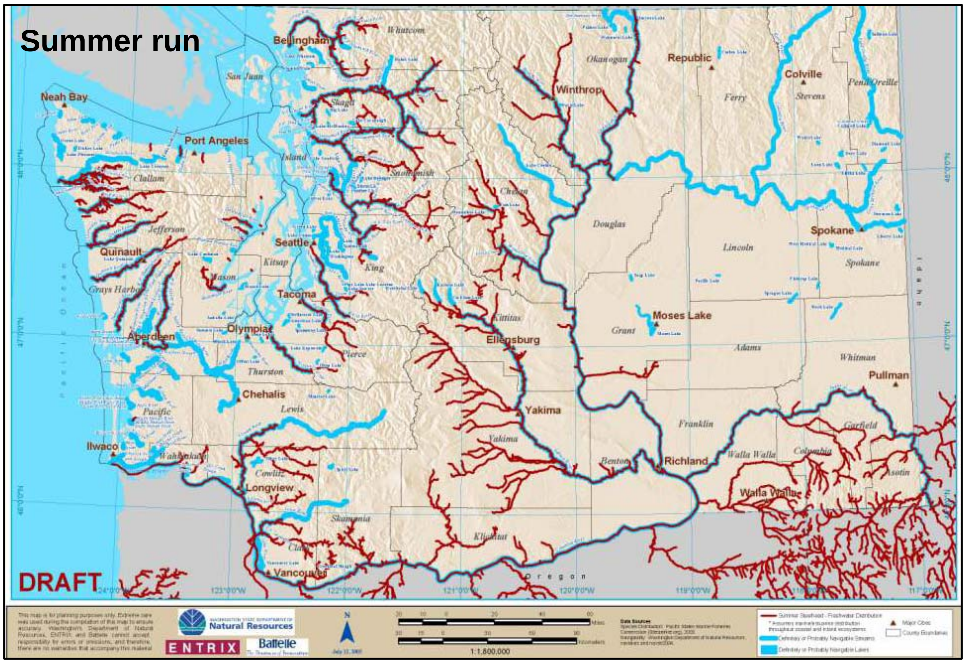
Entity	Status/Rank
NOAA Fisheries	
Lower Columbia River	Threatened
Middle Columbia River	Threatened
Olympic Peninsula	Not Listed
Puget Sound	Threatened
Snake River Basin	Threatened
Southwest Washington	Not Listed
Upper Columbia River	Threatened
Washington State	
Lower Columbia River	Candidate Species
Middle Columbia River	Candidate Species
Snake River Basin	Candidate Species
Upper Columbia River	Candidate Species
Natural Heritage Program	
Lower Columbia River	G5, T2Q; SNR
Middle Columbia River	G5, T2Q; SNR
Snake River Basin	G5, T2T3; SNR
Southwest Washington	G5, T3Q; SNR
Upper Columbia River	G5, T2Q; SNR

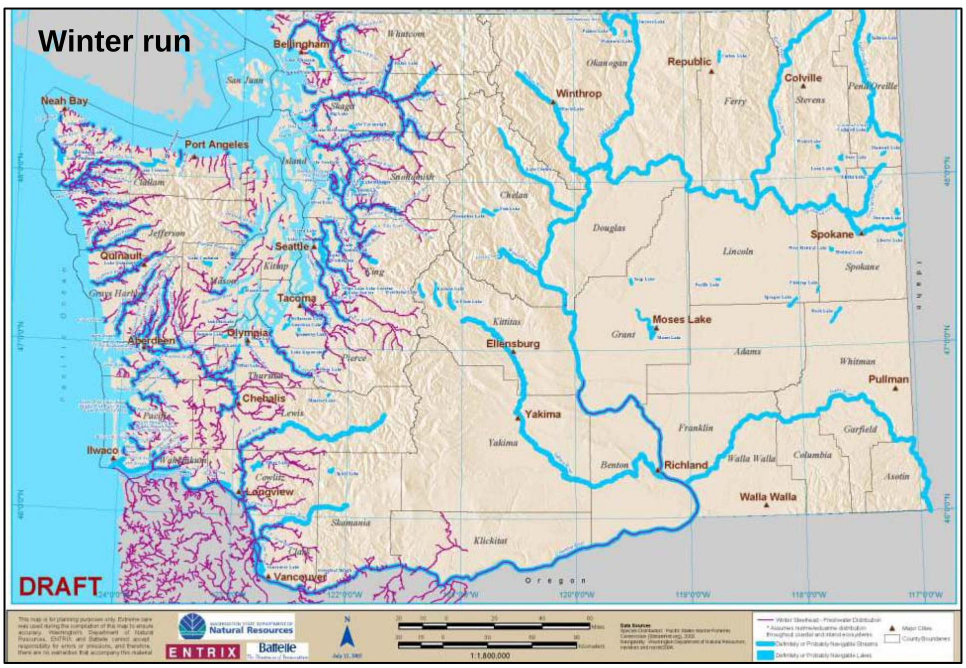
RANGE

Currently, steelhead trout occur naturally from Alaska through British Columbia, Washington, Oregon, California and Idaho. The historic range is thought to be from northern Mexico to Alaska in most rivers with access to the Pacific Ocean (Groot and Margolis 1991; Busby et al. 1996; Wydoski and Whitney 2003). Steelhead trout have also been introduced worldwide, becoming naturalized in many areas with rainbow trout, the non-anadromous form of steelhead.

Steelhead populations in Washington occur in the Upper, Lower and Middle Columbia River, Puget Sound, on the Olympic Peninsula, in southwest Washington and the Snake River Basin (Figure 2.19).

Figure 2.19 – Distribution of steelhead.





HABITAT USE

Adult

During their ocean phase of life, steelhead range from Alaska to Japan (McKinnell et al. 1997) and are generally found within 16 to 40 kilometers (10 to 25 miles) of the shore (Wydoski and Whitney 2003). Steelhead remain in the marine environment 2 to 4 years and attain lengths of approximately 0.6 meters, with weights ranging from 2.5 to 5

kilograms (Wydoski and Whitney 2003). Although the species is mainly piscivorous feeding on juvenile rockfish (*Sebastes* spp.), sand lance (*Ammodytes hexapterus*), sculpin (Cottidae), and greenlings (Hexagrammidae) they also feed on invertebrates, especially euphausiids, amphipods, copepods and squid (Groot and Margolis 1991). Unlike most other salmonids, steelhead are iteroparous - capable of spawning more than once and adults return to the ocean after spawning (Wydoski and Whitney 2003).

Spawning/Incubation/Emergence

Most steelhead spawn at least twice in their lifetimes with many returning to spawn three or four times (Wydoski and Whitney 2003). However, in larger rivers where steelhead travel long distances to their natal spawning grounds, the proportion of returning adults who spawn more than once is considerably lower (Meehan 1991). While steelhead typically spawn in the spring, there are two runs: a summer run that enters freshwater in August and September, and a winter run that occurs from December through February (Wydoski and Whitney 2003).

Spawning behavior is similar to other salmonids, with females digging redds in cold, well-oxygenated waters where there are gravel substrates (Groot and Margolis 1991; Wydoski and Whitney 2003). Escape cover, such as logs, undercut banks and deep pools are also important for adult and young steelhead (Meehan 1991).

The length of time it takes for eggs to hatch is heavily dependent on water temperature, and under controlled conditions, steelhead eggs usually hatch after about 30 days at a temperature of 10° Celsius. Although eggs hatch sooner in warmer water, the young fish are smaller and generally have lower survival rates. If the temperature goes too high, eggs will not hatch at all (Groot and Margolis 1991).

After hatching, alevins typically remain in the gravel for another 4 to 6 weeks, obtaining nutrients from the yolk sack attached to their body. When they emerge from the gravel as fry, the young move to shallow, protected areas at the stream margins where they establish and defend feeding areas. Most juveniles can be found in riffles, although larger ones will move to pools or deep runs (Meehan 1991).

Rearing/Out-migration

Cool, clean water is essential for the survival of steelhead during all portions of their freshwater rearing. Warmer water (>20° Celsius) not only can impair growth rates by reducing food supplies, but also holds less dissolved oxygen and increases the steelhead’s susceptibility to disease (Meehan 1991).

Steelhead may rear in freshwater for up to 4 years before migrating to sea, although the most common pattern for fish in Washington is 2 years in fresh water followed by 2 years at sea before spawning (Busby at al. 1996). This species can use all types of freshwater riverine habitat for rearing, but prefers faster water (e.g., riffles or runs) than Coho and Chinook salmon rearing in the same streams (Meehan 1991).

During their first summer, juvenile steelhead are typically found at the downstream end of relatively shallow areas with cobble and boulder bottoms or in riffles less than two feet deep (Meehan 1991). Similar to other species of salmonids, juveniles generally prefer areas that include large woody debris, root wads and/or boulders as cover from predators

and as protection from both high and low stream-flow events. As juvenile steelhead grow, pools with an abundance of escape cover become more important as habitat (Stouder et al. 1997). Young-of-the-year steelhead feed primarily on aquatic insects, such as mayflies, caddisflies and chironomids, although terrestrial invertebrates are also considered important prey (Groot and Margolis 1991). Out-migrating smolts typically leave their natal streams between 2 and 4 years of age (Groot and Margolis 1991) traveling through most, if not all, of the marine environments, including estuaries, nearshore habitat and open ocean.

POPULATION TRENDS

In general, steelhead populations throughout the region are considered depressed from historical levels, with 5 of the 15 ESUs in the Pacific Northwest considered to be in danger of extinction and 4 others considered Threatened or likely to become Endangered (NOAA Fisheries 1996). Populations for the seven stocks occurring in Washington are:

Puget Sound ESU

Recent population trends within the Puget Sound ESU are predominantly decreasing; however, trends in the two largest stocks (Skagit and Snohomish Rivers) have been increasing (Busby et al. 1996).

Olympic Peninsula ESU

Although population trends for Olympic Peninsula steelhead are generally increasing, some stocks appear to be declining and there is also uncertainty regarding the degree of interaction between hatchery and natural stocks (Busby et al. 1996).

Southwest Washington ESU

This ESU occupies the tributaries to Grays Harbor, Willapa Bay and the Columbia River below the Cowlitz River in Washington (including the Grays River basin). Most population trends within this ESU have been declining and there is also uncertainty regarding the degree of interaction between hatchery and natural stocks (Busby et al. 1996).

Lower Columbia ESU

The Lower Columbia ESU occupies tributaries to the Columbia River between the Cowlitz and Wind Rivers in Washington. While most of the stocks in this ESU for which data exists have been declining, others have been increasing strongly (Busby et al. 1996).

Middle Columbia ESU

The Middle Columbia River ESU occupies the Columbia River Basin from above the Wind River in Washington and the Hood River in Oregon upstream to the Yakima River. Some uncertainty exists about the exact boundary between coastal and inland steelhead, and the western margin of this ESU reflects currently available genetic data. Most natural stocks for which we have data within this ESU have been declining (Busby et al. 1996).

Upper Columbia ESU

The Upper Columbia ESU occupies the Columbia River Basin upstream from the Yakima River. Total abundance of populations within this ESU has been relatively stable or increasing; however, this trend appears to be primarily a result of major hatchery supplementation programs. The major concern for this ESU is the clear failure of natural stocks to be self-sustaining. (Busby et al. 1996).

Snake River Basin ESU

This ESU occupies the Snake River Basin of southeast Washington, northeast Oregon and Idaho. The majority of natural stocks for which we have data within this ESU have been declining (Busby et al. 1996).

THREATS WARRANTING ESA PROTECTION

Because juvenile steelhead spend a significant portion of their lives in rivers and streams, they are particularly susceptible to human-induced degradation of water quality and habitat. In addition, adult spawning habitat is also subject to the negative impacts of land-use activities such as logging, agricultural, grazing, and urban/suburban development. Common problems include modification of the natural hydrologic regime, non-point-source pollution and physical habitat destruction. Finally, adults and juveniles are affected by the presence of physical barriers to migration, including blocking culverts, dams, water-diversion structures and low-flow barriers, as well as by high temperatures.

Destruction, Modification, or Curtailment of Habitat or Range

Habitat degradation and loss in freshwater, estuarine and marine systems is thought to be a significant contributing factor to steelhead population declines in Washington and throughout the Pacific Norwest region (Busby et al. 1996). Habitat degradation and loss has been linked to timber harvest activities, agriculture, grazing, and urbanization (Stouder et al. 1997). Hydroelectric dams and irrigation withdrawals have also been identified as causal (Stouder et al. 1997).

Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes

Fishing pressure (commercial and recreational) has been identified as a contributing factor in the decline of steelhead populations (Stouder et al. 1997).

Disease or Predation

Neither disease nor predation has been identified as a significant threat to the species as a whole (Stouder et al. 1997).

Adequacy of Existing Regulatory Mechanisms

Existing regulatory mechanisms attempt to differentiate between hatchery and wild stock harvests, and include geographic regulations such as specific river drainages. However, it is not clear that these measures have been effective in protecting steelhead populations. In addition, current harvest regulations also may not be adequate to protect these fish. Finally, it is not clear whether current regulations governing land-use activities (timber

harvest, agriculture and urban/suburban development) will be adequate to prevent further habitat degradation or loss.

Other Factors Affecting Continued Existence

Fish passage barriers have long been a problem for steelhead, which often use upper tributaries to spawn. Additionally, unfavorable climatic conditions during the last several years may have negatively affected marine survivability for steelhead.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Although steelhead do not extensively use nearshore habitats, they may be affected by activities authorized by Washington DNR occurring in state-owned riverine habitats. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality and increased potential for the bioaccumulation of pollutants. Over-water structures (e.g., boat ramps/launches, jetties) may alter shallow-water habitats. The construction of roads and bridges may result in increased sedimentation during construction, and may increase temperature and pollutant loads from stormwater runoff during operation. Aquaculture operations may result in disease transmission, decreased dissolved oxygen levels and genetic dilution. They may also impact salmon through the increases in nitrogenous waste and the introduction of chemicals such as antifoulants, pesticides and antibiotics.

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2-3.9 Green sturgeon (*Acipenser medirostris)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	
Northern Distinct Population Segment	Not Listed
Southern Distinct Population Segment	Endangered
Washington State	Not Listed
Natural Heritage Program	G3; S2N

RANGE

Range-wide, green sturgeon occur in nearshore marine habitats along the Pacific coast from Ensenada, Mexico, north to southeastern Alaska (Wydoski and Whitney 2003). An anadromous species, the green sturgeon spends more time in the ocean than any other sturgeon, but occurs seasonally in the lower reaches of larger rivers and estuaries (Adams et al. 2002; Wydoski and Whitney 2003). Reproductive populations of green sturgeon currently occur in the Sacramento, Klamath and Rogue Rivers, and were historically thought to spawn in the Eel, Umpqua and South Fork of the Trinity River (Adams et al. 2002).

Green sturgeon are present in all marine areas of Washington State, with minor catches occurring in Puget Sound and coastal Washington. Concentrations of green sturgeon are found during the summer in Willapa Bay, Grays Harbor and the lower 60 miles of the Columbia River (to Bonneville Dam) (Adams et al. 2002). Green and white sturgeon have also been observed concentrating in some tributaries (e.g., Salmon Creek in

Discovery Bay) of Puget Sound / Strait of Juan de Fuca (Johnson, Personal communication. March 16, 2005). However, information regarding the geographic distribution of green sturgeon in Washington State is incomplete, therefore no species distribution map is presented for this species.

HABITAT USE

Adult

Like all sturgeon species, green sturgeon are characterized by their large size, longevity, delayed maturation, high fecundity and slow growth. Adults are estimated to live for up to 60 years and reach a maximum length of 2.1 meters and 136 kilograms (Hart 1988; Emmett et al. 1991). As adults they are tolerant of a wide range of salinities and spend most of their life in nearshore marine waters and estuaries (Emmett et al. 1991). Green sturgeon are anadromous, with adults residing in subtidal areas and appearing to move from coastal marine waters into estuaries and rivers to feed and spawn (Emmett et al. 1991).

Green sturgeon have a ventral, protrusible mouth that is adapted to feeding over unconsolidated sediments; prey include benthic and epibenthic invertebrates (e.g., shrimp, mollusks, amphipods) and small fish, such as Pacific sand lance (Hart 1988; Adams et al. 2002; Wydoski and Whitney 2003). The species life history, habits, age, and growth have not been studied extensively (Emmett et al. 1991; Wydoski and Whitney 2003), although the proposed federal listing has spurred a number of recent research projects designed to clarify ecological and biological questions (Beamesderfer and Webb 2002; Farr and Rien 2002).

Some individuals travel extensive distances in the ocean, with fish tagged in the Sacramento-San Joaquin estuary being collected from the Columbia River and Grays Harbor one to three years later (Emmett et al. 1991). Tagging studies suggest that many immature green sturgeon migrate north from their natal rivers in California and Oregon, and concentrate in Washington and Oregon coastal estuaries during the summer (Adams et al. 2002). Reasons for these seasonal concentrations are unclear, as there is no documented spawning in these systems and stomachs are generally empty.

Spawning

While there are no documented spawning locations for green sturgeon within Washington State; spawning locations currently exist within the Sacramento, Klamath and Rogue Rivers. In these systems, adults migrate into rivers to spawn during March to July, with a peak in mid-April to mid-June. Green sturgeon males reach sexual maturity at 15 to 30 years of age, and females mature at 17 to 40 years (Adams et al. 2002). Spawning is thought to be episodic, occurring once every 3 to 5 years (Adams et al. 2002), and annual success likely varies greatly depending on conditions (Beamesderfer and Webb 2002). Adult green sturgeon broadcast spawn in deep areas with swift current and substrate ranging from clean sand to bedrock (Emmett et al. 1991), although the relatively nonadhesive eggs are most likely broadcast over large cobble, where they settle into crevices and interstitial spaces until hatching (Adams et al. 2002). Female green sturgeon have relatively low fecundity compared with other sturgeon species, and produce 60,000 to 140,000 eggs (Adams et al. 2002).

Incubation / Emergence / Larvae

Temperatures above 20° Celsius are lethal to green sturgeon eggs in the laboratory (Adams et al. 2002). It is unclear from the literature what the flow requirements are for incubation; however, time to hatching has been estimated to be 196 hours at 12.7° Celsius for similar species (Emmett et al. 1991). Green sturgeon larvae are fast-growing and robust, with optimal laboratory growth rates observed at 15° Celsius (Adams et al. 2002). Larvae are also photonegative and appear to be nocturnal, potential adaptations for avoiding downstream displacement and predation (Adams et al. 2002). Larvae begin to exhibit feeding behavior at about 10 days post-hatch, and metamorphose to juveniles in freshwater riverine habitats at approximately 2.0 centimeters in 45 days (Emmett et al. 1991).

Early Juvenile

Juvenile green sturgeon are common in tidal freshwater areas of their natal rivers, and migrate out to nearshore marine waters between one and four years of age (Emmett et al. 1991). They grow rapidly (to 300 millimeters in one year) on a diet of benthic invertebrates, such as amphipods and mysid shrimp (Adams et al. 2002; Wydoski and Whitney 2003). Juvenile green sturgeon are often found in shallow water (1 to 3 meters deep), and may forage over tidal flats (Emmett et al. 1991).

The scientific literature generally does not distinguish any differences between habitat use by older, sexually immature green sturgeon and adults (see adult section).

POPULATION TRENDS

Two green sturgeon DPSs were identified based on preliminary genetic evidence and spawning site fidelity: 1) the northern DPS, encompassing all populations from the Eel River, in northern California, northward, and 2) the southern DPS, including all populations south of the Eel River (essentially the Sacramento River population) (Adams et al. 2002).

Researchers recently concluded that there is not adequate population abundance or trend data to assess the population status of green sturgeon (Adams et al. 2002; 50 C.F.R. 223-224, 2003). Because green sturgeon are not a targeted fishery, all harvest data are based on bycatch from white sturgeon and tribal salmon gillnet fisheries; only one nonharvest population estimate is made and it is based on incidental monitoring of white sturgeon populations. Taken together, the data may suggest that green sturgeon harvest has declined in recent years while average green sturgeon size has increased. However, these data time series suffer from changing regulations and effort levels, and no analysis resulted in significant abundance trends (Adams et al. 2002). The National Marine Fisheries Service biological review team did conclude that green sturgeon in each DPS "faced considerable threats to their populations" and "should be placed on the Candidates list and have their status reviewed within five years" (Adams et al. 2002). These finding were especially relevant to the much smaller southern DPS, for which summer temperatures in the Sacramento River approach the lethal limits for larvae.

However, it should be noted that in an independent review of the same information, Beamesderfer and Webb (2002) suggest that green sturgeon abundance may be increasing primarily based on their interpretation of Columbia River harvest data and

apparent increasing trends in average size. They suggest that increasing trends in average size are a result of decreasing recruitment or mortality; however, these suggestions are not the only explanation for these trends, and warrant more critical evaluation.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

The loss and/or destruction of critical spawning habitat are of utmost concern in the decline of green sturgeon, which are concentrated in three significant spawning locations (Adams et al. 2002). The concentration of these physically unique spawning locations (high flow, deep water, specific substrate characteristics) makes green sturgeon vulnerable to possible catastrophic events. This is especially relevant to the southern DPS in the Sacramento River, which has a number of state and federal water-diversion facilities that entrain juvenile sturgeon as water is withdrawn from the Sacramento-San Joaquin Delta. Dam operation and land-use practices may also affect green sturgeon spawning habitat.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Although the green sturgeon is not specifically targeted in many commercial, tribal, or recreational fisheries because of the inferior quality of its flesh and eggs (Wydoski and Whitney 2003), there are concerns because it is commonly harvested as bycatch in those fisheries targeting more highly prized white sturgeon and salmon (Adams et al. 2002).

Disease or Predation

Neither disease nor predation has been identified a significant threat to the species as a whole.

Adequacy of Existing Regulatory Mechanisms

Current population abundance and trend data are inadequate to assess green sturgeon population status (Adams et al. 2002), and it is therefore not possible to determine the adequacy of existing regulatory mechanisms. While some authors have suggested that management activities designed to protect white sturgeon have incidentally benefited green salmon (Beamesderfer and Webb 2002), this observation highlights the problem that green sturgeon catch often falls under the umbrella of the white sturgeon regulations.

Other Factors Affecting Continued Existence

Additional threats especially relevant to green sturgeon in the southern DPS include potentially lethal temperature limits for larvae, juvenile entrainment by water projects and bioaccumulation of toxic materials such as polychlorinated biphenyls (PCBs) (Adams et al. 2002).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Green sturgeon in the offshore environment are not likely to be affected by most activities authorized on state-owned aquatic lands by Washington DNR. Areas of concern include activities authorized within the estuarine and freshwater habitat systems of Grays Harbor, Willapa Bay, the lower Columbia River and some areas of Puget Sound, where concentrations of green sturgeon are found during the summer. Discharges from outfalls and runoff from impervious surfaces (roads, docks) may contribute toxic contaminants to aquatic habitats used by sturgeon. Activities that alter feeding and rearing habitats, such as shellfish aquaculture in tidal flats and sediment disturbance associated with mining and dredging activities, may adversely impact green sturgeon. Green sturgeon may be affected by invasive-species control activities that affect prey species (e.g., benthic and epibenthic invertebrates).

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2-3.10 White sturgeon (*Acipenser transmontanus)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Not Listed
Natural Heritage Program	G4; S3B, S4N

RANGE

White sturgeon are found in coastal marine waters from Ensenada, Mexico, northward to Cook Inlet in northwestern Alaska (Emmett et al. 1991). Significant, reproducing populations of the species appear to be limited to the Sacramento, Columbia and Fraser Rivers (Wydoski and Whitney 2003). The Kootenai River white sturgeon in Idaho, Montana and British Columbia was genetically isolated from the lower Columbia River drainage by a natural barrier present since the last ice age and is the only population considered Endangered (Wydoski and Whitney 2003).

In Washington, white sturgeon are found in all nearshore marine waters in interior and coastal waters, and are considered common to abundant in Willapa Bay, Grays Harbor and the lower Columbia River, and rare in Puget Sound and Hood Canal (Emmett et al. 1991). The species can also be found in several large freshwater rivers, although the only reproductive populations in the state are found in the Columbia River (Wydoski and Whitney 2003). Dams along the Columbia River have changed the white sturgeon's historical range, creating a number of landlocked populations that are functionally restricted to these impoundments. Columbia River populations are divided into those downstream of Bonneville Dam with access to the ocean, and those present in the reservoirs and stretches of river above Bonneville Dam. White sturgeon have also been observed concentrating in some other freshwater tributaries (e.g., Salmon Creek in Discovery Bay) of Puget Sound / Strait of Juan de Fuca (Johnson, Personal communication: March 16, 2005) (Figure 2.20).

HABITAT USE

Adult

The white sturgeon is a long-lived species, with a life span that may exceed 100 years (Emmett et al. 1991) and is the largest fish found in freshwater in North America (Wydoski and Whitney 2003). This species is anadromous, although it is also capable of completing its entire life cycle in fresh water. White sturgeons are slow to mature, with 95 percent of females in the lower Columbia River becoming sexually mature between 16 and 35 years of age when they are approximately 2 meters in length; males in some areas mature as young as 9 years of age and at a smaller size than females (approximately 1.3 meters) (Wydoski and Whitney 2003).

In freshwater systems, adult white sturgeon occur in large, low-gradient rivers and associated impoundments, and are generally found in the larger, deeper pools and eddies

of main river channels where water velocity is lower. In the unimpeded reach of the Columbia River below Bonneville Dam, sturgeon appear to migrate upstream into tidal freshwater habitats during the fall and downstream into marine-influenced habitats in the late winter and spring (Wydoski and Whitney 2003). In marine systems, adult and subadult white sturgeon use a variety of unconsolidated estuarine and nearshore marine habitats, and may move onto intertidal flats to feed at high tide (Emmett et al.1991). Adult and subadult white sturgeon may also spend time in the open ocean of the Pacific, and some individuals move among coastal river systems and estuaries.

White sturgeon are generally demersal (associated with the bottom), and use barbels on their snout to locate prey in turbid bottoms. Adults feed on a variety of organisms, including fish (smelt, northern anchovy, salmon and herring), crustaceans (shrimp, amphipods, isopods and crab), worms and mollusks (clams, snails and mussels) (Emmett et al. 1991; Wydoski and Whitney 2003). Older juveniles and subadults in unimpounded river systems (e.g., Fraser and Columbia Rivers) are often found in estuarine habitats, where they consume a variety of benthic and epibenthic invertebrates, including tube-dwelling amphipods (*Corophium* sp.), bivalves, shrimp and chironomids (Emmett 1995; Wydoski and Whitney 2003).

Figure 2.20 – Distribution of white sturgeon.

Spawning

Spawning by adult white sturgeon typically occurs in early spring to early summer (Emmett et al. 1991; Wydoski and Whitney 2003). Adults generally spawn in large river channels with swift currents (0.7 to 2.8 meters per second in the Columbia River) and a substrate composed of cobble or boulders. These habitats are often limited to areas below rapids or dams. White sturgeon are broadcast spawners with external fertilization and adults may spawn multiple times within their life, with 3 to 11 years between

spawning events (Emmett et al. 1991; Wydoski and Whitney 2003). Fecundity of white sturgeon is high with mature females producing between 100,000 to 300,000eggs and larger individuals producing over a million eggs.

Incubation, Emergence and Larvae

The sticky fertilized eggs of white sturgeon settle to the river bottom, where they attach to cobble, incubate and hatch in 4 days to 2 weeks, depending on temperature (Emmett et al. 1991). Incubation occurs at temperatures ranging between 10° Celsius to 18° Celsius egg mortality occurs at temperatures exceeding 20° Celsius (Wydoski and Whitney 2003).

Larvae range in size between 8 to 19 millimeters in total length (Emmett et al. 1991). Larvae are found throughout the water column, but become oriented to the bottom within 5 to 6 days after developing pectoral fins. Larval survival is likely dependent on sustained, high riverine flows and low temperatures (Emmett et al. 1991). Larval white sturgeon deplete their yolk sacs approximately 12 days after hatching, and metamorphose to juveniles when about 20 millimeters long.

Early Juveniles

Juveniles less than one year old are found only in freshwater habitats, where they feed on algae and small invertebrates (Emmett et al. 1991). In the Columbia River, young-of-the-year white sturgeon were collected over unconsolidated sediments in water 13 to 27 meters deep with an average velocity of 0.4 meters per second (Wydoski and Whitney 2003). Subyearlings were also common during the summer over unconsolidated substrates in shallow freshwater areas of the San Joaquin Delta (Emmett et al. 1991).

Habitat use by older juveniles (subadults) is similar to that of adult white sturgeon.

POPULATION TRENDS

White sturgeon populations in the Columbia River were nearly decimated in the 1890s as a result of unregulated exploitation, obstruction of migration by dams, altered streamflows, altered temperature regimes and reduced spawning habitat (DeVore et al. 1999; Wydoski and Whitney 2003). In the Lower Columbia River, populations rebounded after maximum size regulations designed to protect sexually mature sturgeon were enacted in 1950 (DeVore et al. 1999). Since that time, management restrictions on harvested fish size, daily quotas and yearly quotas have allowed the Lower Columbia population to recover and harvest to continue at a sustainable level. Currently, the white sturgeon population in the Lower Columbia River downstream of Bonneville Dam is the most productive in the species' range (DeVore et al. 1999). More conservative management strategies have recently been recommended for this population because of evidence of reduced recruitment into Lower Columbia fisheries and increased emigration from the Lower Columbia (DeVore et al. 1999).

Populations in impounded sections of the Columbia Basin have been depressed since construction of mainstem dams, which limit seasonal streamflows and the movement of individuals, as well as adversely affect spawning and recruitment (Parsley and Beckman 1994; Wydoski and Whitney 2003). Of the 11 mainstem Columbia River populations

isolated between dams, white sturgeon are considered relatively abundant in only 3 locations in Washington (above Bonneville, the Dalles and Grand Coulee Dams) (Miller et al. 2005). White sturgeon are considered relatively abundant in only 2 of the 12 impoundments located in the Snake River (in Washington State above the Lower Granite Dam) (Miller et al. 2005). The Kootenai River population is unstable and declining as a result of the loss of spawning habitat from altered river flows (Miller et al. 2005; US Fish and Wildlife 2005).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Dam construction and channel modifications are considered major causes of the sturgeon decline in the Columbia River basin and many other locations (Beamesderfer and Farr 1997). The loss of spawning grounds and suitable sites for incubation and rearing of early life stages by creation of reservoirs has appeared most critical. In addition to isolating populations (Wydoski and Whitney 2003), dams also alter seasonal streamflows and water temperatures affecting the composition and extent of spawning habitat, as well as spawning behavior (Parsley and Beckman 1994; Wydoski and Whitney 2003; Miller et al. 2005).

Recruitment failure is a major feature of many of the subpopulations segmented by dams (Parsley et al. 2002; Upper Columbia White Sturgeon Recovery Initiative 2002). The species continues to persist in most of its range largely because of individual longevity (up to 100 years), but the population status is not satisfactory enough to sustain a major fishery except in the lower river downstream of Bonneville Dam, the lowermost dam in the river (Parsley et al. 2002).

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Overharvest by commercial and recreational fisheries has been the major contributor to the collapse of some stocks of sturgeon (Dumont 1995; Echols 1995; Rosenthal et al. 1999). White sturgeon are particularly susceptible to overharvest because of their slow growth, late onset of maturity and episodic spawning behavior (Wydoski and Whitney 2003). Refinement of management strategies is still needed in some areas (DeVore et al. 1999).

Disease or Predation

Disease and predation are not currently thought to represent major threats to the continued survival of white sturgeon.

Adequacy of Existing Regulatory Mechanisms

Regulatory mechanisms (e.g., harvest regulations) are generally considered adequate for protection of white sturgeon populations, although more conservative management strategies have recently been recommended for the population in the Lower Columbia River because of evidence of reduced fishery recruitment and increased emigration from the system (DeVore et al. 1999).

Other Factors Affecting Continued Existence

White sturgeon are a long-lived species and may also be at risk due to bioaccumulation and concentration of contaminants (Emmett et al. 1991). Additional factors affecting their existence include impacts to eggs and larvae from climate induced changes in water temperature and hydrology; decreases in dissolved oxygen resulting from anthropogenic eutrophication (Klyashtorin 1976; Secor and Gunderson 1998).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

White sturgeon in the offshore environment are not likely to be affected by most activities authorized by Washington DNR on state-owned aquatic lands. Areas of concern include activities authorized within nearshore and estuarine habitats of Grays Harbor, Willapa Bay, Puget Sound, Hood Canal and the Columbia River, and in freshwater habitats of the upper Columbia River, where isolated white sturgeon populations still exist. Discharges from outfalls and runoff from impervious surfaces (roads, docks) may contribute toxic contaminants to aquatic habitats used by sturgeon. Activities that alter feeding, spawning and rearing habitats, such as shellfish aquaculture in tidal flats and sediment disturbance associated with mining and dredging activities, may adversely impact white sturgeon. White sturgeon may be affected by invasive-species control activities that affect prey species (e.g., benthic and epibenthic invertebrates). Transportation-related activities involving construction of highways, roads and railroad structures, including pile-driving may affect sturgeon habitat.

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2-4 Marine Mammal

2-4.1 Southern resident orca (*Orcinus orca)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Endangered
Washington State	Endangered
Natural Heritage Program	G4, G5, T3Q; SNR

RANGE

Killer whales are more commonly found within 800 kilometers of coastlines and are more abundant at higher latitudes, probably because of higher prey abundances. The species has the broadest distribution of any dolphin (Reeves et al. 2002; Wiles 2004) and occurs within all marine waters of Washington, spending most of late spring through fall around the San Juan Islands (Wiles 2004). At other times of the year, the whales leave the area or stay along the outer coast.

Three distinct forms of killer whales occur in Washington (Krahn et al. 2002; Wiles 2004,) and, although they have overlapping distributions they are genetically different (Hoelzel et al. 1998). All three types were seen annually off the northwest coast of Washington between 1989 and 2002 (Calambokidis et al. 2004).

- **Resident** killer whales occur primarily in near-coastal and inland waters from central California to southeast Alaska (Wiles 2004), feeding on salmon and other fish (Ford et al. 1998). Two principal groups of this form are known: northern residents, which generally occur from central Vancouver Island to southeastern Alaska (Wiles 2004); and southern residents that live most of the year in inland areas around the Strait of Juan de Fuca, the Strait of Georgia and Puget Sound (Krahn et al. 2002). Southern resident killer whales may also occur off the Washington outer coast and can be found from central California to the Queen Charlotte Islands (Krahn et al. 2004; Wiles 2004). The northern resident group has recently been separated into four distinct populations: one in western Alaska, two in southern to southeastern Alaska, and one in British Columbia (Krahn et al. 2004). Southern residents comprise three pods that are named with the letters "J," "K" or "L" (Wiles 2004) (Figure 2.21).

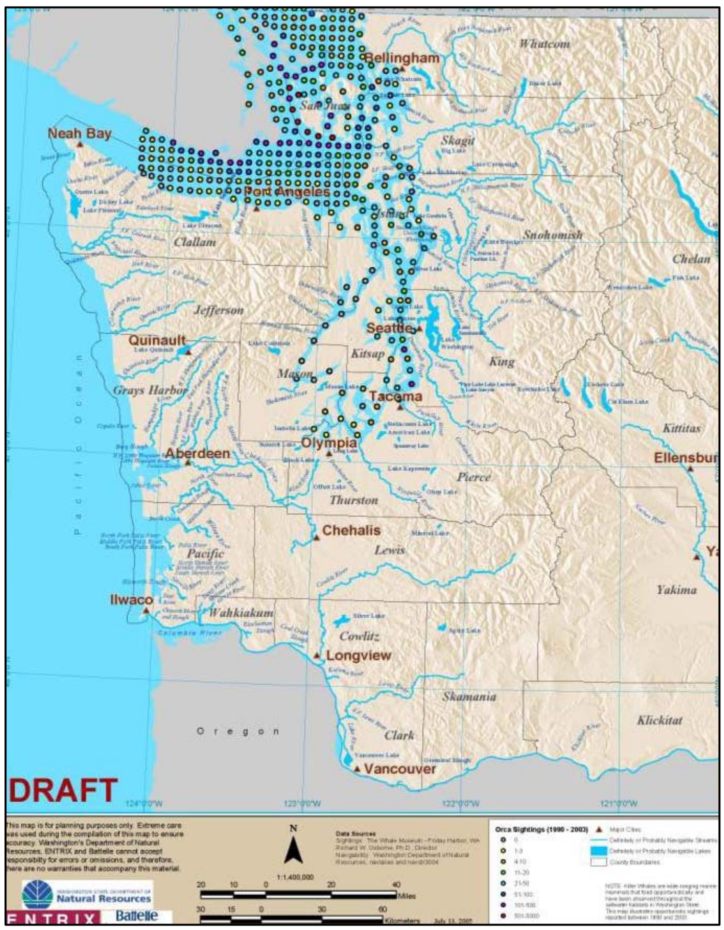
  All three southern resident killer whale pods inhabit waters in the Georgia Strait, the Strait of Juan de Fuca and around the San Juan Islands (i.e., the Georgia Basin) during late spring to fall, although the J pod exhibits a somewhat different occupancy pattern. K and L pods arrive first in the Basin, usually by May or June, and stay until October or November (Wiles 2004). The J pod frequents Puget Sound and the Georgia Basin sporadically during the summer and is the only group to swim among the San Juan Islands with any regularity.

- **Transient** killer whales are found from southern California to the northern Gulf of Alaska (Wiles 2004) and feed primarily on marine mammals and sea birds (Baird and Dill 1995, 1996; Ford et al. 1998). This form does not interact with other killer whale groups and typically travel in small groups consisting of fewer than ten individuals. Transient killer whales roam parts of the Strait of Juan de Fuca, Puget Sound and the Georgia Basin, often remaining for extended periods in locales where harbor seals are abundant.

- **Offshore** killer whales may visit coastal and inland areas, but are more typically found more than 15 kilometers away from land (Krahn et al. 2002). They range from the eastern Aleutians to southern California and feed primarily on fish.

The focus of this paper is on the resident forms that occur within the State of Washington's waters.

Figure 2.21 – Distribution of the southern resident orca.



HABITAT USE

Killer whales' habitat use is not restricted by factors such as salinity, temperature or depth, and the species ranges throughout the deep waters of the open ocean, as well as shallow inland and even intertidal waters (Baird 2001; Wiles 2004). Mating probably

occurs between May and October, but may happen year round (Wiles 2004) with gestation lasting approximately 17 months. Resident whale populations give birth from October to March and calves stay with their mothers for the first year after birth. Females typically give birth to their first young at about 12 years of age, although they probably mature at a slightly younger age (Wiles 2004). Males mature at an average age of 15 years and may live 50 to 60 years, reaching lengths of 9 meters and weights of 5,600 kilograms (Reeves et al. 2002). Females are generally smaller (7.9 meters long, weight 3,500 kilograms) than males, but may live 80 to 90 years (Reeves et al. 2002).

Southern resident orcas do not generally enter water less than 5 meters deep, spending most of their time in deeper waters. Their distribution is strongly associated with salmon abundance, although there is some disagreement over specific feeding habitat. Baird (2001) described studies indicating that southern resident killer whales feed in high-relief areas, such as canyons, ridges and steep slopes that might limit fish movements and help the whales herd fish, while Ford et al. (1998) found no such association between feeding and bottom topography. While preferred prey for resident populations consists of Chinook salmon (*Oncorhynchus tshawytscha*) they also take coho (*O. kisutch*), pink (*O. gorbuscha*), chum (*O. keta*), steelhead (*O. mykiss)* and sockeye (*O. nerka*) (Wiles 2004). Little information exists regarding consumption of other fish species or the animals feeding habits while outside the region (Wiles 2004)

POPULATION TRENDS

While no reliable data exists for resident populations in the British Columbia-Washington region before 1974 (Wiles 2004), there are indications that the southern resident population was much larger than it is now and may have included more than 200 individuals. A retrospective model projection showed that the population probably increased in the early 1960s possibly in response to a decrease in incidental shootings (Wiles 2004). The population then decreased sharply from 1967 to about 1972 because of the impact of the live-capture fishery, and gradually increased through about 1995 to 1996 when it again began a steady decline. Following a slight increase from 2000 through 2003, a direct count of southern resident whales listed the minimum population estimate at 83 whales (Carretta et al. 2004; Wiles 2004) - a population size comparable to that of the early 1960s. Since monitoring began in 1974 there has been no incidental take of southern resident whales by commercial fisheries (Carretta et al. 2004) and during the same time period pods J and K increased by about 31 to 47 percent, while pod L has only increased 5 percent and is showing a decade-long decline (Wiles 2004). Krahn et al. (2002, 2004) modeled survival data for the southern resident group and found that the population showed constant rates within a 6-year period, but that consecutive periods differed from each other. Abundances were low from 1980 to 1984 and from 1993 to 2000, and were high from 1974 to 1979 and 1985 to 1992, showing a slight increase of 4 whales from 2000 to 2003 with no differences in the patterns among pods (Krahn et al. 2002, 2004).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Permanent, or longer-term, habitat destruction is generally much less of an issue for large whales than relatively shorter-term catastrophic events, such as a major oil spill

(Clapham et al. 1999). In addition to resulting in direct mortality, killer whales may be indirectly affected by oil spills through breathing petroleum vapors or by eating contaminated prey (Wiles 2004). Because of their relatively small preferred range, resident killer whales in the Georgia Basin-Puget Sound area may be particularly vulnerable to oil spills. Wiles (2004) compiled a list of major oil spills within the Washington portion of the killer whale range, reporting that 15 spills greater than 100,000 gallons have occurred in the area between 1964 and 1999, or about 1 spill every 2.3 years. Most spills were from ships, but also occurred from refineries and pipelines. Since 1999, Washington has kept a rescue tug in Neah Bay during the winter to assist vessels that become disabled in the heavy winter seas off the coast. No major spills have occurred since then.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

One of the most significant threats to killer whale survival was couched as an educational or entertainment activity. The capture of live animals for display in aquariums began slowly in 1962, but increased considerably in the late 1960s (Baird 2001; Wiles 2004). Although it lasted only about 10 years, this live-capture fishery severely depleted killer whale populations in the northeast Pacific, especially the highly vulnerable southern resident killer whales. Public pressure eventually brought the fishery to a halt in the United States and Canada in the late 1970s, but the impact on the southern resident killer whales was great with about 70 percent of the 275 to 307 whales collected from the area members of the southern resident population. It took about 20 years for the population to recover (Baird 2001; Wiles 2004). Live-capture continues in other regions (for example, Iceland, Japan and Argentina Russia), but is less intense than that in the 1970s (Wiles 2004).

People also enjoy observing animals in their native environs and a substantial tourist industry has built up around “whale-watching” centers worldwide. Within the Georgia Basin the whale watching industry has grown so much that from April through October killer whales are followed throughout much of the day by watercraft (Wiles 2004). Studies investigating the impacts of whale watching on the animals have documented underwater noise from vessel motors reaching about 175 decibels (Wiles 2004), with the noise generated by a fast-moving vessel was likely audible to whales at a distance of at least 16 kilometers (Erbe 2002). While effects induced by slower moving boats were lower, documented noise levels masked whale calls at a distance of 14 kilometers and caused changes in behavior at 200 meters, with hearing loss possible with exposure to fast-moving vessels. There are currently no regulations that apply to whale-watching, although NOAA Fisheries has developed general guidance for observing marine mammals in the northwest Pacific (Carlson 2004). In addition, the Whale Watch Operators Association Northwest has established a set of Best Practice Guidelines for viewing killer whales, baleen whales, pinnipeds and birds to “minimize potential negative impacts on marine wildlife populations…” and to provide the “best viewing opportunities” to allow watchers to enjoy and learn about the wildlife (Whale Watch Operators Association Northwest 2003). The potential impacts of some of the procedures typically contained in existing guidelines were tested by Williams et al. (2002) in waters off northern Vancouver Island. In addition to changes in killer whale behavior consistent with avoidance, the study found that certain whales may have become habituated to the

presence of the vessels, and recommended using slow parallel approaches to mask propeller noise.

Disease or Predation

Predation does not represent a significant threat to killer whales as they do not have any natural predators other than humans. Sharks may kill some small whales, but the impacts on killer whale populations are not important. In addition, human “predation” has decreased substantially since the 1960s and 1970s (Baird 2001; Wiles 2004).

There is not much information about disease risks in free-ranging killer whales. While a recent literature-based survey identified the occurrence of 2 bacteria (*Brucella* and *Edwardsiella tarda)* and a virus (cetacean pox) in wild populations, none of the three has a high potential to cause an epidemic among killer whales (Gaydos et al. 2004). Nonetheless, all three can have significant effects on individual killer whales with *Brucella* reducing fecundity and *Edwardsiella* leading to highly virulent form of gastroenteritis. Cetacean pox virus is highly virulent in young cetaceans and could be an important cause of mortality. *Brucella* antibodies were found in a transient killer whale stranded on the Dungeness Spit near Sequim, Washington, in 2002. Because transients and southern resident killer whales often overlap in occurrence, the presence of *Brucella* in a transient whale indicates that southern resident killer whales could also be exposed to the bacterium (Gaydos et al. 2004).

The small number of pathogens identified from killer whales, especially North Pacific populations, probably reflects lack of sampling and knowledge rather than low pathogen diversity or incidence (Gaydos et al. 2004). Killer whale carcasses are rarely recovered and, therefore, relatively few pathological studies are performed. Diseases affecting fecundity, such as *Brucella*, could impact overall population viability in long-lived killer whales. Small population size and the highly interactive social structure make virulent, contagious pathogens severe threats to southern resident killer whales. Highly virulent cetacean morbillivirus antibodies have been found in related northeastern Pacific common dolphins (Gaydos et al. 2004), but it is not known whether killer whales are susceptible to this virus. Herpesviruses are not yet known from Pacific whales, and killer whales are not known to be susceptible to them, yet these viruses could adversely affect killer whales because they do cause severe outbreaks in some odontocetes.

Adequacy of Existing Regulatory Mechanisms

While killer whales are protected under a number of agreements and acts, none of the existing mechanisms offer complete protection from human predation. The International Whaling Commission prohibits taking killer whales on factory ships, with additional protection provided under the Convention on International Trade in Endangered Species of Wild Fauna and Flora agreement (CITES), United States Marine Mammal Protection Act and the Canadian Marine Mammal Regulations. However, CITES and both the Canadian and U.S. Acts include provisions for collection and/or hunting of limited numbers of animals under specific conditions (Baird 2001). Southern resident populations would see additional protection as a result of a recent recommendation that they be listed as Threatened under the ESA (50 CFR 223 [2004]).

Other Factors Affecting Continued Existence

A number of additional factors may affect both transient and resident killer whale populations, including:

- Fluctuations in the abundance of key prey species such as seals and salmon leading killer whales to switch from a high-energy prey to one of lower energy. The resulting increase in foraging effort may potentially leading to reduced fecundity and higher death rates.
- Potential effects from inbreeding as a result of small population size. The southern resident killer whale population, which has only 28 reproductive individuals, including only 9 males (Krahn et al. 2004; Wiles 2004), could be approaching the level at which inbreeding depression could adversely affect the population.
- Bioaccumulation of toxins. Similarly to other long-lived, top-level predators, killer whales represent the final step in food web contaminant pathways and contaminant burdens born by North Pacific killer whales have been the subject of several studies summarized by Wiles (2004) and Krahn et al. (2004). Ross et al. (2000) and Hayteas and Duffield (2000) described high levels of organochlorine contaminants such as polychlorinated biphenyls (PCBs) and *p,p'*-DDE in killer whales from British Columbia and Oregon, respectively, with PCB concentrations among the British Columbia whales much higher that those reported for marine mammals from other parts of the globe. There were also significant differences among population groups and between genders - transients had higher concentrations than southern residents, which, in turn had higher concentrations than northern residents, and body burdens on males were higher than those in females (Ross et al. 2000). Both PCB concentrations in, and the differences among transient and resident populations were linked to diets comprised of higher level predators (seals, sea lions and salmonids) that accumulate contaminants (Ford et al. 1998; Ross et al. 2000) Differences between the two resident groups may be related to geographic differences in ranges, with the southern resident living near more industrialized coastlines. The specific PCB congener profiles for both transient and resident populations were surprisingly similar given the differences in prey consumed (Ross et al. 2000). Whales found stranded in Oregon, which were thought to be transients, also had very high concentration of PCBs the organopesticide *p,p'*-DDE (Hayteas and Duffield 2000). Killer whales are also facing new threats from contaminants such as those used as flame retardants and endocrine disrupting chemicals (Krahn et al. 2004).
- Noise pollution. Anthropogenic increases in noise greatly exceed background noise levels and are likely to interfere with sound waves used by marine mammals for communication, prey detection and navigation. In addition to noise from whale-watching, marine mammals are impacted by noise associated with commercial and military vessels, sonar, oil exploration and production, and acoustic harassment devices used in aquaculture operations. Sonar may be particularly disruptive, as it is designed to produce sounds of at least 225 decibels that can be detected at distances up to about 30 kilometers (Wiles 2004) and may

cause severe damage, including brain hemorrhaging (Wiles 2004) in cetaceans. Acoustic harassment devices used to keep pinnipeds away from aquaculture pens some fishways emit noise levels sufficient to cause a major shift in habitat use by killer whales of northeastern Vancouver Island (Morton and Symonds 2002; (Wiles 2004). While the use of seismic technology associated with oil exploration may be detrimental to transient and offshore killer whale populations, it is not likely to affect resident killer whale populations.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Killer whales, especially the southern resident killer whales and transients, are common in Puget Sound and other Washington coastal and inland waters throughout much of the year. Therefore, there is the potential for activities authorized by Washington DNR to affect killer whales. Direct impacts could result from new overwater structures and shoreline modifications reducing salmon or pinniped habitats; shifts in habitat use as a result of the use of acoustic harassment devices near aquaculture facilities; and injuries to whales from collisions with vessel traffic associated with marinas and ferry terminals. In addition Killer whales may be indirectly affected by activities such as discharges from outfalls or runoff from impervious surfaces, that increase contaminant loads in the prey. The potential for activities authorized by Washington DNR to adversely impact offshore killer whales is probably relatively low because those whales do not frequently enter state waters. Those that do enter state waters could be affected by many of the activities that affect resident and transient killer whales.

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3. Evaluation Species

3-1 Amphibians

3-1.1 Coastal tailed frog (*Ascaphus truei)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Not listed
Washington State	Monitored
Natural Heritage Program	G4; S4

RANGE

The coastal tailed frog occurs in the Cascade Mountains and Coastal Range from southern Canada to northern California, at elevations from sea level to 2,285 meters (Nussbaum et al. 1983; Stebbins 1985; O'Neil et al. 2001). On the west side of the Cascades, this species is not found above 1,830 meters (O'Neil et al. 2001).

HABITAT USE

The coastal tailed frog is found in fast-moving streams at elevations from sea level to over 2,000 meters (O'Neill et al. 2001; NatureServe 2005). This habitat encompasses most riverine and riparian reach categories in this elevation range. During rainy seasons, tailed frogs are occasionally found on land away from streams (Burke Museum 2004).

Adults

Adult coastal tailed frogs reach lengths of 2 to 5 centimeters and may live 15 to 20 years, becoming sexually mature at 8 to 9 years (B. C. Frogwatch 2001; Hallock and McAllister 2005). The species is diurnal and rests under rocks in cold streams, emerging at night to forage in the stream and along the streambank for invertebrate prey (Nussbaum et al. 1983; Stebbins 1985; O'Neill et al. 2001).

Spawning, Incubation and Tadpoles

Coastal tailed frogs undergo internal fertilization in the fall (B. C. Frogwatch 2001), with females depositing their eggs the following spring on the underside of rocks in stream reaches inhabited by adults (Nussbaum et al. 1983; O'Neill et al. 2001). Metamorphosis occurs 2 to 5 years later (Hallock and McAllister 2005), with tadpoles feeding on algae, pollen and insects (Nussbaum et al. 1983; O'Neill et al. 2001).

Overwintering

Coastal tailed frogs may be active throughout the year (O'Neill et al. 2001), with peak adult activity occurring from April to October (Stebbins 1985).

POPULATION TRENDS

Although little information on population status is available, populations are assumed to be in decline based on information related to changes in habitat used by the species (NatureServe 2005). In suitable habitats, this species may be very common (Burke Museum 2004).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Logging activities have negatively affected coastal tailed frogs in low gradient streams due to increased sedimentation. However, streams with higher gradients and velocities may continue to support tailed frogs even when the forest is repeatedly logged (NatureServe 2005).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Overutilization has not been identified as a major threat to this species.

Disease or Predation

While disease and parasites (*Aeromonas hydrophila, Ribeiroia ondatrae, Batrachochytrium dendrobatidis, Saprolegnia ferax infestation*) have been observed in declining high-elevation amphibian populations (NatureServe 2005), neither cause has been suggested as contributing factors to declines in coastal tailed frog populations.

Adequacy of Existing Regulatory Mechanisms

Because the extent of population declines is uncertain, it is not possible to determine whether existing regulatory mechanisms are adequate.

Other Factors Affecting Continued Existence

While the depletion of stratospheric ozone and an accompanying increase in ultra-violet B radiation (UVB, wavelength 290 to 320 nanometers) at the earth's surface have been postulated as possible threats to all life stages of amphibians, research has yielded mixed

results (Blaustein et al. 1997; Pakhala et al. 2001; Corn and Muths 2002; Diamond et al. 2004).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Coastal tailed frogs depend on rocky bottomed streams and are particularly vulnerable from activities authorized by Washington DNR that increase erosion and sedimentation. Such activities may include construction and maintenance of nearshore structures such as bridges, roads and docks; and stormwater outfalls.

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3-1.2 Oregon spotted frog *(Rana pretiosa)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Candidate Species
Washington State	Endangered
Natural Heritage Program	G2; S1

RANGE

The historic range of the Oregon spotted frog extends from British Columbia southward through the Puget Trough and the Willamette Valley, and along the Cascades to the Pit River watershed in northern California (Green et al. 1997; Hallock and McAllister 2005). In Washington, the frog may be found in both the Puget Trough Physiographic Province and southern Western Cascade Physiographic Province, at elevations from sea level to 610 meters (O'Neil et al. 2001; Hallock and McAllister 2005). Only six populations are currently known to occur in Washington - four in Thurston County in the Black River watershed and two in Klickitat County (Hallock and McAllister 2005).

HABITAT USE

The Oregon spotted frog is highly aquatic and is usually found in marshy edges of ponds and lakes or overflow pools of streams (Nussbaum et al.1983; Stebbins 1985). Extant populations in Washington occur in large shallow wetland systems associated with a stream or stream network, with beaver impounded systems appearing to provide many of the habitat requirements of this species (Hallock and McAllister 2005). While specific habitat needs are dependent on life history stage, wetlands with gradual variation in topography may provide suitable habitat for all life stages (Watson et al. 2000) including adequate water levels for seasonal inter-pool movement.

Adults

Adult Oregon spotted frogs reach lengths of 4 to 10 centimeters (Hallock and McAllister 2005), and while their total lifespan is unknown, they are believed to become sexually mature at 2 to 3 years of age (B. C. Frogwatch 2001). In Thurston County, deep pools were critical dry season habitat for both juveniles and adults (Watson et al. 2000). Two types of annual migration patterns have been observed in this species: infrequent, long-distance migrations between widely separated pools, and frequent movement between pools that are closer together (Watson et al. 2000). As shallow pools evaporate in the dry season (June through August), frogs from these pools are forced to move to deeper permanent pools that may be several hundred meters away. During the wet season (September through January), frogs move back up drainages to reoccupy the breeding area and associated shallow waters (Watson et al. 2000), although Oregon spotted frogs in the Thurston County populations were unlikely to move upland. Thus, an area in

which deep-water pools are separated from those shallow pools suitable for breeding is unlikely to be suitable for all life cycle needs of Oregon spotted frog populations (Watson et al. 2000).

These frogs forage in and under water, primarily consuming beetles, spiders, flies and ants, although the species has been observed eating newly metamorphosed red-legged frogs (O'Neil et al. 2001) and juvenile western toads (Pearl and Hayes 2002).

Spawning, Incubation and Tadpoles

Oregon spotted frogs breed from February to March in seasonally flooded margins of wetlands, with unattached egg masses laid in areas with little or no vegetative shading (Hallock and McAllister 2005; Nussbaum et al.1983; O'Neil et al. 2001). In Thurston County, breeding Oregon spotted frogs were observed in shallow sedge/rush habitat with moderate to high proportions of water surface exposure (50 percent to 75 percent) and a low to moderate proportion of emergent vegetation (25 percent to 50 percent) (Watson et al. 2000). Tadpoles graze on algae and plant detritus, generally metamorphosing after 4 months (B. C. Frogwatch 2001).

Overwintering

In areas subject to freezing, winter survival for these frogs is dependent on the presence of waters that remain aerobic and do not freeze to the sediments (Hallock and McAllister 2005). Overwintering frogs in Thurston County inhabited shallow water in and around inundated dense vegetation, and buried themselves at the base of plants during the coldest periods (Watson et al. 2000).

POPULATION TRENDS

In Washington, the Oregon spotted frog has declined dramatically from its original distribution due to filling and alteration of wetlands. The six remaining populations are isolated and vulnerable to a wide variety of factors that might interfere with reproduction or survival (Hallock and McAllister 2005; Code of Federal Regulations 2004). This species is also designated as a Critical Sensitive Species in Oregon (Oregon Department of Fish and Wildlife 1997) and a Species of Concern in California (California Department of Fish and Game 2004).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Anthropogenic changes in hydrology, water quality and wetland integrity are the major threat to the Oregon spotted frog (Hallock and McAllister 2005; Code of Federal Regulations 2004; NatureServe 2005).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Overutilization has not been identified as a major threat to this species.

Disease or Predation

In addition to predation by non-native fish and bullfrogs (Hallock and McAllister 2005), the Oregon spotted frog may also be negatively impacted by competition with bullfrogs for food and other resources (Witmer and Lewis 2001). Although a number of diseases and parasites (*Aeromonas hydrophila, Ribeiroia ondatrae, Batrachochytrium dendrobatidis, Saprolegnia ferax*) have been observed in declining high-elevation amphibian populations in other states (NatureServe 2005), disease has not been suggested as a contributing factor to this decline of this frog in the state of Washington.

Adequacy of Existing Regulatory Mechanisms

Efforts aimed at restoring riparian woody vegetative communities may be decreasing the marshy edges this species depends on and furthering declining reproductive rates, indicating that existing regulatory mechanisms may be inadequate to protect the species.

Other Factors Affecting Continued Existence

Successional habitat loss to shrub-scrub wetlands and loss of beaver pond habitat as a result of removing beaver have both been suggested as having adverse effects on Oregon spotted frogs (Hallock and McAllister 2005). While the depletion of stratospheric ozone and an accompanying increase in ultra-violet B radiation (UVB, wavelength 290 to 320 nanometers) at the earth's surface have been postulated as possible threats to all life stages of amphibians, research has yielded mixed results (Blaustein et al. 1997; Pakhala et al. 2001; Corn and Muths 2002; Diamond et al. 2004). However, studies of the Oregon spotted frog indicate that UVB is not a factor at the embryonic stage (NatureServe 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Oregon spotted frogs depend on shallow nearshore environments and may be impacted by activities authorized by Washington DNR that alter the hydrology or extent of these areas. Such activities include loss of habitat from filling and/or armoring of shallow water areas; and reductions in vegetated habitat for spawning and tadpoles due to increased shading or trampling during construction and maintenance of overwater structures and recreational activities

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3-2 Birds

3-2.1 American white pelican (*Pelecanus erythrorhynchos)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Endangered
Natural Heritage Program	G3; S1B

RANGE

The American white pelican is found locally west of the Mississippi River and along the Gulf Coast (Peterson 1990; Sibley 2000; King and Michot 2002; Knopf 2004). In Canada, it breeds in southern British Columbia, northern Alberta, northeast Saskatchewan, southwest Manitoba and southwest Ontario. Although seemingly widespread, this species forms two geographic populations that are east and west of the Rocky Mountains, with little intermixing. The eastern population breeds locally from Minnesota west through the Dakotas and into Montana, Wyoming and Colorado, and north to northern Alberta, northeast Saskatchewan, southwest Manitoba and southwest Ontario. Many American white pelicans from the eastern population winter along the southern U.S. coast from Florida to northern Mexico (King and Michot 2002). The western population breeds in parts of Utah, Nevada, California, Oregon, Washington, and north into British Columbia, and winters from the Pacific Northwest south to Baja California, Mexico and into Nicaragua (Knopf 2004). Young pelicans do not mature until the third or fourth year after hatching, and non-breeding pelicans may summer anywhere within their normal winter or migrant range (Knopf 2004).

Historically, American white pelicans have been observed infrequently throughout eastern Washington, with a few existing breeding colonies present (Wahl in press). Current observations are most frequent in the Columbia Basin, with non-breeding pelicans often observed in the Columbia River and its tributaries, the Potholes Reservoir, and many of the smaller lakes in the vicinity (Thompson, Personal communication. February 24, 2005). Non-breeding American white pelicans have also been recorded on the Pend Oreille River, Palmer Lake (Okanogan County), Sprague Lake (Lincoln/Adams County) and on Brown's Island (Columbia River, Klickitat County).

In western Washington, observations are infrequent and unlikely as this species resides almost exclusively east of the Cascade Mountains in the Pacific Northwest (Washington Fish and Wildlife 2005; Thompson, Personal communication. February 24, 2005; Wahl et al. in press). The only known breeding colony is located on Crescent and/or Badger Islands in the Columbia River, approximately 20 kilometers upstream of McNary Dam and part of the McNary National Wildlife Refuge. Successful breeding began in 1994

and has continued annually, except during 2001 (Ackerman 1994; Wahl et al. in press; Washington Fish and Wildlife 2005).

HABITAT USE

American white pelicans have a maximum documented life span of 26 years and reach sexual maturity at 3 years of age (Knopf 2005). Breeding colonies are typically located on isolated islands within freshwater lakes or rivers (Knopf 2004). These birds may fly long distances (greater than 100 kilometers) to forage on fish in lakes and rivers (Knopf 2004), with locations influenced by prey abundance (Derby and Lovvorn 1997; Kaeding 2002).

Nesting

Adults, accompanied by nonbreeding subadults arrive during April to begin nesting and the young are usually fledged by late August (Livingston, Personal communication. February 24, 2005). Nesting generally takes place on islands free of disturbance with little or no woody vegetation. Islands and exposed bars adjacent to foraging areas are used for roosting and loafing (McMahon and Evans 1992). While individuals may return to their natal colony, they do not breed until their third year (Knopf 2004). Adults usually lay two eggs and fledge slightly less than one per nest within 17 to 25 days after hatching (Knopf 2004).

Wintering

This species winters on rivers and/or lakes free of ice and containing ample fish populations from the Pacific Northwest south to Baja California, Mexico and into Nicaragua (Knopf 2004). American white pelicans also use exposed bars and islands for roosting and loafing.

POPULATION TRENDS

The North American Breeding Bird Survey index indicates increasing trends for this species in the western Breeding Bird Survey (BBS) region and the Columbia Plateau, and increasing but highly variable in the Pacific Northwest since 1966 (Sauer et al. 2004). The McNary National Wildlife Refuge colony was monitored from 1994 to present, and reproduction has been stable. During the years from 2002 to 2004, reproduction at the McNary colony has averaged about 226 young per year with a success rate of 1.12 young per mating pair, a high of 301 chicks fledged and 1.48 young per pair during 2004 (Livingston, Personal communication. February 24, 2005).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Human presence and disturbance from a powerboats and low-flying aircraft are known to have caused egg loss or abandonment (Blood 1993).

Also, the bioaccumulation of contaminants in the environment threatens many piscivorous bird populations, including white pelicans. Concentrations of organochlorides, selenium, cadmium and mercury have been detected in pelican livers

and attributed to a fish diet (Donaldson and Braune 1999). In Blus et al. (1998), a limited number of deformities were observed in the Crescent Island Forster's tern (*Sterna forsteri*) that nest concurrently with the pelicans on Crescent Island, and although polychlorinated biphenyls (PCBs), dioxin and furan levels in tern eggs were low deformity rates were similar to those found in highly contaminated areas (Blus et al. 1998). PCBs were not detected in four addled pelican eggs in the Crescent Island colony, but the insecticide, dichlorodiphenyl-trichloroethane (DDT) and its derivatives, as well as other organic contaminants, were detected at low levels (Blus et al. 1998).

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

American white pelicans are not utilized commercially or recreationally. If scientific or educational use does occur, it is highly regulated.

Disease or Predation

Disease or predation are not known to be threats to American white pelican populations.

Adequacy of Existing Regulatory Mechanisms

The single breeding colony of American white pelicans in Washington is located within the boundaries of the McNary National Wildlife Refuge. Current regulations governing public access during the pelican nesting season have proven to be adequate, based on successful reproduction within the colony.

Other Factors Affecting Continued Existence

There are no other known factors affecting the American white pelican's existence.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

American white pelicans are likely to be affected by some activities authorized by Washington DNR on state-owned aquatic lands, particularly those that contribute to disturbance of the colony during the breeding season. Roadways, bridges and docks could reduce foraging habitat and disturb roosting populations. Stormwater runoff may increase concentrations of pesticides, fertilizers, heavy metals, salts and petroleum products in the water column, which directly impacts prey species of the American white pelican. Construction and operation of harbors, ports, shipyards, marinas and petroleum and ferry terminals near nesting areas could increased disturbance to them. These activities could also cause an increased risk of exposure to spilled oil and fuel, which would affect white pelican survival.

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3-2.2 Cassin's auklet (*Ptychoramphus aleuticus)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife	Species of Concern
Washington State	Candidate Species
Natural Heritage Program	G4; S3

RANGE

Cassin's auklet breeds from subboreal to subtropical waters along the Pacific Coast, between the Aleutian Islands, Alaska, and Baja, California (Manuwal 1974; Manuwal and Thoresen 1993; Kaufman 1996). Within this range, the highest breeding densities occur along the coast of British Columbia, particularly Triangle Island, where an estimated 60 to 75 percent of the breeding population resides (Vermeer et al. 1979; Manuwal and Thoresen 1993). Species distribution during the nonbreeding season is poorly known. Although some populations in California appear to be sedentary, it is believed this species spends most of its time at sea (Manuwal and Thoresen 1993).

While breeding populations in Washington have been little studied (Manuwal and Thoresen 1993), Dawson (1908) estimated more than 2,500 breeding adults on four nearshore islands along the outer west coast of Washington. Recently eight known nesting locations have been documented: Mid-Bodelteh Island, East Bodelteh Island, Carroll Island, Jagged Island, Alexander Island, Tatoosh Island, and Dhuoyautzachtahl, all of which are along the Olympic Coast in Clallam and Jefferson counties (Paine et al. 1990; Speich and Wahl 1989).

HABITAT USE

Nesting

Cassin's auklets may live to approximately 6 years of age and are slow to reproduce (Manuwal and Thoreson 1993). Adults may breed the during their second year, but most wait until the fourth year of life (Manuwal and Thoreson 1993). Clutch size is small, typically one egg, therefore limiting the number of fledglings to fewer than one per pair annually (Manuwal 1974).

Breeding is apparently restricted to offshore islands along the Pacific Coast, especially those where soft soils have accumulated (Thoresen 1964; Vermeer et al. 1979). Cassin's auklets typically nest in burrows, but may also use rock crevices, debris piles, or other similar cavities that provide protection from gulls and the elements (Thoresen 1964; Manuwal 1974; Vermeer et al. 1979). Preferred nesting habitat generally contains sparse

shrub cover and short herbaceous vegetation (Thoresen 1964; Vermeer et al. 1979). On Triangle Island, British Columbia, auklets nested on all slopes and relatively flat areas, with the highest densities occurring on southern-facing slopes near the open summit and edge of the plateau (Vermeer et al. 1979). Studies conducted in California indicated that Cassin's auklets typically mate in mid to late spring with eggs hatching after about 38 days of incubation and fledging occurring about 41 days after hatching (Manuwal 1974).

Foraging

Cassin's auklets feed from the ocean surface, concentrating in areas where prey (primarily euphausiids, amphipods, copepods and small fish) is abundant (Speich and Wahl 1989; Manuwal and Thoresen 1993). Average foraging depth of auklets breeding in the Queen Charlotte Islands, British Columbia, was 28 meters (Burger and Powell 1990). In California, auklets generally foraged within 30 kilometers of breeding colonies, although foraging distance was largely attributed to prey availability (Adams et al. 2004). Prey availability, and consequently foraging habitat, is highly variable due to fluctuations in coastal upwellings in the California Current system (Briggs et al. 1987; Bertram et al. 2001; Sydeman et al. 2001; Hedd et al. 2002). In years when ocean-warming events take place, the location of these upwellings may become less predictable, thereby decreasing foraging efficiency (Briggs et al. 1987). Consequently, auklets may abandon nests or breeding altogether when prey availability near breeding colonies becomes limited.

Migration

Little is known about seasonal movement patterns of Cassin's auklets breeding along the Washington coast. Southern populations in California are apparently sedentary, whereas northern populations in Alaska and British Columbia are believed to be migratory (Manuwal and Thoresen 1993). Briggs et al. (1987) estimated peak densities of 500,000 to 1,000,000 individuals off the California coast in late fall, indicating some of these birds may have been migrants.

POPULATION TRENDS

Published information regarding population status and change appears to be limited and highly variable (Manuwal and Thoresen 1993). In Washington, the estimated breeding population was approximately 87,600 pairs between 1978 and 1982 (Speich and Wahl 1989). Other studies have focused primarily on breeding colonies at Triangle Island, British Columbia, and Farallones, California. On Triangle Island, the estimated breeding population was 359,000 pairs in 1977 (Vermeer et al. 1979) and 548,000 pairs in 1989 (Bertram et al. 2000). Bertram et al. (2000) suggest a declining population at Triangle Island between 1994 and 1997 is plausible based on low adult survival, increased reproductive failure and coincident declines in the number of Cassin's auklets breeding in the Farallones. Conversely, populations off British Columbia, Canada appear to have had good productivity and adult survival during this time (Gaston 1992; Bertram et al. 2000).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Human disturbance during nesting, particularly destruction of burrows caused by foot traffic, has reduced productivity (Thoresen 1964; Speich and Wahl 1989).

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known use of Cassin's auklets for commercial, recreational, scientific, or educational purposes.

Disease or Predation

Predation by introduced mammals (mice, foxes) on islands has been documented (Blight et al. 1999; Jones 1992).

Adequacy of Existing Regulatory Mechanisms

The Cassin's auklet is afforded protection under the Migratory Bird Treaty Act. It is not known whether regulatory mechanisms controlling public access to breeding sites within the Washington Islands Wilderness Area are adequate to minimize the effects of disturbance on Cassin's auklet breeding pairs.

Other Factors Affecting Continued Existence

Reduced prey abundance due to ocean warming linked to El Niño events within the California Current System has influenced reproductive success (Bertram et al. 2001; Sydeman et al. 2001; Hedd et al. 2002). Mortality has resulted from direct exposure to floating contaminants (e.g., oil) that accumulate in confluent areas where prey are abundant (Speich and Wahl 1989). Also introduced mammalian fauna may compete for burrows on coastal islands.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Cassin's auklets are likely to be affected by few activities authorized by Washington DNR on state-owned aquatic lands. Stormwater runoff may increase concentrations of pesticides, fertilizers, heavy metals, salts and petroleum products in the water column, which directly impacts prey species of the Cassin's auklet. Construction and operation of harbors and marinas could cause an increased risk of exposure to spilled oil and fuel, which could affect Cassin's auklet survival.

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3-2.3 Common murre (*Uria aalge)*

Two subspecies are recognized in the Pacific Rim: *Uria aalge inornata*, which breeds in North America from Alaska to northwest British Columbia, and *Uria aalge californica*, which breeds in British Columbia south to California (Nettleship 1996). *Uria aalge californica* occurs in Washington.

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	G5; S4B, S5N

RANGE

The common murre is one of the most numerous marine birds in the Northern Hemisphere with populations estimated at 4 to 8 million birds in western North America and a total population of 13 to 21 million birds (Ainley et al. 2002). The species breeds on mainland cliffs and islands along the Bering Sea and Pacific coasts in western North America, from western Alaska south to Monterey County, California. In western North America, common muures winter in coastal shelf waters from the southern extent of the sea ice in the Bering Sea to southern California (Ainley et al. 2002). In eastern North America, common murres breed from Labrador and southeastern Quebec south to Newfoundland, and winter from Newfoundland to Cape Cod, Massachusetts (Ainley et al. 2002).

In Washington, common murres breed on cliffs, rocks, and islands in the Pacific Northwest Coast Ecoregion between Neah Bay and Aberdeen. Five groups of colonies, with a total of over 10,000 nesting birds, are recognized from north to south. The groups are: Tatoosh Island, Carroll-Jagged, Quillayute-Needles, Split-Willoughby and Point Grenville (Warheit and Thompson 2004; Carter et al. 2001; Speich and Wahl 1989). All colonies except Tatoosh Island are part of the U.S. Fish and Wildlife Service National Wildlife Refuge System.

The species is found throughout the year in all marine waters of the state, including the outer coast and Puget Sound (Warheit and Thompson 2004). Their fall and winter range is essentially the same as their breeding range, but extends further south. Common murres nesting in Oregon move northward into Washington after the breeding season, reaching the outer Strait of Juan de Fuca by late July to early August, where they spend the fall and winter (Thompson 1997).

HABITAT USE

Nesting

Common murres are sexually mature between the ages of 4 and 5, with the maximum recorded life being 26 years (Ainley et al. 2002) . Females lay a single egg between March and July (in Washington) on cliff ledges, sloping island surfaces or flat areas on rocky headlands and islands. Incubation typically lasts 4 to 5 weeks and chicks fledge within 4 weeks of hatching. Adults forage in continental shelf and slope waters within a maximum of 70 to 80 kilometers from nesting colonies (Ainley et al. 1990), preying on small fish (2 to 25 centimeters), krill, large copepods and squid (Ainley et al 2002). The species feeds above or on the bottom, at depths of up to 180 meters, using their wings for underwater propulsion (Ainley et al. 2002). From the coast of Washington, fish commonly taken include, Pacific herring (*Clupea pallasi*), Pacific sandlance (*Ammodytes hexapterus*), surf smelt (*Hypomesus pretiosus*), and eulachon (*Thaleichthys pacificus*). Occasionally salmonids (*Onchorynchus* spp.) and rockfish (*Sebastes* spp.) will be taken and rarely, when upwelling predominates, deep-dwelling fish such as lanternfish (Myctophidae) can also comprise a portion of their diet (Ainley et al. 2002, Parrish and Zador 2003).

Wintering

Large numbers of common murres are present from fall through winter along the Pacific coast. They are often close to shore and in the deeper habitats of inland marine waters, such as inlets and sounds. Washington and Oregon breeders disperse, rear chicks, molt, and winter among sheltered bays and straits, such as the Straits of Juan de Fuca and Georgia, and Puget Sound (Ainley et al. 2002). Common murres often feed on spawning herring and move farther offshore in March when spawning is complete (Ainley et al. 2002). Mid-water crustaceans (krill and amphipods) are more prevalent in winter diets than summer, although these items dominate the diet year-round in pelagic waters (Ainley et al. 2002).

POPULATION TRENDS

Numbers of nesting common murres in Washington decreased by 32 percent per year from 26,500 pairs in 1979 to 4,000 in 1989 (Carter et al. 2001). Colonies at Split and Willoughby rocks were almost completely abandoned. This decline was precipitated by warm-water events in 1981 and El Niño in 1983 (Ainley and Divoky 2001). At-sea and colony counts of common murres are inversely proportional, so the proportion of breeding birds in the population is an important parameter for interpreting estimates based on colony counts (Ainley et al. 2002). In addition to the colony counts, comparison of long-term aerial and boat-based surveys for common murres wintering in Washington also indicate declines of 38 to 88 percent from 1978 and 1979 to 2003 (Bower 2004). Common murre distribution and abundance varies substantially with season and location on the outer coast. Total at-sea population estimates were consistent in 2001 and 2002 at 73,000 to 74,000 birds, but variability was high (the 95 percent confidence interval included 30 to 50 percent of total estimate) (Warheit and Thompson 2004).

THREATS WARRANTING ESA PROTECTION

Threats to common murre presented below are summarized from Ainley et al. (2002) and Warheit and Thompson (2004).

Destruction, Modification, or Curtailment of Habitat or Range

Common murres are sensitive to marine circulation changes (El Niño Southern Oscillation) that result in reduced abundance and quality of prey species.–Due to their gregarious nature and habitat use within shipping channels, common murres are extremely vulnerable to oil spills. In addition, human disturbance (foot, boat, kayak) at nesting colonies can result in lost or reduced breeding success.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for common murres.

Disease or Predation

Although common murres do not appear to be at risk from disease, predation by both bald eagles (*Haliaeetus leucocephalus*) and the introduced Norway rat (*Rattus norvegicus*) may lead to direct and indirect impacts on reproductive success.

Adequacy of Existing Regulatory Mechanisms

Colonies are protected because they are located within marine sanctuaries, but are still subject to human disturbance and oil spills. Existing regulatory mechanisms may be inadequate because they may not be able to prevent disturbance to the colonies, and although the risk of oil spills has been reduced, it has not been eliminated.

Other Factors Affecting Continued Existence

An additional factor that may effect this species includes global marine climate change and reduced marine productivity in waters adjacent to breeding colonies. Furthermore, the unintended capture of common murres by longline and gill-net fisheries can result in entanglement and drowning which may negatively impact populations.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Common murres are likely to be affected by activities authorized by Washington DNR on state-owned aquatic lands. Overwater structures such as log booms/rafts, floats, docks/wharves and breakwaters may reduce foraging areas. Roadways, bridges, and docks could reduce habitat and disturb wintering, brood-rearing and potentially nesting populations. Outfalls and discharges associated with aquaculture and industry may cause localized reduction of water quality, which adversely affects forage fish that comprise a large part of the common murre's diet. In addition, aquaculture may cause habitat degradation and a reduction in forage availability resulting in displacement. Nearshore activities such as sand and gravel mining, dredging and dredge disposal may cause

increased sedimentation and/or the direct loss of important prey species. Construction and operation of harbors, ports, shipyards, marinas, petroleum and ferry terminals could cause habitat reduction and degradation and increased disturbance as well as cause an increased risk of exposure to spilled oil and fuel, which would affect common murre productivity and survival.

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3-2.4 Eared grebe (*Podiceps nigricollis)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Not Listed
Natural Heritage Program	G5; S2B, S4N

RANGE

Breeding populations of eared grebes are distributed throughout the western United States and into Canada, with the largest concentrations wintering at Mono Lake, California or the Great Salt Lake, Utah. Individuals also winter in Mexico and along the Pacific coastline as far north as southern British Columbia (Cullen et al. 1999).

In Washington, eared grebes breed on the east side of the Okanogan River in the Columbia Plateau, Okanogan, and Canadian Rockies ecoregions. They winter in coastal areas of the Puget Trough and Pacific Northwest Coast.

HABITAT USE

Eared grebes may life to 12 years of age, becoming sexually mature between 1 and 2 years of age (Cullen et al. 1999).

Nesting

Female eared grebes typically lay 3-4 eggs per clutch from May to June (Seattle Audubon 2002). The birds nest in colonies as large as hundreds of pairs, in small groups or as solitary pairs. They nest on shallow lakes and ponds with emergent vegetation and productive macroinvertebrate communities, and rarely on ponds with fish. Nesting density increases with increased phosphorous levels (conductivity, magnesium) and nesting density decreases with increased calcium and turbidity levels (Savard et al. 1994). These water quality parameters probably influence nesting through the relationship with invertebrate prey species abundance. While nesting on freshwater lakes and ponds, eared grebes feed primarily on aquatic invertebrates including water boatmen (Corixidae), predacious diving beetles (Dystiscidae), caddis fly larvae (Phrygonoidea), mayflies (Ephemiridae), midges (Chironomidae), damselflies (Zygoptera), dragonflies (Anisoptera) and other flies (Diptera) (Palmer 1962).

Migration and Wintering

Eared grebes are often associated with hypersaline lakes and bays during migration and throughout the winter, where they feed on brine shrimp (*Artemia monica*) and brine flies (*Ephedra* sp.). Hundreds of eared grebes stage prior to migration on Soap Lake in Washington (Seattle Audubon 2002). In coastal environments, wintering eared grebes may also use shallow, nearshore waters along open sandy beaches; beaches with rocks and gravel; coastal lagoons with mud and marshes; and kelp beds feeding on small

crustaceans and insects, as well as small fish, mollusks and amphibians (Cullen et al. 1999). Eared grebes commonly use shallow saline lakes and salt ponds throughout their range.

POPULATION TRENDS

The eared grebe is the most abundant species of grebe in North America, with an estimated 4.1 million birds staging on hypersaline lakes in fall (Cullen et al. 1999). There is no demonstrable trend in population size or distribution in North America, although Breeding Bird surveys are inadequate for this species (Cullen et al. 1999).

THREATS WARRANTING ESA PROTECTION

The threats to eared grebes presented below are summarized from Cullen et al. (1999).

Destruction, Modification, or Curtailment of Habitat or Range

Threats include the loss or degradation of wetlands used for breeding and migration due to drainage for agriculture or urban/suburban development.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for eared grebes.

Disease or Predation

Botulism and avian cholera can cause significant mortality to eared grebes; known predators of eggs, young and adults include: American coots (*Fulica americana*), mink (*Mustela vision*), herring gulls (*Larus argentatus*), great horned owl (*Bubo virginianus*), coyotes (*Canis latrans*), common raven (*Corvus corax*), other corvids and osprey (*Pandion haliaetus*).

Adequacy of Existing Regulatory Mechanisms

Current regulations appear to be adequate for the protection of eared grebes during the breeding period, although the species does not consistently use the same wetlands for nesting (Seattle Audubon 2002). Wetland nesting habitats are provided some protection by Section 404 of the Clean Water Act, although these regulations will not prevent all wetland losses or disturbance to nesting, staging or wintering eared grebes.

Other Factors Affecting Continued Existence

Other threats include nest losses due to wave action in windstorms, starvation in El Niño years, and reductions in food supplies due to the use of pesticides. In addition, human disturbance/destruction of nesting colonies or staging aggregations during recreational activities such as swimming, fishing, birding, boating, or canoeing may also pose significant threats to this species.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Eared grebes rely upon freshwater marshes which may be altered by a number of activities authorized by Washington DNR. Transportation projects such as roadways, bridges, and docks may result in habitat loss during construction, while stormwater runoff from the structures may increase concentrations of heavy metals, salts and petroleum products in wetlands that are known to degrade habitat. Invasive species control projects may disturb nesting behavior and alter utilized habitat. Navigation improvements involving dredging, filling or other alteration of wetlands may result in increased sedimentation and/or the direct loss of organisms and habitat. Sewage or other wastewater outfalls may cause localized reductions in water quality resulting in increased turbidity, eutrophication, decreased habitat quality, and the potential disturbance of nesting.

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3-2.5 Tufted puffin (*Fratercula cirrhata)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Species of Concern
Washington State	Candidate Species
Natural Heritage Program	G5; S3/4B, S4N

RANGE

Tufted puffins are distributed throughout the North Pacific Ocean with 80 percent of the world population (2.9 million birds) nesting along coastlines and offshore islands from California to Cape Lisburne, Alaska (Piatt and Kitaysky 2002). Tufted puffins are the most sea-going of the auk, murre and puffin family, spending their non-breeding and wintering stages mid-ocean throughout the North Pacific, south to 35°N latitude (Piatt and Kitaysky 2002).

Tufted puffins arrive at Washington nesting colonies in the Pacific Northwest Coast and Puget Trough ecoregions during early April and they remain through mid-September. An estimated 22,300 birds nest at 16 locations, primarily along the outer coastline (Piatt and Kitaysky 2002, Speich and Wahl 1989) with the largest nesting colonies are on Carroll, Jagged and Alexander Islands (Smith et al. 1997), where tufted puffins dig burrows in grassy slopes or at cliff edges (Speich and Wahl 1989). Less than 1 percent of the North American population nests in Washington.

HABITAT USE

Nesting

Tufted puffins arrive at Washington nesting colonies during early April (Piatt and Kitaysky 2002; Speich and Wahl 1989). Tufted puffins are sexually mature between 3 and 4 years old. During breeding, adults forage in shelf slope and shelf-edge habitats generally within 100 kilometers of colonies (Piatt and Kitaysky 2002). Tufted puffins forage more frequently offshore in continental shelf slope habitats over unconsolidated or consolidated bottoms than in nearshore habitats (Piatt and Kitaysky 2002). About 50 to 70 percent of adult diet is invertebrates, primarily squid, polychaete worms, and euphausiids (krill), with the remaining 30 to 50 percent fish. Females lay one egg between April and June and both parents assist with incubation that usually lasts approximately 7 weeks. Adults feed chicks a wide variety of small schooling fish, such as anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), capelin (*Mallotus villosus*), lanternfish (Myctophidae), juvenile Pollock (*Theragram chalcogram*ma), rockfish (*Sebastes* spp.), greenling (Hexagrammidae) and Pacific sandlance (*Ammodytes hexapterus*). Estimated foraging dive depths are up to 110 meters, but most tufted puffins probably forage at depths of less than 60 meters (Piatt and Kitaysky 2002).

Wintering

Most tufted puffins leave coastal shelf waters by October and winter mid-ocean throughout the North Pacific, (Piatt and Kitaysky 2002) feeding on squid, lanternfish (Myctophidae), northern smoothtongue (*Leuroglossus stilbius*), Pacific saury (*Coloabis saira*), and euphausiids (Piatt and Kitaysky 2002).

POPULATION TRENDS

Tufted puffins nesting populations are currently increasing in the northern portions of their range from the Gulf of Alaska westward, but decreasing in the southern portions of their range from southeast Alaska to California (Piatt and Kitasky 2002).

In Washington, whole colony counts, plot counts within colonies, and pelagic survey counts all indicate a 14 to 17 percent annual decline in abundance from the 1980s to 2001, with recent trends of 21 percent decline per year (Piatt and Kitasky 2002; Wahl and Tweit 2000). Tufted puffins within the waters of the Strait of Juan de Fuca have been reduced from 400 birds at Protection Island during 1970 to 18 birds in 2001 (Speich and Wahl 1989; Piatt and Kitaysky 2002). It has been suggested that the total nesting population for Washington may be an order of magnitude lower than during the 1970s and 1980s (Piatt and Kitasky 2002).

THREATS WARRANTING ESA PROTECTION

The threats to tufted puffins presented below are summarized from Piatt and Kitayski (2002), Speich and Wahl (1989) and Gjerdrum et al. (2003).

Destruction, Modification, or Curtailment of Habitat or Range

Marine circulation changes (El Niño Southern Oscillation) resulting in reduced abundance and quality of prey species. Tufted puffins are vulnerable to oil spills because of their habitat use within shipping channels. Human disturbance (foot, boat, kayak) at nesting colonies can result in lost or reduced productivity.

Over utilization for commercial, recreational, scientific or educational purposes include

Tufted puffin populations have failed to recover from previous declines related to human harvest, especially at small breeding colonies. There are no known scientific or educational uses for tufted puffins.

Disease or Predation

Adults are preyed upon by bald eagles (*Haliaeetus leucocephalus*) and peregrine falcons (*Falco peregrinus*). Chicks and eggs are taken by common ravens (*Corvus corax*) and large gulls (*Larus* spp.). Nests may also be preyed upon by introduced species such as the Norway rat (*Rattus norvegicus*) and the European rabbit (*Oryctolagus cuniculus*).

Adequacy of Existing Regulatory Mechanisms

Although colonies are protected by location within marine sanctuaries, they may still be subject to human disturbance. Oil spills have contributed to mortality during the past 20 years, and birds are still taken as by-catch in drift net and gill net fisheries, indicating that existing regulatory mechanisms may be inadequate to protect tufted puffins.

Other Factors Affecting Continued Existence

Other factors potentially affecting tufted penguins include: reduced marine productivity in coastal and offshore waters from global marine climate change and interannual and decadal climate variability; mortality due to oil spills; gill-net entanglement and drowning; and human disturbance and predation.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Tufted puffins are likely to be affected by activities authorized by Washington DNR on state-owned aquatic lands. Overwater structures such as log booms/rafts, floats, docks/wharves and breakwaters may reduce nesting and foraging areas. Roadways, bridges, and docks could reduce habitat and disturb wintering, brood-rearing and potentially nesting populations. Outfalls and discharges associated with aquaculture and industry may cause localized reduction of water quality which adversely affects forage fish that comprise a large part of the tufted puffin's diet. In addition, aquaculture may cause habitat degradation and a reduction in forage availability resulting in displacement.

Nearshore activities such as sand and gravel mining, dredging and dredge disposal may cause increased sedimentation and/or the direct loss of important prey species. Construction and operation of harbors, ports, shipyards, marinas, petroleum and ferry terminals could cause habitat reduction and degradation and increased disturbance. They could also cause an increased risk of exposure to spilled oil and fuel, which would affect tufted puffin productivity and survival.

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3-3 Fish

3-3.1 Black rockfish (*Sebastes melanops)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Black rockfish range from Amchitka Island, Alaska, to Huntington Beach, in southern California, though they may have been historically present in Baja California, Mexico (Hart 1973; Love et al. 2002). They are most abundant from northern California to

southeast Alaska in water less than 200 meters in depth, though they have been found deeper (Hart 1973).

Black rockfish are found along the outer coast of Washington, in the Strait of Juan de Fuca, and are common in Puget Sound. They are most prevalent in depths from 50 to 100 meters, with juveniles common in kelp beds and nearshore areas. Ideal habitat (consolidated with much structure) is found north of Destruction Island to Cape Flattery, within 200 meters of the shore (Boettner and Burton 1990).

HABITAT USE

Adult

Adult black rockfish occupy a variety of habitats, including caves and crevices in high- and low-relief areas, kelp beds. They are known to be pelagic, forming loose schools in the water column. Often they are inactive at night, settling on the bottom among rocks (Love et al. 2002). Divers in Puget Sound have observed black rockfish resting on the substrata. In a study by Boettner and Burton (1990), hydroacoustic surveys confirmed black rockfish schooling behavior and their tendency to aggregate near the bottom in association with rocky substrate.

Studies of adult black rockfish movement via mark-recapture tagging studies have provided mixed results, with some fish migrating large distances and others remaining close to the release point. Most studies have shown little migratory behavior, with tagged fish often staying within a few kilometers of the release point (Culver 1986). Other studies have shown black rockfish to be highly mobile, ranging hundreds of kilometers along the coast (Coombs 1979; Lai and Culver 1990).

Black rockfish are opportunistic predators, feeding mainly on pelagic zooplankton such as squid, euphausiids and crab larvae, herring and other bait fish (Stein and Hassler 1989; Love et al. 2002), and juvenile rockfishes (Hobson et al. 2001). They can engage in feeding aggregations near the surface of the water (Love et al. 2002).

Adult black rockfish can live to 50 years of age (Wallace et al. 1999). As is common with rockfish, sexual maturity occurs at different ages for males and females, with males maturing as early as 3 years, and females maturing on average at 7.5 years (Bobko and Berkeley 2004).

Reproduction

Mating occurs once a year, generally in the fall. Black rockfish, like other Sebastes species, are ovoviviparous, producing live young. Additionally, black rockfish are known to be matrotrophically viviparous, which means that in addition to nutrients in the yolk, their embryos derive further nutrients directly from the mother (Shimuzu et al. 1991). Females can store sperm for several months while their eggs develop; fertilization occurs from December through February (Bobko and Berkely 2004). Females can produce more than 1 million eggs per season, with older fish producing more eggs (Bobko and Berkeley 2004). Bobko and Berkeley (2004) verified that black rockfish followed the same pattern shown in previous studies (e.g., Gunderson et al. 1980, Cooper 2003) indicating increasing fecundity with age among many rockfish species.

Parturition occurs offshore between January and March, with older, more fecund fish releasing larvae earlier (Bobko and Berkeley 2004). On the Oregon coast, spent females were first found in January but were most common in February and March (Bobko and Berkely 2004). There is evidence that some females may reabsorb some of their eggs; the exact reason is unknown, but it is likely that these eggs were not fertilized (Love et al. 2002). Larvae are about 5 millimeters in length at parturition (Stein and Hassler 1989).

Larvae and Juveniles

Larvae are thought to be released offshore and have been observed associated with kelp mats and other floating debris (Love et al. 2002). As they grow, larvae migrate toward shore and settle at approximately 50 millimeters length (Stein and Hassler 1989; Love et al. 2002). They are often associated with kelp beds, eelgrass, or other structures, such as rocky reef or man-made material.

After settling (often between May and July), black rockfish juveniles stay in shallow, nearshore waters and occasionally in estuaries or tide pools (Boehlert and Yoklavich 1983; Love et al. 2002). Juvenile mortality immediately after settlement is high, and decreases as juveniles grow in size and density dependent predators switch to other prey items (Hobson et al. 2001). As they grow, they tend to inhabit deeper water habitats, occupying crevices and rocky holes.

POPULATION TRENDS

Since the early 1980s, black rockfish, along with several other species, have experienced population declines. Black rockfish are not a common component of commercial groundfish fisheries because their offshore habitat is prohibitive for fishing gear (bottom trawls). For example, in 1999 in Alaska, hook and line landed 118 metric tons of black rockfish, whereas only 1 metric ton was captured in trawls during this same period. In Washington, black rockfish were considered “other rockfish” and, therefore, estimates are imprecise, though the trend is likely similar (Pacific States Marine Fisheries Commission 1999).

Some fish are taken commercially, especially for the live-fish fisheries in California, by hook and line (Love et al. 2002). Some loss is a result of incidental take from commercial salmon trolling or other commercial activities. However, it is estimated that black rockfish make up about half of the total groundfish catch in Oregon’s recreational fishery (Love et al. 2002). Trends in Washington are likely similar. Wallace et al. (1999) assessed the status of black rockfish off the coast of Washington and concluded that the black rockfish stock can be characterized as “declining in abundance but healthy, i.e., displaying abundance levels in excess of those assumed to promote sustainable production.” It is important to note that black rockfish are managed (and assessed) as part of a rockfish complex, and data on individual species trends within the complex are lacking. Few data exist for current populations in Puget Sound.

In recreational fisheries, larger, more fecund fish are preferred by recreational anglers and are being removed from the fishery at higher rates than smaller fish, truncating the population age composition (Coleman et al. 2004). Not only does this practice result in removal of biomass from the population, but more importantly, it jeopardizes the reproduction potential (Bobko and Berkely 2004).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Black rockfish inhabit nearshore and offshore consolidated habitats, which are not at high risk of destruction or modification. However, black rockfish are found in shallower water than other rockfish species, so shore-related activities, such as overwater structures, port development or other construction that extends into the intertidal zone may impact this species. Black rockfish tend to associate with structure (both natural and man-made) in the nearshore and may be drawn to features such as pilings, floating structures and in-water debris. Kelp and eelgrass have been identified as important nearshore habitats for rockfishes, especially juveniles (Murphy et al. 2000). Destruction of kelp and eelgrass habitats may also have trophic impacts for this species.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Black rockfish have been targeted in recreational and commercial fisheries. As with other rockfish species, their population has declined during the last 50 years. However, much of this decline is likely due to recreational fishing rather than commercial trawling. Larger, more fecund fish are being removed from the fishery at the highest rates, narrowing the population age composition, which influences the production of the species in future generations (Coleman et al. 2004). Although stock assessments of coastal populations show populations (spawning biomass) to be healthy, downward trends are also noted (Wallace et al. 1999) and may be cause for more intensive management actions.

Disease or Predation

Neither disease nor predation has been identified as significant threats to the species.

Adequacy of Existing Regulatory Mechanisms

Recreational and live-fish commercial fisheries have had the greatest impact on black rockfish populations. Black rockfish are tightly linked to rocky, consolidated habitats, so are more difficult to target in commercial fisheries (trawls) than are neritic or benthopelagic species, such as widow and canary rockfish, which perhaps alleviates some of the commercial pressure other species have faced. The Puget Sound Groundfish Management Plan aims to manage rockfish in a sustainable manner (Palsson et al. 1998). However, the overall trend in declining populations suggests that stricter regulation of the recreational fishery may be necessary, especially to keep larger, more fecund fish as part of the spawning biomass. Because of the nature of rockfish swimbladders, catch-and-release regulations are difficult—when caught, rockfish usually suffer trauma from increases in dissolved gases in their blood upon surfacing.

Additionally, little is known about the specific ecology of individual rockfish species including larval and juvenile ecology, food habits or how oceanic conditions impact recruitment (Harvey 2005). Further study is needed to adequately manage rockfish species.

Other Factors Affecting Continued Existence

Recreational and commercial take, especially of the largest and oldest fish, are the most significant concerns for rockfish. Because black rockfish, especially as juveniles, are closely associated with nearshore areas, shore-based human activities, such as construction of piers, ports and bridges, as well as associated pollution, are more likely to affect this species than others. Because of the small home range of black rockfish, marine protected areas may be a viable management alternative for this species.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Black rockfish are likely to be affected by activities authorized by Washington DNR within marine nearshore environments. Roadways, bridges, and docks may result in stormwater runoff, which may increase concentrations of toxic contaminants including, but not limited to, hormones, PCBs, heavy metals, and petroleum products in both the sediments and water column. Additionally, discharges containing nitrogenous and bacterial waste associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality as well as contribute towards eutrophication of the nearshore environment. Net pens associated with fish hatcheries and aquaculture operations may also contribute to the loss of adult habitat from shading and the introduction of disease and parasites. Because black rockfish have a preference for shallow, rocky substrates, they are especially vulnerable to habitat disturbance and loss. Overwater structures and shoreline modifications may negatively affect habitat by reducing or modifying macroalgae, kelp and eelgrass habitat. Furthermore, sediment flow could be changed by bulkheads and jetties and subsequently suffocate habitat.

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3-2.2 Bocaccio (*Sebastes paucispinis)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	G5, State Not Ranked

RANGE

Bocaccio are found from Alaska to northern Baja California, Mexico, and are most abundant in the offshore waters of Oregon and California (Dark et al. 1983; Eschmeyer et al. 1983; Love et al. 2002).

Bocaccio have been found on rocky outcroppings in the offshore waters of Washington (Love et al. 2002) and in the coastal waters of Puget Sound from Bellingham to Tacoma (Miller and Borton 1980). Canadian assessments have shown bocaccio to be present in the Strait of Juan de Fuca and abundant along the northwest coast of Vancouver Island (COSEWIC 2002).

HABITAT USE

Adult

Like other rockfish, bocaccio are associated with rocky outcroppings and walls (consolidated habitat) in both coastal and inland waters. Bocaccio most commonly inhabit depths less than 200 meters, but can be found at greater depths (Dark et al. 1983). In a tagging study, Starr et al. (2002) found that bocaccio occupied waters between 10 and 170 meters. Love et al. (1990) showed larger fish to occupy deeper habitats, a trend common in other rockfish species. Bocaccio co-occur with several other species of semi-pelagic rockfish, including yellowtail and widow rockfish, and are often caught in mid-water trawls.

Starr et al. (2002) showed that half of the bocaccio tagged with implanted acoustic tags remained in the 12 kilometer^2 study area, which consisted of pinnacled consolidated habitat. Other species of rockfish have shown site fidelity in tagging experiments (Eisenhardt 2004), and the results from Starr et al. (2002) suggest that bocaccio display similar behavior. It is important to note that some fish in the tagging study may have moved large distances because they were absent from the area for prolonged periods (Starr et al. 2002).

Like yellowtail rockfish, bocaccio make rapid vertical migrations, which indicates they may be able to regulate air in their swim bladder (Starr et al. 2002). The reason for rapid vertical migrations is unknown, but may have to do with feeding behavior. Bocaccio are

mainly piscivorous, consuming other rockfish, hake, sablefish, myctophids and other species of fish, as well as squids (Love et al. 2002).

Bocaccio are slow-growing and late-maturing, though age at sexual maturity is unclear (Love et al. 2002). Studies in California have shown 50 percent of females to reach maturity at 36 centimeters, though in Oregon the size is 54 centimeters (Love et al. 2002); Gunderson et al. (1980) found 50 percent maturity of fish off of Washington and Oregon to be 44.8 centimeters for males and 48.2 centimeters for females. Because of the difficulty in reading bocaccio otoliths, aging bocaccio and determining their age and growth, scientific understanding of age at maturity and maximum age is not complete (Love et al. 2002).

reproduction

Mating occurs once a year, generally in the fall or winter, though timing is not well known, especially for northern populations (Garrison and Miller 1982). Female bocaccio store sperm for 4 to 6 weeks while their eggs develop (Wyllie-Echeverria 1987). Like other Sebastes species, bocaccio are ovoviviparous, producing live young. Females produce between 20,000 and 2.3 million eggs per season (Phillips 1964, in Stanley et al. 2001), though fecundity is not well studied in all geographic ranges (Garrison and Miller 1982).

Parturition occurs offshore during the winter months (Wyllie-Echeverria 1987). Moser (1967, in Garrison and Miller 1982) noted that bocaccio may mature two broods per year, a characteristic unique among rockfish. Once the first brood is released in early winter, the second brood begins developing and is released in the spring. This behavior has not been well documented in Washington (Love et al. 2002).

Larvae and juveniles

Larvae most likely are released offshore and are found in the upper mixed zone of the ocean (Moser and Boehlert 1991). They are between 4.0 and 5.0 millimeters at parturition. Bocaccio larvae remain in the water column for several months while transitioning to pelagic juveniles, which occurs at about 30 millimeters (Garrison and Miller 1982). Larvae feed on zooplankton, diatoms and dinoflagellates, and increase zooplankton consumption with size (Love et al. 2002).

After spending several months in the neritic zone, bocaccio juveniles settle in nearshore areas in coastal and inland waters (MacCall 2002). As they grow, they tend to inhabit deeper habitats and occupy crevices and rocky holes in deeper water (Garrison and Miller 1982). Juveniles have been observed occupying areas of high relief and have also been associated with anthropogenic structures including off-shore oil platforms in southern California (Love et al. 2002).

POPULATION TRENDS

Because of their life-history characteristics (long-lived, late-maturing, slow-growing) and high habitat fidelity as adults, bocaccio, like other rockfish, are particularly vulnerable to overfishing, with stocks that could take years to recover (Leaman 1991). The National Marine Fisheries Service declared bocaccio overfished, and a rebuilding plan was put into place in 2000 (see MacCall 2003 for current rebuilding analysis). It is likely that two

distinct stocks exist: one ranging throughout southern/central California and one centered around the Queen Charlotte Islands in British Columbia (MacCall, Personal communication, March 2, 2005.).

Few data exist for the history of bocaccio in Washington, but bocaccio have been commercially important along the West Coast, especially in California, for over 100 years and have been targeted in groundfish fisheries since the 1960s. The Pacific Fishery Management Council has been managing the fishery (off the California, Oregon and Washington coasts) since 1982 (MacCall 2002); however, management actions during the 1980s and 1990s failed to slow the rapid decline in population. The cause for the decline is mostly attributable to overharvest, although poor larval survival and recruitment may also have contributed to the decline (Love et al. 2002; MacCall 2002).

By the late 1990s, it was estimated that exploitable biomass of bocaccio in the southern portion of their range was three percent of historical (pre-1960s) levels (Love et al. 2002; NOAA Fisheries 2004). In Canada, the species is undergoing review for the Species at Risk Act (Department of Fisheries and Oceans 2004) and is already designated as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2002). It is estimated that the population off the west coast of Vancouver Island declined by 95 percent between 1980 and 2000 (Department of Fisheries and Oceans 2004), though the current population (1996 to 2000) is stable (Stanley et al. 2001). Bocaccio is of little commercial importance in Canada (Stanley et al. 2001) and Washington (MacCall, Personal communication. March 2, 2005). The status of the population in Washington is currently unknown, but it is likely that population trends similar to those in British Columbia have resulted in offshore waters (MacCall, Personal communication. March 2, 2005).

A petition to list Puget Sound bocaccio and 13 other species of rockfish under the Endangered Species Act was submitted to the National Marine Fisheries Service in 1999 (Wright 1999). Because of a lack of information regarding population structure and status for bocaccio and ten other species, they were eliminated from the review process (50 CFR 223 to 224 [1999]). In 2001, the Natural Resources Defense Council petitioned the National Marine Fisheries Service to list the southern population of bocaccio as Threatened under the Endangered species act (Natural Resources Defense Council 2001). Despite populations that were assessed at 3 percent of the unfished level, the petition was denied on the basis that the National Marine Fisheries Service had established a rebuilding plan and restricted commercial and recreational take (NOAA Fisheries 2004).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Bocaccio inhabit offshore and nearshore neritic habitats and are associated with rocky consolidated substrate, habitats which are not at high risk of destruction or modification. Historically, the species has been taken by the commercial fishery in mid-water and bottom trawls, the latter of which disturbs soft benthic habitats. Current limits on catch have reduced fishing pressure. Despite the lack of direct impact to consolidated habitats, the species is at risk from direct harvest.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

The National Oceanic and Atmospheric Administration (NOAA) Fisheries has declared bocaccio overfished, and a rebuilding management plan is in place (MacCall 2003). Overharvest has resulted from both commercial and recreational fisheries, especially in the southern portion of the range. Bocaccio are less abundant in Washington than in other regions (MacCall, Personal communication. March 2, 2005) and, therefore, they have not been aggressively harvested for commercial purposes.

Disease or Predation

Bocaccio are known to harbor parasites, especially tapeworms and nematodes (Stanley et al. 2001), although these parasites are thought to be harmless (Love et al. 2002). Kent et al. (2001) documented *Icthyophonus* infection rates of up to 50 percent in populations of Pacific rockfish. *Icthyophonus hoferi* is a chronic disease that may allow hosts to survive for extended periods with little or not deleterious effects; however Icthyophonus infections can cause significant pathological changes and mortality of the host.

Adequacy of Existing Regulatory Mechanisms

Bocaccio have been heavily targeted by commercial fisheries, especially off the coast of California (Love et al. 2002). By declaring the species overfished, NOAA Fisheries triggered a rebuilding plan, which is currently in effect. However, for southern populations, this action probably occurred too late, and rebuilding will take place slowly over a protracted period. This species is not commercially important in Washington, though through Pacific Fishery Management Council actions, harvest has been reduced (MacCall, Personal communication. March 2, 2005).

Other Factors Affecting Continued Existence

Recreational and commercial take, especially of the largest, oldest, most fecund fish, are the most significant concerns for all rockfish species (Parker et al. 2000).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Bocaccio are found around consolidated habitats in marine waters, often at depths greater than 20 meters along the continental shelf (Stanley et al. 2001). Therefore, the overall potential for activities authorized by Washington DNR to impact to adult bocaccio is probably low. However, some nearshore activities, especially those such as overwater structures and shoreline modifications that disturb kelp and eelgrass beds, may affect juveniles because they use habitats in shallower, nearshore waters. Activities resulting in pollution, such as outfalls and runoff from roads, docks and bridges, may have negative impacts on bocaccio.

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3-3.3 Brown rockfish (*Sebastes auriculatus)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Brown rockfish range from northern Gulf of Alaska to southern Baja California (Stout et al. 2001; Love et al. 2002). In Washington, brown rockfish appear to be limited to Central and South Puget Sound, with the most reports of the species occurring near Seattle and Bainbridge Island (Miller and Borton 1980; Stout et al. 2001).

The NOAA Fisheries status review (Stout et al. 2001) described two distinct population segments consisting of Puget Sound proper (the area south of Admiralty Inlet and east of Deception Pass), and the coastal waters west of Cape Flattery. The few brown rockfish reports outside of Puget Sound proper and inland of Cape Flattery were considered to represent vagrant brown rockfish from the Puget Sound proper population segment.

HABITAT USE

Adult

Adult brown rockfish most commonly use consolidated habitats in nearshore and offshore ecosystems in inland and coastal waters. While they prefer consolidated, low relief areas in shallow water bays with kelp, they have also been found in unconsolidated habitats (Matthews 1990b; Stout et al. 2001). The depth range of the brown rockfish is surface to 128 meters, and they are most common below 6 meters (Stout et al. 2001). In Puget Sound proper, the highest population densities were reported on natural reefs and rock piles in water less than 30 meters (Matthews 1990b).

Adults are solitary or occur in small aggregations, and are often associated with quillback rockfish (*Sebastes maliger*). They have a small home range, 30 square meters on Puget Sound artificial reefs to 1,500 square meters on natural low relief reefs, and exhibit strong home range fidelity that is not affected by season (Matthews 1990a, b).

Adults feed primarily near the bottom. Prey includes small fish, shrimp, polychaetes and isopods (Washington et al. 1978; Hueckel and Buckley 1987; Matthews 1987; Stein and Hassler 1989).

Reproduction

In Puget Sound proper, 50 percent of male and female brown rockfish are sexually mature at 4 to 5 years old and 23 to 25 centimeters total length; with all individuals maturing by year 7 (Matthews 1987; Stout et al. 2001). Brown rockfish can reach 56 centimeters total length (Hart 1973) and have a life span of approximately 34 years (Love et al. 2002). The mortality rate for brown rockfish from central Puget Sound proper has been reported to be 0.274 (Gowan 1983).

Brown rockfish mate in March and April (Stein and Hassler 1989), have internal fertilization, and retain embryos until larval release (Boehlert and Yoklavich 1984). In Puget Sound proper, ova develop during winter, with females in Washington probably giving birth annually from May through July (Stout et al. 2001).

Larvae and Juveniles

Brown rockfish are 5 to 6 millimeters in length at birth and are free floating, preying upon zooplankton (Stout et al. 2001). Larvae and juveniles use the open water habitat in the nearshore ecosystem of inland and coastal waters, as well as estuaries for nursery grounds (Stein and Hassler 1989; Stout et al. 2001).

Juvenile brown rockfish settle into shallow, vegetated habitats such as low-relief natural and artificial reefs and beds of kelp or eelgrass (West et al. 1994) at 18 to 25 millimeters total length, preferring shallower water than adults (Love 1996). After settling, juveniles feed on amphipods, copepods, polychaete worms, shrimp and small fish (Matthews 1987; Stein and Hassler 1989).

Predators on juveniles and adults include lingcod (*Ophiodon elongatus)*, cabezon (*Scorpaenichthys marmoratus*), salmon (*Onchorynchus* spp.), river otters (*Lutra canadensis*), sea lions (*Zalophus califonianus*), harbor seals (*Phoca vitulina)*, great blue heron (*Ardea herodias*), cormorants (*Phalacrocorax* spp.) and various other marine bird species (Fresh et al. 1981; Jones 2000; Eisenhardt 2001).

POPULATION TRENDS

In Puget Sound proper, scuba surveys showed brown rockfish populations increasing by a factor of approximately 6 between 1987 and 1995 (Matthews 1990a; Stout et al. 2001). However, annual trawl surveys during the same period suggested a decline from 761,000 to approximately 30,000 individuals (Stout et al. 2001). Data from recreational fisheries for the years 1996 to 1999 indicated variable recreational catches ranging from 800 to 6,000 with the highest catches in 1997 (6,000 fish) and 1999 (4,000), and the lowest catches in 1998 (800) and 1996 (1,800) (Stout et al. 2001).

Brown rockfish are rare in coastal ecosystems, and no data was available for analysis by the NOAA Fisheries status review (Stout et al 2001).

THREATS WARRANTING ESA PROTECTION

The risks to the survival of brown rockfish were listed by West (1997) as “anthropogenic stressors and natural limiting factors,” and include “over-harvesting, loss or degradation of habitat, predation by pinnipeds and fish, and pollution-related adverse effects."

Destruction, Modification, or Curtailment of Habitat or Range

Habitat for juvenile rockfish could be affected through shoreline development. Sediment flow can be affected by bulkheads or jetties and change sediment characteristics in shallow water where benthic juvenile brown rockfish concentrate. Loss of eelgrass or kelp through dredging or filling may negatively affect juvenile and adult habitat (Palsson et al. 1998).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Brown rockfish have comprised up to 31 percent of the recreation harvest in Puget Sound proper (Gowan 1983) and like most rockfish are vulnerable to commercial and recreational over-harvest (West 1997; Stout et al. 2001). There are no known scientific or educational uses for brown rockfish.

Disease or Predation

While disease is not known to be a significant threat to this species, predation from sea lions (*Zalophus califonianus*) and harbor seals (*Phoca vitulina*) may be a factor in decreasing population trends. Due to their protection under the Marine Mammal Protection Act of 1972 pinniped populations have increased and may be placing additional strain on brown rockfish populations.

Adequacy of Existing Regulatory Mechanisms

While Washington Fish and Wildlife has prohibited the direct harvest of rockfishes in Puget Sound, rockfish continue to be at risk from bycatch for lingcod and salmon fisheries.

Other Factors Affecting Continued Existence

Additional factors affecting brown rockfish include possible sub-lethal affects from bioaccumulation and concentration of chemical contaminants (West 1997; West and O'Neill 1998); and the possible feminization of male rockfish as a result of human estrogen/progesterone in the water (West 2004). While some studies have suggested decreases in reproductive success and survival of young rockfish as a result of ocean climate fluctuations such as El Nino and La Nina Southern Oscillation and Pacific Decadal Oscillation (Partnership for Interdisciplinary Studies of Coastal Oceans 2004), the magnitude of this variable in Washington is currently unknown.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Brown rockfish are likely to be affected by activities authorized by Washington DNR within marine nearshore environments. Roadways, bridges, and docks may result in stormwater runoff which may increase concentrations of contaminants such as hormones, PCBs, heavy metals and petroleum products in both the sediments and water column. Additionally, discharges containing nitrogenous and bacterial waste associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality as well as contribute to eutrophication of the nearshore environment.

Net pens associated with fish hatcheries and aquaculture operations may also contribute to the loss of adult habitat from shading and the introduction of disease and parasites. Since brown rockfish have a relatively small home range and a preference for shallow, low relief reefs, and artificial structures (e.g., piers), they are especially vulnerable to habitat disturbance and loss. Overwater structures and shoreline modifications may negatively affect habitat by reducing or modifying macroalgae, kelp, and eelgrass habitat. Dredging or disposal of dredged materials has the potential to cover brown rockfish habitat. Furthermore, sediment flow could be changed by bulkheads and jetties and subsequently suffocate habitat.

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3-3.5 Canary rockfish (*Sebastes pinniger)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

National Oceanic and Atmospheric Administration (NOAA) Fisheries declared canary rockfish overfished in 2000

RANGE

Canary rockfish are distributed from the Gulf of Alaska to northern Baja California, Mexico, but are thought to be most abundant from southeastern Alaska to northern California (Hart 1973). They live close to the ocean bottom near the edge of the continental shelf, from 40 to 450 meters deep (Methot and Piner 2001). In Washington, while canary rockfish are found offshore along the outer coast, and were once common in Puget Sound (Garrison and Miller 1982), their current distribution is unknown.

HABITAT USE

Adult

Adult canary rockfish are benthopelagic, forming loose schools in the water column over rocky habitat, similar to widow and yellowtail rockfish. They have been observed over cobble, mud and sand habitats as well, especially in the interface between those habitats and rock structure (Love et al. 2002). Canary rockfish appear to inhabit deeper waters as they age (Methot and Piner 2001) and are found in shallower waters in the northern part of their range (Love et al. 2002). Canaries co-occur with yellowtail, black, widow, silvergray and other species of rockfish (Tagart 1987).

Adult canary rockfish feed on both water-column and benthic prey items, with euphausiids and fish (myctophids, anchovies, flatfish and juvenile rockfish) common prey (Love et al. 2002).

Canary rockfish can live to more than 80 years and reach a maximum size of more than 70 centimeters long (Wilkins et al. 1998). Maturity schedules vary within west coast studies, but off the Washington and Oregon coasts, it is believed that females reach sexual maturity at about 8 years of age and about 50 centimeters in length (Methot and Piner 2001), whereas males become sexually mature at about 7 years of age and 40 centimeters in length (Methot and Piner 2001; Love et al. 2002). Little is known about age and growth of canary rockfish in Puget Sound relative to offshore populations, although for many species of rockfish, maturity schedules and growth rates vary by geographic location (Matarese et al. 1989).

REPRODUCTION

Mating occurs from September to March, with the peak being in December and January off the Washington coast (Methot and Piner 2001). Females produce from 250,000 to over 2 million eggs per year (Love et al. 2002), and egg production is correlated with fish size (Gunderson et al. 1980). Like other species of rockfish, canary rockfish are ovoviviparous, producing live young.

Parturition occurs from January to March in north Pacific waters (Westrheim 1975), but timing is not well known for canary rockfish in Puget Sound or on the Washington coast.

Larvae and JUVENILES

Canary rockfish larvae are generally less than 4 mm in length at parturition (Love et al. 2002) and are found in the upper portion of the water column (Methot and Piner 2001), generally in the winter and spring (Matarese et al. 1989). Because of the difficulty in

identifying larval rockfish, little is known about the ecology of individual species (Matarese et al. 1989).

Juvenile canary rockfish are thought to remain in the plankton for up to 4 months or until about 4 centimeters in length (Love et al. 2002). When in their pelagic phase, juveniles eat zooplankton and their eggs, specifically, copepods and euphausiids (Love et al. 2002).

Once they settle to benthic habitats, they are often associated with kelp beds or other nearshore areas with relief and structure (Sampson 1996). They can be found in water that is shallow (10 to 20 meters) and may be in small schools. They have been observed schooling over rocky reefs and the adjacent unconsolidated sediment, forming small groups in cracks and crevices (Love et al. 2002). As they grow, they move to deeper habitats (Boehlert 1980).

POPULATION TRENDS

Canary rockfish have been declared overfished by NOAA Fisheries, and a rebuilding management plan is currently in place (Pacific Fishery Management Council 2003). The current biomass is estimated at approximately 8 percent of the unfished spawning biomass (Methot and Piner 2001). In British Columbia, the stocks are considered close to maximum exploitation, though surveys have been imperfect at assessing populations (Department of Fisheries and Oceans 1999).

Trawl harvest for canary rockfish began in the 1940s but gathered momentum in the late 1970s and 1980s (Williams and Adams 2001). Since then, canary rockfish have experienced population declines as a result of being targeted by recreational and commercial fisheries. The decline in population wasn't recognized by managers until the mid-1990s, at which point the acceptable catch was lowered (Methot and Piner 2001). Today, the commercial effort has been cut dramatically, and the majority of the catch is either from bycatch or other incidental take (Pacific Fishery Management Council 2003). This reduction has meant lesser pressure on other fish species associated with canary rockfish, such as yellowtail rockfish.

Canaries were sought by the recreational fishery off the Washington and Oregon coast, but are now a prohibited catch in both states. Few data exist for population trends in Puget Sound. Washington Department of Fish and Wildlife plans to conduct population assessments in Puget Sound in the near future.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Canary rockfish inhabit offshore consolidated habitats, which are not at high risk of destruction or modification. They are taken by the commercial fishery in mid-water trawls, which have minimal impacts on benthic habitats. Despite the lack of direct impact to consolidated habitats, the species is at risk from direct harvest.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

NOAA Fisheries has declared canary rockfish to be overfished. Commercial harvest quotas have been reduced significantly in the last decade, and a rebuilding plan is in place (Pacific Fishery Management Council 2003). The recreational fisheries in Washington and Oregon have restricted the retention of incidentally caught canary rockfish, because of their declining populations. The harvest of larger, more fecund fish has led to poor recruitment in some years, especially given unfavorable oceanic conditions (Parker et al. 2000).

Disease or Predation

While disease is not known to be a significant threat to this species, predation from sea lions (*Zalophus califonianus*) and harbor seals (*Phoca vitulina*) may be a factor in decreasing population trends. Due to their protection under the Marine Mammal Protection Act of 1972 pinniped populations have increased and may be placing additional strain on canary rockfish populations.

Adequacy of Existing Regulatory Mechanisms

Stocks of canary rockfish were targeted heavily for commercial harvest starting in the 1970s. By the 1990s, managers realized that the population had decreased significantly and began lowering allowable catch (Methot and Piner 2001). By declaring the species overfished, NOAA Fisheries triggered a rebuilding plan, which is currently in effect (Pacific Fishery Management Council 2003). The Puget Sound Groundfish Management Plan (Palsson et al. 1998) stresses the management of the resource in a conservative manner to prevent overharvest, but rockfish stocks in Puget Sound have declined, largely prior to adoption of the most recent plan.

Additionally, little is known about the specific ecology of individual rockfish species. Little is known about larval and juvenile ecology, food habits, or how oceanic conditions impact recruitment (Harvey 2005). Further study is needed to adequately manage rockfish species.

Other Factors Affecting Continued Existence

Recreational and commercial take, especially of the largest, oldest, and thus, most fecund fish are the most significant concerns for rockfish (Parker et al. 2000).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Canary rockfish are generally found offshore at the edge of the continental shelf, so the potential effects from activities authorized by Washington DNR are probably low. However, while the overall impacts from shore-based activities (such as overwater structures and piers) are thought to be minimal, within Puget Sound pollution from outfalls and runoff from roads, docks and bridges, may have negative impacts on canary rockfish.

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3-3.5 *Sebastes* Complex

For the purposes of this paper, the following four rockfish species are considered as a "complex": Greenstriped rockfish (*Sebastes elongatus*); China rockfish (*Sebastes nebulosus*); Tiger rockfish (*Sebastes nigrocinctus*); and Redstripe rockfish (*Sebastes proriger*). These species share common life histories traits and occupy similar habitats, allowing them to be treated together.

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked
Greenstriped rockfish	G5; S4
China rockfish	Not Ranked
Tiger rockfish	G4; S2
Redstripe rockfish	G5; S3, S4

RANGE

All four species in this complex range from Alaska, Gulf of Alaska or the Aleutian Islands to southern California (Love et al. 2002). The individual species have the following distributions in Washington:

- Greenstriped rockfish - coastal waters, the Strait of Juan de Fuca, Central and South Puget Sound, and Hood Canal (DeLacy et al. 1972; Gardner 1981).

- China rockfish - Strait of Juan de Fuca, San Juan Islands (DeLacy et al. 1972).
- Tiger rockfish - San Juan Islands, Central Puget Sound (DeLacy et al. 1972).
- Redstriped rockfish - San Juan Islands, North Puget Sound (eastern San Juan Islands, Bellingham), Possession Sound (Everett), Central Puget Sound, Hood Canal (DeLacy et al. 1972; Gardner 1981).

It is likely that all four species use coastal offshore habitats as indicated by the fact that all except tiger rockfish, were reported using coastal waters in British Columbia by Hart (1973).

HABITAT USE

Adult

- Adult fish in this complex are generally benthic but may use the water column for feeding. Although little is known of the ecology and behavior of these four species in Washington, their habitat preferences have been documented: Greenstriped rockfish - Offshore and deep offshore ecosystem, primarily coastal waters, between 100 to 250 meters in consolidated and unconsolidated rocky habitats (Love et al. 2002). Greenstriped rockfish are benthic resting on the bottom (Love et al. 2002). Adults of this species may reach 54 years of age and a maximum-recorded size of 43 centimeters. Off the Washington coast, 50 percent of male greenstriped rockfish reach sexual maturity at age 10 (23 centimeters) and 50 percent of females reach sexual maturity at age 7 (21 centimeters) (Love et al. 2002).
- China rockfish - Nearshore and offshore ecosystems, primarily coastal waters, between 3 and 128 meters in consolidated habitats including high-relief outcrops with caves and crevices, rugged bottoms, and boulder fields with high wave or current energy (Love et al. 2002). Male and female China rockfish reach sexual maturity at approximately 30 centimeters in length and at 6 years of age. The maximum-recorded age for China rockfish is 79 years with a maximum size of 45 centimeters (Love et al. 2002).
- Tiger rockfish - Nearshore and offshore and deep offshore ecosystems, inland waters, between 18 to 298 meters in consolidated habitats in the form of rock outcrops with caves and crevices (Love et al. 2002). This species is benthic and uses crevices and shallow caves. On average, female tiger rockfish reach sexual maturity between 28 and 47 centimeters, while males mature between 36 to 49 centimeters. Tigers are a long-lived species and are known to reach at least 116 years in age (Oregon Department of Fish and Wildlife 2002), with a maximum size recorded of 61 centimeters.
- Redstriped rockfish - Offshore ecosystem, primarily coastal waters, between 150 to 275 meters in consolidated habitats in the form of rugged solid rock bottoms with high relief (Love et al. 2002). The species is usually benthic but may be parademersal forming dense near-bottom schools by day and dispersing at night (Love et al. 2002). Fifty percent of the redstripe rockfish off the Washington coast reach sexual maturity at seven years of age (Love et al. 2002), with males

approximately 26 centimeters in length and females 28 centimeters. Redstripe rockfish reach a maximum size of 51 centimeters and a maximum age of 55 years (Love et al. 2002).

Reproduction

Similarly to other rockfish, this complex, has internal fertilization and is ovoviviparous, producing live young. Eggs develop internally and hatch several days before they are extruded (parturition) (Love et al. 2002). Some species are multiple brooders, releasing young two or more times per year.

- Greenstriped rockfish release larvae that are approximately 5 millimeters long during late spring and early summer off Oregon, Washington and British Columbia (Hart 1973).
- China and tiger rockfish undergo parturation from May to June off the Oregon coast.
- Redstripe rockfish release their larvae in Puget Sound during July (Kendall and Lenarz 1986; Garrison and Miller 1982), with the larvae 3 to 7 millimeters upon release.

Larvae and Juveniles

Little data are available on predators of these fish, however they are likely vulnerable to predation by larger fish, birds and marine mammals with younger, smaller individuals particularly susceptible (Oregon Department of Fish and Wildlife 2002). Love et al. (2002) reported that both redstripe and greenstriped rockfish have been found in the stomachs of Chinook salmon (*Oncorhynchus tshawytscha*).

- Greenstriped rockfish - Larvae undergo a planktonic period lasting one to two months. While drifting, these fish mostly feed on smaller plankton such as copepods and are likely preyed upon by siphonophores and chaetognaths (Oregon Department of Fish and Wildlife 2002). In Monterey Bay, greenstriped rockfish larvae settle at 3 centimeters in length in water deeper than 40 meters over soft bottoms. Newly settled fish have a growth rate of 0.17 millimeters per day, with the juveniles moving to deeper water as they mature. Juvenile prey items include krill, fishes, shrimp, calanoid copepods, squid, and gammarid amphipods (Love et al. 2002).
- China rockfish - The planktonic period for this species lasts one to two months, with the larvae feeding on smaller plankton such as copepods and preyed upon by siphonophores and chaetognaths (Oregon Department of Fish and Wildlife 2002). Settlement occurs when larvae reach 6 centimeters (Love et al. 2002) in depths between 30 to 89 meters (Love et. al. 1990). In southeast Alaska, Rosenthal et al. (1982) observed juvenile China rockfish in shallow subtidal water during summer and early fall. Juveniles likely feed on benthic organisms such as echinoderms, crabs, shrimp, chitons and small fish (Rosenthal 1988).
- Tiger rockfish - Similarly to China rockfish, tiger rockfish larvae undergo a planktonic period for one to two months. While drifting, these larvae feed on

smaller plankton such as copepods and are likely prey for siphonophores and chaetognaths (Oregon Department of Fish and Wildlife 2002). Larvae in Puget Sound and off the Washington and British Columbia coast were reported by Love et al. (2002) as associating with drifting vegetation. In Alaska, Love et al. (2002) reported they settle in waters as shallow as 9.1 meters. Little additional data are available for tiger rockfish juveniles.

- Redstripe rockfish - Larvae feed on all stages of copepods and euphausiids (Kendall and Lenarz 1986) and are likely a food source for planktonic predators such as siphonophores and chaetognaths (Oregon Department of Fish and Wildlife 2002). Juvenile redstripe rockfish exhibit a pelagic to semi-demersal movement pattern (Garrison and Miller 1982) and utilize both marine and estuarine habitat feeding on all stages of copepods and euphausiids (Kendall and Lenarz 1986).

POPULATION TRENDS

There are little data on population trends for this complex of rockfish. However, population trends for many other species of rockfish show evidence of declining abundance due to overharvest as either the target species or as by-catch (Wright 1999; Love et al. 2002). Wright (1999) stated that the entire genus (*Sebastes*) is at risk because the life history characteristics (slow growth and late maturity) make them extremely vulnerable to over fishing.

THREATS WARRANTING ESA PROTECTION

Wright's (1999) petition to list 13 species of rockfish in Puget Sound (including this complex) discusses several activities that threaten either the rockfish or their essential habitat. These threats are listed below.

Destruction, Modification, or Curtailment of Habitat or Range

With the exception of china rockfish, this complex generally inhabits deeper nearshore and offshore-consolidated habitats and are therefore not at high risk for the destruction or modification of habitat.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There are no known commercial fisheries that target this complex of rockfish and Washington Fish and Wildlife has strict limits for recreational take (Palsson et al. 1997). Similarly to all rockfish, this complex is at risk due to recreational fishing pressure on the largest and oldest fish and a resulting depletion in reproductive populations. There are no known scientific or educational uses for this complex of rockfish.

Disease or Predation

While disease is not known to be a significant threat to these species, predation from sea lions (*Zalophus califonianus*) and harbor seals (*Phoca vitulina*) may be a factor in decreasing population trends. Due to their protection under the Marine Mammal

Protection Act of 1972 pinniped populations have increased and may be placing additional strain on rockfish populations.

Adequacy of Existing Regulatory Mechanisms

Washington Fish and Wildlife manages all of these species and imposes strict catch limits (Palsson et al. 1997). However, the limits may be inadequate protection due to the fact that rockfish constitute a large percentage of the bycatch for lingcod and salmon fisheries.

Other Factors Affecting Continued Existence

Additional factors affecting this complex rockfish include possible sub-lethal affects from bioaccumulation and concentration of chemical contaminants (West 1997; West and O'Neill 1998); and the possible feminization of male rockfish as a result of human estrogen/progesterone in the water (West 2004). While some studies have suggested decreases in reproductive success and survival of young rockfish as a result of ocean climate fluctuations such as El Nino and La Nina Southern Oscillation and Pacific Decadal Oscillation (Partnership for Interdisciplinary Studies of Coastal Oceans 2004), the magnitude of this variable in Washington is currently unknown.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

The four species of rockfish that constitute this complex are likely to be affected by activities authorized by Washington DNR within marine nearshore environments. Roadways, bridges, and docks may result in stormwater runoff which may increase concentrations of toxic contaminants including but not limited to hormones, PCBs, heavy metals and petroleum products in both the sediments and water column. Additionally, discharges containing nitrogenous and bacterial waste associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality as well as contribute towards eutrophication of the nearshore environment. Net pens associated with fish hatcheries and aquaculture operations may also contribute to the loss of adult habitat from shading and the introduction of disease and parasites. Overwater structures and shoreline modifications may negatively affect habitat by reducing or modifying macroalgae, kelp, and eelgrass habitat. Dredging or disposal of dredged materials has the potential to cover rockfish habitat. Furthermore, sediment flow could be changed by bulkheads and jetties and subsequently suffocate habitat. Deep-water activities in the offshore ecosystem such as utility corridors may also disrupt and affect adult habitat.

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http://www.nwr.noaa.gov/1salmon/salmesa/pubs/petmfish.pdf.

3-3.6 Copper rockfish (*Sebastes caurinus*)

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Copper rockfish range from the Gulf of Alaska to central Baja California (Miller and Lea 1972). This species is widely distributed in Puget Sound and Washington's coastal waters with the exception of the Southeast Georgia Strait area (Miller and Borton 1980).

The NOAA Fisheries status review delineated three distinct population segments within Washington's waters - Northern Puget Sound (San Juan Islands and Straits of Juan de Fuca), Puget Sound Proper, and Outer Coast (Cape Flattery west) (Stout et al. 2001). The North Puget Sound population segment includes not only Washington waters but also the Canadian Gulf Islands and the Strait of Georgia (Stout et al. 2001). The boundaries of the Outer Coast population segment are also broad and ill defined, including areas south into California and north into Alaska. Only the Puget Sound population segment was clearly defined as that area labeled "Puget Sound proper," defined as the marine waters south of Admiralty Inlet and east of Deception Pass.

HABITAT USE

Adults

Adult copper rockfish prefer consolidated habitats of nearshore and upper offshore ecosystems in coastal and inland waters. Their depth range is between 1 and 23 meters in high relief rocky reefs and low relief areas when kelp cover is present (Matthews 1990a). Adults are solitary or occur in small aggregations with a small home range of 10 to 4,000 square meters (Mathews and Barker 1983; Matthews 1990b). During the winter this species may migrate to deeper water or retreat into crevasses (Richards 1987).

Copper rockfish feed primarily near the bottom during mid-day. Prey includes brachyuran crabs, gammarid amphipods, euphausiids, calanoid copepods, and fish such as shiner surfperch (*Cymatogaster aggregata*), Pacific herring (*Clupea pallasi*) cottids, kelp greenling (*Hexagrammos decagrammus*) and spiny dogfish (*Squalus acanthias*) (Patten 1973; Wingert 1979; Hueckel and Stayton 1982; Murie 1995). Predators may include lingcod (*Ophiodon elongatus*), cabezon (*Scorpaenichthys marmoratus*), salmon (*Onchorynchus* spp.), river otters (*Lutra canadensis*), sea lions (*Zalophus califonianus*), harbor seals (*Phoca vitulina*), great blue heron (*Ardea herodias*), cormorants (*Phalacrocorax* spp.) and various other marine bird species.

Reproduction

All species of rockfish have internal fertilization and retain the eggs until larval release (Boehlert and Yoklavich 1984). Mating behavior of copper rockfish has been observed during October in mid-water in San Juan Channel (Eisenhardt, Personal communication. September 27, 2003). Both sexes mature around the same time, at 4 to 6 years of age (Richards and Cass 1985; Stein and Hassler 1989) with parturition occurring in April, May and June in Washington (DeLacy et al. 1964; Moulton 1977; Washington et al. 1978). Copper rockfish can reach 55 years old (Matthews 1987) and 57 centimeters total length (Stein and Hassler 1989).

Larvae and Juveniles

Larval fish are extruded into the nearshore inland and coastal neritic zones and associate with shallow water habitats including algae attached to overwater structures, shallow consolidated reefs and eelgrass meadows (Doty et al. 1995). They remain off the bottom in these habitats until they reach 20 to 45 millimeters total length (Buckley 1997; Love et al. 2002), preying on zooplankton (calanoid copepods, gammarid amphipods, cyprid larvae), polychaetes and larval fish (Murie 1995; Hueckel and Stayton 1982).

At 50 to 90 millimeters total length, juveniles settle into benthic habitats on consolidated high-relief rocky reefs, and/or in kelp or eelgrass beds at the unconsolidated and consolidated rock interface in water no deeper than 18 meters (Matthews 1988; Matthews 1990a; West et al. 1994; Doty et al. 1995; Buckley 1997). Movement from off bottom to benthic habitats occurs from July to October.

The juveniles are crepuscular feeders, concentrating feeding activity at dawn and dusk on small fish and crustaceans (Patten 1973; Hueckel and Stayton 1982; Hueckel and Buckley 1987).

POPULATION TRENDS

The NOAA Fisheries status review (Stout et al. 2001) found differing population trends within the three population segments defined in Washington. Within the Outer Coast population segment, data for recreational catches within three miles of the Pacific Coast for 1993 to 1999 suggest a gradual decline in catch in 1995, a modest increase in 1996 and a decrease in 1997. Since 1997, a gradual increase was observed in 1999 (Stout et al. 2001). Length-frequency patterns for these years were similar.

In North Puget Sound, a number of different methods each provided descriptions of population trends (Stout et al. 2001). Trawl surveys indicate a decline from 72,000 fish in 1987 to 17,000 in 1995. Data from scuba diving surveys show a lower density of copper rockfish at a fished site in contrast to an unfished location. The catch per trip of all rockfish species (data for copper rockfish were not separated) in the recreational fishery fluctuated between 0.6 and 1.0 during 1980 to 1999, with no apparent trend after a decline from higher levels in the late-1970s. The length frequency data in this fishery show a decline prior to 1985 in the average length due to a reduction in the fraction of fish greater than 45 centimeters (Stout et al. 2002).

In the Puget Sound proper population segment, trawl, scuba, and video surveys indicate a substantial decline in the numbers and biomass of copper rockfish during 1987 to 1997. For instance, the numbers in scuba surveys declined from 40 to 4.88 copper rockfish per 270 square meters. In addition, an analysis of fish taken in the recreational fishery indicated that egg production also declined substantially. In summary, the decline in population in the Puget Sound proper population segment appears to be 70 to 80 percent over 25 years (Stout et al. 2001).

THREATS WARRANTING ESA PROTECTION

The risks to the survival of the copper rockfish were listed by West (1997) as “anthropogenic stressors and natural limiting factors,” and include “overharvesting, loss

or degradation of habitat, predation by pinnipeds and fish, and pollution-related adverse effects."

Destruction, Modification, or Curtailment of Habitat or Range

Habitat for juvenile rockfish could be affected through shoreline development. Adult habitat does not appear to be limiting at this time because unoccupied habitat is apparently present in Puget Sound (Stout et al. 2002).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Copper rockfish are vulnerable to over harvest by recreational fisheries in all population segments. West's (1997) presentation of risk factors for copper rockfish in greater Puget Sound points to overharvest as the probable major factor contributing to the decline of these fish. This conclusion was further supported by the findings of the NOAA Fisheries status review (Stout et al. 2001). Late maturing, long-lived species such as rockfish are slow to rebuild depleted populations making them particularly sensitive to overfishing. There are no known scientific or educational uses for copper rockfish.

Disease or Predation

While disease is not known to be a significant threat to this species, predation from sea lions (*Zalophus califonianus*) and harbor seals (*Phoca vitulina*) may be a factor in decreasing population trends. Due to their protection under the Marine Mammal Protection Act of 1972 pinniped populations have increased and may be placing additional strain on copper rockfish populations.

Adequacy of Existing Regulatory Mechanisms

The current Washington Department of Fish and Wildlife management strategy is to eliminate targeted harvest of rockfishes in Puget Sound. These rules became effective in 2004 and will help reduce fishing effort on rockfishes. However, the limits may be inadequate protection due to the fact that rockfish constitute a large percentage of the bycatch for lingcod and salmon fisheries

Other Factors Affecting Continued Existence

Additional factors affecting copper rockfish include possible sub-lethal affects from bioaccumulation and concentration of chemical contaminants (West 1997; West and O'Neill 1998); and the possible feminization of male rockfish as a result of human estrogen/progesterone in the water (West 2004). While some studies have suggested decreases in reproductive success and survival of young rockfish as a result of ocean climate fluctuations such as El Nino and La Nina Southern Oscillation and Pacific Decadal Oscillation (Partnership for Interdisciplinary Studies of Coastal Oceans 2004), the magnitude of this variable in Washington is currently unknown.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Copper rockfish are likely to be affected by activities authorized by Washington DNR within marine nearshore environments. Roadways, bridges, and docks may result in stormwater runoff which may increase concentrations of toxic contaminants including but not limited to hormones, PCBs, heavy metals and petroleum products in both the sediments and water column. Additionally, discharges containing nitrogenous and bacterial waste associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality as well as contribute towards eutrophication of the nearshore environment. Net pens associated with fish hatcheries and aquaculture operations may also contribute to the loss of adult habitat through shading and the introduction of disease and parasites. Since copper rockfish have a relatively small home range and a preference for shallow, low relief reefs and artificial structures (e.g., piers), they are especially vulnerable to habitat disturbance and loss. Overwater structures and shoreline modifications may negatively affect habitat by reducing or modifying macroalgae, kelp, and eelgrass habitat. Dredging or disposal of dredged materials has the potential to cover brown rockfish habitat. Furthermore, sediment flow could be changed by bulkheads and jetties and subsequently suffocate habitat.

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3-3.7 Eulachon (*Thaleichthys pacificus)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	G5; S3

RANGE

Eulachon naturally occur from the Pribilof Islands in the Bering Sea south to Monterey Bay, California (Eschmeyer and Herald 1983). They are anadromous and are found in the nearshore zone, coastal inlets and rivers.

In Washington, eulachon spawn in the Columbia River below Bonneville Dam and in the Cowlitz, Grays, Kalama, Lewis, Sandy and Nooksack Rivers (Wydoski and Whitney 2003). These fish are important prey items for many species of fish, marine mammals and birds along the Pacific coast.

HABITAT USE

Adult

Eulachon are found in inshore marine waters throughout the Pacific Ocean at depths of 80 to 200 meters. The species is pelagic and is not associated with a particular substrate or habitat type, except during periods of spawning. Eulachon become sexually mature at 2 to 5 years of age, with average lengths ranging between 7 and 12 centimeters (Wydoski and Whitney 2003). Despite its widespread occurrence, very little is known about eulachon during its saltwater phase, except that they are known to prey heavily on euphausiid shrimp in shallow waters (Wydoski and Whitney 2003) and are often bycatch in the shrimp fishery. Eulachon use only 20 to 30 river systems on the west coast for spawning (Canadian Department of Fisheries and Oceans 2004) and spawning runs have been identified as critical feeding opportunities for marine mammals as well as several species of fish and birds, because of the eulachon's high energy content (Wydoski and Whitney 2003; Sigler et al. 2004).

Spawning/Incubation / Emergence

Eulachon return to fresh water to spawn from December until March, with peak spawning activity in Washington occurring in February and March (Wydoski and Whitney 2003). Eulachon are broadcast spawners, generally spawning in lower gradient reaches with coarse sediments (McLean et al. 1999). Although timing is highly dependent on river conditions, eulachon prefer to spawn in systems with strong freshets (Canadian Department of Fisheries and Oceans 2004) with spawning generally occurring at night

(Wydoski and Whitney 2003). Eulachon are thought to die after spawning, generally washing out to the ocean or being consumed locally by birds, mammals and fish, such as sturgeon (Wydoski and Whitney 2003).

Hatching occurs within 2 to 3 weeks, with the larvae passively washed downstream to the ocean (McClean et al. 1999).

Rearing / Outmigration

Though anadromous, eulachon spend no time rearing in fresh water as larvae and juveniles. Once in the marine environment, postlarval eulachon are neritic and stay near the surface of the water, feeding on copepod larvae in both the nearshore and offshore ecosystems. Prey items range from phytoplankton to copepods, Cladocera and euphausiids, with larger eulachon eating larvae of their own species (Hart 1973).

POPULATION TRENDS

Populations of eulachon have declined drastically in the last decade and although the cause is unknown, unfavorable ocean conditions, overharvesting and habitat loss are thought to have played a part. Although stock assessments have not been conducted, commercial harvest data for the Columbia River have been kept since the 1930s (Bargmann 1998) and the 5 year average catch has declined from almost 900 tons during 1990 to 1994, to less than 75 tons for 1995 to 1997 (Wydoski and Whitney 2003) . While harvest data is largely market driven and may not reflect population size, the declining trend is notable. Stock assessments have been conducted in British Columbia and show that populations have declined since the late 1980s, with the Fraser River showing a decline over the last decade similar to that for the Columbia River (Canadian Department of Fisheries and Oceans 2004).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

The destruction or alteration of spawning habitats is of concern and dredging for the maintenance of shipping lanes may be detrimental to spawning habitat in the Columbia River and other navigable waterways,.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Eulachon are harvested commercially and recreationally by using gillnets, dip nets and trawls and are noted as a significant bycatch in the shrimp fishery. Overharvest has resulted from targeted recreational and commercial activities.

Disease or Predation

Neither disease nor predation has been identified as a significant threat to the species.

Adequacy of Existing Regulatory Mechanisms

Although the Washington Department of Fish and Wildlife has a forage fish management plan (Bargmann 1998), a harvest management plan has not been established for eulachon.

Other Factors Affecting Continued Existence

Global climate change and oceanic conditions may have contributed to the recent reduction of eulachon in Washington and British Columbia.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Eulachon are dependent on freshwater ecosystems for reproduction and the marine nearshore zone for their early life history. Any Washington DNR activity that could negatively impact the riparian corridor could in turn negatively affect the eulachon population. Authorized activities, such as overwater structures, nearshore activities (such as the construction of piers, docks and marinas) and multiple or complex structures, could affect the migration to and from spawning grounds. Additionally, alterations to the substrate itself (via increased/decreased sediment transport, dredging and filling) will have negative impacts on eulachon spawning, because reproductive success is highly dependent on suitable sediment.

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3-3.8 Leopard dace (*Rhinichthys falcatus*)

Leopard dace are members of the Genus *Rhinichthys* and are very similar morphometrically to Umatilla dace *Rhinichthys umatilla*. Leopard and Umatilla dace were previously considered to be sub-species of the taxonomically similar speckled dace (Wydoski and Whitney 2003) and have only recently been recognized as separate species by the American Fisheries Society (Nelson et al. 2004). Leopard dace exhibit only small morphological differences from Umatilla dace such as the presence of fleshy stays on the rays of the pelvic fins, the presence of dark spots along the lateral line, a relatively narrow caudal peduncle and, larger and fewer lateral line scales (Hass 2001, Wydoski and Whitney 2003). Leopard dace also exhibit different habitat usage than Umatilla dace, opting for greater water velocities (Haas 2001).

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	G4; S2, S3

RANGE

Leopard dace occur in sporadic and disconnected regions of British Columbia, Idaho, Oregon and Washington. Although information regarding this species is generally lacking, it is believed that they are limited to the Fraser and Columbia River systems east of the Cascade Mountains (Scott and Crossman 1973). Within Washington, leopard dace currently inhabit the lower, mid and upper reaches of the Columbia, Snake, Yakima and Similikameen Rivers although they are exceptionally rare below Prosser, Sunnyside and Roza Dams in the Yakima River (Wydoski and Whitney 2003). Leopard dace have been found to be allopatric and sympatric with Umatilla and speckled dace.

HABITAT USE

Adults

Leopard dace are a demersal fish, and utilize habitat on or near the bottom of streams and small to mid-sized rivers with stream velocities less than 0.5 meters per second. The species prefers substrates comprised of stones covered by fine sediments, with summer water temperatures ranging between 15 and 18° Celsius, and is rarely found at depths greater than 1 meter (Peden 1991; Wydoski and Whitney 2003). Individuals may live up to 5 years in the wild, attaining lengths of 6 to 15 centimeters (Wydoski and Whitney 2003; Froese and Pauly 2004). Although juveniles feed primarily on aquatic insects, adult leopard dace consume terrestrial insects (Wydoski and Whitney 2003).

Spawning

Very little is known about leopard dace spawning habitat or behavior, although it is believed to be similar that of longnose and speckled dace. These dace primarily spawn in riffles with females depositing adhesive eggs over unprepared gravel or small stones in the presence of multiple males (Scott and Crossman 1973; Wydoski and Whitney 2003). Although males remain at the spawning site well after females, it is thought they remain to spawn with other females as opposed to engaging in nest-guarding behavior (Wydoski and Whitney 2003). Prior to spawning, male lower fin insertions and lips change color to orange or scarlet; whereas both male and female leopard dace develop breeding tubercles on the head and body (Peden 1991; Wydoski and Whitney 2003). Spawning takes place between May and July (Wydoski and Whitney 2003).

Juveniles

Young of the year mostly feed on dipterous larvae (Ephemeroptera and Diptera) until age one when their diet shifts to terrestrial insects (Froese and Pauly 2004). Juveniles have been observed to migrate to deeper water at night effectively changing positions with adults who move to shallower water (Peden 1991), although the purpose of these nocturnal movements is not well understood.

POPULATION TRENDS

Insufficient information exists regarding past and current abundance to draw conclusions regarding population trends. Washington Fish and Wildlife is currently continuing its efforts to determine the population trends and status of leopard dace in Washington.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Since leopard dace are dependent on river and stream shoreline habitat, they are vulnerable to a number of impacts affecting their habitat. Sand and gravel mining, logging, agriculture, grazing or urbanization may increase sediment deposition, which degrades habitat. Shoreline armoring and fill may decrease critical areas of shallow, slow moving habitat. Furthermore, shoreline development, grazing and agriculture may decrease both riparian cover and terrestrial insects that are important prey items for dace. Bank armoring impacts dace by removing refuge from predators found with undercut banks, log snags, and streamside vegetation. The removal of woody debris from rivers, streams and estuaries to improve navigability, decrease channel meander, and aesthetically improve “views” has resulted in a significant loss of refuge from predators and may increase scour from high flow events caused by water releases from dams and flooding. Point source and non-point source pollution can have deleterious effects on food web assemblages and individuals.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There are no known commercial, recreational, scientific or educational uses for leopard dace.

Disease or Predation

Although dace likely serve as forage fish for trout, salmon, and other native and introduced fishes, insufficient information exists to determine that disease or predation is a current threat to leopard dace survival. However, it is important to note that small isolated populations can be highly sensitive to disease events or an increase in predation rates from native or introduced predators.

Adequacy of Existing Regulatory Mechanisms

Leopard dace may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and degradation such as changes in sediment load, fill and bank armoring, point and non-point source pollution, and water diversions.

Other Factors Affecting Continued Existence

Temperature change brought about by local land and watershed management that decreases riparian zone shading and cover, as well as broader scale factors such as global climate change may negatively impact leopard dace populations. Furthermore, isolated stocks may not be able to effectively restock weakened populations due to habitat separation caused by dams. Low-density populations may also decline due to the inability to find mates; which may place isolated populations at further risk of extirpation.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Leopard dace are likely to be affected by a variety of activities authorized by Washington DNR on state-owned rivers. In addition to providing a refuge for predators, overwater structures frequently reduce or prevent the growth vegetated habitat by preventing the transmission of light. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality, and potential bioaccumulation of pollutants. Construction of roads and bridges may result in increased sedimentation during construction, as well as increase temperature and pollutant loads from stormwater runoff during operation. Pollutants that are harmful to dace and that are present in stormwater runoff and outfalls include but are not limited to hormones, PCBs, heavy metals, salts, fertilizers, and petroleum products. Dredging, fill, shoreline armoring, and sand and gravel mining may either remove habitat or prevent the formation of habitat, or alter sediment loads, thereby decreasing habitat through increased scour or deposition. Aquaculture operations also have the potential to impact this species through disease transmission, decreased dissolved oxygen levels, increases in nitrogenous waste and the introduction of chemicals such as, pesticides and antibiotics.

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Wydoski, R.S. and R.L. Whitney. 2003. Inland Fishes of Washington. University of Washington Press. Seattle, Washington

3-3.9 Olympic mudminnow (*Novumbra hubbsi)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Sensitve
Natural Heritage Program	G3; S2, S3

RANGE

The Olympic mudminnow is endemic to western Washington. The species is well documented, occurring in the southern and western lowlands of the Olympic Peninsula, the Chehalis River drainage, lower Deschutes River drainage and South Puget Sound lowlands west of the Nisqually River (Mongillo and Hallock 1999). However, recent observations have extended their range into the Cherry and Issaquah Creek drainages (Trotter et al. 1998). Because of the elevation at which these populations are found (240 and 135 meters receptively), there is debate as to whether they are naturally occurring or introduced (Trotter et al. 1998; Mongillo and Hallock 1999). More than 96 percent of Olympic mudminnows are found at elevations less than 100 meters above sea level (Mongillo and Hallock 1999).

HABITAT USE

Olympic mudminnows are found mostly in riverine, palustrine and lacustrine wetland habitats. They have also been found in other still-waters habitats such as the littoral areas of lakes, backwater areas of low gradient valley streams and possibly in riffle-pool habitats. According to Harris (1974), Olympic mudminnows are closely associated with three essential habitat characteristics: 1) a soft mud bottom at least several centimeters in depth; 2) little or no flow; and 3) dense aquatic vegetation. He further stated that if any of these characteristics were missing, mudminnows were not found. A study conducted by Washington Fish and Wildlife (Mongillo and Hallock 1999) at a site in Lake Ozette found that the species was present immediately after vegetation was removed, however

the minnows were not present in later surveys. As the vegetation returned, so did Olympic mudminnows.

Spawning occurs from late November to mid June, with a peak during April and May. Water temperature during spawning ranges from 10 to 18° Celsius. Eggs are usually deposited near the bottom and no parental care of eggs or fry is given. In laboratory conditions with water temperatures between 15 to 17° Celsius, eggs hatch within nine days, and fry disperse about seven days after hatching (Mongillo and Hallock 1999).

Olympic mudminnow prey items includes a variety of invertebrate species including those from the following families; Ostracoda, Isopoda, Oligochaeta, Mysidacaea, Megaloptera, Mollusca, and Diptera (Mongillo and Hallock 1999). While little is known about predators of this species, it is likely that fish, birds, and mammals prey upon them. In a study of fishes in oxbow lakes in Washington, Beecher and Fernau (1983) noted that Olympic mudminnows were not found in lakes that contained non-native fish predators.

POPULATION TRENDS

While historic data on Olympic mudminnow population status is not available, several studies have documented the dependence of Olympic mudminnow on wetland habitats. Because of the widespread loss of wetlands within the Olympic mudminnow range, it is reasonable to conclude that the overall population size is likely smaller than prior to Euro-American settlement. Olympic mudminnows are locally common within the known range, with a recent population study conducted at 16 sites between 1993 and 1998 that showed 14 populations appear to be stable and two are at risk. Even if present populations are healthy, the distribution of the Olympic mudminnow is extremely restricted, and local disturbances may have profound effects on its persistence (Mongillo and Hallock 1999).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Threats to the Olympic mudminnow include, but are not limited to, any form of wetland degradation (natural or anthropogenic) that alters or eliminates mud substrate or aquatic vegetation, increases water flow or degrades water quality. Because of the Olympic mudminnow’s limited range, further habitat modification or reduction could critically impair the long term survival of the species (Harris 1974; Mongillo and Hallock 1999). Residential and commercial development may also impact these fish by draining or channeling wetlands resulting in a direct loss of suitable habitat.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

The Olympic mudminnow is not a sought-after game fish and has no commercial value. Therefore, there are no harvest-related issues (Mongillo and Hallock 1999). In addition, there are no known scientific or educational uses for Olympic mudminnows.

Disease or Predation

Little information exists concerning the impact of disease or predation on Olympic mudminnow populations. However, a study conducted by Beecher and Fernau (1983) examined fish populations in 16 oxbow lakes and found that Olympic mudminnows are absent in sites that include exotic fish predators.

Adequacy of Existing Regulatory Mechanisms

Although not a protected species under federal or state regulatory requirements, the needs of the Olympic mudminnow are often taken into account when a proposed project may impact its habitat. However, recommendations for protection are often only advisory and these measures typically offer limited protection (Mongillo and Hallock 1999). State and federal regulations that may provide direct protection to this species habitat include Washington State's Growth Management, Shoreline Management and Water Pollution Control Acts, and the Federal Clean Water and the Food Security Act.

Other Factors Affecting Continued Existence

Alterations to habitat designed to enhance salmon habitat and eliminate mud substrate and vegetation or increase water flow may be in conflict with Olympic mudminnow habitat requirements (Mongillo and Hallock 1999).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

The Olympic mudminnow is likely to be affected by a variety of activities authorized by Washington DNR on state-owned rivers and lakes. In addition to providing a refuge for predators, overwater structures frequently reduce or prevent the growth vegetated habitat by preventing the transmission of light. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality, and potential bioaccumulation of pollutants. Construction of roads and bridges may result in increased sedimentation during construction, as well as increase temperature and pollutant loads from stormwater runoff during operation. Pollutants that are harmful to dace and that are present in stormwater runoff and outfalls include but are not limited to hormones, PCBs, heavy metals, salts, fertilizers, and petroleum products. Dredging, fill, shoreline armoring, and sand and gravel mining may either remove habitat or prevent the formation of habitat, or alter sediment loads, thereby decreasing habitat through increased scour or deposition. Aquaculture operations also has the potential to impact this species through disease transmission, decreased dissolved oxygen levels, increases in nitrogenous waste and the introduction of chemicals such as, pesticides and antibiotics.

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3-3.10 Pacific cod (*Gadus macrocephalus)*

The common and scientific names are valid and correct as they are listed above and currently used by state and federal agencies (Nelson et al. 2004). Additional common names may include “grey cod,” “cod,” "true cod" and “Alaska codfish.”

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Species of Concern
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Pacific cod occur around the Pacific Rim from the Sea of Japan to Santa Monica Bay, California (Hart 1973; Bakkala et al. 1984; Gustafson et al. 2000). However, the primary concentrations of Pacific cod have historically been in the North Pacific, including the Bering Sea and the waters near northern Japan. This suggests that the Pacific cod populations in Puget Sound are relatively isolated (Gustafson et al. 2000).

The Washington State Department of Fish and Wildlife (Washington Fish and Wildlife) group Puget Sound Pacific cod into the following population segments: North Sound (U.S. waters north of Deception Pass, including the San Juan Islands, Strait of Georgia, and Bellingham Bay); West Sound (west of Admiralty Inlet and Whidbey Island, and the U.S. section of the Strait of Juan de Fuca, including Port Townsend); and South Sound (south of Port Townsend and Admiralty Inlet).

However, NOAA Fisheries Status Review for Pacific cod stated that the distinct population segment delineation is ambiguous and it is not clear if the Puget Sound stock extends to Dixon entrance between Alaska and Canada or farther north into southeast Alaska (Gustafson et al. 2000).

HABITAT USE

Adult

Adult Pacific cod use unconsolidated habitats in the offshore and deep offshore ecosystem of coastal and inland waters. Adults and large juveniles seem to utilize soft

bottom habitats associated with clay, sand, or mud (Garison and Miller 1982) and form large concentrations near the bottom at depths of 200 to 500 meters. While Pacific cod occur as deep as 875 meters, they are most common in the 50 to 300 meter range (Hart 1973; NOAA 1990).

In Puget Sound, 50 percent of the male and female Pacific cod reach sexual maturity at 2 to 3 years of age and 45 centimeters total length (NOAA 1990). In coastal waters, males mature when 41 to 53 centimeters and females at 47 to 56 centimeters at 2 to 3 years of age (Westrheim 1996). The maximum observed size for fish in Puget Sound is 91.4 centimeters but adults are usually smaller than 70 centimeters with an average maximum age of 6 years old (Karp 1982). In coastal waters, the average is 8 years old and 83 centimeters (Ketchen 1961).

Adults are carnivorous and opportunistic, feeding at night on whatever prey item is abundant. Dominant prey items vary seasonally with availability and include shrimp, mysids, amphipods crabs, sand lance, euphausiids, copepods, and small fishes, including Pacific cod juveniles. Predators include toothed whales, pinnipeds, Pacific halibut, salmon sharks, and larger Pacific cod (Hart 1973; NOAA 1990; Palsson 1990).

Pacific cod form large aggregations for feeding and spawning. Pacific cod are considered a non-migratory species but have discrete areas for spawning and feeding, with oceanic fish concentrated at deep spawning areas off the outer and upper slope in fall and winter, and in shallower middle and upper shelf areas in spring and summer for feeding (Westrheim and Taggert 1984).

Reproduction

Pacific cod are oviparous with a single release of eggs and sperm (Sakurai and Hattori 1996). Eggs have been found associated with coarse sand and cobble bottoms, and because most winter concentration areas have bottom sediments consisting of coarse sand and cobble, it is inferred that Pacific cod preferentially spawn near these bottom types (Palsson 1990). Spawning locations of Pacific cod have been identified in Washington primarily on the basis of wintertime aggregations and have been reported in Agate Passage northwest of Bainbridge Island; Port Townsend Bay; Port Gamble; Dalco Passage near Tacoma; Eliza Island off Bellingham; and off Protection Island and Port Angeles in the Strait of Juan de Fuca (Gustafson et al. 2000). Because of population declines and the age of the data on which Gustafson et al. (2000) based this list, several of these locations may no longer be viable. Spawning aggregations form in January through May with heaviest spawning in February and March (Miller et al. 1978; Bargmann 1980; Wildermuth 1986). Eggs hatch in 8 to 28 days depending on temperature (Gustafson et al. 2000).

Larvae and Juveniles

Pacific cod larvae hatch at about 3 to 4 millimeters with a yolk sac, which is absorbed in about 10 days. Larvae are pelagic and concentrated at the 15 to 30 meter depth zone, settling into nearshore intertidal and shallow subtidal sand and eelgrass habitats at 20 to 25 millimeters (Palsson 1990; Gustafson et al. 2000). While larvae of 2 centimeters length prey upon copepods (Hart 1973), it is not known what larvae feed on between yolk

absorption and this size (Gustafson et al. 2000). Larvae are preyed upon by seabirds and pelagic fishes (Hart 1973; NOAA 1990; Palsson 1990).

Juvenile fish move into deeper water as they grow, shifting from shallow sand and eelgrass habitats to unconsolidated habitats in deeper basins (Hart 1973; Karp and Miller 1977; NOAA 1990). The juvenile fish feed on copepods, small shrimps and amphipods at night (Palsson 1990). Juveniles between 6 and 15 centimeters in length prey on euphausiids, amphipods and small fishes (Walters 1984).

POPULATION TRENDS

Pacific cod stocks have declined throughout their range and little migration between spawning locations has been documented with tagging studies (Westerheim 1982). However, genetic studies indicate that there are no genetically discrete stocks in North American Pacific cod populations (Gustafson et al. 2000).

Assessments of population trends in Washington's inland waters are based on trends in fishery statistics since 1970 (Palsson et al.1990; Palsson et al. 1997; Gustafson et al. 2000). North of Admiralty Inlet, the catch rate of the commercial bottom trawl fishery varied between 42 and 73 kilograms/hour during the 1970s but was generally stable until 1988 (around 39 kilograms/hour), after which it declined continuously to 12 kilograms/hour (1994). Since 1994, Washington Fish and Wildlife data indicate that catch rates in the bottom trawl fishery were somewhat higher than the low in 1994. In addition, beginning in 1991, the bottom trawl fishery near Port Townsend and Protection Island was closed during the winter to protect Pacific cod and other marine fish (Gustafson et al. 2000).

The South Sound population includes both Port Townsend Bay, where Pacific cod supported bottom trawl and set net fisheries during the winter, and Agate Passage, where a popular sport fishery harvested Pacific cod in the 1970s and early 1980s (Palsson et al. 1997). Catch rates, estimated catches and effort fluctuated during this period, with the highest catch estimated at 32,800 Pacific cod taken during 8,100 angler trips (4 cod caught per angler trip) during 1981. Estimated catch and effort reached a low of 146 Pacific cod taken during 393 angler trips (0.4 cod caught per angler trip) in 1989 (Palsson 1990).

After 1989, catches and effort remained at low levels and several restrictions were placed on recreational and commercial fisheries for Pacific cod in South Puget Sound. Due to concerns for the status of Pacific cod, commercial fishing for the species was prohibited (Palsson et al. 1997). The Agate Passage area was closed to Pacific cod fishing in 1991 due to concerns over the low numbers and the daily limit for the recreational fishery in Puget Sound south of Admiralty Inlet was reduced from 15 fish to two fish in 1991 and no fish in 1997.

THREATS WARRANTING ESA PROTECTION

A NOAA Fisheries status review, Gustafson et al. (2000) concluded that data were insufficient to conduct quantitative analyses of the extinction risks for Pacific cod. Palsson (1990) concluded that the decrease in stock abundance through the 1980s corresponded to a change to a warmer oceanographic regime, and increases in the

abundance of pinnipeds and in fishing effort. Overall, it is uncertain which factors, either singly or in combination, may be significantly contributing to the current low abundance of Pacific cod.

Destruction, Modification, or Curtailment of Habitat or Range

West (1997) considered the loss or degradation of nearshore nursery habitats as a factor that may decrease survival of juvenile Pacific cod. Small juveniles usually settle into sand and eelgrass habitats, and the areal extent and quality of such habitats have declined in Puget Sound (West 1997).

West (1997) also suggested that declines in the abundance of two primary prey species, Pacific herring and walleye pollock, may have contributed to the decline of Pacific cod in Puget Sound. The effects of contaminants or toxins from phytoplankton blooms ("red tides") on Pacific cod abundance have also not been evaluated.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Current fishing regulations prohibit the commercial and recreational fishing for Pacific cod in Puget Sound (Gustafson et al. 2000). There are no known scientific or educational uses for Pacific cod.

Disease or Predation

In limited studies, Pacific cod have not been found to be major components of pinniped diets in Puget Sound (Gustafson et al. 2000). However, the impacts of pinniped predation on Pacific cod have not been evaluated quantitatively. Gustafson et al. (2000) also indicated concern regarding increased releases of yearling Chinook salmon from state hatcheries, which coincided with changes in Pacific cod abundance.

Pacific cod are one of several populations of wild marine fish susceptible to viral haemorrhagic septicaemia (VHS). The infection of susceptible fish species is often lethal, due to the impairment of the osmotic balance, and occurs within a clinical context of oedema and haemorrhages. Virus multiplication in endothelial cells of blood capillaries, leukocytes, haematopoietic tissues and nephron cells, underlies the clinical signs. Disease generally occurs at temperatures between 4^{o} C and 14^{o} C. Low water temperatures (1^{o}-5^{o} C) generally result in an extended course with low daily mortality but high accumulated mortality. Several factors influence susceptibility to VHS. Among each fish species, there is individual variability in susceptibility, and the age of the fish appears to be of some importance - the younger the fish the higher the susceptibility. In highly susceptible fish stocks, however, overt infection is seen in all sizes of fish (OIE 2003).

Adequacy of Existing Regulatory Mechanisms

Existing regulations related to Pacific Cod are focused on fishery harvest management. If factors contributing to the decline and low current abundance are not related to harvest, existing regulations may be inadequate. Overall, it is not certain which risk factors, either singly or in combination, may be significantly contributing to the current low stock sizes of Pacific cod (Gustafson et al. 2000). Furthermore, if the declines are related to

natural, large scale oceanographic and climate changes these factors are certainly beyond the influence of existing regulatory mechanisms.

Other Factors Affecting Continued Existence

Pacific cod populations in Puget Sound have remained low, although fishing effort for Pacific cod dropped substantially during the 1980s and has been at extremely low levels during the 1990s. Dorn (1993) and Westrheim (1996) suggested that a warmer oceanographic regime may have unfavorable effects on Pacific cod south of Alaska.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Pacific cod are likely to be affected by activities authorized by Washington DNR. Over water structures such as marinas, docks, and wharfs may shade eelgrass or kelp thus reducing available juvenile Pacific cod habitat. Construction and operation of harbors, ports, shipyards, marinas, and ferry terminals could cause habitat reduction and degradation. Transportation projects such as roadways and bridges may result in habitat loss during construction, while stormwater runoff from the structures may increase concentrations of heavy metals, salts and petroleum products that are known to degrade habitat. Both sewage outfalls and discharges associated with aquaculture may cause localized reductions in sediment and water quality resulting in increased turbidity, eutrophication and decreased habitat quality. Aquaculture operations may also provide a disease vector and may impact Pacific cod spawning and feeding aggregations. Navigation improvements involving dredging, filling or other alteration of the marine nearshore may result in increased sedimentation and/or the direct loss of organisms and habitat.

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3-3.11 Pacific hake (*Merluccius productus)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fishereis	Species of Concern
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Pacific hake occur on the continental shelf and slope from Sanak Island in the western Gulf of Alaska to southern Baja California (Hart 1973; Love 1991). In Washington waters, the fish occur throughout coastal waters, the Strait of Juan de Fuca, and all parts of Puget Sound.

The NOAA Fisheries status review (Gustafson et al. 2000) concluded that Pacific hake in inland Washington waters are part of a separate population segment from coastal populations that migrate from southern California to southeastern Alaska. The inland

Pacific hake were identified as the "Georgia Basin Pacific hake distinct population segment." The Georgia Basin Pacific hake are not migratory and spend their entire lives in local waters (McFarlane and Beamish 1986).

HABITAT USE

In Washington adult Pacific hake use water column habitats in offshore ecosystems of oceanic and inland waters. Eggs and larvae occur in the water column habitat in nearshore and offshore ecosystems in inland waters, but rarely in coastal waters when influenced by El Nino conditions. Puget Sound juveniles use off bottom nearshore habitats.

Adults

Adult Pacific hake are pelagic and generally concentrated between 50 and 500 meters deep (Bailey et al. 1982). Both coastal and inland populations use the open water habitat in the offshore ecosystem.

The maximum age of Pacific hake is approximately 20 years, but fish over age 12 are rare (Gustafson et al. 2000). In the Strait of Georgia, female Pacific hake mature at 37 centimeters and 4 to 5 years of age (McFarlane and Beamish 1986) while they mature at 29 centimeters in Puget Sound (Goñi 1988). Females of the coastal stock mature at 3 to 4 years and 34 to 40 centimeters, and nearly all males are mature by age 3 at lengths as small as 28 centimeters. Females grow more rapidly than males after maturity, however growth ceases for both sexes at 10 to 13 years (Bailey et al. 1982). The size-at-age of coastal Pacific hake has been declining since the 1960s (Methot and Dorn 1995; Gustafson et al. 2000). In the early 1990s, age-10 (10 to 11 years old) males and females were 47 and 48 centimeters in length, respectively. In Puget Sound, male Pacific hake rarely exceed a length of 40 centimeters, and females tend to be approximately 4 centimeters longer than males (Gustafson et al. 2000).

Adults are carnivorous, feeding on amphipods, squid, Pacific herring, smelt, crabs, shrimp and sometimes juvenile Pacific hake (Bailey 1981; McFarlane and Beamish 1986). Pacific hake school at depth during the day and move to surface waters at night and disperse to feed (McFarlane and Beamish 1986). Major predators include sablefish (*Anoplopoma fimbria*), albacore (*Thunnus alalunga*), walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*), soupfin sharks (*Galeorhinus galeus*), spiny dogfish (*Squalus acanthias*), northern elephant seals (*Mirounga angustirostris*), northern fur seals (*Callorhinus ursinus*), harbor seals (*Phoca vitulina)*, California sea lions (*Zalophus califonianus*), marine birds, and cetaceans (Fiscus 1979; McFarlane and Beamish 1986; Methot and Dorn 1995).

Reproduction

Coastal migratory stocks spawn off Baja California in the winter. After spawning, mature adults begin moving northward and inshore, following food supplies and ocean currents (Gustafson et al. 2000). Pacific hake reach as far north as southern British Columbia by fall and by late fall begin their return migration to southern spawning grounds and further offshore. These fish may be feeding off the Washington coast near the edge of the continental shelf for 6 to 8 months of the year (Smith 1995).

In Puget Sound, spawning occurs from February through April with a peak in March. Gustafson et al. (2000) and Palsson et al. (1997) reported that spawning aggregations have been recorded in Port Susan, Dabob Bay, and Carr Inlet.

Pacific hake are oviparous with external fertilization, and may spawn more than once per season. Eggs develop in the water column. The eggs of Pacific hake off California are found at depths between 50 and 75 meters over a bottom depth of at least 300 meters. Within Puget Sound, eggs are found at approximately the same depth, but in the bottom 25 meters of the water column over a bottom depth of about 110 meters (Gustafson et al. 2000).

Within Washington large numbers of Pacific hake eggs and larvae only have been found in Port Susan and Saratoga Passage, with small numbers occurring in Hood Canal and near Possession Sound (Gustafson et al. 2000; Palsson et al. 1997). Embryonic development and time to hatching is temperature dependant, occurring in 5 to 6 days at 9° to 10° Celsius and 4 to 5 days at 11° to 13° Celsius (Gustafson et al. 2000).

Larvae and Juveniles

Larvae hatch at 2 to 3 millimeters total length and metamorphose in 3 to 4 months into their juvenile forms. Juveniles range from 35 millimeters to 40 centimeters depending on sex. Juveniles of the coastal migratory population segment remain in the southern waters for feeding and later migrate northwards.

Larvae eat calanoid copepod eggs, nauplii, and adults and are prey to walleye pollock, herring, invertebrates and occasionally adult Pacific hake. Juveniles feed in the water column, preying primarily on euphausiids and are prey to lingcod (*Ophiodon elongatus)*, Pacific cod (*Gadus macrocephalus*), and rockfish (*Sebastes* spp.) (Gustafson et al. 2000).

POPULATION TRENDS

Information on population trends of Pacific hake in Washington waters is dependent on commercial fisheries and Washington Department of Fish and Wildlife (Washington Fish and Wildlife) surveys. The only location at which a commercial fishery and/or surveys have been conducted on a regular basis is Port Susan and adjacent Saratoga Passage, which are also referred to as “Southern Puget Sound” (Palsson et al. 1997; Gustafson et al. 2000). Gustafson et al. (2000) estimated that the Port Susan stock represents 3 to 17 percent of the Georgia Basin Pacific hake population segment.

The winter Pacific hake fishery once accounted for the greatest landings of any groundfish species in Washington. Commercial fisheries on Pacific hake in Port Susan began in 1982 with a high catch of 8,986 metric tons. In 1990, the catch was only 41 metric tons, after which the fishery was suspended (Palsson et al. 1997; Gustafson et al. 2000). Surveys in Port Susan conducted by Washington Fish and Wildlife showed a steady decline in biomass from 1982 with 14,826 metric tons through 2000 with 992 metric tons, an 85 percent decline (Gustafson et al. 2000). In addition, the size composition of the stock showed a marked shift towards smaller fish. Since 1991, the Pacific hake fishery in Puget Sound waters has been suspended due to depressed abundance and small sizes of Pacific hake.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

The NOAA Fisheries status review (Gustafson et al. 2000) did not cite habitat loss or degradation as a risk factor contributing to the extinction of Puget Sound Pacific hake. A decline in nearshore kelp and eelgrass beds may only indirectly affect Pacific hake through changes in detritus-based trophic webs. West (1997) speculated that juvenile survival could be reduced through loss or degradation of nearshore nursery habitats.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There are no commercial or sport fisheries on the Port Susan stock of Pacific hake at this time. The decline in this population is likely in part a result of the intense commercial fishery up to 1991 (Gustafson et al 2000; Palsson et al. 1997). There are no known scientific or educational uses for Pacific hake.

Disease or Predation

Wright's (1999) petition to list Pacific hake and the Endangered Species Act status review (Gustafson et al. 2000) highlight predation by pinniped marine mammals as the greatest threat to Pacific hake. In Puget Sound, there is a threat from increasing populations of predators such as harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus califonianus*). Pacific hake are estimated to comprise around 32 percent of the sea lion diet and 40 percent of the harbor seal diet near Port Susan (Schmitt et al. 1995; Gustafson et al. 2000). Palsson et al. (1998) observed that marine mammals appear to be limiting the population of Pacific hake in Port Susan (Palsson et al. 1998).

Adequacy of Existing Regulatory Mechanisms

Existing regulations prohibiting commercial fishing for Pacific hake in Puget Sound appear to be adequate and Gustafson et al. (2000) did not cite inadequate regulations as a factor in their risk assessment.

Other Factors Affecting Continued Existence

Decadal climate oscillations and El Nino events may be affecting the reproductive success and survival of Pacific hake. The effect of warm, El Nino years is evident in the coastal migratory population as spawning occurs farther north in those years. In addition, the Port Susan population apparently has changed more than the Canadian portion of the Georgia Basin population segment (Gustafson et al. 2000). It is possible that warm environmental conditions have caused the Port Susan area to be relatively less favorable for Pacific hake spawning than the Canadian portion of the Strait of Georgia. Some of the Port Susan population may have migrated to Canadian waters, or perhaps there has been less movement from Canadian waters than in previous years.

Anthropogenic changes in river flow patterns and increased turbidity could also cause changes in the ecosystem that trigger changes in planktonic trophic webs. These changes in turn could be adverse to Pacific hake (Gustafson et al. 2000). Insufficient studies are

available to determine if there have been impacts from anthropogenic sources of toxic chemicals.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Pacific hake are likely to be affected by activities authorized by Washington DNR within marine nearshore environments. Roadways, bridges, and docks may result in stormwater runoff which may increase concentrations of toxic contaminants including but not limited to hormones, PCBs, heavy metals and petroleum products in both the sediments and water column. Additionally, discharges containing nitrogenous and bacterial waste associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality as well as contribute towards eutrophication of the nearshore environment. Net pens associated with fish hatcheries and aquaculture operations may also contribute to the loss of adult habitat from shading and the introduction of disease and parasites. Overwater structures and shoreline modifications may negatively affect habitat by reducing or modifying macroalgae, kelp, and eelgrass habitat. Dredging or disposal of dredged materials along with bulkheads and jetties may alter sediment flow from freshwater systems that may disrupt planktonic food web assemblages.

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3-3.12 Pacific herring (*Clupea pallasii)*

The common name, Pacific herring, is approved and listed by the American Fisheries Society (Nelson et al. 2004). Pacific herring were formerly known under the same scientific name as the "Atlantic herring" (*Clupea harengus*), but were recognized as a distinct species in 1986 based on a study of biochemical genetics. Pacific herring is referred to as Atlantic herring in older publications and in local literature as an invalid composite name (*Clupea harengus pallasii*).

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

All Puget Sound Pacific herring were proposed for listing as Threatened or Endangered in 1999, with NOAA Fisheries determining that listing under the Endangered Species Act was not warranted in 2001 (66 CFR 2001). A petition for listing the Pacific herring stock that spawns along the Cherry Point shoreline (north of the city of Bellingham in Puget Sound) was submitted and rejected in January 2004 (69 CFR 153 (2004)), with a supplemental petition for the Cherry Point stock submitted in May of 2004. In June 2005, NOAA Fisheries determined that Cherry Point herring "…doesn't qualify for Endangered Species Act protection because it does not meet the standard for a species under the law".

RANGE

The geographic range of Pacific herring includes most of the waters over continental shelves in the Northeast Pacific Ocean from Baja California, Mexico, to the Bering Sea and northeast to the Beaufort Sea. The species also ranges along the Asian coast from the Arctic Ocean to Japan (Washington Fish and Wildlife 1997). Within Washington, Pacific

herring occur as adults in all marine waters and use both state and privately owned shorelines for spawning. Information collected on Pacific herring spawning does not distinguish between private or state-owned beaches.

Puget Sound (those waters south of Port Townsend and east of Deception Pass) stocks apparently do not migrate and all life stages remain in Puget Sound waters (Lassuy 1989; Washington Fish and Wildlife 1997; Gao et al. 2001; Stout et al. 2001). However, stocks spawning at Cherry Point and in Discovery Bay may migrate to the waters offshore of the West Coast of Vancouver Island (EVS 1999; Gao et al. 2001; Stout et al. 2001).

Washington Fish and Wildlife recognizes 18 distinct herring stocks in Washington waters east of Cape Flattery and two on the outer coast (Willapa Bay and Grays Harbor) based on spawning grounds (Lemberg et al. 1997; Washington Fish and Wildlife 1997; Stout et al. 2001; O'Toole, Personal communication. March 3, 2005). Stout et al. (2001), concluded that a "distinct population segment" (DPS) of the Pacific Coast herring population consisted of the herring within the Georgia Basin. This DPS includes all Puget Sound, Cherry Point, Discovery Bay (Strait of Juan de Fuca), and Strait of Georgia (British Columbia) spawning stocks. In addition, on the outer coast of Washington, Pacific herring spawn has been documented in Willapa Bay and Grays Harbor and reported from the Columbia River estuary (Lemberg et al. 1997; Stout et al. 2001; O'Toole, Personal communication. March 3, 2005).

HABITAT USE

Herring are primary and secondary consumers in all their habitats and are a critical "keystone species" with trophic links to a large number of other marine biota. Adult and larval Pacific herring feed and depend on phytoplankton and zooplankton, especially crustaceans (e.g., copepods and decapod and barnacle larvae) and a variety of other prey items such as protozoans, diatoms, molluscan larvae, euphausids, and larval fish (Lassuy 1989; Washington Fish and Wildlife 1997).

In addition, a number of secondary and tertiary consumers in marine food webs depend on herring. This species is taken as prey by marine mammals, seabirds, other fishes, and marine invertebrates (e.g., jelly fish) (Lassuy 1989). Environment Canada (1998) estimated that herring comprise 71 percent of lingcod (*Ophiodon elongatus*), 62 percent of Chinook salmon (*Oncorhynchus tshawytscha*), 58 percent of coho salmon (*Oncorhynchus kisutch*), 53 percent of Pacific halibut (*Hippoglossus stenolepis*), 42 percent of Pacific cod (*Gadus macrocephalus*), 32 percent of Pacific hake (*Merluccius productus*), 18 percent of sablefish (*Anoplopoma fimbria*), and 12 percent of spiny dogfish (*Squalus acanthias*) diets off the West Coast of Vancouver Island. Pacific herring also comprise an estimated 6 percent of the diet of California sea lions in Puget Sound and 32 percent of harbor seal diets (Stout et al. 2001).

Herring are also prey for a variety of marine birds including loons (*Gavia* spp.), grebes (*Podiceps* spp.), cormorants (*Phalacrocorax* spp.), great-blue heron (*Ardea herodias*), common mergansers (*Mergus merganser*), terns (*Sterna and Chlidonias* spp.), the common murre (*Uria aalge*), the pigeon guillemot (*Cepphus columba*), the rhinoceros auklet (*Cerorhinca monocerata*), and the tufted puffin (*Fratercula cirrhata*). While estimates of herring consumption by these birds are not available (Stout et al. 2001),

marine birds are also known to consume herring eggs after deposition on marine vegetation.

Adults

Adult herring use the water column habitat in nearshore and offshore ecosystems in both coastal and inland waters (Stout et al. 2001). Spawning adults use unconsolidated nearshore habitats in the form of intertidal and shallow subtidal beaches vegetated with eelgrass and macroalgae on which eggs are deposited. Herring deposit transparent, adhesive eggs on intertidal and shallow subtidal (generally above minus 3 meters mean lower low water) eelgrass and marine algae. Marine birds feed heavily on herring eggs and adult forms may comprise a vital food source for some migratory birds such as surf scoter (*Melanitta perspicillata*) and white-winged scoters (*Melanitta fusca*). While most Washington State herring stocks spawn from late January through early April (Washington Department of Fish and Wildlife 1997), the Cherry Point stock spawns from early April through early June.

Larvae

Larvae are planktonic and use the shallow waters (less than 10 to 20 meters) over the intertidal and shallow subtidal zones while growing. Following metamorphosis, juvenile herring use the same ecosystem and habitats as adults.

POPULATION TRENDS

Petitions to list herring as Threatened or Endangered have included all Puget Sound stocks (1999) or focused on the Cherry Point stocks (2004). However, because the first petition for listing was rejected and no decision on the recent petitions has been publicized at the time of this writing, Pacific herring in Washington are treated as a single distinct population segment. Additional information is provided for the Cherry Point stock because of the recent listing petitions. Washington Fish and Wildlife classifies Pacific herring populations in Washington into five status categories (Lemberg et al. 1997):

- Healthy – recent two year mean abundance above or within 10 percent of the 20 year mean.
- Moderately Healthy – recent two year mean abundance within 30 percent of the 20 year mean and/or with high dependence on recruitment.
- Depressed – recent abundance well below the long-term mean, but not so low that permanent damage to the population is likely (i.e., recruitment failure).
- Critical – abundance low enough that permanent damage to population is likely or has already occurred.
- Extinct – no longer can be found in a formerly and consistently utilized spawning ground.
- Unknown – insufficient assessment data to identify stock status with confidence.

Table 3.1 - Status of Inland Herring Populations (east of Cape Flattery) of Puget Sound (From Stout et al. 2001).

	Stock Status		
Stock Name/Location	**1996**	**1998**	**2000**
Squaxin Pass	Moderately Healthy	Depressed	Healthy
Quartermaster Harbor	Healthy	Healthy	Healthy
Port Orchard/Port Madison	Depressed	Depressed	Healthy
South Hood Canal	Unknown	Moderately healthy	Healthy
Quilcene Bay	Healthy	Healthy	Healthy
Port Gamble	Healthy	Depressed	Healthy
Kilisut Harbor	Unknown	Moderately Healthy	Healthy
Port Susan	Depressed	Healthy	Moderately Healthy
Holmes Harbor	Unknown	Healthy	Depressed
Skagit Bay	Healthy	Moderately Healthy	Moderately Healthy
Fidalgo Bay	Moderately Healthy	Healthy	Healthy
Samish – Portage Bay	Healthy	Healthy	Healthy
Interior San Juan Islands	Unknown	Unknown	Depressed
Northwest San Juan Islands	Unknown	Depressed	Unknown
Semiahmoo Bay	Healthy	Depressed	Depressed
Cherry Point	Depressed	Critical	Critical
Discovery Bay	Critical	Critical	Critical
Dungeness Bay	Healthy	Healthy	Healthy

The Cherry Point population was one of the largest Puget Sound stocks of Pacific herring, and its late spawning time is unique for Puget Sound (Bargmann 1998, 2001; Lemberg et al. 1997; Stout et al. 2001). This stock has declined substantially since the 1970s when populations had attained a relatively high abundance. Landis et al. (2004) suggests this high abundance may be due to favorable oceanic conditions, three consecutive years of excellent age 0+ (0 to 1 year old) class survival and recruitment and a potential influx of fish from other regional stocks. The biomass continued to decline until 2001 when an increase began continuing through 2004 as shown by the following data[1]:

Year	1999	2000	2001	2002	2003	2004
Tons of spawners	1,266	808	1,241	1,330	1,611	1,734

[1] Spawning survey data by G. Bargmann, Washington Fish and Wildlife Marine Fish, supplied to the Cherry Point Technical Work Group through emails from 1999 through 2004.

Washington Fish and Wildlife's Forage Fish Management Plan reported that estimates of natural mortality rates in the Cherry Point Pacific herring stock increased from less than 0.4 between 1976 and 1980 to more than 0.6 between 1990 and 1995 (Bargmann 1998; Stout et al. 2001). During the same period, the number of age groups comprising the bulk of the populations decreased from five to two or three. While herring formerly lived to ages exceeding 10 years, fish older than 6 years are now rare (Bargmann 1998). A combination of reduced recruitment of 3-year-old herring and increased non-fishery related losses of older fish appear to be the primary causes of the Cherry Point declines and may also be impacting other Puget Sound populations (Stout et al. 2001; EVS 1999; Landis et al. 2004).

It should be noted that the Cherry Point Pacific herring stock was historically not the most abundant in Puget Sound. During the expansion of the herring fishery in Washington State between 1890 and 1935, the Cherry Point herring stock was not considered among the five most productive stocks in the Puget Sound region, with other Puget Sound stocks including Holmes Harbor, Hood Canal and Bremerton-Keyport yielding the highest catches (Markiewicz and Landis 2003). As a result, it is possible that the Cherry Point stocks' abundance during the 1970s may have either been anomalous or and indication that the stock experiences significant natural abundance fluctuations.

THREATS WARRANTING ESA PROTECTION

When interpreting the behavior of Pacific herring distinct population segments and evaluating their status, the nature of the responses of Pacific herring to environmental stress must be considered. Pacific herring belong to the family Clupeidae, a family of small pelagic fish species (e.g. Atlantic herring, sardines, anchovies, shad, menhaden) that are broadly distributed in coastal waters around the globe and are sensitive to broad scale changes in environmental conditions. Temporal and spatial fluctuations in biomass resulting from shifts in environmental conditions can be rapid, large and persistent, often lasting for decades or more. The life history strategy and population structure of clupeoids has evolved in response to environmental variability and are characterized by periodic substantial fluctuations in abundance. The greatest risks to future Cherry Point and other Pacific herring stocks' survival include predation, adverse climatic conditions, loss or degradation of habitat, disease and parasites, and pollution-related effects (Stout et al. 2001; EVS 1999; Landis et al. 2004).

Destruction, Modification, or Curtailment of Habitat or Range

As stated by EVS (1999), Stout et al. (2001) and Landis et al. (2004), loss or modification of habitat poses the greatest ecological risk to Cherry Point herring, and by extrapolation, to other stocks of Pacific herring in Washington. Loss and modification of habitat can occur through physical disruption of spawning grounds, including shading of vegetation, construction of nearshore structures that affect sediment movement, or by degradation of the open water habitat by pollution.

The near shore, shallow-water spawning habitat causes Pacific herring to be particularly vulnerable to exposure to contaminants from such sources as oil spills, urban and agriculture runoff and chronic air pollution (Stout et al. 2001). As the most vulnerable and critical life stage, herring eggs can be exposed to contaminants during embryonic

development. Because of their importance to the food web, there is concern that if herring are exposed to toxic contaminants and accumulate them, much of the local food web could be affected (Stout et al. 2001; O'Neill and West 2001). O'Neill and West (2001) documented that Pacific herring from the central and southern Puget Sound basins had higher body burdens of polychlorinated biphenyls (PCBs) than fish from northern Puget Sound and the Strait of Georgia. In addition, low hexachlorobenzene (HCB) concentrations were observed for all stocks but were significantly lower for the Cherry Point stock.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Commercial fisheries on Pacific herring are closely co-managed by Washington Fish and Wildlife and Tribal agencies. No commercial fishery is allowed on the Cherry Point or coastal stocks. Existing fisheries consist only of a commercial sport bait and recreational fishery in South and Central Puget Sound, which utilizes juvenile fish (Bargmann 1998). Stout et al. (2001) considered these and other small fisheries as minor and taking fewer fish than consumed by natural predators.

Disease or Predation

An increased incidence of parasitism, disease, and larval deformities in Puget Sound Pacific herring and especially in the Cherry Point stock has been observed in recent studies (e.g., Hershberger and Kocan 1999, 2000; Hershberger et al. 2002; Hershberger, Personal communication. March 3, 2005). These factors may contribute to the decline or slow recovery of Puget Sound stocks, especially the Cherry Point Pacific herring. In 2000, Hershberger detected a prevalence of Ichthyophonus infections in 17 to 55 percent of prespawn Pacific herring in 10 different Puget Sound stocks. The prevalence of high-level infections (i.e., observable gross signs of disease) was generally low (0 to 5 percent) with the exception of the Cherry Point stock, where 31 percent of the fish demonstrated infections and 15 percent demonstrated high-level infections (Hershberger, Personal communication. March 3, 2005).

Herring are intensely preyed upon by a wide variety of predators as discussed previously. Further increases in these predators (e.g., pinnipeds) could cause subsequent declines in Pacific herring populations.

Adequacy of Existing Regulatory Mechanisms

Stout et al. (1999) did not cite the inadequacy of regulatory mechanisms as a risk factor. Indeed, because of the intense public attention to the Cherry Point Pacific herring stock, management and conservation of Pacific herring in Puget Sound is probably receiving more attention than in the past.

Other Factors Affecting Continued Existence

Despite the presence of baseline data describing the abundance and age structure of the Cherry Point herring prior to their documented decline, it is difficult to show that changes are due to a single or combination of specific perturbations or conditions. Potential causes of decline that cannot be excluded as potential causative factors include: changes in oceanic conditions associated with the Pacific Decadal Oscillation; introduction of new

diseases to a previously naïve stock; potential reduced abundance of prey items for adults within feeding areas; or reduced viability of offspring due to anthropogenic impacts to spawning areas. Observed population trends that may have resulted from these causes include: increasing natural mortality of Cherry Point herring, low weight at hatch of Cherry Point offspring, loss of older individuals from the population, reduction of geographic extent of spawning, and decreased overall population abundance and spawning escapement. Overall, it is uncertain which factors, either singly or in combination, may be significantly contributing to the decline and current low abundance of Cherry Point herring.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Pacific herring in Puget Sound are particularly vulnerable to nearshore and onshore activities authorized by Washington DNR that affect intertidal and shallow subtidal spawning habitats. The Discovery Bay, Cherry Point, and coastal Pacific herring stocks probably migrate out of Washington waters for juvenile rearing and adult feeding. Thus, while few Washington DNR authorized activities could directly affect adult populations, activities authorized within or adjacent to the spawning grounds could have impacts. Because juveniles and adults use Puget Sound water column habitats throughout the year, they are vulnerable to activities that degrade marine water quality and affect planktonic food sources. Roadways, bridges, and docks may result in stormwater runoff which may increase concentrations of toxic contaminants including but not limited to hormones, PCBs, heavy metals and petroleum products in both the sediments and water column. Additionally, discharges containing nitrogenous and bacterial waste associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality as well as contribute towards eutrophication of the nearshore environment. Net pens associated with fish hatcheries and aquaculture operations may also contribute to the loss of adult habitat from shading and the introduction of disease and parasites. Overwater structures and shoreline modifications may negatively affect habitat by reducing or modifying macroalgae, kelp, and eelgrass habitat, thereby reducing available spawning habitat. Dredging or disposal of dredged materials along with bulkheads and jetties may alter sediment flow from freshwater systems that may disrupt planktonic food web assemblages.

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3-3.13 Pacific lamprey (*Lampetra tridentate)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Species of Concern
Washington State	Not Listed
Natural Heritage Program	G5; S3, S4

RANGE

The Pacific lamprey ranges from Baja California to the Aleutian Islands in Alaska (Wydoski and Whitney 2003). They are also found along the eastern Asia coast as far south as Japan.

Within Washington State, the Pacific lamprey is found in most large rivers and streams along the coast, Strait of Juan de Fuca, and Puget Sound, and occurs far inland in the Columbia, Snake and Yakima Rivers (Wydoski and Whitney 2003). They occur below Chief Joseph Dam in the Columbia River system and below Hells Canyon Dam in the Snake River (Moser and Close 2003). Historically, Pacific lamprey were found as far upstream as Kettle Falls on the Columbia River and Spokane Falls on the Spokane River, but passage was blocked with the completion of Grand Coulee Dam in 1941, and in 1955, Chief Joseph Dam blocked an additional 52 miles of the Columbia (Wydoski and Whitney 2003). Pacific lamprey are also located in streams along the southern, western and northern boundaries of the Olympic Peninsula. Evidence of dwarf parasitic landlocked populations in Oregon and California exists, but no documentation of such occurs within Washington (Wydoski and Whitney 2003).

HABITAT USE

Adult

Pacific lampreys are anadromous fish that utilize both freshwater and marine environments during their complex life history. They are the largest of the native lamprey, and adults may reach a length of 76 centimeters and a weight of 450 grams (Wydoski and Whitney 2003). Young Pacific lamprey migrate from their natal rivers to the Pacific Ocean, where they remain as adults from 20 to 40 months before returning to freshwater for spawning. Pacific lamprey have been found from 9 to 100 kilometers

offshore in waters as deep as 800 meters, although they are more commonly located in water depths of 70 to 250 meters (Wydoski and Whitney 2003). Adult Pacific lamprey are parasitic toward other fish (for example, salmonids, rockfish, flounders, lingcod, sablefish, cod and halibut) and some marine mammals (such as whales), and utilize suckerlike mouthparts to remove body fluids from host organisms. Landlocked Pacific lamprey populations spend their entire lives in fresh water, but still exhibit a parasitic adult phase (Wydoski and Whitney 2003).

Spawning

Adult Pacific lamprey begin the journey to freshwater streams and rivers as early as one year before they intend to spawn, overwinter in deep pools, and then spawn in the spring. Some individuals may migrate hundreds of miles upstream to spawning habitats, and may pass barriers such as waterfalls by slowly ascending them with their suckerlike mouths (Wydoski and Whitney 2003). Pacific lamprey appear to be nocturnal and appear to move primarily at night (Moser and Close 2003). Upon returning to freshwater, Pacific lamprey stop parasitic feeding and rely exclusively on stored carbohydrates, proteins and lipids until they spawn. Spawning occurs from February through July, with spawning in coastal streams occurring earlier than those more inland (Moser and Close 2003). Both male and female Pacific lamprey help in the construction of the nest on the gravel stream bed; nests measure 20 to 30 centimeters in diameter and 2.5 to 8 centimeters deep (Wydoski and Whitney 2003). Nests are generally located in riffles or the tails of pools in moderate- to high-flow streams at depths less than one meter (Moser and Close 2003). Pacific lamprey deposit eggs and milt in the gravel nest; one female can produce between 34,000 and 238,400 eggs, depending on her size (Wydoski and Whitney 2003).

Although Pacific lampreys typically die within days after spawning, tag-recapture observations cited by Wydoski and Whitney (2003) suggest that some individuals may spawn more than once in their lifetime. Historically, lamprey returning to spawn in freshwater streams and rivers were often captured by Pacific Northwest American tribes, who considered them important for food, as well as for ceremonial and medicinal purposes (Wydoski and Whitney 2003). They are also considered ecologically important to Pacific Northwest ecosystems, returning marine-derived nutrients to the freshwater environment and providing an important forage base for marine mammals, birds and fishes (Lower Columbia Fish Recovery Board 2004).

Incubation / Emergence / Larvae

Pacific lamprey spawn at water temperatures between 10 and 15° Celsius; eggs are incubated in 15° Celsius water and hatch in 2 to 3 weeks (Wydoski and Whitney 2003). After hatching at about 1 centimeter length, larvae (“ammocoetes”) burrow into silty substrates and remain within slow-moving reaches of streams, where they feed by filtering microscopic plants and animals out of the water (Moser and Close 2003). The ammocoete stage is characterized by undeveloped eyes, reduced fins and the absence of tooth-like plates at its oral opening (Meeuwig et al. 2003). The Pacific lamprey remains as an ammocoete in freshwater habitats for 4 to 7 years and can reach a size of up to 17 centimeters before metamorphosing into its parasitic adult phase (Moser and Close 2003). Adulthood for the Pacific lamprey follows a metamorphosis in which the larvae develop eyes, an oral disc and “teeth” (supra-oral lamina) (Wydoski and Whitney 2003). Metamorphosis occurs from July until November, and the newly metamorphosed

lamprey may either begin a migration toward sea immediately or remain in fresh water for up to 10 months before beginning its journey (Wydoski and Whitney 2003). Just as anadromous Pacific lamprey move from their natal streams to the marine environment for their adult parasitic phase, landlocked Pacific lamprey similarly exhibit movements from a stream to a larger body of freshwater (Meeuwig et al. 2003).

POPULATION TRENDS

Similarly to the river lamprey (*Lampetra ayresi*), the population status of Pacific lamprey is difficult to assess because 1) most freshwater observations are based on juveniles that are difficult to differentiate from other lamprey species, 2) data are often incidental to salmon monitoring programs, and 3) there are few historical datasets on lamprey populations in existence (Kostow 2002). Fish ladder observations, although focused on salmon, have suggested that the numbers of adult Pacific lamprey returning to spawn have declined severely as recently as the 1980s. Counts from Bonneville Dam in 1968 reported 380,000 adults, but more recently, the annual counts are nearer 40,000 adults; counts from other dams show similar declines (Wydoski and Whitney 2003). Anecdotal historical observations and information from Northwest tribes suggest a similar declining abundance pattern (Kostow 2002). However, Pacific lamprey populations occur in clusters (Lower Columbia Fish Recovery Board 2004), and lamprey abundance can fluctuate wildly from year to year and between locations. Because the dynamics of lamprey populations and the distribution of lamprey production remain rather enigmatic, it is difficult to interpret the few quantitative data that have been collected (Kostow 2002).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

General causes of Pacific lamprey declines throughout their range include flow regulation (Wallace and Ball 1978; Beamish and Northcote 1989), channelization (Kirchhofer 1995), poor water quality (Myllynen et al. 1997), and chemical treatments (Schuldt and Goold 1980). Flow regulation, which is common throughout most of the United States, impacts adults by impeding passage at dams, while larvae are affected by the dewatering of rearing habitat. River channelization negatively impacts larval lamprey habitat by increasing velocity, thereby reducing depositional areas. Furthermore, larvae are more susceptible to toxicological effects from contaminants because of their sedentary life in the benthos, as demonstrated by chemical treatments used in streams of the Great Lakes to control nonnative sea lamprey (*Petromyzon marinus*) and resulting declines in native lamprey populations (Close et al. 2002).

Modification of river habitats used by spawning adult and larval stages is thought to represent the biggest threat to Pacific lamprey (as it does to other lamprey species). Dams, culverts, tidegates, weirs and water-diversion structures prevent adult Pacific lamprey from accessing spawning habitats and may cause high mortality of outmigrating ammocoete larvae (Kostow 2002). River flows, which stimulate migratory behavior of outmigrating larvae, have been altered substantially by reservoir and dam construction, and may be detrimental to Pacific lamprey populations by delaying outmigration behavior (Kostow 2002). In addition, rapid water drawdown in reservoirs may strand lampreys in their burrows (Kostow 2002). Most industrial, urban and agricultural

development is concentrated in low-gradient, lower river flood plains that are favored by Pacific lampreys.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Commercial harvest of Pacific lamprey has occurred historically in some locations, where it was exported to Europe or used to formulate feed for salmon hatcheries, livestock and poultry; commercial harvest has been limited in the Willamette River, Oregon, since 2000 because of concerns about declining populations. The Pacific lamprey is also used for food, ceremonial and medicinal purposes by Native Americans (Lower Columbia Fish Recovery Board 2004). White sturgeon fishermen on the Columbia use adult Pacific lamprey as bait, and ammocoetes have been used by trout fisherman as bait in other locations (Wydoski and Whitney 2003). A biological supply company regularly collected Pacific lamprey at Willamette Falls, Oregon, as teaching specimens (Wydoski and Whitney 2003). Sustainable harvest rates are unclear, because there is often very little information about lamprey population dynamics or productivity (Kostow 2002).

Disease or Predation

There are two periods when larvae are subjected to predation: during emergence from nests and during scouring events that dislodge the larvae from their burrows (Close et al. 2002). Adult lamprey comprise a high value food resource for a wide variety of consumers because they have high caloric value per unit weight, travel in schools, and are rich in fats (Close et al. 2002). Pacific lamprey is found in the diets of several fish species (Poe et al. 1991) , birds (Merrell 1959) and pinnipeds (Roffe and Mate 1984), with Close et al. (2002) suggesting that some density dependent predators may pose a barrier to recovery for Pacific lamprey.

Adequacy of Existing Regulatory Mechanisms

The current lack of data related to populations, distribution, harvest and the ability of the Pacific lamprey's to survive upstream-passage facilities make it likely that existing regulatory mechanisms are inadequate to protect this species.

Other Factors Affecting Continued Existence

Much like salmon, there are many reasons for the observed reductions in range and abundance of Pacific lampreys, and no single threat can be pinpointed as the primary reason for their apparent decline.

Larval lamprey burrow in river-bottom sediment during their entire larval life span, and may be affected by toxic pollutants sequestered in areas with contaminated sediment. Pacific lamprey may also be taken by dredging operations (Kostow 2002). This species is often concentrated in remarkably high densities in some stream areas, and as such, is particularly vulnerable to chemical spills or other catastrophic events (Kostow 2002).

Some have also suggested that declines in salmonid populations have resulted in declines in Pacific lamprey populations because lampreys rely heavily on salmonids for food (Wydoski and Whitney 2003). Declines in adult populations of Pacific salmon (*Oncorhynchus* spp.), Pacific hake (*Merluccius productus*), and walleye pollock

(*Theragra chalcogramma*), which serve as host species to the parasitic adult stage of Pacific lampreys, may affect populations of Pacific lamprey (50 CFR 17, 2004).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Pacific lamprey are most likely to be affected by activities authorized by Washington DNR on state-owned aquatic lands in riverine and nearshore marine habitats of the interior coastal rivers of Puget Sound, the outer coast and the Columbia River and its tributaries. Areas of concern include dams and other diversion/impoundment structures blocking adult migration, entraining outmigrating larvae, and altering stream flow and temperature; outfalls or other activities that may contribute toxic contaminants to riverine sediment used by larvae; and sediment disturbance or removal associated with mining and dredging activities.

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3-3.14 Pygmy whitefish (*Prosopium coulteri)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Sensitive
Natural Heritage Program	G5; S1, S2

RANGE

The pygmy whitefish is a freshwater fish of the family Salmonidae, subfamily Coregoninae and is often confused with the young of a close relative, the mountain whitefish (*Prosopium williamsoni*) (Mackay 2000). Relict populations of pygmy whitefish from the last Pleistocene Ice Age are found in deep lakes throughout northern North America, but have also been found in one lake in Russia (Hallock and Mongillo 1998; Wydoski and Whitney 2003). In North America, they are distributed within the northern portion of the United States (Lake Superior, Montana and Idaho), throughout western Canada (British Columbia, Saskatchewan and the Northwest Territories), and into southeast Alaska. Wydoski and Whitney (2003) note that the pygmy whitefish may actually occur more widely than is currently reported because of the likelihood that targeted sampling with deepwater gear probably has not been intensive.

Pygmy whitefish in Washington State are found at the extreme southern edge of their natural range. According to a survey conducted by the Washington State Department of Fish and Wildlife (Washington Fish and Wildlife) between 1993 and 1997, pygmy whitefish were once found in at least 15 Washington lakes but have a current distribution in 9 (Hallock and Mongillo 1998; Wydoski and Whitney 2003) (Table 3.2). All

remaining populations in Washington State are believed to have been identified (Hallock and Mongillo 1998).

Table 3.2 - Lakes where pygmy whitefish were historically found in Washington State, with indication of current presence

Lake	County	Current Presence
Bead	Pend Oreille	X
Buffalo	Okanogan	
Chelan	Chelan	X
Chester Morse	King	X
Cle Elum	Kittitas	X
Crescent	Clallam	X
Diamond	Pend Oreille	
Horseshoe	Pend Oreille	
Kachess	Kittitas	X
Keechelus	Kittitas	X
Little Pend Oreille Lakes	Stevens	
Marshall	Pend Oreille	
North Twin	Ferry	
Osoyoos	Okanogan	X
Sullivan	Pend Oreille	X

HABITAT USE

Adult

Pygmy whitefish most often occur in deep, oligotrophic (unproductive) lakes where temperatures are 10° Celsius or lower (Wydoski and Whitney 2003), with Canadian studies noting that they are also typically found in some fast, cold mountain streams (Mackay 2000). Although adults are generally found in deepwater lake habitats, they may move into shallow water or tributary streams during the spawning season (Hallock and Mongillo 1998). Adult pygmy whitefish have also been collected in the surface waters of some lakes (Hallock and Mongillo 1998).

Pygmy whitefish feed primarily during daylight hours on zooplankton, such as cladocerans, copepods, and midge larvae, as well as small molluscs and fish eggs (Wydoski and Whitney 2003). Two forms, bottom feeders and plankton feeders, have been described in some Alaska lakes.

While the species is classified as a coldwater stenotherm (narrow range of temperature requirements), temperature and dissolved oxygen requirements have not been determined (Hallock and Mongillo 1998). This species is slow growing, with a maximum recorded age of 9 years and lengths under 29 centimeters (Wydoski and Whitney 2003). In Washington, two of the most common fishes co-occurring with pygmy whitefish are kokanee (*Oncorhynchus nerka*) and rainbow trout (*Oncorhynchus mykiss*) (Hallock and Mongillo 1998).

Spawning/Incubation/Emergence

Pygmy whitefish mature at an early age (age 1 to 4 years), with males maturing earlier than females (Wydoski and Whitney 2003). They spawn at night from late summer to early winter along the shoreline of lakes or in the riffles of tributary streams, with timing dependent on geographic location and elevation (Hallock and Mongillo 1998). Spawning substrate is likely coarse gravel or rocky material, with individuals from Chester Morse Lake observed spawning in pools just below riffles in lake tributaries (Cedar and Rex Rivers) during late December and early January (Hallock and Mongillo 1998; Wydoski and Whitney 2003).

Juvenile

Juvenile pygmy whitefish from a lake in Alaska were found primarily in open water and nearshore habitats (Hallock and Mongillo 1998). No other published information on juvenile habitat was found in the literature.

POPULATION TRENDS

In Washington State, the current population status of pygmy whitefish is unknown (Hallock and Mongillo 1998). In general, pygmy whitefish are not common and too few have been collected to establish any firm data on population status or trends (Mackay 2000). Although new observations of this species are occurring across their range, it is believed that all remaining populations in Washington State have been identified. Use of piscicides (chemicals used to kill fish), combined with the introduction of non-native fish predators (e.g., smallmouth bass, *Micropterus dolomieu*), is thought to have extirpated a number of isolated lake populations (Hallock and Mongillo 1998).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Because pygmy whitefish in Washington State are limited to 9 remaining populations in lakes with fairly specific conditions (high oxygen, low temperature and low nutrients), they are vulnerable to threats associated with habitat destruction and alteration. These threats include eutrophication, siltation and increased water temperatures associated with logging, agriculture, grazing and urban/suburban development in riparian habitats (Hallock and Mongillo 1998). However, habitat associated with the existing lake populations is generally considered stable because most is owned by various government agencies or public utilities (Hallock and Mongillo 1998).

Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes

Over utilization has not been cited as a threat to pygmy whitefish (Hallock and Mongillo 1998).

Disease or Predation

Although disease has not been cited as a threat to pygmy whitefish, predation by non-native species is thought to have contributed to the extirpation of some populations (Hallock and Mongillo 1998).

Adequacy of Existing Regulatory Mechanisms

Pygmy whitefish are listed as a Priority species under Washington's Priority Species and Habitat Program, which provides some protection under existing regulatory mechanisms (Hallock and Mongillo 1998). The species may also receive some protection through the Washington Forest Practices Act, other salmonid protection programs, and the Aquatic Species Nuisance Plan (Washington Aquatic Nuisance Species Coordinating Committee 2001).

Other Factors Affecting Continued Existence

While past use of piscicides has resulted in the extirpation of some Washington State pygmy whitefish populations, the future use of these chemicals is not considered likely (Hallock and Mongillo 1998). Although unstudied, the effects of warming temperatures associated with global climate change may force habitat shifts by pygmy whitefish that could result in competition with other species and/or extirpation from existing habitat (Mackay 2000).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Pygmy whitefish are likely to be affected by any activity authorized by Washington DNR within their known range; in lakes where the species may have historically occurred and may be reestablished (e.g., Marshall Lake); and in the surrounding watersheds of existing or potential habitat (Hallock and Mongillo 1998). Discharges from outfalls may lead to increased eutrophication, siltation, and/or water temperatures; while overwater structures and bank armoring may alter shallow lake and stream tributary habitats. Nearshore and transportation-related activities (e.g., fill and bank armoring, sediment disturbance, utility line construction) can alter shallow water lake and stream tributary habitat. Aquaculture may also increase eutrophication or introduce invasive species, and the use of piscicides to control invasive species may directly impact pygmy whitefish.

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3-3.15 Quillback rockfish (*Sebastes maliger)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Quillback rockfish range from Kenai Peninsula in the Gulf of Alaska to southern California (Stout et al. 2001; Love et al. 2002). In Washington, they are common in the San Juan Islands and Puget Sound proper (the area south of Admiralty Inlet and east of Deception Pass) (Miller and Borton 1980, Stout et al. 2001). Washington State Department of Fish and Wildlife (Washington Fish and Wildlife) trawl surveys found quillback rockfish in the Strait of Juan de Fuca, the Washington portion of the Strait of Georgia, and in the Gulf of Bellingham (Stout et al. 2001). In addition, reports have confirmed the occurrence of quillback rockfish in non-estuarine coastal waters of Washington, with Gardner (1981) indicating that quillback rockfish were not found in Grays Harbor, Willapa Bay or the Columbia River estuary.

The NOAA Fisheries status review (Stout et al. 2001) proposed 3 distinct population segments for Washington - the coastal waters west of Cape Flattery, Puget Sound proper and a northern Puget Sound population that includes the San Juan Islands, Strait of Georgia, and a portion of the coast. It should be noted that the NOAA Fisheries status review did not cite any data or sources of information detailing the occurrence of quillback rockfish off the Washington coast.

HABITAT USE

Adults

In Washington, adult quillback rockfish prefer consolidated habitats in the shallow subtidal nearshore and upper offshore ecosystems of inland waters (Stout et al. 2001). While maximum depths are 275 meters (Stout et al. 2001, Love et al. 2002), in greater Puget Sound the highest densities are on shallow reefs less than 30 meters deep (Matthews 1990a; Stout et al. 2001).

Adults are solitary, bottom oriented fish with a small home range (10 to 100 square meters) (Matthews 1990a, b) that prefer consolidated, high relief rocky reefs with kelp cover. However, these rockfish will also use low relief reefs and unconsolidated habitats when ribbon kelp (*Laminaria* sp.) is present (Matthews 1990a; Stout et al. 2001; Love et al. 2002) and may migrate to deeper water during the winter (Matthews 1990a).

Quillback rockfish can reach 61 centimeters total length and live to be 95 years old (Love et al 2002). Both sexes mature around the same time, between 5 and 13 years of age and 29 centimeters total length (Matthews 1987, Stout et al. 2001).

Adult quillback rockfish primarily feed in the morning and evening and are probably inactive at night (Love et al. 2002). Prey includes brachyuran crabs, gammarid amphipods, isopods, and fish (Hueckel and Stayton 1982; Matthews 1990a; Murie 1995; Love et al. 2002). Predators of juveniles and adults include lingcod (*Ophiodon elongatus*), cabezon (*Scorpaenichthys marmoratus)*, salmon (*Onchorynchus* spp.), river otters (*Lutra canadensis)*, sea lions (*Zalophus califonianus*), harbor seals (*Phoca vitulina*), great blue heron (*Ardea herodias*), cormorants (*Phalacrocorax* spp.) and various other marine bird species (Fresh et al. 1981; Jones 2000; Eisenhardt 2001).

Reproduction

Quillback rockfish, like all fish in the Genus Sebastes, have internal fertilization and brood their eggs to the larvae stage. Solitary gestating females were recorded resting on the bottom on consolidated reefs in Puget Sound (Palsson, personal communication, September 26, 2003). Mating probably occurs in March in greater Puget Sound (Matthews 1990b), with larval release occurring in May (Matthews 1990a; Love et al. 2002). Following parturition, larval quillback rockfish use the open water habitat in mid water for two months (Moser and Boehlert 1991; Buckley 1997).

Larvae and Juveniles

Larvae at 18 to 25 millimeters total length settle during July through November in shallow nearshore waters and become juvenile fish. These fish are associated with a variety of unconsolidated habitats including soft sediment, cobble, drifting aggregates and beds of macroalgae including bull kelp (*Nereocysis luetkeana*). Young-of-the-year quillback rockfish are widely distributed among a variety of habitat types (Matthews 1990b). In the summer, they use varied habitats including sand with eelgrass or kelp and low-relief reefs. The juvenile quillback rockfish move to high-relief and artificial reefs in the late summer and fall (Matthews 1990b, Stout et al. 2001).

Larval quillback rockfish prey upon zooplankton such as barnacle cyprids, shrimp, calanoid copepods, and larval fish (Hueckel and Stayton 1982, Murie 1995). After settling, the benthic juveniles primarily feed at night on shrimp, invertebrates and small fish associated with macroalgae (Moulton 1977; Washington et al. 1978; Hueckel and Stayton 1982; Murie 1995).

POPULATION TRENDS

The NOAA Fisheries status review found differing population trends within the three population segments described for this species. Within the Puget Sound proper segment, quillback rockfish were not found by Washington Fish and Wildlife surveys at numerous

sites with apparently suitable habitat. In addition, diving surveys showed an 85 percent decrease in the quillback population. Trawl surveys estimated the number of quillback rockfish in 1987 and 1989 at 1,153,000 and 1,055,000, respectively (Stout et al. 2001). In 1991, this value declined to 668,000 and gradually increased to 766,000 in 1995.

Despite data from a variety of survey methods applied by Washington Fish and Wildlife, the population trend for quillback rockfish in the North Puget Sound population segment was not clear. Because of the substantial numbers of quillback rockfish found in these surveys, the NOAA Fisheries status review (Stout et al. 2001) considered the risk of extinction to be no greater than the risk to quillback in the Puget Sound proper population segment.

THREATS WARRANTING ESA PROTECTION

The risks to the survival of quillback rockfish were listed by West (1997) as "anthropogenic stressors and natural limiting factors", and include "over harvesting, loss or degradation of habitat, predation by pinnipeds and fish and pollution-related adverse effects."

Destruction, Modification, or Curtailment of Habitat or Range

Habitat for juvenile rockfish could be affected through shoreline development. Sediment flow can be affected by bulkheads or jetties and change sediment characteristics in shallow water where benthic juvenile brown rockfish concentrate. Kelp and eelgrass have been identified as important nearshore habitats for rockfishes and the loss of eelgrass or kelp through dredging or filling may negatively affect juvenile and adult habitat (Palsson et al. 1998). Destruction or degradation of kelp and eelgrass habitats from eutrophication or invasive species may also have negative trophic impacts for this species

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Quillback rockfish are vulnerable to over harvest by recreational fisheries in all population segments. Recreational catches of quillback rockfish continued to decline through 1999 (Stout et al. 2001). Similarly to other rockfish, recreational and commercial take of the largest and oldest fish targets reproductive populations leaving the species particularly sensitive to overfishing. There are no known scientific or educational uses for quillback rockfish.

Disease or Predation

While disease is not known to be a significant threat to these species, predation from sea lions (*Zalophus califonianus*) and harbor seals (*Phoca vitulina*) may be a factor in decreasing population trends. Due to their protection under the Marine Mammal Protection Act of 1972 pinniped populations have increased and may be placing additional strain on rockfish populations.

Adequacy of Existing Regulatory Mechanisms

Washington Fish and Wildlife manages all of these species and imposes strict catch limits (Palsson et al. 1997). However, while the limits may be inadequate protection due to the fact that rockfish constitute a large percentage of the bycatch for lingcod and salmon fisheries, NOAA Fisheries status review did not cite inadequate regulatory mechanisms as a risk factor.

Other Factors Affecting Continued Existence

Demersal rockfish have several traits that may predispose them to accumulation of contaminants. They are carnivorous and may consume prey with bioaccumulated contaminants, and they are long-lived, non-migratory, and reside close to sediments. Available data indicate that quillback rockfish of the Puget Sound proper population segment are exposed to PCBs, PAHs, and mercury at concentrations that could potentially lead to sublethal health effects and reduce the productivity of these fish (West 1997; Stout et al. 2001).

Additional factors affecting this complex rockfish include possible sub-lethal affects from bioaccumulation and concentration of chemical contaminants (West 1997; West and O'Neill 1998); and the possible feminization of male rockfish as a result of human estrogen/progesterone in the water (West 2004). While some studies have suggested decreases in reproductive success and survival of young rockfish as a result of ocean climate fluctuations such as El Nino and La Nina Southern Oscillation and Pacific Decadal Oscillation (Partnership for Interdisciplinary Studies of Coastal Oceans 2004), the magnitude of this variable in Washington is currently unknown.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Quillback rockfish are likely to be affected by activities authorized by Washington DNR within marine nearshore environments. Roadways, bridges, and docks may result in stormwater runoff which may increase concentrations of toxic contaminants including but not limited to hormones, PCBs, heavy metals and petroleum products in both the sediments and water column. Additionally, discharges containing nitrogenous and bacterial waste associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality as well as contribute towards eutrophication of the nearshore environment. Net pens associated with fish hatcheries and aquaculture operations may also contribute to the loss of adult habitat from shading and the introduction of disease and parasites. Overwater structures and shoreline modifications may negatively affect habitat by reducing or modifying macroalgae, kelp, and eelgrass habitat. Dredging or disposal of dredged materials has the potential to cover brown rockfish habitat. Furthermore, sediment flow could be changed by bulkheads and jetties and subsequently suffocate habitat.

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3-3.16 River lamprey (*Lampetra ayresi)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Species of Concern
Washington State	Candidate Species
Natural Heritage Program	G4; S2

RANGE

The river lamprey inhabits coastal streams from northern California to northern British Columbia and southeastern Alaska (Wydoski and Whitney 2003). However, there have been few definitive collections or sightings of lamprey within its entire range in recent years (Meeuwig et al. 2003). The Oregon Department of Fish and Wildlife is not even certain if river lampreys are still present in Oregon (Kostow 2002). Part of this confusion may be that, except for the last 6 months to 1 year of life, the western brook lamprey and the river lamprey are indistinguishable from each other (Kostow 2002).

In Washington, there are no detailed distribution records for river lamprey, although the species probably occurs in most major rivers (Wydoski and Whitney 2003) and is thought to inhabit portions of the Columbia River, some rivers of the Western coast, and Puget Sound. Reports of river lamprey exist for the Lake Washington drainage, Lake Sammamish and within Hood Canal near Seabeck (Wydoski and Whitney 2003). River lamprey have also been collected more recently in Skagit Bay (Meeuwig et al 2003).

HABITAT USE

Adult

River lamprey are anadromous fish that utilize freshwater and marine environments throughout their life history. Young river lampreys from British Columbia rivers migrate to the sea between the months of April and June at an average size of almost 11 centimeters. Adults then spend 4 to 5 months feeding at sea before returning in the fall for spawning the following spring (Wydoski and Whitney 2003). While at sea, adult river lamprey use cusped teeth in their sucker-like mouths to remove large chunks of

flesh from host fish and because of this behavior, some consider the river lamprey to be more predatory than parasitic (Kostow 2002). Diet studies have shown that adult river lamprey in marine habitats feed on herring, smelt and salmonids; in laboratory studies, they have been observed feeding on shiner perch, English sole and even other river lamprey (Wydoski and Whitney 2003). River lamprey are found near the mouth of major rivers at depths of less than 49 meters (160 feet), although off the coast of British Columbia, adults are found in the surface waters at depths of 26 to 33 meters (85 to 108) feet between May and September (Wydoski and Whitney 2003). It is thought that river lamprey may have a preference for water with reduced salinity because they tend to be distributed in surface waters in the vicinity of major rivers, where salinities ranged between 26 to 30 practical salinity units. Adult river lamprey in the Pacific Ocean off British Columbia ranged in size from 14 to 25 centimeters. River lamprey begin their return to freshwater in September after several months of feeding at sea.

Spawning

Adult river lamprey begin the journey to freshwater in the fall, overwinter in freshwater streams and rivers, and then spawn the following spring (Wydoski and Whitney 2003). In Washington State, spawning typically occurs from April to June, with the peak occurring in May, when water temperatures are around 12° Celsius. In a laboratory study, river lamprey were observed to construct nests in gravel of roughly 15 centimeters in diameter (Wydoski and Whitney 2003). They then deposit eggs and milt in the gravel nest; females produce 11,000 to 37,000 eggs during a spawning event. All river lamprey die soon after spawning (Wydoski and Whitney 2003).

Incubation / Emergence / Larvae

Little published information exists on the early life history of river lamprey, including the temperature and flow requirements of their eggs or the specific freshwater habitat requirements of their larvae (Kostow 2002). After hatching, river lamprey ammocoetes remain in the silt and sediment of coldwater streams and rivers, where they feed on microscopic organisms and algae (Wydoski and Whitney 2003). Ammocoetes are thought to remain in freshwater river habitats for up to several years, where they favor low-gradient reaches in lower river flood plains. As the ammocoetes migrate downriver to the Pacific Ocean, they metamorphose into young adults, developing eyes and an oral disc.

POPULATION TRENDS

The population status of the river lamprey is difficult to assess because 1) most freshwater observations are based on juveniles that are difficult to differentiate from other lamprey species, 2) data are often incidental to salmon monitoring programs, and 3) there are few historical datasets on lamprey populations in existence. Abundance in the Strait of Georgia, British Columbia, was estimated at 189 river lamprey per square kilometer (Wydoski and Whitney 2003). Because adult river lamprey tend to not move far from the estuaries of their natal rivers, it is thought that this species is geographically discrete, with individual stocks genetically unique (Kostow 2002).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

River lamprey are likely susceptible to threats similar to those described for the Pacific lamprey. Modification of river habitats used by spawning adult and larval stages of river lamprey is thought to represent the biggest threat to this species. Dams, culverts, tidegates, weirs and water-diversion structures prevent adult river lamprey from accessing spawning habitats and may cause high mortality of outmigrating ammocoete larvae (Kostow 2002). River flows, which stimulate migratory behavior of outmigrating larvae, have been altered substantially by reservoir and dam construction, and may be detrimental to river lamprey populations by delaying outmigration behavior (Kostow 2002). In addition, rapid water drawdown in reservoirs may strand lampreys in their burrows (Kostow 2002). Most industrial, urban, and agricultural development is concentrated in low-gradient, lower river flood plains that are favored by lampreys.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

River lamprey are of relatively small size (returning adults are between 20 to 30 centimeters in length) (Wydoski and Whitney 2003) and are not used extensively for commercial, recreational, scientific or educational purposes.

Disease or Predation

Disease and predation are not currently thought to represent major threats to the continued survival of river lamprey.

ADEQUACY OF EXISTING REGULATORY MECHANISMS

The current lack of data related to populations, distribution, harvest and the ability of the river lamprey to survive upstream-passage facilities make it likely that existing regulatory mechanisms are inadequate to protect this species. Other Factors Affecting Continued Existence

Larval river lampreys burrow in river-bottom sediment during their entire larval life span, and may be affected (through ingestion and external exposure) by toxic pollutants sequestered in areas with contaminated sediment. River lamprey were often found in dredged sediment taken from the lower Fraser River, and have relatively low survival rates (3 to 26 percent) after passing through the dredge (Kostow 2002). River lamprey are often concentrated in remarkably high densities in some stream areas, and as such, are particularly vulnerable to chemical spills or other catastrophic events.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

River lamprey are most likely to be affected by activities authorized by Washington DNR on state-owned aquatic lands in riverine and nearshore marine habitats of interior and coastal rivers of Puget Sound, the outer coast and the Columbia River and its tributaries. Areas of concern include dams and other diversion/impoundment structures blocking

adult migration, entraining outmigrating larvae, and altering stream flow and temperature; outfalls or other activities that may contribute toxic contaminants to riverine sediment used by larvae; and sediment disturbance or removal associated with mining and dredging activities.

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3-3.17 Umatilla dace (*Rhinichthys Umatilla)*

Umatilla dace are members of the genus *Rhinichthys* and are morphometrically similar to leopard dace *Rhinichthys falcatus*. Umatilla and leopard dace were previously considered to be sub-species of the taxonomically similar speckled dace (Wydoski and Whitney 2003), with the American Fisheries Society only recently recognizing the Umatilla dace as a valid species (Nelson et al. 2004). Umatilla and leopard dace exhibit only small morphological differences such as the absence of fleshy stays on the rays of the pelvic fins, the presence of all but connected dark spots along the lateral line, a wider caudal peduncle and smaller, more numerous, lateral line scales (Wydoski and Whitney 2003). Umatilla dace also exhibit different habitat usage than Leopard dace, opting for slower currents typically found in glides (Haas 1999). Although hybridization is possible between speckled, leopard, and Umatilla dace, genetic differences reveal that Umatilla dace are not early generation hybrids of Leopard and speckled dace (Haas 2001). Previous research has indicated that Umatilla dace are intermediate between speckled and leopard dace in morphometry, distribution, and ecology (Haas 2001). It has been suggested that Umatilla dace have evolved from an ancient hybridization of leopard and speckled dace that occurred directly after the last Pleistocene glaciation (Haas 2001).

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Candidate Species
Natural Heritage Program	G4; S2

RANGE

Umatilla dace populations are sporadic and disconnected, occurring throughout North America in British Columbia, Idaho, Oregon and Washington. In Washington the species is found in the Columbia Basin above the Dalles Dam, in the Upper reaches of the Yakima river, and in the Similikameen, Colville, Methow and Wenatchee rivers (Peden and Hughes 1988; Haas 2001; Wydoski and Whitney 2003).

HABITAT USE

Adults

Umatilla dace are benthic and prefer productive, low elevation streams with currents strong enough to contain clean gravel. Although early studies (Peden and Hughes 1988; Peden 1991) suggested that Umatilla dace occupy positions with higher velocities than leopard dace, evidence from a recent study indicates the opposite (Haas 2001). Umatilla dace are found at depths less than 1 meter, in substrates comprised of rock, boulder and cobble (Wydoski and Whitney 2003). Individuals may live as long as 4 years in the wild and attain lengths of approximately 10 centimeters (Haas 2001; Wydoski and Whitney 2003). While prey preferences are unknown, they are assumed to feed on aquatic insects similarly to other dace species (Wydoski and Whitney 2003).

Spawning

Although little is known regarding spawning behavior, Umatilla dace may utilize habitat similar to other dace species, spawning over unprepared gravel or small stones in riffles. In Washington, it is believed that spawning occurs in early to mid-July (Wydoski and Whitney 2003).

Juveniles

Little is known regarding the diet of juvenile Umatilla dace yet it likely mirrors that of other dace, which consists of aquatic insect larvae. Juveniles are likely found in slow-moving backwater pools of less than 0.5 meter in depth (Haas 2001) with cobble substrates covered with algae (Wydoski and Whitney 2003).

POPULATION TRENDS

Insufficient information exists regarding past and current abundance to draw conclusions regarding population trends. In 1998, due to its unknown status and an irregular distribution, the Umatilla dace was listed as a state Candidate Species by Washington Fish and Wildlife (Mongillo and Hallock 1999). Washington Fish and Wildlife is currently continuing its efforts to determine whether Umatilla dace should be listed as an Endangered, Threatened or Sensitive species in Washington.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Umatilla dace are dependent on river and stream shoreline habitat, they are vulnerable to a number of impacts affecting their habitat. Sand and gravel mining, logging, agriculture, grazing or urbanization may increase sediment deposition, which degrades habitat. Shoreline armoring and fill may decrease critical areas of shallow, slow moving habitat.

Furthermore, shoreline development, grazing and agriculture may decrease both riparian cover and terrestrial insects that are important prey items for dace. Bank armoring impacts dace by removing refuge from predators found with undercut banks, log snags, and streamside vegetation. The removal of woody debris from rivers, streams and estuaries to improve navigability, decrease channel meander, and aesthetically improve "views" has resulted in a significant loss of refuge from predators and may increase scour from high flow events caused by water releases from dams and flooding. Point source and non-point source pollution can have deleterious effects on food web assemblages and individuals.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There are no known commercial, recreational, scientific or educational uses for Umatilla dace.

Disease or Predation

Although dace likely serve as forage fish for trout, salmon, and other native and introduced fishes, insufficient information exists to determine that disease or predation is a current threat to Umatilla dace survival. However, it is important to note that small, isolated populations can be highly sensitive to disease events or an increase in predation rates from native or introduced predators.

Adequacy of Existing Regulatory Mechanisms

Umatilla dace may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and degradation such as changes in sediment load, fill and bank armoring, point and non-point source pollution and water diversions.

Other Factors Affecting Continued Existence

Temperature change brought about by local land and watershed management that decreases riparian zone shading and cover, as well as broader scale factors such as global climate change may negatively impact Umatilla dace populations. Furthermore, isolated stocks may not be able to effectively restock weakened populations due to habitat separation caused by dams. Low-density populations may also decline due to the inability to find mates; which may place isolated populations at further risk of extirpation.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Umatilla dace are likely to be affected by a variety of activities authorized by Washington DNR on state-owned rivers. In addition to providing a refuge for predators, overwater structures frequently reduce or prevent the growth vegetated habitat by preventing the transmission of light. Outfalls may cause localized reductions in water and sediment quality, resulting in increased turbidity, reduced foraging efficiency, diminished habitat quality, and potential bioaccumulation of pollutants. Construction of roads and bridges may result in increased sedimentation during construction, as well as increase temperature and pollutant loads from stormwater runoff during operation. Pollutants that are harmful to dace and that are present in stormwater runoff and outfalls include but are

not limited to hormones, PCBs, heavy metals, salts, fertilizers, and petroleum products. Dredging, fill, shoreline armoring, and sand and gravel mining may either remove habitat or prevent the formation of habitat, or alter sediment loads, thereby decreasing habitat through increased scour or deposition. Aquaculture operations also has the potential to impact this species through disease transmission, decreased dissolved oxygen levels, increases in nitrogenous waste and the introduction of chemicals such as, pesticides and antibiotics.

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3-3.18 Walleye pollock (*Theragra chalcogramma)*

The common and scientific names are valid and correct as they are listed above and currently used by state and federal agencies (Nelson et al. 2004). Additional common names may include “Pacific pollock,” "Alaska or Alaskan Pollock," "scrapcod" and “bigeye pollock.”

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Walleye pollock occur on the continental shelf and slope from the Sea of Japan to Central California (Hart 1973; Saunders et al. 1989). Gustafson et al. (2000) defined one distinct population segment in the northeastern Pacific Ocean, the Lower Boreal Eastern Pacific population. This segment includes walleye pollock from Puget Sound to Southeast Alaska and offshore into the Northeast Pacific Ocean.

Within Washington waters, walleye pollock occur throughout Puget Sound, the San Juan Archipelago, and the lower Strait of Georgia (Miller and Borton 1980). The Washington Department of Fish and Wildlife recognizes two stocks of walleye pollock in Puget Sound, North Sound and South Sound with the dividing line at Port Townsend. Washington Fish and Wildlife differentiates the stocks by spawning location, growth rates, and other biological characteristics (Palsson et al. 1997). Walleye pollock in the southern stock are on the extreme southern end of their global distribution (Palsson et al. 1997; Gustafson et al. 2000). Specific records on bathymetric range and occurrence in Washington coastal waters were not found.

HABITAT USE

Adults

Adult walleye pollock are semi-demersal, using openwater and unconsolidated habitats in the nearshore, offshore, and deep offshore ecosystems in both coastal and inland waters. The depth range of walleye pollock is surface to 366 meters (Hart 1973), with the largest abundance occurring between 40 and 120 meters (Gustafson et al. 2000).

Walleye pollock are carnivorous, feeding on euphausiids, copepods, amphipods and small fishes, including age-0 (0 to 1 year old) walleye pollock (Livingston 1989, 1993). Dominant prey items vary seasonally with availability. Predators include lingcod (*Ophiodon elongatus*), salmon (*Onchorynchus* spp.), river otters (*Lutra canadensis)*, sea lions (*Zalophus califonianus*), harbor seals (*Phoca vitulina*), great blue heron (*Ardea herodias)*, cormorants (*Phalacrocorax* spp.) (Pitcher 1980; Lowry et al. 1996).

Reproduction

In Puget Sound, male and female walleye pollock reach sexual maturity at age 1 and older and between 25 to 38 centimeters total length (Gustafson et al. 2000), with fish in coastal waters maturing later at 2 to 3 years old and 40 centimeters (Saunders et al. 1989). The maximum age for fish in Puget Sound is estimated to be 10 years with a maximum size of 91.4 centimeters, and 8 years and 74 centimeters total length in coastal waters (Saunders et al. 1989).

Most pollock populations spawn at predictable times in the same locations year after year, usually in sea valleys, canyons, or indentations in the outer margin of the continental shelf. In Puget Sound, they spawn in deep-water bays (Gustafson et al. 2000) forming spawning aggregations during February through April at depths of 110 to 145 meters.

After pairing, the female releases batches of eggs over a short period of time that are fertilized in the water column (Sakurai 1982). Eggs are pelagic occurring in water

column habitats above 60 meters in nearshore and offshore ecosystems (Saunders et al. 1989; Gustafson et al. 2000). Incubation is dependent on temperature and varies from 10 days at 10° Celsius to nearly 30 days at 2° Celsius.

Larvae and Juveniles

Early-stage larvae grow about 0.10 to 0.20 millimeter per day and metamorphose into juveniles at a length of about 18 millimeter (Gustafson et al. 2000). In the first year, juveniles grow up to 1 millimeter per day, reaching 80 to 100 millimeters in length in six months and 120 to 140 millimeters by the end of the first year.

Larvae tend to aggregate in patches under the influence of currents, geographical formations, and availability of prey. Larvae and small juveniles are found down to depths of 60 meters, with juveniles in North Puget Sound and the Strait of Georgia, juveniles moving quickly into nearshore nursery areas in May and June. Fish between 21 and 87 millimeters in length have been found associated with eelgrass habitat (Gustafson et al. 2000), while larger juveniles occupy the water column and also use unconsolidated gravel and cobble seafloor habitats (Miller et al. 1976; Sogard and Olla 1993). As the juveniles grow, they migrate to deeper water (Quinnell and Schmitt 1991).

Small juveniles rise to the surface at night to feed, primarily preying on copepod nauplii (Garrison and Miller 1982), and are prey to euphausiids, amphipods and small fishes (Canino et al. 1991; Bailey et al. 1999). Larger juveniles feed in the water column, preying on euphausiids, copepods, decapod larvae and larvaceans (Brodeur 1998; Bailey et al. 1999) and are preyed upon by seabirds, sea lions (*Zalophus califonianus*), harbor seals (*Phoca vitulina*) and adult walleye pollock (Bailey et al. 1989; Hunt et al. 1996).

POPULATION TRENDS

A sport fishery near Tacoma once made walleye pollock the most common bottomfish harvested in Puget Sound recreational fisheries. Catches in southern Puget Sound exceeded 181 metric tons per year from 1977 to 1986 (Gustafson et al. 2000). Catch rates in the recreational fishery exceeded 1.3 fish per angler trip in 1978 and 1979 after which the rate declined to 0.5 fish per trip in 1986 and to negligible levels by 1991 (Palsson et al. 1997; Gustafson et al 2000). Due to concerns about the status of the population, Washington Fish and Wildlife reduced the daily catch limit from 15 fish to 5 in 1992 and to zero in 1997.

North Puget Sound walleye pollock are caught in a commercial trawl fishery, which apparently exploits a spawning aggregation in the Strait of Georgia extending into Washington waters from Canada (Gustafson et al. 2000). Pedersen and DiDonato (1982) identified a walleye pollock trawl fishery that operated from December to April with a peak in March to April at an average depth of 128 meters along the international border southwest of Point Roberts. Catch between 1970 and 1998 was low with two peak periods, and by 1992 to 1994, catch was almost zero (Palsson et al.1997).

Washington Fish and Wildlife bottom trawl surveys showed a decline in the Southeast Strait of Georgia-Bellingham area from approximately 34 million fish in 1987 to 1.5 million in 1997 (Gustafson et al. 2000). More recent data have not been published yet and no data is available for a coastal population off Washington. However, a commercial

fishery was recently allowed because of the occurrence of “large quantities every 5 to 7 years” (68 CFR 18 (2003)).

THREATS WARRANTING ESA PROTECTION

Wright’s 1999 petition to list walleye pollock and the Endangered Species Act status review (Gustafson et al. 2000) discusses several activities that threaten walleye pollock or their essential habitat.

Destruction, Modification, or Curtailment of Habitat or Range

Water column habitats and planktonic trophic webs supporting adult and juvenile fish and their reproductive products could be affected by pollutants from oil spills, wastewater and storm water discharge, and untreated ballast water release and by introduced species (Washington Fish and Wildlife 1998). In addition, they could be affected by the loss of nearshore juvenile habitats from shoreline modification and overwater structures.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Trawl surveys and commercial and recreational landings of walleye pollock reached zero in all areas in 1998. This decline was probably due in part to fishing, but also may be attributable to biological factors such as climate change causing a shift in distribution. (Washington Fish and Wildlife 1998; Gustafson 2000). As the population declined it is possible that catch rates exceeded maximum sustainable yields for the population and contributed to the overall rate of population decline.

Disease or Predation

Walleye pollock was the number one prey item for harbor seals (*Phoca vitulina*) in the Gulf of Alaska (Pitcher 1980) and increases in pinniped populations in Puget Sound could be a threat (Washington Fish and Wildlife 1998). The recovery of pinniped populations may reduce the ability of this population to recover and may have contributed to its decline.

Adequacy of Existing Regulatory Mechanisms

Existing harvest regulatory mechanisms are apparently adequate. Washington Fish and Wildlife reduced the catch limit for walleye pollock from 15 per trip to zero in 1997 for the South Puget Sound stock (Gustafson et al. 2000). However, regulatory mechanisms may be inadequate where pollution and marine mammal predation are concerned.

Other Factors Affecting Continued Existence

Decadal climate oscillations may be affecting population abundance. Walleye pollock in Puget Sound are at the southern limit of abundance. Warm water events such as El Nino could affect their distribution (Washington Fish and Wildlife 1998; Gustafson et al. 2000).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Walleye pollock are likely to be affected by activities authorized by Washington DNR within marine nearshore environments. Roadways, bridges, and docks may result in stormwater runoff which may increase concentrations of toxic contaminants including but not limited to hormones, PCBs, heavy metals and petroleum products in both the sediments and water column. Additionally, discharges containing nitrogenous and bacterial waste associated with wastewater treatment, industrial processes or fish hatcheries may decrease water quality as well as contribute towards eutrophication of the nearshore environment. These discharges will directly affect the growth and development of pelagic embryos, larvae, and juveniles. Net pens associated with fish hatcheries and aquaculture operations may also contribute to the loss of adult habitat from shading and the introduction of disease and parasites. Overwater structures and shoreline modifications may negatively affect habitat by reducing or modifying macroalgae, kelp, and eelgrass habitat, thereby reducing available juvenile pollock habitat. Dredging or disposal of dredged materials along with bulkheads and jetties may alter sediment flow from freshwater systems that may disrupt planktonic food web assemblages.

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3-3.19 Widow rockfish (*Sebastes entomelas)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Widow rockfish range from Kodiak Island, Alaska to northern Baja California, Mexico (Love et al. 2002; Hart 1973). While they are most abundant from northern British Columbia to northern California at depths of 150 to 200 meters, they have been found in large schools in shallower waters (approximately 25 meters) near seamounts. In Washington Widow rockfish are found along the outer coast and are a pelagic schooling species most common in depths from 50 to 100 meters (Tagart 1987). Although records indicate widow rockfish have been reported in the San Juan Islands, they remain undocumented in other areas in Puget Sound (Miller and Borton 1980), suggesting that this species may be found only in coastal and offshore areas.

HABITAT USE

Adult

Adult widow rockfish are known to be pelagic, forming loose schools in the water column over rocky consolidated habitats, and often co-occurring with yellowtail and dusky rockfishes (Tagart 1987). Widow rockfish school at night and disperse during the day, behavior that is thought to be unique among rockfish (Wilkins 1987).

This species are opportunistic predators that feed during the day on salps, fish (specifically myctophids and Pacific hake), caridean shrimp and euphausiids (Adams 1987). They have also been known to feed on amphipods, squid and anchovies (Love et al. 2002).

Widow rockfish can live to 60 years (Love et al. 1990), with fish in northern latitudes (Oregon and Washington) growing faster than those in California (Love et al. 2002). Widow rockfish are dimorphic (Lenarz and Wyllie Echeverria 1991) with sexual maturity for males occurring at 4 years (33 centimeters in length), with females maturing at 7 years (38 centimeters in length) on average (Barss and Wyllie Echeverria 1987).

Reproduction

Mating occurs once a year, generally in the fall (Barss and Wyllie Echeverria 1987) with females producing from 100,000 to more than 1 million cream-colored eggs (Love et al. 2002). Females store sperm for up to a month while their eggs fully develop, at which time fertilization occurs. Widow rockfish, like other Sebastes species, are ovoviviparous and produce live young, although no additional nutritive material is supplied by the

parent (Barss and Wyllie Echeverria 1987). Embryos develop for about one month before parturition, the timing of which varies by region (Matarese et al. 1989).

Parturition occurs between December and April, with fish in Oregon and British Columbia (northern regions) releasing larvae later than those in California (Barss and Wyllie Echeverria 1987; Matarese et al. 1989). Given these studies, it is likely that fish in Washington release larvae in the late winter, though no data on parturition rates for the Washington coast or Puget Sound presently exist.

Larvae and Juveniles

Larvae are about 5 millimeters in length at parturition (Love et al. 2002). Although larvae of most rockfish species can be found in the upper portion of the water column in the springtime, difficulty in identifying individual species has led to a lack of information regarding early life histories for many species (Matarese et al. 1989).

Widow rockfish juveniles are thought to remain neritic longer than other rockfish species spending up to 5 months in the plankton and experiencing rapid growth and development (Love et al. 2002; Matarese et al. 1989). After settling, at about 5 to 7 centimeters, juveniles occupy rocky areas in nearshore waters and are often associated with kelp, macro-algae, and manmade structures (Love et al. 2002). They can be found in or just outside of kelp forests and feed mainly on calanoid copepods and subadult euphausiids (Reilly et al. 1992).

POPULATION TRENDS

Since the early 1980s, widow rockfish, along with several other species, have experienced dramatic population declines as a result of being sought by recreational and commercial fisheries. Because widow rockfish are pelagic schooling fish, they are easily targeted in commercial fisheries (using mid-water trawls), where catches of 100 percent widow rockfish are not uncommon (Tagart 1987). In addition to being a targeted species, widow rockfish made up about 50 percent of the rockfish incidental catch taken in the 1980s from bottom trawls (Tagart 1987). By the mid-1980s their population was a fraction of peak levels and catch limits were set in place (He et al. 2003a). Widow rockfish are often caught with yellowtail rockfish, Pacific ocean perch, Pacific whiting, bocaccio, canary rockfish and sharpchin rockfish.

Widow rockfish were declared overfished by NOAA Fisheries in 2001, and the Pacific Fishery Management Council has established a rebuilding plan (Williams et al. 2000; He et al. 2003b).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Widow rockfish generally inhabit offshore neritic habitats, which are not at a high risk of destruction or modification. Although this species is often associated with consolidated substrate for diel migration , they are one of the more pelagic rockfish species and are frequently found in the water column. Widow rockfish are caught by the commercial fishery in mid-water trawls, which have minimal impacts on benthic habitats. Despite the lack of direct impact to consolidated habitats, the species is at risk from direct harvest.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

The widow rockfish population was designated overfished by NOAA fisheries in 2001. A rebuilding plan is currently imposed and commercial catch is tightly regulated, as a result of drastic reductions in population size incurred during the "boom and bust" fishery of the 1970s and 1980s.

Disease or Predation

Neither disease nor predation is known to be a significant threat to this species.

Adequacy of Existing Regulatory Mechanisms

Although existing harvest regulations for widow rockfish and related species have decreased the commercial harvest of these species, past over-utilization has resulted in depressed populations. As of 2003, widow rockfish were estimated to be slightly less than 25 percent of their unfished spawning potential (He et al. 2003b). Current management efforts may be aiding in the rebuilding of the stock, but given the loss of large, fecund fish and a period of poor recruitment, possibly due to climate, the rebound will not be rapid.

Other Factors Affecting Continued Existence

Recreational and commercial take, especially of the largest and oldest fish, are the most significant concerns for rockfish.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

As an offshore neritic species that does not commonly occur in Puget Sound, the widow rockfish has a lower potential for adverse impacts from activities authorized by Washington DNR than other rockfish species. However, nearshore activities as port development and construction of overwater structures that remove or modify kelp forests may impact juvenile widow rockfish habitat.

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3-3.20 Yelloweye rockfish (*Sebastes ruberrimus)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Yelloweye rockfish range from the Unalaska Island in the Aleutian Islands of Alaska to Baja California, Mexico (Hart 1973; Love et al. 2002) and are most abundant from central California to southeast Alaska. This species is found in water from 40 to 550 meters in depth, though they are most common from 100 to 150 meters (Eschmeyer and Herald 1983; Love et al. 2002).

In Washington, Yelloweye rockfish are found offshore along the outer coast and are rare in Puget Sound (Love et al. 2002). While data for Washington populations are quite limited (Wallace 2001), in 1982 Garrison and Miller stated that yelloweye rockfish were common on consolidated rocky habitats in coastal waters and Puget Sound.

HABITAT USE

Adult

Yelloweye rockfish occupy complex rock and wall habitats and are often associated with boulder fields, broken rock, overhangs and crevices (Yoklavich et al. 2000; Jagielo et al. 2003). They are sedentary demersal fish, generally found on or just above rocky substrates (Love et al. 2002; Yamanaka et al. 2002), and are thought to possess strong site fidelity because of their sedentary nature (Methot et al. 2002). Yelloweye rockfish are opportunistic predators, feeding mainly on other rockfish, flatfish, herring, sandlance, crab and shrimp (Love et al. 2002; Yamanaka et al. 2002).

Yelloweye are among the largest and longest lived of rockfish and Andrews et al. (2002) used otolith measurements to confirm ages of more than 100 years for several yelloweye rockfish specimens. This species is slow-growing and late-maturing, reaching sexual maturity at a length of about 45 centimeters and 20 years of age (Barss 1989). Males and females mature at about the same age, and there is no evidence that sexual maturity occurs at different ages within their geographic ranges (Methot et al. 2002). Sexual dimorphism is absent, with males and females approximately the same size at a given age (Lenarz and Wyllie Echeverria 1991).

Reproduction

Mating occurs once a year, generally in the winter, and while timing and fecundity is not well known (Garrison and Miller 1982), females are thought to produce between 1 and 3 million eggs per season (Love et al. 2002).

(Garrison and Miller 1982). Females store sperm for 4 to 6 weeks while their eggs develop and once the eggs are fertilized, the embryos develop for about 5 weeks before parturition (Wourms 1991). Like other Sebastes species, yelloweye rockfish are ovoviviparous and produce live young. Parturition occurs offshore between February and September, peaking at different times depending upon location in the range (Love et al. 2002); off British Columbia, the peak occurs in May or June (Westrheim 1975).

Larvae and Juveniles

Few data exist for the early life-history stages of yelloweye rockfish (Love et al. 2002). Larvae are thought to be released offshore and are found in the upper mixed zone of the ocean, where they are believed to be dispersed by physical transport processes (Yamanaka et al. 2002).

Yelloweye rockfish juveniles settle in shallow (50 to 100 meters) nearshore and offshore rocky areas (Yamanaka et al. 2002), probably during their first year of life, but exact timing is unknown. Juveniles have been observed occupying areas of high relief and have also been associated with off-shore oil platforms in southern California (Love et al. 2002).

Juvenile yelloweye rockfish likely eat plankton, such as crustaceans, and fish eggs, though few diet data exist for early life-history stages of this species. Although rockfish typically move to deeper habitats as they age, given their strong site fidelity and sedentary nature, it is currently unknown if yelloweye rockfish follow the same pattern (Yamanaka et al. 2002).

POPULATION TRENDS

Despite not maturing until age 20 (Wallace 2001), yelloweye rockfish recruit to the fishery at age three which has dramatic impacts on the reproductive potential of the stock (i.e., many fish are removed by the fishery prior to reaching sexual maturation). Because of their life-history characteristics (long-lived, late-maturing, slow-growing) and habitat fidelity, they are particularly vulnerable to overfishing, and stocks could take years to recover (Leaman 1991).

These rockfish occupy habitats that are inherently difficult to survey with conventional methods such as trawls, therefore, it is likely that many of the population estimates that exist for yelloweye rockfish are biased, incomplete or otherwise inaccurate (Yamanaka et al. 2000; Jagielo et al. 2003). For example, Jagielo et al. (2003) observed yelloweye rockfish at much higher densities in Oregon and California than on the Washington coast. While one possible explanation is that the Washington fishery has long been subjected to heavy fishing pressure, it is more likely that the survey design didn’t capture specific substrate features utilized by yelloweye rockfish (Jagielo 2003). This sampling bias may lead to inaccurate stock assessments (Methot et al. 2002). Submersibles and acoustic surveys are becoming more common for stock assessments.

Throughout the history of the yelloweye rockfish fishery, trawl landings are believed to be small, as these rockfish occupy habitats that are inaccessible to trawl gear (Methot et al. 2002). However, yelloweye rockfish are the target of long-line fisheries, including a targeted commercial long-line fishery in the Gulf of Alaska (Johnson et al. 2003), and

they are often caught as bycatch in the commercial Pacific halibut long-line fishery (Yamanaka et al. 2000). Additionally, they have been highly valued in the recreational hook-and-line fishery on the north Pacific coast for many years, both for the quality of their flesh and their bright color. Their site fidelity and association with specific habitat types have made them easy targets for fishermen, who are able to locate bottom features by using modern fishing equipment, such as depth finders and global positioning systems.

Yelloweye rockfish were declared overfished by the National Oceanic and Atmospheric Administration (NOAA) Fisheries in 2002 and a rebuilding plan is being drafted by NOAA Fisheries and the Pacific Fishery Management Council. In addition, both Washington and Oregon Fish and Wildlife have prohibited the retention of yelloweye rockfish in recreational fishing areas, and some groundfish management plans stress utilizing either marine protected areas, “no-take” designations or regional closures for rebuilding the stock (Palsson et al. 1998). While these actions may aid in rebuilding this sedentary stock, it is likely that it will take decades for the fishery to recover, (Yamanka et al. 2000).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Yelloweye rockfish inhabit offshore and nearshore rocky, consolidated habitats, which are not at high risk of destruction or modification.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

NOAA Fisheries has declared yelloweye rockfish overfished, and a rebuilding plan is in place. State agencies, such as Washington Fish and Wildlife and Oregon Fish and Wildlife, have prohibited retention of yelloweye rockfish in the recreational fishery. However, the inability of rockfish species, like yelloweye, to survive catch-and-release fishing (they are subject to swim bladder embolism upon surfacing) has made the reduction of incidental loss difficult. Their high market value has also contributed to continued harvest, specifically from commercial long-line and recreational fisheries.

Disease or Predation

Neither disease nor predation has been identified as a significant threat to the species.

Adequacy of Existing Regulatory Mechanisms

While the species has been formally declared overfished, no commercial fishery regulations are specific for yelloweye, in part because trawl fisheries cannot access yelloweye rockfish habitat (Methot et al. 2002). As yelloweye rockfish continue to be targeted in both commercial long-line and recreational fisheries, as well as captured as bycatch in other long-line fisheries, existing regulations may be inadequate to protect this species.

Other Factors Affecting Continued Existence

Recreational and commercial take, especially of the largest, oldest, most fecund fish, are the most significant concerns for rockfish. Additionally, the lack of data regarding the specific ecology of individual rockfish species, larval and juvenile ecology, food habits or how oceanic conditions might affect recruitment may complicate conservation efforts (Love et al. 2002; Harvey 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Because yelloweye rockfish have strong site fidelity and are sedentary (Berkeley et al. 2004, Palsson et al. 1998), they are especially vulnerable to habitat disturbance and loss. While this species is mostly found offshore, activities authorized by Washington DNR that reduce or modify macroalgae, kelp and eelgrass habitat may impact juveniles of this species.

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3-3.21 Yellowtail rockfish (*Sebastes flavidus)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

Yellowtail rockfish are found from Unalaska Island, Alaska, to San Miguel Island in southern California (Hart 1973; Love et al. 2002) and are most common from Oregon to British Columbia in water 90 to 200 meters deep (Lai et al. 2003).

In Washington yellowtail rockfish are found along the outer coast and although they were once common at shallow depths (12 to 25 meters) in Puget Sound, the Strait of Juan de Fuca and around the San Juan Islands (Garrison and Miller 1982), their current distribution is poorly understood.

HABITAT USE

Adult

Adult yellowtail rockfish are benthopelagic, forming loose schools in the water column over consolidated habitat, similar to widow rockfish. They tend to be associated with high-relief substrate, although they have been observed over cobble and mud habitats as well (Love et al. 2002; Jagielo et al. 2003). Yellowtail co-occur with canary, black, widow, silvergray and other species of rockfish (Tagart 1987).

Tagging studies have been conducted to assess yellowtail movement patterns (Matthews and Barker 1983; Pearcy 1992). Pearcy's study (1992), which used acoustic tags, showed that most fish remained local or homed back to the capture site (up to 4 kilometers). Matthews and Barker (1983) showed that fish (mostly juveniles) ranged hundreds of kilometers, migrating from Puget Sound to the coast of Washington. Yellowtail rockfish have also been observed to make rapid vertical migrations, although no pattern in migratory behavior could be discerned (Pearcy 1992; Love et al. 2002).

Yellowtail rockfish can live to more than 60 years, reaching a maximum size of about 65 centimeters in length at approximately 15 years of age (Lai et al. 2003), with fish in northern latitudes (Oregon and Washington) growing faster than those in California (Love et al. 2002). As is common with rockfish, sexual maturity occurs at different ages and sizes for males and females. Males mature at a slightly smaller size (approximately 40 centimeters) than females (approximately 42 centimeters) (Garrison and Miller 1982). Yellowtail rockfish recruit to the fishery at an age of 4 years (Lai et al. 2003).

Juvenile and adult yellowtail rockfish are opportunistic predators, feeding on water-column and benthic-prey items (Reilley et al. 1992), as well as euphausiids and fish, specifically myctophids (Rosenthal et al. 1988).

Reproduction

Mating occurs once a year, generally in the fall, with the females retaining pockets of sperm until eggs have fully developed (Eldridge et al. 1991; Love et al. 2002). Females produce from 50,000 to more than three million eggs per year (Love et al. 2002) and like other Sebastes species, yellowtail rockfish are viviparous, producing live young. Eldridge et al. (2002) showed the gestation period of this species to average 29.2 days, including 6 days of larval incubation before parturition.

Parturition occurs January through March in north Pacific waters (Garrison and Miller 1982), with Eldridge et al. (1991) observing that all parturition occurs during the night and that females stop feeding prior to releasing larvae.

Larvae and Juveniles

Yellowtail rockfish larvae are about 4.5 millimeters in length at parturition (Love et al. 2002). They have been found more than 260 kilometers offshore and are known to have an extended pelagic juvenile stage (Garrison and Miller 1982; Love et al. 2002).

Juvenile yellowtail rockfish remain in the plankton for up to 4 months or until they are about 4.5 centimeters in length (Love et al. 2002), foraging on copepods and euphausiids, including their eggs (Reilly et al. 1992). Juveniles, in particular, are thought to be highly motile (Matthews and Baker 1983; Love et al. 2002). After settling, at about 5 to 7 centimeters in length (as small as 2.5 centimeters in California waters), yellowtail rockfish juveniles occupy consolidated habitats in nearshore waters, associated often with kelp or algae (Love et al. 2002). They have been seen schooling over rocky reefs and will form small groups in cracks and crevices (Garrison and Miller 1982; Johnson et al. 2003).

POPULATION TRENDS

Although harvested since the 1940s by midwater and bottom trawls, yellowtail rockfish and several other species have experienced population declines since the 1970s from being targeted by recreational and commercial fisheries. In the 1970s, yellowtail (along with widow rockfish) were the main target of fishermen from Oregon and Washington. Yellowtail rockfish have been reported as bycatch in the Pacific whiting fishery and in the salmon trolling and halibut long-lining fisheries in Canada.

Because yellowtail rockfish co-occur with species that are strictly regulated because of very low population levels (e.g., canary rockfish), fishing pressure on this species has relaxed in recent years, affording the species some level of protection (Lai et al. 2003). The biomass estimated in 2000 is believed to be about 50 percent of the unfished biomass estimated in 1967 (Lai et al. 2003).

Current population assessments for Puget Sound are unavailable, but Washington Fish and Wildlife has plans to conduct surveys. Moulton (1977) saw large schools in northern Puget Sound at the time of his survey, though the distribution and abundance of these fish today are unknown.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Yellowtail rockfish inhabit offshore neritic habitats, which are not at high risk of destruction or modification. Although are often associated with consolidated, high-relief substrate, they are one of the more pelagic rockfish species, found in the water column. Despite the lack of direct impact to consolidated habitats, the species is affected by direct harvest.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Although the yellowtail rockfish population has declined by 50 percent in the last 40 years (Lai et al. 2003), it has not been designated overfished (this designation is given to stocks that are less than 25 percent of their unfished levels). Yellowtail rockfish are an important species in the commercial groundfish fishery; however, catch limits on co-occurring species have led to decreased harvest pressure for this species.

Disease or Predation

Neither disease nor predation has been identified as significant threats to the species.

Adequacy of Existing Regulatory Mechanisms

The Pacific Fishery Management Council manages the yellowtail rockfish fishery in the United States. This fishery saw substantial growth in the 1970s and 1980s; however, as stocks of other species, such as canary rockfish, began to collapse in the 1990s, fishing pressure on yellowtail rockfish declined. Current population assessments for this species in Puget Sound are unavailable; therefore, the adequacy of regulatory mechanisms can not be assessed. It is likely that yellowtail rockfish populations have population trends similar to other rockfish species and that conservation measures should be implemented (Palsson et al. 1998).

Other Factors Affecting Continued Existence

Recreational and commercial take, especially of the largest and oldest fish, are the most significant concerns for rockfish (Parker et al. 2000). The effects of climate, variable oceanic conditions and other man-made impacts, such as pollution, have not been well documented, though there is some evidence that climate change impacts recruitment (Parker et al. 2000; Harvey 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Although nearshore activities that remove or modify kelp forests, such as port development and construction of overwater structures may be detrimental to yellowtail rockfish populations, the overall impact from activities authorized by Washington DNR is thought to be minimal. Because juveniles are more commonly found in shallow nearshore areas than adults they are most susceptible to shore-based changes

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3-4 Invertebrates

3-4.1 Ashy pebblesnail and Olympia pebblesnail (*Fluminicola fuscus, Fluminicola virens)*

The two species of Hydrobiid snails from the genus *Fluminicola* are considered as a guild for purposes of this paper due to common life histories traits and habitat requirements. *Fluminicola fuscus* was previously known as *Lythoglyphus columbianus, Fluminicola columbiana* and *Fluminicola nuttiliana columbiana* are known as junior synonyms of *Fluminicola fuscus*. *Fluminicola virens* was previously known as *Lithoglyphus virens* (Hershler and Frest 1996).

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife	
Ashy pebblesnail	Species of Concern
Olympia pebblesnail	Not listed
Washington State	Candidate Species
Ashy pebblesnail	Candidate Species
Olympia pebblesnail	Not Listed
Natural Heritage Program	Not Ranked
Ashy pebblesnail	G3; S2
Olympia pebblesnail	G2; S?

RANGE

Although the ashy pebblesnail historically occurred throughout the Columbia and Snake River basins in Washington, Oregon, and Idaho, its current range is restricted to rivers, streams, and creeks of the Columbia River basin (Neitzel and Frest 1989). Within the State of Washington, a 1988 survey by Neitzel and Frest (1990) found ashy pebblesnails only in the upper Columbia, Okanagon, Wenatchee, and Methow rivers. Neitzel and Frest (1989) suggest that ashy pebblesnails may also occur in rivers with similar characteristics to those with documented populations, such as the Sanspoil, Klickitat, Grande Ronde, Spokane and the lower Snake however researchers are unaware of surveys documenting the species in these basins (Figure 3.20). A figure representing the distribution of ashy pebblesnails in Washington may be found in Appendix F.

The historic range of the Olympia pebblesnail included the middle and lower Willamette River as well as a large stretch of the Columbia River extending from The Dalles pool to the Pacific Ocean (Natureserve 2005). While Olympia pebblesnails are currently common in the Willamette River system in Oregon, the species has a scattered distribution in Washington and is only found locally in the lower Columbia River downstream of Portland, Oregon (Hershler and Frest 1996; Natureserve 2005). The range of the Olympia pebblesnail has been found to overlap with that of the ashy pebblesnail in the Columbia River.

HABITAT USE

As with all other aquatic mollusks, these two species of Hydrobiid snails use gills for respiration. Both species require clear, cold streams with highly oxygenated water for survival (Frest and Johannes 1995, Pacificbio 2005) and graze on algae and small crustaceans attached to rocks and gravel with a flexible tooth-bearing appendage called a radula. Ashy pebblesnails and Olympia pebblesnails are typically found in riffle pool, plane bed and step pool environments on substrates ranging from sand to gravel or rock and are unable to survive in lakes or impounded waters. Surveys have found ashy pebblesnails to be abundant within 1 to 5 meters of the shoreline in water depths of less than 10 centimeters (Neitzel and Frest 1990). Although it was assumed that the species only occurred in large river habitats, recent surveys indicate that they may also be present in smaller rivers with widths of less than 50 meters (Neitzel and Frest 1990). Very little is known regarding the depth preference of Olympia pebblesnails.

Although little information exists for both species regarding reproduction, they are thought to be short lived, with a life span of 1 year and to die after reproduction. Due to this relatively short life cycle, entire populations can be replaced annually (Pacific Biodiversity Institute 2005).

POPULATION TRENDS

Insufficient information exists regarding past and current abundance to draw conclusions regarding population trends for either species. It has been suggested that habitats of the ashy pebblesnail overlap with that of the giant Columbia River limpet, and that this range once encompassed the entire Columbia River basin. While early surveys for both species were geographically limited to the Hanford Reach in the Columbia River, more recent collecting efforts have determined that the ashy pebblesnail occurs in places outside the

Hanford Reach (Neitzel and Frest 1990). Subsequent surveys that have not found Olympia pebblesnails in its historic range may indicate declining populations.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Both species dependence on cold, constant water flow makes them vulnerable to changes in flow regime and temperatures resulting from water diversions, impoundments and dam releases. Furthermore, because they are found in shallow depths and require dissolved oxygen for respiration, reservoirs that are periodically dewatered offer unsuitable habitat for both species. In addition, due to their substrate preference of soft sandy bottom, dredging may damage Olympia pebblesnail populations.

Eutrophication caused by high nutrient levels in fertilizers, fish hatchery discharges, and lumber mill runoff may also negatively affect this species by decreasing foraging opportunities. High nutrient levels can create dense filamentous algae blooms that the snails may not be able to consume as well as algae blooms that may cover important food resources such as lithophytes (primary producers that grow on rocks). In addition, high sediment loads from recreational mining, sand and gravel mining, or dredging may decrease survival rates by impeding respiration and feeding efficiency. Pesticides, herbicides, heavy metals and hydrocarbons in point and non-point source pollution may also decrease food supplies as well as contaminate habitat.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for ashy pebblesnails or Olympia pebblesnails.

Disease or Predation

Disease or predation is not currently known to be a threat to either species. However because both species are short-lived and occur in low densities within isolated populations, there may be limited opportunities for the reproductive replenishment that is needed after significant disease or other events that may cause mass mortality. Furthermore, population growth may decline at low densities due to the inability to find mates, which may place isolated populations at further risk of extirpation.

Adequacy of Existing Regulatory Mechanisms

Ashy pebblesnails and Olympia pebblesnails may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and modification. Specifically, the regulation of contaminants, sediment load and water flow alteration is of particular concern to these species.

Other Factors Affecting Continued Existence

The New Zealand mudsnail (*Potamopyrgus antipodarum*), an introduced exotic species, may pose a threat to ashy pebblesnails and Olympia pebblesnails. New Zealand mudsnails reproduce rapidly and are found in a wide variety of habitats including those

typical of both species; riffle pool environments with rocky substrates. They have been known to dominate invertebrate biomass (up to 95 percent) in colonized habitats and may out-compete native species for habitat and food resources (Mountains and Minds 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Ashy pebblesnails and Olympia pebblesnails are likely to be affected by activities authorized by Washington DNR within riverine environments. Roadways, bridges, and docks may result in increased sedimentation and habitat loss during construction, while stormwater runoff from the structures may increase temperatures as well as concentrations of heavy metals, salts and petroleum products in both the sediments and water column. Upstream activities such as dredging, recreational mining, and sand and gravel mining may also result in increased sedimentation and either loss of habitat or direct mortality. Additionally, discharges associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality.

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3-4.2 California floater (*Anodonta californiensis*)

This species is closely related to and has been commonly confused with *Anodonta nuttaliana*, *Anodonta wahlamatensis*, and *Anodonta oregonensis*. Although these species are morphologically and ecologically similar, their combination into a composite species has not been fully acknowledged resulting in taxonomic uncertainty (Frest and Johannes 1995, Taylor 1981, Natureserve 2005).

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife	Species of Concern
Washington State	Candidate Species
Natural Heritage Program	G3; S1, S2

RANGE

While taxonomic uncertainty and the possibility of misidentification, make it difficult to ascertain the range of the California floater it has been suggested that the species historically occurred from southern British Columbia to Baja California and as far east as Wyoming, and eastern Arizona (Taylor 1981, Henderson 1929, Natureserve 2005). In Washington, the historic range of the California floater included Cowlitz, Clark, King, Klickitat, Skamania, and Wahkiakum Counties (Henderson 1929, Frest and Johannes 1995).

Currently the species occurs throughout a scattered range in Nevada, Arizona, California, Idaho, Oregon, and Washington. Its range is severely limited in Arizona and Nevada, and in Idaho populations are limited to the middle Snake River. Within California, the species is known to survive only in the Fall and Pit Rivers in northern California. In Washington, the species has recently been found near The Dalles on the Columbia River and occurs in the Okanagon River, as well as Roosevelt and Curlew Lakes (Frest and Johannes 1995, Natureserve 2005).

HABITAT USE

The California floater is a freshwater bivalve that resides in lakes and large, low elevation rivers with slow to moderate current and cold, well oxygenated water. It is generally found on soft substrates such as sand or mud that it can burrow into. As with other freshwater mussels, this species is intolerant of habitats with shifting substrates, excessive water flow fluctuations, or seasonal hypoxia. California floaters may tolerate some water pollution, they seem to be averse to intense nutrient enrichment (Frest and Johannes 1995). This species are filter feeders that sieve the water column for bacteria, detritus, and plankton for nourishment. Adults may live to be over 100 years in age, with females reaching maturity at 12 years of age (Pacificbio 2005).

Although specific information on the life cycle of this species is lacking, it is generally accepted that its reproductive biology is similar to other freshwater mussels. Reproductive timing is also likely similar with spawning occurring annually in the spring

and triggered by day length and/or water temperatures (Watters and O'Dee 1998). During reproduction, females siphon sperm from the water column while filter feeding in order to fertilize the eggs internally. Females may extrude several million parasitic larvae from brood chambers found in their gills each year (Pacificbio 2005). After release, the larvae drift through the water until reaching a host to parasitize. Hosts are almost always fish but some species of freshwater mussels have been observed to utilize amphibian hosts, which may also be true of California floaters (Natureserve 2005). Fish that are commonly parasitized include those of the genus *Gila* that include freshwater minnows, mosquito fish (*Gambusia affinus*), and dace (*Rhinichthys* spp.) (Pacific Biodiversity Institute 2005). Larvae most commonly attach to the gills as the fish takes in water for respiration, but larvae of some freshwater mussel species also attach to the host's fins (Natureserve 2005). Post larval mussels "hatch" from cysts as free living juveniles to settle and bury in the substrate for continued growth once development is complete. Dispersal and colonization is entirely dependent on larval transport in the water column either by currents or fish host movement. Since juvenile mussels are sedentary, suitable substrate is critical to survival after settlement. Low turbidity and the ability of juveniles to embed in the substrate determine suitability.

POPULATION TRENDS

It has been suggested that California floaters have been extirpated from most of its historic range, which may have been from southern British Columbia to Baja California reaching as far east as Wyoming, and eastern Arizona (Taylor 1981, Henderson 1929, Natureserve 2005). In the Pacific Northwest, surveys conducted between 1988 and 1990 by Frest and Johannes (1995) found no living individuals throughout the Willamette and lower Columbia River. The species is considered to be extinct in Utah and throughout the Sacramento River system in California. In 1995, Frest and Johannes stated that the species "...is clearly declining in numbers and in area occupied throughout its range."

THREATS WARRANTING ESA PROTECTION

Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

As filter feeders, California floaters are particularly sensitive to nutrient enrichment from nitrogenous pollution. Nutrient inputs from fertilizers found in agricultural, fish hatcheries, and lumber mill runoff can cause eutrophication that can interfere with feeding and respiration of California floaters. Although this species may be more tolerant of pollution than other freshwater species, pesticides, herbicides, and fertilizers from agriculture as well as petrochemicals, salts and heavy metals from stormwater runoff and mining operations can be threats to its survival. Increased suspended solids and sediment load from sand and gravel mining, dikes, and levees may also impede feeding function and smother California floaters. Entrainment and habitat destruction as a result of recreational mining may also impact the species. Significant water flow and temperature changes from water diversions, impoundments, and dam releases can affect populations that require the constant flow of cold water in order to survive. In areas where water levels drop due to diversions, it is possible that thermal buffering may be lost entirely enabling lethal temperatures to occur (Watters 1999). Furthermore, because this species depends on a host for reproduction and dispersal, any decline in fish populations that are

used as hosts may lead to a decline in population size or a decrease in range (Frest and Johannes 1995, Natureserve 2005). Impoundments, water diversions, and other fish passage barriers may also present dispersal barriers for the California floater and preclude exchange of genetic material amongst isolated populations.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

There is no known commercial, recreational, scientific, or educational use for California floaters.

Disease or Predation

Neither disease nor predation is currently known to be a threat to this species. However, because it occurs in low densities within isolated populations, there may be limited opportunities for the reproductive replenishment that is needed after significant disease or other events that may cause mass mortality. Population growth may decline at low densities due to the inability to find mates; which may place isolated populations at further risk of extirpation.

Adequacy of Existing Regulatory Mechanisms

California floaters may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and degradation. Specifically, the regulation of contaminants, water quality, and water flow alteration is of particular concern to this species.

Other Natural or Manmade Factors Affecting Continued Existence

Temperature changes that arise from increased levels of global carbon dioxide may significantly alter reproduction timing in California floaters due to the possible utilization of water temperature cues for larval release. Additionally, periodic drought events may increase mortality by exposing juvenile mussels deposited earlier in the year through the dewatering of channel areas.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

California floaters are likely to be affected by activities authorized on state-owned aquatic lands. Both outfalls and discharges associated with aquaculture may cause localized reductions in sediment and water quality resulting in increased turbidity, eutrophication, and decreased habitat quality. Roadways, bridges, and docks may result in increased sedimentation and habitat loss during construction, while stormwater runoff from the structures may increase concentrations of heavy metals, salts and petroleum products in both the sediments and water column. Turbulence from watercraft frequenting marinas and docks may increase the suspension of bottom sediments, thereby impeding mussel feeding and respiration (Watters 1999). Upstream activities, such as recreational mining, commercial sand and gravel mining and dredging, may also result in fluctuations of sediment delivery, which may or may not be detrimental to the habitat utilization by California floaters.

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3-4.3 Lynn's clubtail (*Gomphus (Gomphurus) lynnae)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife	Species of Concern
Washington State	Not Listed
Natural Heritage Program	G2; S1

RANGE

Lynn's clubtail is currently known to occur in a few small areas within Washington and Oregon. Within the State of Washington, this dragonfly has only been observed in a reach of the Yakima River that is approximately 32 kilometers in length and entirely in Benton County. In Oregon, it is thought to occur in a 24 kilometer reach of the North Fork of the John Day River and in one location on the Owyhee River (Paulson 1983; Natureserve 2005). Although the species has only been observed in these locations, comprehensive surveys have yet to be conducted and it is likely to exist elsewhere in similar habitats (Paulson, Personal communication. March 8, 2005).

HABITAT USE

Little information exists concerning the life cycle of Lynn's clubtail, yet habitat usage has been assumed to be similar to that of the plains clubtail (*Gomphus externus*) (Paulson 1983). Reproduction is thought to occur from early June to mid July when females broadcast eggs in low gradient valleys of medium sized rivers. Upon settling, immature nymphs burrow into sediments to feed as lie-and-wait predators feeding on tadpoles, other aquatic invertebrates, and larval fish using specialized, elongated mouthparts (Pacific Biodiversity Institute 2005). Nymphs overwinter in sand, mud, or silt substrate and once mature, crawl along the bottom to the stream bank to emerge as adults (Natureserve 2005). Unlike many aquatic insects, Lynn's clubtail adults are active predators feeding along stream bank vegetation by catching insects from the air. On the Yakima River, adults have been observed near "...dense grass growing from muddy banks..." (Paulson 1983). Information regarding lifespan and age at maturity is lacking for this species.

POPULATION TRENDS

Insufficient information exists regarding past and current abundance to draw conclusions regarding population trends. Since the known range of Lynn's clubtail is limited to a few small areas it is presumed to be an extremely rare species. Yet because the areas where it has been found are varied, its range and abundance may be larger than currently known (Natureserve 2005).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Since information regarding habitat use and behavior is lacking, it is difficult to assess possible threats to the habitat or range of this species. Any practice that degrades riparian vegetation may be harmful due to its reliance upon terrestrial insects that inhabit riparian vegetation for food.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

There is no known commercial, recreational, scientific, or educational use for Lynn's clubtail.

Disease or Predation

Disease and predation are not known to be specific threats. However, because this dragonfly occurs in low densities within isolated populations, there may be limited opportunities to rebuild populations after significant disease or other events that may cause mass mortality due to both genetic isolation and the inability to find mates.

Adequacy of Existing Regulatory Mechanisms

Lynn's clubtail may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and modification from agricultural inputs, stormwater runoff and clearing of riparian areas.

Other Natural or Manmade Factors Affecting Continued Existence

In addition to loss of habitat due to fill and bank armoring, competition from mosquitofish for small aquatic invertebrates as prey may pose a threat to Lynn's clubtail during its larval stage (Pacific Biodiversity Institute 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Lynn's clubtail is likely to be affected by activities authorized on state-owned aquatic lands. Levee construction, fill and bank armoring will decrease habitat by removing streambank vegetation utilized for foraging and eliminating spawning and larval habitat. In addition, roads and bridges may result in increased pollution associated with stormwater runoff, thereby decreasing riparian vegetation and increasing larval mortality.

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3-4.4 Masked duskysnail and Washington duskysnail (*Lyogyrus* sp. 2, *Amnicola* sp. 2)

For the purposes of this paper, the Washington duskysnail (*Amnicola* sp. 2) and masked duskysnail (*Lyogyrus* sp. 2) will be treated as a guild. These species share common life history traits, similar habitats and global distributions allowing them to be treated together. Although neither species is currently described taxonomically, it has been suggested that *Lyogyrus* be considered a subgenus of *Amnicola* due to slight morphological differences between the two species.

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Not Listed
Natural Heritage Program	G2; S1

Entity	Status/Rank
Masked Duskysnail	G1, G2; S1
Washington duskysnail	G1; S1

RANGE

Frest and Johannes (1995) report that Washington duskysnails in northern Washington were "…once common in kettle lakes..." east of the Cascades, reaching into northern Idaho and northwest Montana. Masked duskysnails may also been common in lakes between the Cascade and Rocky Mountains in the northern portions of Washington, Idaho and Montana. Frest and Johannes (1995) speculate that the species may have occurred in Pend d'Oreille, Stevens, Ferry, Okanogan and Chelan counties in Washington State.

Currently, the Washington duskysnail occurs in Washington and Montana, whereas the masked duskysnail is known to reside only in Washington. In Washington, the species distributions overlap, and they are known to occur in two large kettle lakes east of the Cascades- Curlew Lake in Ferry County and Fish Lake in Wenatchee National Forest (Frest and Johannes 1995).

HABITAT USE

Washington and masked duskysnails are found on soft bottom substrates in well oxygenated lake environments and are considered to be pelophiles (mud specialists). Washington duskysnails have been observed at depths of between 0.6 and 1.8 meters. Both species occur in areas with aquatic vegetation, grazing on periphyton (plants or animals that cling to leaves and stems of aquatic plants) and decomposing plant material. Neither species has been found in anoxic areas or zones of dense vegetation (Frest and Johannes 1995; Natureserve 2005).

Although life history information is sparse for both species, their reproductive cycles are probably similar to other Hydrobiid snails with individuals having a life span of 1 year. Hydrobiid snails breed only once before dying, with females laying eggs in the spring and incubation lasting 2 to 4 weeks.

POPULATION TRENDS

The limited success of recent surveys for both species in kettle lakes east of the Cascades indicates declining populations as well as declining numbers of individuals (Frest and Johannes 1995). Both species are considered to be rare and locally endemic.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Increases in nutrient levels from fertilizers used in agriculture, hatchery waste, fecal matter from livestock and lumber mill may decrease foraging opportunities by creating dense mats of filamentous algae on important food resources. In addition, pesticides, herbicides and petroleum products in stormwater runoff or chemicals used to control aquatic vegetation may also harm both species by eliminating or altering habitat and decreasing foraging opportunities. Armoring and filling of suitable shoreline habitat,

along with increases in sedimentation from loss of riparian habitat may also have significantly reduced the range of Washington and masked duskysnails

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for Washington or masked duskysnails.

Disease or Predation

Natural predators of these species may include turtles, amphibians, sculpin, and trout, however neither disease nor predation have been documented as reasons for the decline of either species. Because both species occur in low densities within isolated populations, there may be limited opportunities to rebuild populations after significant disease or other events that may cause mass mortality due to both genetic isolation and the inability to find mates.

Adequacy of Existing Regulatory Mechanisms

Washington or masked duskysnails may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and modification due to water and sediment quality degradation

Other Factors Affecting Continued Existence

Both species can be infected by trematode parasites, which may impede physiological processes and harm hydrobiid snail populations. No other natural or manmade factors are currently known to affect the existence of either species.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Both Washington and masked duskysnails are likely to be affected by activities authorized by Washington DNR. Roadways, bridges, and docks may result in increased sedimentation and habitat loss during construction, while stormwater runoff from the structures may increase temperatures as well as concentrations of heavy metals, salts, and petroleum products in both the sediments and water column. In addition, shading from overwater structures, filling and/or bulkheading shorelines and chemical management of aquatic vegetation will continue to limit or remove habitat for both species.

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3-4.5 Nerite rams-horn (*Vorticiflex neritoides)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Not Listed
Natural Heritage Program	G1Q; S?

RANGE

The nerite rams-horn is a freshwater snail, which can be found in Washington and Oregon. Although a 1988 survey (Frest and Johannes 1995) documented the species on the Washington side of the lower Columbia River, researchers are unaware of surveys that have documented nerite rams-horn elsewhere in the state. Museum records indicate that the historic range of nerite rams-horn extended from The Dalles to the mouth of The Columbia River

HABITAT USE

The life history and ecology of the nerite rams-horn is largely unknown. The species has been observed in low-elevation streams, with moderate flows and well-oxygenated waters. Streams where the species occurs are associated with low gradient valleys and riffle-pool environments, with the snail found on stable, rocky substrates (Frest and Johannes 1995). Similarly to other freshwater gastropods, nerite rams-horn may graze on the algal and microbial film found on the surface of stones (Frest and Johannes 1995). Morphologically, nerite rams-horn are small relative to other snail species, having fewer whorls on its comparatively thick shell (Frest and Johannes 1995). Insufficient information pertaining to the age of maturity, lifespan, and reproductive timing exists for the nerite rams-horn.

POPULATION TRENDS

Insufficient information exists regarding past and current abundance to draw conclusions regarding population trends, with researchers suggesting that it may be extinct throughout much of its historic range (Frest and Johannes 1995).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

This species is highly dependent on constant flows of cold, well oxygenated waters and is likely at risk due to changes in flow an temperature regimes associated with water withdrawals and diversions; impoundments, and dam releases. Anthropogenic increases in nutrient levels from fertilizers from agriculture, fish hatchery waste, and lumber mill runoff may also negatively affect this species by decreasing dissolved oxygen levels as well as foraging opportunities. In addition to creating filamentous algal blooms that gastropods may not be able to consume, increased nutrient levels also stimulate algal blooms that cover important food resources on stones. Food resources may also be

reduced as a result of stormwater run-off containing pesticides, herbicides, heavy metals and/or petroleum products. The nerite rams-horn may also be at risk due to increased sediment loading upstream of impoundments, as well as downstream of dredging and various forms of in-water mining.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for nerite rams-horn.

Disease or Predation

While neither disease nor predation has been identified as a threat to this species, it occurs in low densities within isolated populations, and may have low reproductive potential after a significant outbreak of disease. In addition, population growth may decline at low densities due both the inability to find mates and low genetic diversity placing isolation populations at risk of extirpation or extinction.

Adequacy of Existing Regulatory Mechanisms

Nerite rams-horn populations may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and modification. Specifically, the regulation of contaminants, sediment load and water flow alteration is of particular concern to this species.

Other Factors Affecting Continued Existence

The New Zealand mud snail (*Potamopyrgus antipodarum*), an introduced exotic species, may pose a threat to nerite rams-horn populations. New Zealand mud snails reproduce rapidly and are found in a wide variety of habitats including the riffle pool environments typical of nerite rams-horn. They have been known to dominate invertebrate biomass (up to 95 percent) in colonized habitats and may out-compete native species such as nerite rams-horn for habitat and food resources (Mountains and Minds 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

If nerite rams-horn populations are present on state-owned aquatic lands, they are likely to be affected by activities authorized by Washington DNR. Roadways, bridges, and docks may result in increased sedimentation and habitat loss during construction, while stormwater runoff from the structures may increase temperatures as well as concentrations of heavy metals, salts and petroleum products in both the sediments and water column. Upstream activities such as dredging, recreational mining, and sand and gravel mining may also result in increased sedimentation and either loss of habitat or direct mortality. Additionally, discharges associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality.

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3-4.6 Newcomb's littorine snail (*Littorina subrotundata)*

This species is also known as *Algamorda newcombiana* and *Algamorda subrotundata*. The American Fisheries Society (Turgeon et al. 1998) stated that *Algamorda newcombiana* is a synonym (i.e., name of lesser standing and taxonomically invalid) of *Littorina subrotundata*. The genus *Algamorda* is a synonym of *Neritrema*, which a subgenus of *Littorina*. Thus, the correct scientific name for this snail is *Littorina subrotundata*.

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife	Species of Concern
Washington State	Candidate Species
Natural Heritage Program	G1, G2; Not Ranked

RANGE

In Washington, Newcomb's littorine snail has been reported in Neah Bay, Mukkaw Bay, Grays Harbor, and Willapa Bay with its current known distribution limited to Grays Harbor and Willapa Bay (Larsen et al. 1995; Kozloff 1983). This species also occurs in Coos and Siletz Bays in Oregon, as well as Humboldt Bay in California.

HABITAT USE

Newcomb's littorine snail uses the nearshore ecosystem, coastal waters, and unconsolidated habitat. This snail inhabits the narrow strip of land where glasswort (*Salicornia virginica*) occurs in coastal estuarine wetlands (Larsen et al. 1995), living on the stems of *Salicornia* and possibly some other marsh plants. It also lives on the substrate beneath vegetation. Information regarding age at maturity, lifespan, and reproductive habitat use and timing is not available.

POPULATION TRENDS

The current population status of Newcomb's littorine snail is uncertain. While no information on past or present population numbers is available, in 1977 the U.S. Fish and Wildlife stated that although the species had been reported in Willapa and Neah Bays, it

was no longer found there. Larsen et al. (1995) indicated that Newcomb's littorine snail was present in Willapa Bay, however the document did not cite any references that provided population surveys. In addition, this species may be confused during biological resource surveys with the similar species *Littorina scutulata*, adding to the inaccuracy of current population estimates.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Larsen et al. (1995) stated that estuarine habitat loss and pollution are the greatest threats to the Newcomb's littorine snail. In addition to population and habitat infringement associated with salt marsh development, the species could be significantly impacted by habitat loss from destruction or modification of tidelands and tidal wetlands.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There is no known commercial, recreational, scientific or educational use for Newcomb's littorine snails.

Disease or Predation

While there is no information available on predators or diseases for Newcomb's littorine snail, geographically isolated populations may be susceptible to disease or predation.

Adequacy of Existing Regulatory Mechanisms

Newcomb's littorine snail may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and modification. Specifically, the regulation of contaminants, sediment load and habitat modification is of particular concern to these species.

Other Factors Affecting Continued Existence

Larsen et al. (1995) stated that estuarine habitat loss and pollution are the greatest threats to the Newcomb's littorine snail. Populations and habitats may be destroyed as salt marsh habitat is used as dumps for fill, spoils, or waste. In 1977, a notice of review from US Fish and Wildlife concluded that "... in Grays Harbor, Washington, it is potentially threatened by oil spill, pulp mill waste, and municipal waste." Impacts associated with discharges and spills are likely to effect water and sediment quality in this snail's habitat. In addition, existing areas of the snails preferred habitat *Salicornia*, are being invaded and in some cases replaced by the invasive cordgrass *Spartina* (Larsen et al 1995).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

A variety of intertidal activities authorized by Washington DNR could affect Newcomb's littorine snail, including modifications such as shoreline armoring, fill, and dredging that removes or degrades existing habitat or individuals. Shoreline residential development is a major threat to existing habitat. Roadways, bridges, and docks may result in increased sedimentation and habitat loss during construction, while stormwater runoff from the

structures may increase temperatures as well as concentrations of heavy metals, salts and petroleum products in both the sediments and water column. Upstream activities such as dredging, recreational mining, and sand and gravel mining may also result in increased sedimentation and either loss of habitat or direct mortality. Additionally, discharges associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality. While the species benefits from *Spartina* control, the chemical management of aquatic vegetation may continue to limit or remove habitat for this species.

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3-4.7 Olympia oyster (*Ostrea conchaphila)*

The Olympia oyster was formerly known as *Ostrea lurida*. This name was synonomized[2] with *O. conchaphila* in 1997 (Gillespie 1999). The American Fisheries Society (Turgeon et al. 1998) lists this oyster as the "Olympia oyster," *O. conchaphila*. The term "native Pacific oyster" is also commonly used (West 1997). Additionally, this species is also known as the California oyster (Rehder 1981) and historically as the "Native Western

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Candidate Species
Natural Heritage Program	Not Ranked

RANGE

[2] A taxonomic synonym is a published name that is invalid for any one of a several different reasons.

The Olympia oyster ranges from Southeast Alaska to Baja California (West 1997, Couch and Hassler 1989). In Washington, the Olympia oyster is found throughout the inland waters of Puget Sound, as well as in Willapa Bay and possibly Grays Harbor (Baker 1995; Steele 1957). However, Baker found no records of the Olympia oyster from Grays Harbor and concluded that it is uncommon there. Past and present commercial quantities have been reported in Bellingham, Quilcene, and Samish bays in North Puget Sound, Discovery Bay, Hood Canal, and throughout South Puget Sound and Willapa Bay. The greatest population density is in the north end of Case Inlet (Rogers, Personal communication. January 3, 2005).

HABITAT USE

Adult Olympia oysters use the nearshore ecosystem in inland waters and unconsolidated habitats in the form of mixed substrates with solid attachment surfaces. They are usually found along the lower intertidal line from 0.3 meters above mean lower low water (MLLW) (zero tide level) to 0.6 meters below MLLW (West 1997) and in tidal channels above a maximum depth of 10 meters below MLLW. Olympia oysters prefer shallow subtidal areas or large tide pools (Baker 1995; West 1997) and can form loose reefs in soft mud or on consolidated bedrock, with both individuals and clusters common on rocks in Puget Sound (Baker 1995). Olympia oysters have been observed at depths of up to 71 meters (Hertlein 1973).

While this oyster tolerates a wide range of salinities, they are most common from 22 to 28 parts per thousand (Baker 1995; Baker et al. 1999). The species northern distribution is limited both by its intolerance of freezing and a reproductive temperature requirement of at least 12.5 degrees Celsius (Baker 1995). Olympia oysters are also intolerant of siltation and grow best on firm substrates with substantial water flow (Couch and Hassler 1989; West 1997).

Olympia oysters are hermaphrodites that initially reproduce as males and then alternate gender between each subsequent spawning cycle. Reproduction begins when water temperatures are between 12.5 and 16 degrees Celsius. Although age at sexual maturity in unknown, males release packets of sperm into the mantle cavity from spring to fall throughout Puget Sound. These sperm packets are released into the water column with contractions of the shell and once in seawater, spermatozoa are released. Female oysters then bring spermatozoa into the mantle cavity in order to fertilize the eggs. Brood size averages 200,000 to 300,000. After 8 to 12 days, larvae develop into free-swimming larvae and are released from the mantle cavity. Larvae are free swimming for two to three weeks (Imai et al. 1954) and settle onto hard substrate such as oyster shells, rocks, wood, metal, and portland cement. Relative to other species, Olympia oysters grow slowly with average shell heights of 40 millimeters after 3 years. Maximum reported size is 75 millimeters (Hertlein, 1959). Maximum age is unknown.

POPULATION TRENDS

In Puget Sound and Willapa Bay, it was reported that native Indians historically gathered oysters as part of their diet. This is substantiated by the numerous shell middens with a large proportion of oysters found throughout Puget Sound. The first pioneers had described the abundance of shellfish, which the Indians harvested to sell to the early white settlers (Swan 1982; Steele 1957).

Commercial harvest records indicate that large beds of Olympia oysters were discovered in Willapa and Samish Bay near Bellingham in 1850. Harvest peaked in 1874 at 250,000 bushels (2,500 individual oysters in each bushel) and although the 1890s effectively depleted the population, harvest continued until 1936.

Culture of the Olympia oyster began in approximately 1900 in Samish Bay using diked impoundments and was initially unsuccessful. However, the species was cultured successfully in South Puget Sound using shallow diked ponds. Aquaculture combined with harvest of wild stocks allowed a sustained yield of approximately 80,000 bushels per year until about 1911 when natural populations were finally depleted. After 1911, the industry in South Puget Sound declined to about one half previous levels, with overall production continuing to decline as pulp mill discharges increased. Production in the Southern Sound stopped completely in the 1950s (Baker 1995) and the Olympia oyster did not regain its commercial significance until the 1980s.

Olympia oysters are not included in Washington Department of Fish and Wildlife (Washington Fish and Wildlife) intertidal shellfish surveys (Blake, personal communication. January 3, 2005) and there are no estimates of the current population densities. However, the species is not currently in danger of extinction due to its present widespread distribution, as well as on-going culture and restoration efforts (Blake, Personal communication. January 3, 2005)

THREATS WARRANTING ESA PROTECTION

Protection under the Endangered Species act for the Olympia oyster does not appear warranted at this time as indicated by the population trends described in the previous section. However, the oyster is vulnerable to the following threats:

Destruction, Modification, or Curtailment of Habitat or Range

Olympia oyster populations could be impacted from uses in intertidal and shallow subtidal marine waters. This includes uses that displace essential oyster habitat or create unsuitable conditions for oyster growth and survival. In addition, wastewater discharges containing elevated levels of sulfites and other toxic compounds (e.g. pulp mill and other industrial discharges) may threaten oyster populations by decreasing water quality and impacting gametes and larvae.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Washington Department of Fish and Wildlife regulations protect the Olympia oyster from over harvesting. In addition, extensive aquaculture and restoration efforts will aid in the protection of the species. There is no known recreational, scientific or educational use for Olympia oysters.

Disease or Predation

Native predators of Olympia oysters include starfish and ducks (Steele 1957), which present substantial impacts. Other animals impacting the growth and survival of Olympia oysters include burrowing shrimp (*Neotrypaea californiensis* and *Upogebia pugettensis*) and slipper shells (*Crepidula fornicata*). Burrowing shrimp create burrows, bringing

sediment to the surface and depositing it on oyster beds, which suffocates oysters. Slipper shells, which were accidentally introduced with eastern oysters, are filter feeders that could compete with Olympia oysters for food. Additionally, Olympia oyster populations are threatened by depredation from the following introduced predators: 1) Japanese oyster drill (*Ceratostoma inornatum*); 2) Flatworm (*Pseudostylochus ostreophagus*); 3) Eastern oyster drill (*Urosalpinx cinera*) (Blake 1995); and 4) European green crab (*Carcinus maenas*) (Washington Fish and Wildlife January 8, 2005).

Adequacy of Existing Regulatory Mechanisms

Current regulatory support for Olympia oyster culture and restoration appear adequate to protect this species.

Other Factors Affecting Continued Existence

Olympia oysters are subject to decreasing genetic diversity due to restoration and commercial efforts using a small number of stocks (Rogers, Personal communication. January 3, 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Olympia oyster populations and their habitat may be vulnerable to a number of nearshore activities authorized by Washington DNR including loss of habitat due to shoreline armoring, over water structures and dredging. In addition, wastewater and stormwater outfalls could affect water and sediment quality and in turn impact Olympia oyster gametes, larvae and habitat.

It should be noted that the culture of Olympia oysters modifies intertidal habitats and that these changes may affect other Species of Concern or listed and Candidate Species.

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3-4.8 Pinto abalone (*Haliotis kamtschatkana)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Species of Concern
Washington State	Candidate Species
Natural Heritage Program	None

RANGE

The pinto abalone occurs from Point Conception in California to Sitka, Alaska (National Oceanic and Atmospheric Administration [NOAA] Fisheries 2004). In Washington, the species is limited to the Strait of Juan de Fuca and the San Juan Island Archipelago (Gardner 1981; West 1997; Rothaus, Personal communication. December 21, 2004). Insufficient information exists to assess the historic range of the pinto abalone.

HABITAT USE

Pinto abalone typically use the nearshore ecosystem in inland waters and consolidated habitats consisting of bedrock, boulders, or a combination of these from extreme low tide to approximately 30 meters below mean lower low water (MLLW) (NOAA Fisheries 2004). In British Columbia, pinto abalone are found in greatest abundance between the lower subtidal down to 10 meters in depth yet individuals have been recorded as deep as 100 meters in the northern end of their range (Species at Risk 2005). The species is usually associated with kelp beds (*Nereocystis luetkeana*) and prefers habitats with swift currents and/or moderate wave action and constant temperatures (Gardner 1981; Rothaus, Personal communication. December 21, 2004).

Pinto abalone are broadcast spawners releasing pelagic gametes that develop into free swimming larvae. These larvae use nearshore and offshore water column habitat. Mature larvae settle on crustose corralline algae, which is considered as critical to abalone reproductive success (Roberts 2001; Rothaus, Personal communication. December 21, 2004).

POPULATION TRENDS

Pinto abalone has shown a 60 to 90 percent reduction in adults since 1978 (NOAA Fisheries 2004), with the decline further documented by Washington Fish and Wildlife survey and monitoring results. In 1979 to 1981, the Washington Department of Fisheries conducted baseline surveys of pinto abalone abundance at 29 locations throughout the San Juan Island Archipelago (San Juans) (Rothaus, Personal communication. December 21, 2004). When these sites were again examined in 1990, pinto abalone had disappeared from 9 of 23 sites and decreased at 9 others. Continued monitoring in 1992 through 1994 at 10 index sites throughout the San Juans showed a continued decline. Because of this decline, Washington Fish and Wildlife closed the sport fishery for pinto abalone in August 1994 (Rothaus, Personal communication. December 21, 2004).

While the species appeared to stabilize from 1994 to 1996 with only a slight decline at the index stations, monitoring in 2003 found a 50 percent decline in abalone abundance at the same stations. The populations in the western part of the San Juans were apparently stable with relatively normal size distributions. In contrast, populations in the eastern San Juans showed a significant decrease in population numbers with abalone less than 95 millimeters in length completely absent (Rothaus, Personal communication. December 21, 2004). In addition, populations at 9 of the 10 index stations were below the densities known to be critical for successful fertilization in other gastropod species (NOAA Fisheries 2004; Rothaus, Personal communication. December 21, 2004).

THREATS WARRANTING ESA PROTECTION

According to Washington Fish and Wildlife (Rothaus, Personal communication. December 21, 2004), it is likely that a petition to list the pinto abalone as Threatened or Endangered with U.S. Fish and Wildlife Service will be submitted in the future. The primary threat to the pinto abalone is poaching (West 1997).

Destruction, Modification, or Curtailment of Habitat or Range

Excessive siltation, especially in the eastern San Juans may be interfering with adult and juvenile feeding and larval settlement (NOAA Fisheries 2004; Rothaus, Personal communication. December 21, 2004). This sediment may be originating from nearby rivers such as the Nooksack and Skagit. Impacts to kelp beds may impact growth and survival. Use of state-owned aquatic lands that impact bull kelp (*Neoreocystis leuteana*) and giant kelp (*Macrocystis integrifola*) beds may impact pinto abalone resources.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

The pinto abalone is particularly vulnerable and significantly affected by poaching from commercial sea urchin harvesters (Rothaus, Personal communication. December 21, 2004). In addition, continued illegal harvest by sport divers is a serious problem (West 1997; NOAA Fisheries 2004; Rothaus, Personal communication. December 21, 2004). There is no known scientific or educational use for pinto abalone.

Disease or Predation

Juvenile abalone have a variety of predators, while the adults have relatively few. These include the octopus (*Octopus dofleini*), sunflower star (*Picnopodia helianthoides*), wolf eel (*Anarricthys ocellantus*). In addition, pinto abalone populations are threatened by predation from sea otters (*Enhydra lutris kenyoni*), which is listed as Threatened under the U.S. Endangered Species Act (NOAA Fisheries 2004; Rothaus, Personal communication. December 21, 2004). Sea otter predation could exacerbate illegal harvesting by sport and commercial fishers. Additionally, *Labryinthuloides haliotidis* is a protozoan parasite that is lethal to animals under 6 months of age and infects the head and foot tissues. This parasite has only been observed in the hatchery and nursery settings (NOAA Fisheries 2004).

Adequacy of Existing Regulatory Mechanisms

Washington State law prohibits taking of abalone for commercial or recreational purposes. However, inadequate enforcement allows poaching to be a continuing problem.

Other Factors Affecting Continued Existence

No other natural or manmade factors are known to affect the continued existence of the pinto abalone.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Pinto abalone populations and their habitat may be vulnerable to activities authorized by Washington DNR that affect consolidated habitats and water quality in the nearshore ecosystem, especially the intertidal zone. These activities include shoreline armoring, over water structures that shade the associated habitat and inhibit growth of macroalgae. In addition, dredging and dredged material disposal, storm water discharge, and upland

activities including logging and road building, could exacerbate siltation impacting intertidal and shallow subtidal vegetation critical for juvenile settlement.

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3-4.9 Shortface lanx (*Fisherola nuttalli)*

Common Name(s): Shortface lanx, giant Columbia River limpet, and great Columbia River limpet

STATUS AND RANK

Entity	Status/Rank
Federal Gvernment	Not Listed
Washington State	Candidate Species
Natural Heritage Program	G2; S2?

RANGE

Although the shortface lanx formerly occurred throughout the rivers and streams of the Columbia River Basin, its present range is largely unknown. Within the State of Washington, a survey completed in 1988 by Neitzel and Frest (1990) found Columbia River limpets in the Columbia, Okanagon, Wenatchee, and Methow rivers. Neitzel and Frest (1989) suggest that the species may also occur in rivers with similar characteristics to those with documented populations such as the Sanspoil, Klickitat, Grande Ronde, Spokane, and lower Snake. However, at this time researchers are unaware of surveys that have documented shortface lanx in these basins.

HABITAT USE

Freshwater gastropods require flowing water with relatively high dissolved oxygen content and utilize habitat in clear, cold streams. Shortface lanx are found in shallow, rocky areas of cobble to boulder substrate and are rarely found on sandy substrate. The species feeds by grazing on algae and small crustaceans attached to rocks and gravel with a flexible, tooth-bearing appendage called a radula. Shortface lanx are typically found in riffle pool, plane bed, and step pool environments that have rocky or gravel substrates in areas of slightly lower current velocities than those preferred by the sympatric (co-occurring) ashy pebblesnail. Due to their habitat requirement of cold flowing water for respiration, they are unable to survive in lakes or impounded waters that are devoid of permanent current flow. It was previously assumed that the species was exclusive to large river habitats, but recent surveys indicate that they may be present in smaller streams of less than 30 meters in width (Neitzel and Frest 1990).

POPULATION TRENDS

Insufficient information exists regarding past and current abundance to draw conclusions regarding population trends. As previously noted, shortface lanx habitat overlaps with that of the ashy pebblesnail and it is possible that their combined range may have once encompassed the entire Columbia River basin (Pacific Biodiversity Institute 2005). While early surveys for both species were geographically limited to the Hanford Reach in the Columbia River, more recent collecting efforts have determined that both gastropods occur in places outside the Hanford Reach (Neitzel and Frest 1990). In addition, it is likely that habitat degradation and loss caused by impoundments has caused the extinction of historic populations in the lower Columbia River.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

This species' dependence on cold, constant water flows makes it vulnerable to changes in water flow and temperature resulting from water diversions, impoundments, and dam releases. Furthermore, because this species is found in shallow depths and requires dissolved oxygen for respiration, reservoirs that are periodically dewatered offer unsuitable habitat for shortface lanx. Eutrophication caused by high nutrient levels in fertilizers, fish hatchery and wastewater discharges, and lumber mill runoff may also negatively affect this species by decreasing foraging opportunities. High nutrient levels

can create dense filamentous algae blooms that limpets may not be able to consume as well as algae blooms that may cover important food resources such as lithophytes (primary producers that grow on rocks). In addition, high sediment loads from recreational mining, sand and gravel mining, or dredging may decrease survival rates by impeding respiration and feeding efficiency. Pesticides, herbicides, heavy metals and hydrocarbons in point and non-point source pollution may also decrease food supplies as well as contaminate habitat.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

There is no known commercial, recreational, scientific, or educational use for shortface lanx.

Disease or Predation

Disease or predation is not currently known to be a threat to shortface lanx; however because they occur in low densities within isolated populations, there may be limited opportunities for the reproductive replenishment that is needed after significant disease or other events that may cause mass mortality. Furthermore, population growth may decline at low densities due to the inability to find mates, which may place isolated populations at further risk of extirpation.

Adequacy of Existing Regulatory Mechanisms

Shortface lanx may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and degradation. Specifically, the regulation of water quality and contaminants as well as alterations to water flow is of particular concern for this species.

Other Factors Affecting Continued Existence

The New Zealand mud snail (*Potamopyrgus antipodarum*), an introduced exotic species, may pose a threat to Columbia River limpets. New Zealand mud snails reproduce rapidly and are found in a wide variety of habitats including the riffle pool environments with rocky substrates typical of shortface lanx. They have been known to dominate invertebrate biomass (up to 95 percent) in colonized habitats and may out-compete native species such as the shortface lanx for habitat and food resources (Mountains and Minds 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Shortface lanx are likely to be affected by activities authorized by Washington DNR within riverine environments. Roadways, bridges, and docks may result in increased sedimentation and habitat loss during construction, while stormwater runoff from the structures may increase temperatures as well as concentrations of heavy metals, salts, and petroleum products in both the sediments and water column. Upstream activities such as dredging, recreational mining and sand and gravel mining may also result in either increased sedimentation or direct habitat loss and mortality. Additionally, discharges associated with wastewater treatment, industrial processes or fish hatcheries may decrease water and sediment quality.

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3-4.10 Western ridged mussel (*Gonidea angulata)*

Common Name(s): Western ridged mussel, western ridge mussel and Rocky Mountain ridged mussel

The western ridged mussels occurs more regularly throughout eastern Washington than western Washington. *Gonidea angulata* is the only known extant species in the genus and there are no closely related species among North American freshwater mussels.

STATUS AND RANK

Entity	Status/Rank
Federal Gvernment	Not Listed
Washington State	Not Listed
Natural Heritage Program	G3; S2

RANGE

The western ridged mussel currently occurs throughout Washington, Oregon, Idaho, Nevada, California and southern British Columbia, with the species northern population limit thought to be defined by the Columbia River system in British Columbia. The species may have historically occurred as far south as the Central Valley in California (Natureserve 2005), but its current southern limit is unknown (Taylor 1981). Populations in Washington are documented to occur west of the Cascades and sporadically in the Willapa Hills.

HABITAT USE

Western ridged mussels are freshwater mollusks and reside on substrates ranging from dense mud to coarse gravel in creeks, streams and rivers; it is rarely found in lakes or reservoirs. As with all filter feeders, constant water flow is critical, therefore, Western ridged mussels are found in a variety of flow regimes ranging from slow moving water in

backwater pools to fast flowing streams. In a study done in the Salmon River Canyon in Idaho by Vannote and Minshall (1982), dense beds of western ridged mussels were found co-occurring with freshwater pearl mussels (*Margaretafera falcatus*) in "...cobble and boulder ramp-like runs connecting deep pools to riffles or rapids...". The authors also suggest that the species may be densely distributed in these areas due to high delivery rates of food (fine particulate matter), along with protection from scour and periodic sedimentation (Vannote and Minshall 1982).

Western ridged mussels are usually found in water less than 3 meters in depth and although they are often partially buried in fine substrates, they typically reside in stable habitats without shifting substrates, excessive water flow fluctuations, or seasonal hypoxia (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2003). While the species may tolerate seasonal turbidity, it is absent from areas with continuous turbidity (i.e. glacial streams) and is not usually found in areas with high nutrient content (COSEWIC 2003).

When co-occurring with freshwater pearl mussels, western ridged mussels dominate streams with high levels of sedimentation or sand.

Although the western ridged mussel has a distinct siphon and a wedge-shaped shell that assists in movement through fine substrate (Vannote and Minshall 1982), they are primarily sessile, displaying movement only when re-burying themselves after disturbance (COSEWIC 2003). The species orients with their posterior end directed upstream and as a result, is dependent on the presence of oxygenated water in interstitial spaces.

It is believed that western ridged mussels live between 20 and 30 years, with females reaching sexual maturity at approximately 10 years of age (COSEWIC 2003). Adult shell size is approximately 12.5 centimeters in length, 6.5 centimeters in height and 4.0 centimeters in width with the shell having a "moderately heavy" hinge, obscure hinge teeth, and a distinctive posterior ridge (COSEWIC 2003, Henderson 1929).

Although specific information on the life cycle of this species is lacking, it is generally accepted that its reproductive biology is similar to other freshwater mussels. Western ridged mussels are thought to be annual spawners (COSEWIC 2003), with reproduction triggered by day length and/or water temperatures (Watters and O'Dee 1998). During reproduction, females siphon sperm from the water column while filter feeding in order to fertilize the eggs internally. Incubation periods are thought to be similar to freshwater pearl mussels, lasting from one to four months with females extruding the developing larvae from brood chambers in their gills during spring and early summer (COSEWIC 2003).

After release, larvae drift for a few days in search of a host to parasitize. Larvae generally attach to the gills of fish, although some species of freshwater mussels also attach to fish fins or amphibians (Natureserve 2005). The larvae remain attached for one to six weeks while growing to nearly 600 times its size at attachment (COSEWIC 2003). Post larval mussels "hatch" from cysts as free living juveniles to settle and bury in the substrate for continued growth once development is complete. Dispersal and colonization is entirely dependent on larval transport in the water column either by currents or fish host movement. Since juvenile mussels are sedentary, suitable substrate

is critical to survival after settlement. Low turbidity and the ability of juveniles to embed in the substrate determine suitability.

POPULATION TRENDS

Western ridged mussel populations are declining throughout their range and there have been indications that the species is no longer found in streams where it previously existed. A survey conducted on the west coast of North America between 1998 and 2001 found that, although the species could be locally abundant, it was found to have a spotty distribution overall (COSEWIC 2003). Where locally abundant, it is known to have populations in the tens of thousands.

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

As filter feeders, western ridged mussels are particularly sensitive to chemicals associated with agriculture (i.e. pesticides, herbicides), as well as transition elements and heavy metals from stormwater runoff and mining operations. In addition, nutrient inputs from fertilizers, hatcheries and lumber mills may lead to anthropogenic eutrophication and decreased oxygen levels. Increased suspended solids and sedimentation as a result of sand and gravel mining, dikes and levees may also impede feeding function and smother western ridged mussels. Entrainment and habitat destruction as a result of recreational mining may also impact the species. Significant water flow and temperature changes from water diversions, impoundments, and dam releases can affect populations that require the constant flow of cold water in order to survive. In areas where water levels drop due to diversions, it is possible that thermal buffering may be lost entirely enabling lethal temperatures to occur (Watters 1999). Furthermore, because this species depends on a host for reproduction and dispersal, any decline in fish populations that are used as hosts may lead to a decline in population size or a decrease in range (Frest and Johannes 1995, Natureserve 2005). Impoundments, water diversions, and other fish passage barriers may also present dispersal barriers for the western ridged mussels and preclude exchange of genetic material amongst isolated populations.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

There is no known commercial, recreational, scientific or educational use for western ridged mussels.

Disease or Predation

While neither disease nor predation has been identified as a threat to this species, where it occurs in low densities within isolated populations, it may have low reproductive potential after a significant outbreak of disease. In addition, population growth may decline at low densities due both the inability to find mates and low genetic diversity placing isolation populations at risk of extirpation or extinction.

Adequacy of Existing Regulatory Mechanisms

Western ridged mussels may be at risk due to the inadequacy of regulatory mechanisms regarding habitat loss and degradation. Specifically, the regulation of contaminants, water quality, stream flow and habitat alteration is of particular concern to this species.

Other Factors Affecting Continued Existence

In addition to a population decreases associated with a decline in host fish populations (COSEWIC 2003), western ridged mussels are at risk from stream flow temperature changes associated with global warming and decreases in groundwater inputs. Additionally, periodic drought events may increase mortality as a result of channel dewatering and dissection.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Western ridged mussels are likely to be affected by activities authorized by Washington DNR on state-owned aquatic lands. Both outfalls and discharges associated with aquaculture may cause localized reductions in sediment and water quality resulting in increased turbidity, eutrophication, and decreased habitat quality. Roadways, bridges, and docks may result in increased sedimentation and habitat loss during construction, while stormwater runoff from the structures may increase concentrations of heavy metals, salts and petroleum products in both the sediments and water column. Turbulence from watercraft frequenting marinas and docks may increase the suspension of bottom sediments, thereby impeding mussel feeding and respiration (Watters 1999). Upstream activities, such as recreational mining, commercial sand and gravel mining, and dredging, may also result in increased sedimentation and/or the direct loss of organisms and habitat.

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3-5 Marine Mammals

3-5.1 Humpback whale (*Megaptera novaeangliae)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fishereis	Endangered
Washington State	Endangered
Natural Heritage Program	G3; SZN

RANGE

The humpback whale is distributed worldwide and frequently occurs in coastal waters (Wynne 1997; Clapham et al. 1999). Calambokidis et al. (2001) asserts that based on wintering populations in Japan, Hawaii and Mexico there are at least three distinct subpopulations in the North Pacific and that humpback management would be better served by considering six subpopulations derived by subdividing the Japan and Mexico wintering areas. Eight feeding areas are identified, all of which are located in the northeast Pacific from California to the Aleutian Islands (Calambokidis et al. 2001).

Humpback whales off Washington appear to belong to either an aggregate population that extends southward from Washington to California or one that encompasses northern Washington and southern British Columbia (Calambokidis et al. 2004a, Calambokidis et al. 2004b). While there appears to be little interchange among animals from the various feeding areas, (Calambokidis et al. 2001, Calambokidis et al. 2004b) feeding area boundaries are not clearly defined and the ranges of feeding aggregations may overlap (Calambokidis et al. 2004a).

Humpback whales have primarily been observed off the central and northern reaches of the Washington coast (Calambokidis et al. 2004; Carretta et al. 2004), with a detailed, ship-based study defining the primary area inhabited as near the edge of the continental shelf between 125 and 126 degrees west longitude, more than 20 kilometers off Cape Flattery (Calambokidis et al. 2004). While a few whales were observed closer to shore, they were still likely to be outside Washington State waters.

While humpback whales were once common in Puget Sound and sighted as far south as Henderson Inlet (Scheffer and Slipp 1948), their current populations are generally restricted to the main channels (Osborne, Personal communication. March 15, 2005). Although a few sightings have been made north of the San Juan Islands and in the northern portion of Admiralty Inlet, most sightings occur in Canadian waters between Port Angeles, Washington, and Victoria, British Columbia. The species may have recently become more common in Puget Sound, with six confirmed sightings in San Juan County from 1998 through 2003 (Whale Museum 2005) and additional sightings in 2004 of individuals in the southern Sound documented by Falcone et al. (2005) in 2004.

HABITAT USE

Humpback whales have the most varied diet of any of the baleen whales, feeding on several planktonic crustacean groups (euphausiids, mysids, pelagic amphipods and copepods) and several species of schooling fish (e.g., herring, anchovies, walleye pollock and Atka mackerel) (National Marine Fisheries Service, 1991). Because their prey are small, humpback whales must consume large quantities of individual prey and feeding areas are likely to be associated with oceanographic conditions and topographic features that concentrate plankton into dense aggregations. The primary habitat used off Washington is near the edge of the continental shelf between 125 and 126 degrees west longitude, more than 20 kilometers off Cape Flattery (Calambokidis et al. 2004).

Both males and females of this species reach sexual maturity at about 7 years of age, with females reproducing every 2 to 4 years. Calves are born in the tropics after a one-year gestation period, and although the calves are weaned within 11 months they may stay with their mother of over a year. Humpback whales may reach 17 meters in length, weigh 40,000 kilograms and live at least 50 years (Reeves et al. 2002).

POPULATION TRENDS

Pre-whaling populations of humpbacks planet wide have been estimated at over 100,000, (National Parks Conservation Association 2005), with eastern North Pacific stocks estimated at 15,000 (Carretta et al. 2004). By the time whaling stopped in the mid-1960s, the population had been reduced to about 1,200 (Carretta et al. 2004).

Ship-based surveys and mark-recapture studies both indicate that eastern North Pacific stocks have increased steadily since whaling stopped, with current populations numbering about 6,000 (Calambokidis and Barlow 2004; Carretta et al. 2004). In waters off Washington, the humpback whale population appeared to show a dramatic increase in numbers in 2002 (Calambokidis et al. 2004a), a change that may also have been reflected in the increase in sightings within Puget Sound (Falcone et al. 2005; Whale Museum 2005).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Migratory species like humpbacks may be affected by long term habitat modification from activities such as oil exploration, as well as by short term loss of key resources. However, permanent habitat destruction is generally much less of an issue for large

whales than relatively shorter-term catastrophic events, such as a major oil spill (Clapham et al. 1999).

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Commercial whaling initially focused on the humpback whale because of its affinity for coastal areas (Clapham et al. 1999) and Scheffer and Slipp (1948) report that over 70 percent of the whales processed in Grays Harbor between 1911 and 1925 were humpbacks. By the time commercial harvest stopped in 1965, stocks were so depleted that a ban on taking humpback whales went into effect in 1966 (Carretta et al. 2004). However, humpbacks are still occasionally taken for subsistence off Bequia in the Caribbean (Clapham et al. 1999).

Disease or Predation

There are no known instances of epidemic disease among baleen whales (Clapham et al. 1999). While there are no indications that predation has an important impact on humpback populations, Steiger and Calambokidis (2000) recorded scars that were attributed to unsuccessful predatory attacks by killer whales on the flukes of 30% of the mature humpback females they observed.

Adequacy of Existing Regulatory Mechanisms

The regulatory prohibitions implemented in the 1960s appear to be adequate to keep the impacts from whaling to a minimum. Subsistence whaling on humpback whales should not adversely affect the species (Clapham et al. 1999). Although not regulatory, the implementation of a Take Reduction Plan in 1997 has reduced the potential for humpback whale entanglement in fishing gear from the United States gillnet fishery.

Other Factors Affecting Continued Existence

There are several additional factors that may affect the continued existence of humpback whales, including:

- Increases in the occurrence of harmful algal blooms. A major stranding of 14 humpback whales on Cape Cod was linked to saxitoxin, a poison produced by dinoflagellates associated with red tides, in mackerel that had been eaten by the whales (Geraci et al. 1989).

- Collisions with ships. The occurrence of humpback whales in the proximity of a major shipping lanes such as the Strait of Juan de Fuca, makes them vulnerable to collisions with large vessels, especially container ships (Clapham et al. 1999), and whale mortalities are known to have occurred as a result of such collisions. NOAA Fisheries estimated that between 1997 and 2001, ship strikes accounted for about 0.2 humpback deaths per year (Carretta et al. 2004).

- Entanglement. Baleen whales are subject to becoming entangled in the vast array of fishing gear used by modern fishing fleets. While entanglement does not immediately cause mortality, it can lead to eventual starvation by impairing a whale’s feeding ability (Clapham et al. 1999). From 1997 through 2001, there

were no mortalities to eastern North Pacific humpback whale populations from entanglement with gear from the drift gillnet fishery (Carretta et al. 2004), a decrease that may be related to NOAA Fisheries 1997 Take Reduction Plan.

- Chemical contamination. The potential impacts of contaminants on humpback whales is relatively unclear. A study of 25 live humpback whales in the Gulf of St. Lawrence showed that the main contaminant loads were pesticides (mainly DDT) and PCBs (Metcalfe et al. 2004). No significant differences were detected between the loads carried by juveniles and females; no males were sampled. Importantly, this study documented that contaminant concentrations in young-of-the-year (i.e., unweaned) calves were similar to those in females, emphasizing maternal transfer as a pathway for bioaccumulation of pollutants. A single humpback whale that stranded along the central California coast was found to have accumulated relatively low levels of PCBs and pesticides; much lower than those found in stranded gray whales or sea lions sampled during the same study (Kannan et al. 2004). While it is clear that humpback whales can accumulate organic contaminants, the potential impacts of these compounds on the whales remains unclear.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

The numbers of eastern North Pacific humpback whales that enter waters of the State are relatively small. However, a recent increase in sightings of humpback whales within Puget Sound may indicate that the whales are returning to an area in which they were once relatively common (Falcone et al. 2005) and the potential exists for some activities authorized by Washington DNR to affect this species. Specific affects include alteration of prey habitat from new overwater structures and/or shoreline modifications, injury or changes in habitat use resulting from acoustic harassment devices near aquaculture facilities, and injury due to collisions with vessel traffic associated with marinas and ferry terminals. Although the effects of contaminants and algal blooms is unclear, the potential also exists for waste- and stormwater discharges to affect humpbacks through ingestion of contaminated prey and/or toxic algal compounds

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3-5.2 Northern sea otter (*Enhydra lutris (Enhydra lutris kenyoni))*

Three subspecies have been identified; the southern sea otter, *Enhydra lutris nereis*, the northern (Alaskan) sea otter, *E. l. kenyoni*, and the Asian (northern) sea otter, *E. l. lutris* (Lance et al. 2004). Because the common name "northern" sea otter is used for the Alaskan and Asian sea otters, the subspecies discussed in this paper, *E. l. kenyoni*, will be referred to only as the sea otter.

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Endangered
Natural Heritage Program	G4; S1 (E. lutris); G4, T4; S3? (E. l. kenyoni)

RANGE

The sea otter (*Enhydra lutris*) ranges widely across the rim of the North Pacific, extending from Baja California northward to Alaska and across the Aleutian Islands to Kamchatka and the northern tip of Japan (Richardson and Allen 2000; Reeves et al. 2002). Evidence from early fur trading expeditions indicate that sea otters may have been distributed from the mouth of the Columbia north and into the Strait of Juan de Fuca as far east as Discovery Bay (Lance et al. 2004), however their current range stretches from about Destruction Island northward along the outer coast to Cape Flattery and into the Strait of Juan de Fuca as far east as Pillar Point (Richardson and Allen 2000; Jameson and Jeffries 2001).

HABITAT USE

Sea otters use shallow coastal waters within 1 to 2 kilometers of shore and are generally associated with rocky (consolidated) substrates where kelp is present (Richardson and

Allen 2000; Lance et al. 2004). While generally found in the water, sea otters will occasionally rest on offshore rocks and islands or mainland beaches (Lance et al. 2004). Sea otters feed on the surface, but prey on a variety of benthic invertebrates found in and near kelp beds, including echinoderms (sea urchins, sea cucumbers and sea stars), molluscs (clams, chitons and octopus) and crabs (Richardson and Allen 2000). Most foraging occurs at depths of between 2 and 30 meters, although feeding forays have been documented at depths of 100 meters (Bodkin et al. 2004).

Female sea otters are sexually mature at 4 to 6 years of age, with males maturing at 5 to 6 years of age and reproducing successfully 2 to 3 years later after they have established territories (Lance et al. 2004). Although the species may mate year round, peak mating activity occurs in the fall with about half of sea otter births occurring 6 months later during February, March and April (Lance et al. 2004).

Sea otters may reach a length of 1.5 meters, weigh 45 kilograms and have life spans of 15 to 20 years, with females slightly smaller and longer lived than males (Reeves et al. 2002; Lance et al. 2004).

POPULATION TRENDS

While historic populations of sea others in the North Pacific have been estimated at between 100,000 to 300,000, by the time harvest ceased in 1911 the population had been reduced to fewer than 2,000 animals (Richardson and Allen 2000). Reintroduction and conservation efforts throughout the species range steadily increased the species numbers and in the year 2000 sea otter populations were estimated at over 100,000 (Richardson and Allen 2000). While the southwest Alaska stock has experienced a sharp decline in abundance since 1965 (US Fish and Wildlife 2002a), 2 additional Alaskan stocks, as well as the British Columbia sea otter population have shown increasing population trends (Watson et al. 1997; US Fish and Wildlife 2002b, 2002c).

There are no numeric estimates of pre-harvest sea otter populations in Washington and the species was extirpated from the state shortly after 1911 (Richardson and Allen 2000). During 1969 and 1970, 59 animals were reintroduced off the Olympic Peninsula and although at least 16 of those animals died not long after being released (Lance et al. 2004), populations gradually increased to about 100 animals in 1988 (Richardson and Allen 2000). Population estimates based on surveys conducted in 2003 and 2004 indicated that the sea otter population in Washington has increased to about 672 to 743 individuals (Lance et al. 2004), with the animals range expanding northward (Kvitek et al. 1998; (Laidre et al. 2002).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Sea otters in Washington primarily occupy rocky habitats with kelp (Lance et al. 2004), in a relatively restricted part of the outer coast and the western Strait of Juan de Fuca. As a result, the species is particularly vulnerable to anthropogenic loss of habitat. However, because most of the animal's current range is within federally protected areas, the potential for loss is considered minimal except for losses attributable to catastrophic events.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Commercial harvest of sea otters for their pelts probably began in Washington with the earliest explorers and became so intense that the otter population in the state was extirpated by the early 1900s (Richardson and Allen 2000). While there is currently no legal sea otter hunt in Washington, Native Americans on the Olympic Peninsula historically hunted otters and the right has been reserved in treaties made with the tribes (Richardson and Allen 2000).

Disease or Predation

Although sea otters are preyed on by bald eagles (primarily pups), killer whales and sharks, predation by non-humans is not usually a major threat (Richardson and Allen 2000). However, Alaskan populations of sea otters have seen significant increases in predation by killer whales as a result of a decrease in the abundance of traditional Orca prey items such as sea lions and seals (Estes et al. 1998).

Recently encephalitis attributed to *Sarcocystis neurona*, a protozoan found in the fecal matter of opossums, birds and horses, was discovered in a young male that stranded on Roosevelt Beach (Lindsay et al. 2001). This individual also had toxoplasmosis, which is caused by *Toxoplasma gondii*, a protozoan found in cat feces. In central California, 76 percent of the otters living near sources of heavy freshwater runoff had *Toxoplasma* antibodies (Anonymous 2003) and the disease is thought to be a contributing factor to the population declines in California sea otters. Sea otters most likely become infected by eating clams that filter and retain the protozoan cysts from the water.

Adequacy of Existing Regulatory Mechanisms

Although sea otters are not listed under the Endangered Species Act, they are afforded protection by the Marine Mammals Protection Act and are listed as Endangered by the State of Washington. In addition, the species primary habitat is located within the boundaries of the Olympic Coast National Marine Sanctuary, and much of the shoreline adjacent to these habitats is part of the Olympic National Park. The potential for incidental take by gill-net fisheries has been reduced by a prohibition on the use of gill nets, except those allowed by treaty provisions, within the current sea otter range (Richardson and Allen 2000). However, as the range of the sea otter in Washington expands, the level of take may increase unless the gill-net prohibition is concomitantly extended.

Other Factors Affecting Continued Existence

There are several additional factors that may affect sea otters, including:

- Oil spills associated with the high volume of shipping traffic off the Olympic Peninsula. Catastrophic spills pose a significant risk and may constitute the greatest risk for Washington's sea otters (Gerber et al. 2004). Richardson and Allen (2000) reviewed some of the potential impacts of oil spills on sea otters and found that in addition to oil fouling the otter's dense fur, thereby reducing its insulating ability and causing death from exposure, sublethal exposure to oil could induce chronic pathologies.

- Entanglement in gill nets and other small-mesh fishing gear had significant impacts on sea otters in California (Richardson and Allen 2000) and led to restrictions on the mesh size that could be used in shallow water within the sea otter range. Although all gill nets except those used by Native Americans are prohibited within the range of Washington's sea otters, the likelihood of entanglement may increase as populations expand beyond the Olympic Marine Sanctuary and National Park. Sea otters also may be caught in shrimp and crab traps, although no fatalities in Washington have been reported (Richardson and Allen 2000).

- Resource competition with humans. Sea otters are extremely successful predators and as their range expands it may lead to conflicts with humans over decreases in wild stock sea urchin (of the Class Echinoidea), Dungeness crab (*Cancer magister*) and razor clam (*Siliqua patula*) fisheries (Richardson and Allen 2000), as well as increasing impacts to cultured or enhanced fisheries (Nash et al. 2000).

- Inbreeding. The sea otter population presently occupying Washington waters was derived from the 40 or so otters translocated to the state, leaving the population susceptible to reduced genetic variability and an increased likelihood of an inbreeding depression that could impede the population's survival and expansion (Larson et al. 2002). However, a recent study showed that genetic variability in translocated sea otter populations, including the Washington stock, was not reduced from that occurring in the parent populations and that the small size of the founding Washington population contributed to some genetic divergence from its parent population from Amchitka, Alaska (Larson et al. 2002). Thus, the apparent bottleneck related to translocation was short and not likely to adversely affect reestablishment.

- Illegal shooting, collisions with boats and injuries caused by boat propellers may affect sea otters, but are not yet significant issues for Washington sea otters (Richardson and Allen 2000).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

While the current range of sea otters in Washington makes them unlikely to be affected by activities authorized by Washington DNR, an expansion of their range would increase the likelihood. Potential affects include decreases in kelp habitat from overwater structures, increases in mammal pathogens from storm- and wastewater discharges, and increases in human predation as a result of sea otter predation on aquaculture operations.

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3-5.3 Steller sea lion (*Eumetopias jubatus)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Threatened
Washington State	Threatened
Natural Heritage Program	G3; S2N

RANGE

The Steller sea lion occurs primarily in coastal waters from central California to Hokkaido, Japan (National Marine Fisheries Service 1992; Reeves et al. 2002). Two stocks are recognized within United States waters: a western U.S. Stock that ranges from Cape Suckling in Alaska, west through the Aleutian Islands to the Bering Sea; and an eastern U.S. Stock that ranges from Cape Suckling east and south to central California (Calkins et al. 1999; Angliss and Lodge 2004). Only the eastern stock will be discussed in this paper.

A relatively small population of Steller sea lions occurs in Washington waters and while there are no breeding sites in the state, haulout sites are located along the outer coast from the Columbia River north to Cape Flattery and Tatoosh Island (Jeffries et al. 2000). Steller sea lions also haulout on the Vancouver Island side of the Strait of Juan de Fuca and are occasionally observed on Puget Sound navigation buoys (Jeffries et al. 2000).

HABITAT USE

Steller sea lions use two primary types of shore-based habitats: rookeries and haulout sites. Rookeries are breeding areas that are usually located on isolated sandy beaches, while haulouts are located in rocky areas, beaches, reefs, breakwaters, jetties, navigational devices and docks (National Marine Fisheries Service 1992). Adults generally stay within 500 kilometers of their natal rookery, returning to breed at or near the same site throughout their lives (NOAA Fisheries 2001). Male and female Steller sea

lions may both reach a length of about 3 meters, with males weighing about 1,100 kilograms at maturity and surviving into their mid-teens. Females are considerably smaller (about 350 kilograms), but may reach 30 years of age (NOAA Fisheries 2001; Reeves et al. 2002).

While both males and females reach sexual maturity at about 3 to 8 years, females may not successfully pup until year 4 and males generally lack the size needed to defend breeding territories until they are about 9 years of age (NOAA Fisheries 2001). Females give birth from May to July, with mating occurring 1 to 2 weeks after birth (NOAA Fisheries 2001). Pups are weaned within 11 months and little is known about the behavior or movements of juveniles (NOAA Fisheries 2001). Steller sea lions feed on a wide variety of fish (e.g. sand lance [*Ammodytes hexapterus*], greenling [*Hexagrammos spp, and Oxylebius pictus*], herring [*Clupea pallasii*], smelt, walleye pollock [*Theragra chalcogramma*], salmonids [*Oncorhynchus* spp.]), as well as cephalopods (NOAA Fisheries 2001) and diet varies geographically and seasonally with prey availability (Reeves et al. 2002). While predation by great white sharks (*Carcharodon carcharias*) and killer whales (*Orcinus orca*) occurs, the rate of predation varies geographically and seasonally (NOAA Fisheries 2001).

POPULATION TRENDS

Steller sea lion populations in the United States declined by about 70 to 75 percent from the late 1970s to the late 1990s, with the trend being more severe for the western U.S. stock (Trites and Larkin 1996; Calkins et al. 1999). While the underlying causes of the decline are not well understood, the most plausible explanations appear to be nutritional stress resulting from dramatic changes in prey abundance and/or relative composition; and a sequential shift in the diet of killer whales from other whale species, to small seals, Steller sea lions and sea otters (Benson and Trites 2002; Springer et al. 2003; Trites and Donnelly 2003).

However, the eastern stock considered in this paper, has shown an increasing population trend since 1982 (Trites and Larkin 1996, Calkins et al. 1999, Angliss and Lodge 2004), with numbers increasing from about 15,000 to 22,000 individuals. The Steller sea lion stock assessment is based primarily on animals at rookeries and haulout sites and does not provide separate population trends for the animals occurring in Washington. Trends for the areas adjacent to Washington have been steady (Oregon) or increasing (British Columbia) since 1982 (Angliss and Lodge 2004). Angliss and Lodge (2004) reported 523 Steller sea lions counted in Washington in 1996, although that number was based on the 2001 stock assessment. However, as many as 1,000 individuals may occur in the state during the fall and winter (Jeffries et al. 2000).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Permanent or longer-term habitat destruction is probably a relatively minor issue for Steller sea lions because of the relative remoteness of primary rookeries or haul-outs. However, relatively shorter-term catastrophic events, such as a major oil spill could have severe effects on sea lion populations. Although clear links between oil spills and major

population impacts have not been established, oils spills are still a concern (COSEWIC 2003).

Although Steller sea lions may acclimate to repeated disturbances, rookery and haul-out habitat may be either degraded or curtailed by repeated aircraft over-flights, interruptions by boat traffic and pedestrians, and by fishing activities, (COSEWIC 2003).

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

While small subsistence harvesting is allowed under the Marine Mammal Protection Act, Steller sea lions are not currently subject to threats related to commercial overutilization. There are no known recreational, scientific or educational uses for Steller sea lions.

Disease or Predation

While the overall impacts of diseases on Steller sea lion populations are difficult to evaluate diseases are not currently thought to be a threat to Steller sea lion populations (National Marine Fisheries Service 1992; Trites 2005). However, increases in predation as a result of shifts in shark or killer whale diets could have severe impacts to Steller sea lion populations. Williams et al. (2004) calculated that the 170 mammal-eating killer whales estimated to frequent the Aleutians, could consume up to 40,000 Steller sea lions annually. In addition, while transient killer whales in Puget Sound/Georgia Basin waters feed primarily on harbor seals, they have also been observed taking Steller sea lions (Baird and Dill 1995, Ford et al. 1998).

Adequacy of Existing Regulatory Mechanisms

Existing protections derived from the U.S. Marine Mammal Protection Act, the Endangered Species Act, and commercial fishing regulation appear to be adequate for the protection of Steller sea lion populations in Washington.

Other Factors Affecting Continued Existence

Barron et al. (2003) summarized the literature on tissue contaminant loads in Steller sea lions and reported that butyltins, mercury, PCBs, DDTs, chlordanes and hexachlorobenzene had been identified in the tissues. They also reported that Steller sea lion habitats and prey are contaminated with additional chemicals including pesticides and metals, and that haulouts and rookeries are located near other hazards including radioactivity, solvents, ordnance and chemical weapon dumps. However, no adverse affects have been documented (Barron et al. 2003) and the potential effects of contamination are unknown.

Steller sea lion ranges shift with prey populations and it is likely that they will increasingly encounter and forage in aquaculture operations. As a result they may also be at risk from human predation. British Columbia currently allows sea lions to be killed as part of the Aquaculture Anti-predator Program (Angliss and Lodge 2004), with at least 316 Steller sea lions killed under this program from 1999 to 2000 (COSEWIC 2003).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

The limited numbers and range of Steller sea lions in Washington reduces the likelihood that activities authorized by Washington DNR will adversely impact the species. However, activities such as marinas or transfer terminals may increase the potential for oil spills, while storm- and wastewater discharges may increase the potential for contaminants to affect the species. Aquaculture facilities are not currently found within the primary range of the species in Washington.

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3-6 Plants

3-6.1 Persistentsepal yellowcress (*Rorippa columbiae)*

STATUS AND RANK

Entity	Status/Rank
US Fush and Wildlife	Species of Concern
Washington State	Endangered
Natural Heritage Program	G3; S1, S2

RANGE

Persistentsepal yellowcress is endemic to Washington, Oregon and California. Within this overall range, populations are found in two widely separated regions: the shorelines of the Columbia River in Oregon and Washington, and in an assortment of habitats in south-central Oregon and California. (Washington DNR 2005).

Although the original range of the species was probably considerably larger in Washington than at present, major populations of Persistentsepal yellowcress is currently found in two specific reaches of the Columbia River. The largest population is found within the Hanford Reach in Benton, Franklin and Grant counties, and another significant population occurs in the vicinity of Pierce Island and Pierce National Wildlife Refuge approximately three miles downstream from Bonneville dam (Washington DNR 2005).

HABITAT USE

The species is low-growing, with most stems either laying on the ground surface or rising slightly at the tips. It spreads via underground stems (rhizomes), and is perennial (Sauer and Leder 1985; Habegger et al. 2000; Simmons 2000). Along the Columbia River, the species' habitat consists of gently sloped cobble and graveled, silty shoreline beaches (Simmons 2000). It typically occurs in open areas with little competing vegetation along a thin band as the lowest elevation riparian zone (Washington DNR 2005). Construction of hydroelectric dams along the Columbia River has eliminated most of the species historical habitat (NatureServe 2005). The reservoirs have either permanently inundated the populations sites, or operation of the dams has altered the hydrologic regime. Under the natural hydrologic cycle of the Columbia River, spring floods would scour the portions of the shoreline used by Persistentsepal yellowcress, and remove much of the silt from the gravel or cobble matrix. This flooding and scouring probably also reduced the competitive environment.

In Washington, Persistentsepal yellowcress has been observed only along the Columbia River, but in Oregon and California, it has been found in intermittent streams, permanent and vernal lakes, wet meadows, and ditches. All known populations sites inundated

during at least part of the year. Wet soil throughout the growing season is required for survival and reproduction. Populations have been found in nearly all soil types ranging from clays and sands to gravel and cobbles (Washington DNR 2005).

POPULATION TRENDS

In the mid 1980's it was suggested that persistentsepal yellowcress was abundant in Washington (Sauer and Leder 1985). In the mid 1990's there were over a million persistentsepal yellowcress plants in approximately 30 populations throughout Washington, Oregon and California (NatureServe 2005). However, more recent field evidence (Habegger et al. 2000; Simmons 2000), coupled with an increased understanding of the general effects of the hydropower system on the species' growth, reproduction and habitat conditions, indicate that populations along the Columbia River likely are declining. Water levels in dammed river systems fluctuate daily in response to power demands and inundate the species earlier in the growing season than natural flow regimes do. Stem density and frequency declined from 1991 to 1998 in the Pierce Island population which has been attributed to the altered hydrodynamics of the Columbia River (Habegger et al. 2000). The frequent flooding associated with dams during the growing season was shown to reduce the species' growth (stem production) and flowering from 1994 to 1998 along the Hanford Reach, which is considered the species' most vigorous population (Simmons 2000). In addition, daily flooding tends to increase siltation, which promotes the colonization of other species that may grow and reproduce better under flooded conditions and thus outcompete persistentsepal yellowcress.

THREATS WARRANTING ESA PROTECTION

Of the factors discussed below, water availability and hydrological conditions are certainly the most important, because persistentsepal yellowcress requires moist to wet soil (NatureServe 2005).

Destruction, Modification, or Curtailment of Habitat or Range

Habitat destruction is the most prevalent concern throughout the species range. Several populations that were discovered along the Columbia River in the late 1800s have been inundated behind dams, with numerous populations in Oregon documented in the late 1800s and early 1900s appearing to have disappeared. Agriculture or urbanization are likely responsible for the destruction of most of the Oregon populations. Other factors that have contributed to habitat loss include road-building, dredging, development, and recreation (NatureServe 2005).

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Over-utilization has not been identified as being an issue for persistentsepal yellowcress (NatureServe 2005; Washington DNR 2005).

Disease or Predation

Disease and predation have not been identified as being an issue for persistentsepal yellowcress (Washington DNR 2005; NatureServe 2005).

Adequacy of Existing Regulatory Mechanisms

The adequacy of existing regulatory mechanisms has not been identified as an issue for persistentsepal yellowcress (Washington DNR 2005; NatureServe 2005). However, because the species does not have protection under the Endangered Species Act (ESA), decisions regarding the operation of the Columbia River dam system, such as how much water to release and when to release it, are made without regard to the potential impacts to this species.

Other Factors Affecting Continued Existence

Along the Columbia River in Washington and northern Oregon, river flows and water levels impact the growth and reproduction of persistentsepal yellowcress (Harbegger et al. 2000; Simmons 2000). Although the species appears to be adapted to occasional prolonged inundation (NatureServe 2005), the cumulative effects of frequent, short-term inundation during the growing season may depress its vigor (Harbegger et al. 2000; Simmons 2000) and may affect its long term reproduction (Washington DNR 2005).

At the south-central Oregon and northern California persistentsepal yellowcress sites, the hydrological cycle is controlled by meteorological trends is. There is a positive correlation between the amount of precipitation, and the number of populations as well as the population size and individual plant vigor (NatureServe 2005).

Although cattle trampling is probably not a significant threat to Washington State populations, it (and potentially grazing) is considered a threat at the southern Oregon and California sites (NatureServe 2005).

In addition, persistentsepal yellowcress is usually found in areas with very little other vegetation, and it appears that it is a poor competitor. Because the species is low growing, other plants readily shade it. In addition, because water is, competing plant species may reduce available water resources that are necessary for successful growth and reproduction. Therefore, interspecific competition may be an important indirect threat, particularly if invasion by weedy species is exacerbated by artificial hydrological cycles or other factors such as cattle grazing (NatureServe 2005). Woody vegetation encroachment has been identified as being of particular concern (Washington DNR 2005).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Persistentsepal yellowcress is likely to be affected by some activities authorized on state-owned aquatic lands. Habitat destruction is the main concern for the species. Activities that may cause habitat loss, such as roadways, bridges, docks, marina construction and operation and dredging may adversely affect the species. Increased siltation from dredging, construction, and turbulence from watercraft frequenting marinas and docks may allow other species to outcompete persistentsepal yellowcress. Turbulence from boats may also increase bank erosion, reducing habitat.

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3-6.2 Water howellia (*Howellia aquatilis)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife	Threatened
Washington State	Threatened
Natural Heritage Program	G3; S2, S3

RANGE

Water howellia occurs in freshwater pothole ponds or abandoned river ox-bow sloughs in Washington, Idaho, Montana and California. The largest cluster of populations is found in the Swan River drainage in northwestern Montana, where there are approximately 138 known occurrences (Montana Natural Heritage Program 2005); almost 66 percent of the known populations of water howellia are in this area. There is one known occurrence in Idaho in northern Latah County (Idaho Fish and Game 2005). In California, there are five known occurrences, all in Mendocino County (CalFlora 2005). It had previously been recorded from at least four different places in northwestern Oregon, but is now thought to be extirpated from the state (US Fish and Wildlife 2005).

In Washington, there are over 60 occurrences of water howellia (US Fish and Wildlife 1996), with the majority in Spokane County and smaller clusters in Pierce and Clark counties. In Spokane County, it occurs in the forested portions of the channeled scablands. The Clark County sites are in the broad floodplain of the Columbia River, and the Pierce County populations are in the Douglas fir-dominated forests of the Puget trough lowlands, mainly on Fort Lewis (US Fish and Wildlife 1996).

HABITAT USE

Water howellia is an annual, rooted, aquatic plant that is mostly submerged. It is restricted to small, vernal, freshwater wetlands (US Fish and Wildlife 1996). These wetlands normally fill with water in the fall and remain inundated through the spring and early summer, but then dry out by the end of the growing season. This dry period is critical for seed germination. The substrates supporting the Howellia are usually firm, consolidated clays and organic sediments.

Wetlands that support water howellia are typically located within the forested portion of a matrix of forested and non-forested communities (US Fish and Wildlife 1996), with conifers making up most of the trees in the surrounding forests. In western Washington, these are typically Douglas fir (*Pseudotsuga menziesii*); in Spokane County, they are Ponderosa pine (*Pinus ponderosa*); and in Idaho and Montana, they are a mixture of species. There are almost always broadleaf deciduous trees partially surrounding the supporting wetlands, including black cottonwood (*Populus trichocarpa*), quaking aspen (*P. tremuloides*) or Oregon ash (*Fraxinus latifolia*), and there is usually a well-developed shrub component, such as dogwood (*Cornus stolonifera*), snowberry (*Symphoricarpos albus*), or spirea (*Spiraea douglasii*) in the surrounding community (US Fish and Wildlife 1996).

Water howellia produces two types of flowers. Early cleistogamous flowers (flowers that are self-pollinating and do not open) that are small and remain submerged are produced in May and June. In July and August, flowers emerge above the surface. These latter flowers are open but apparently also are primarily self-pollinating (Lesica et al. 1988). Seed germination occurs in the fall in sediment where water has receded. The seeds require an aerobic environment and cool temperatures to germinate, and optimal germination occurs on peaty, coarse-textured sediment (Lesica 1992).

POPULATION TRENDS

The overall population trend for water howellia appears to be stable (Caplow, Personal communication. March 18, 2005). Many of the known populations are on federal or protected lands, and its federal Threatened status provides regulatory protection on all federal lands where it occurs. In the year 2000, the Fort Lewis water howellia population was considered stable (Lombardi 2000).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Threats to water howellia habitat include logging, drainage of aquatic habitat for urban and agricultural development, invasive noxious weeds (reed canarygrass [*Phalaris*

arundinacea], purple loosestrife [*Lythrum salicaria*]), disturbance and trampling by livestock, and removal of native vegetation surrounding ponds (Center for Plant Conservation 2005). Timber harvest may affect wetland vegetation by increasing siltation of the wetlands as a result of runoff from the logging areas. In addition, removal of the tree canopy may increase runoff and decrease evapotransipration, which can prolong inundation (US Fish and Wildlife 1996). Livestock may affect populations primarily by trampling and physical disturbance, which can lead to increased invasion by weedy species. Invasive species, such as reed canarygrass, can crowd out species such as water howellia, and also can alter the rate of wetland succession, making the site less suitable for water howellia. Additional threats described by US Fish and Wildlife (1996) include noxious weeds on adjacent lands, conversion of habitat, road construction and maintenance and military training exercises.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There are no known threats related to over-utilization of this species (US Fish and Wildlife 1996).

Disease or Predation

Disease and predation are not believed to be serious threats to water howellia. Livestock have not been observed to feed on water howellia, although some native animals might (US Fish and Wildlife 1996).

Adequacy of Existing Regulatory Mechanisms

The Endangered Species Act (ESA) provides for protection of water howellia on all federal lands. Approximately two-thirds of all of the known occurrences of this species occur on federal property (US Fish and Wildlife 1996); therefore, ESA protection is likely to help prevent global extinction of the species. However, activities such as timber harvest on adjacent, nonfederal lands could have serious adverse impacts on the federally managed populations. The ESA provides no protection for listed plants on nonfederal lands.

Other Factors Affecting Continued Existence

Climate change and the species' low genetic diversity may pose a threat (Center for Plant Conservation 2005), although the plant has likely adapted to the range of changes and variation in its natural habitat. Human factors may accelerate these changes or increase the amplitude of these changes beyond the adaptive capability of the species (US Fish and Wildlife 1996). water howellia has a very narrow range of ecological requirements. It is restricted to fairly specific substrates in portions of wetlands that are seasonally inundated, but the substrate must dry out enough to allow for seed germination. The species has very little genetic variation within or among populations (Lesica et al. 1988), which may greatly limit the species ability to adapt to environmental changes. Global climate change could result in altered hydrologic regimes across the range of the species, putting many of the populations at risk. Natural succession and fire are other factors affecting the survival of water howellia populations (US Fish and Wildlife 1996).

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Water howellia is likely to be affected by Washington DNR authorized activities. It is particularly susceptible to activities, such as the construction of roadways that would alter the shoreline of the ponds where the populations are located. Altered shorelines could enhance colonization by introduced species that can outcompete, or render the habitat unsuitable for, water howellia. Runoff from roads causes increases sedimentation and deposits fertilizer into wetlands causing increased eutrophication.

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3-6.3 Water lobelia (*Lobelia dortmanna)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Threatened
Natural Heritage Program	G4; S2, S3

RANGE

Water lobelia occurs throughout the northeastern United States, the northern Midwest, across Canada and south into Washington and Oregon (NatureServe 2005), as well as throughout northern Europe, Scandinavia and Scotland. In British Columbia, most of the populations are found on Vancouver Island and the southwestern part of the mainland, with a few populations recorded in central British Columbia and the Queen Charlotte Islands (Klinkenberg 2004). In Oregon, it occurs in the eastern Cascade Mountains in Jefferson and possibly Deschutes counties (Oregon Natural Heritage Program 2004; Oregon Vascular Plant Database 2005). In Washington, water lobelia is found in the northwestern part of the state, with known populations in King, Skagit, San Juan, Clallam and Mason counties and historical populations in Snohomish and Whatcom counties (Washington DNR 2005).

HABITAT USE

Several morphological and physiological features are important in understanding the habitat requirements of water lobelia and the threats that various environmental impacts may have on this species. Water lobelia belongs to the isoetid group of aquatic plants, a morphological / functional group that includes species from vastly different taxonomic groups (for example, *Isoetes*, a primitive fern ally, *Litorella uniflora* [Plantaginaceae] and *L. dortmanna* [Campanulaceae]). Isoetids are characterized by thick, stiff leaves that form basal rosettes, with a relatively high proportion of below-ground biomass and large air passages, or lacunae, that connect the leaves with the tips of the roots. While most aquatic plants obtain carbon dioxide and nutrients from the water, almost all isoetid gas exchange and nutrient uptake occurs between the roots and the sediment (Smolders et al. 2002). In fact, Pedersen and Sand-Jensen (1992) found that even when the leafy rosette water lobelia is exposed to air, virtually the entire carbon-dioxide uptake is still through the roots. Isoetid plants have a high rate of radial oxygen loss from the roots, which in turn, can significantly alter the oxidation-reduction potential of the sediment (Smolders et al. 2002) and enhance microbiological activity (Karjalainen et al. 2001).

Water lobelia is a perennial species that normally occurs in the shallow water along the margins of ponds and lakes (Hitchcock et al. 1959; Gleason and Cronquist 1991) in mineral sand (Smolders et al. 2002). Isoetids, such as water lobelia, are slow-growing plants that, at least in parts of Europe, can dominate in weakly buffered, nutrient-poor (oligotrophic) lakes and ponds. They also dominate in areas that have high oxidation-reduction potential in the sediment; relatively low alkalinity and high acidity of the water

layer and the sediment pore water; low phosphate levels in the water and sediment pore water; and nitrate as the dominant nitrogen form (Smolders et al. 2002).

Water lobelia has several adaptations that allow it to thrive in nutrient-poor conditions. For example, it increases oligotrophic conditions in its environment by releasing oxygen from its roots, which creates a nitrification-denitrification system (Risgaard-Petersen and Jensen 1997) that reduces the availability of nitrogen and phosphate. In essence, the nutrient-poor conditions of the habitat are largely created and perpetuated by the plants themselves (Smolders et al. 2002), which greatly reduces the competition from faster growing species with greater nutrient requirements. Unlike most aquatic plants, water lobelia is able to form mycorrhizal associations that allow for increased phosphorus uptake in the nutrient-poor conditions (Brock-Nielsen and Madsen 2001).

POPULATION TRENDS

Trends for the known populations in Washington are not well known, but are probably declining due to increased shoreline development near several of the populations (Caplow, Personal communication. March 18, 2005).

THREATS WARRANTING ESA PROTECTION

Destruction, Modification, or Curtailment of Habitat or Range

Because this species is highly dependant on oligotrophic conditions, any alterations of water-quality factors, pH, or nutrient conditions could dramatically change the populations, or cause local extirpation of the species. Smolders et al. (2002) identified several threats to isoetid vegetation, including accumulation of organic matter, acidification and liming, increased nutrient levels in the water layer and epiphytic shading (which may result from increased nutrient availability). Therefore, factors such as fertilizer run-off, erosion and siltation, as well as acidic deposition could alter the self-maintained oligotrophic conditions within the water lobelia populations. Data summarized by Smolders et al. (2002) indicate that even relatively small changes in some of these parameters can lead to rapid population declines and community dominance shifts. The species also can be susceptible to physical alteration of the habitat via dredging or filling, and changes in the natural hydrologic regime.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There are no known threats related to over-utilization threats associated with this species.

Disease or Predation

No specific disease or predation threats are known for this species.

Adequacy of Existing Regulatory Mechanisms

There are currently few if any regulatory mechanisms protecting this species. It is not protected under the Federal Endangered Species Act (ESA), and because it is not considered globally rare, federal protection is not likely to be forthcoming. At least some

of the existing sites are not protected by administrative measures, and development at several sites has threatened local populations.

Other Factors Affecting Continued Existence

This species could be at risk from herbicides used to control water milfoil, shoreline development, pollution from boats and personal watercraft and trampling (Washington DNR 2005). Szmeja (1994) found that water lobelia individuals in shallower areas are more susceptible to damage by wave action than those in deeper areas. Therefore, activities that increase wave action such as bulkheading and boating could damage populations in shallow areas.

POTENTIAL EFFECTS FROM WASHINGTON DNR AUTHORIZED ACTIVITIES

Water lobelia is likely to be adversely affected by Washington DNR authorized activities. It is particularly susceptible to shoreline development, such as roads, bridges, docks and marinas, and any activity that could result in changes to the water-quality profile of the inhabited waters, such as run-off from roads and other overwater structures that increase the concentrations of concentrations of heavy metals, salts and petroleum products in the sediments and water column. Fertilizer run-off and increases in nutrients from septic and wastewater treatment systems may affect the species.

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4. Watch List Species

4-1 Amphibians and Reptiles

4-1.1 Cascades frog (*Rana cascadae)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not listed
Washington State	Not Listed
Natural Heritage Program	G3; S4?

RANGE

The range of the Cascades frog extends along the Cascades Mountains from Washington to Mount Lassen in northern California (Stebbins 1985; Martin 2001). Although this frog has been reported from sea level to 1,885 meters in Washington, it rarely occurs below 620 meters (O'Neil et al. 2001). At the southern extent of its range in California, this frog may be found at elevations from 900 to 2,727 meters (Zeiner et al.1988).

HABITAT USE

The Cascades frog is usually found near water, inhabiting shallow palustrine and lacustrine habitats as well as small streams (riverine habitat) (Stebbins 1985). This frog breeds in ponded water and lays its eggs in areas with low or patchy aquatic vegetative cover such as lake margins or in montane ponds and stream pools (Nussbaum et al. 1983; Stebbins 1985; Zeiner et al. 1988). Adults may be found along streams in summer (Olson et al. 2001) and over-winter in water or in saturated soils (California Department of Fish and Game 2003).

POPULATION TRENDS

While there is little information regarding population trends in Washington, population trends for Cascades frogs in Oregon are mixed with declines on the east side of the Cascades and increases on the west side due to habitat creation.

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4-1.2 Northern red-legged frog (*Rana aurora aurora)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Not listed
Washington State	Not Listed
Natural Heritage Program	G4; S4

RANGE

The red-legged frog occurs west of the Cascade Mountains from British Columbia to northern California at elevations from sea level to 1,480 meters (Stebbins 1985; O'Neil et al. 2001).

HABITAT USE

The northern red-legged frog occupies low-gradient riverine, palustrine, and lacustrine habitats throughout its range, including freshwater marshes and wet meadows (Nusbaum et al. 1983; Stebbins 1985; O'Neil et al. 2001; Burke Museum 2004). Adults of this species also use upland habitats such as moist forests, damp meadows, marshes, ponds, lakes and streamsides (Nusbaum et al. 1983; Stebbins 1985; O'Neil et al. 2001).

Adult red-legged frogs may forage 300 meters or more away from water when not breeding, but return to permanent waters during drought (Nusbaum et al. 1983; O'Neil et al. 2001) They feed on a variety of invertebrates and also eat fish, amphibians and even small mammals (O'Neil et al. 2001). The species generally breeds in permanent ponds and attaches its eggs to stiff submerged stems, but may also breed in streams and seasonal ponds (Stebbins 1985; Wright and Wright 1995). While these frogs may be active in any month when the temperature is above 5 degrees Celsius, they undergo periods of inactivity from November through January (Nusbaum et al. 1983; O'Neil et al. 2001).

POPULATION TRENDS

The northern red-legged frog is still widespread and common in some areas, although the closely related California red-legged frog has been federally listed as threatened (NatureServe 2005). However, the northern subspecies has been extirpated from parts of the Puget Trough and the Willamette Valley (O'Neil et al. 2001).

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4-1.3 Rocky mountain tailed frog (*Ascaphus montanus)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Not listed
Washington State	Candidate Species
Natural Heritage Program	G4; S2?

RANGE

The Rocky Mountain tailed frog inhabits rocky streams in mountains from southeastern British Columbia through Idaho and Montana. This species is also found in the Blue Mountains of eastern Washington and Oregon and the Wallawa Mountains of Oregon (Nussbaum et al. 1983; Stebbins 1985; Nielson et al. 2001).

HABITAT USE

The Rocky Mountain tailed frog is found in cold, fast-moving streams with cobble bottoms and occurs at elevations from 1,000 to over 2,000 meters (O'Neill et al. 2001; NatureServe 2005). This frog usually stays within a stream and bank area no more than 40 meters in diameter (O'Neill et al. 2001) and although movements up and downstream have been reported, information related to the extent of such movement is lacking (Adams and Frissell 2001; O'Neill et al. 2001).

Similarly to the coastal tailed frog, this species is diurnal and rests during daylight hours under rocks in cold streams, emerging at night to forage within and along the stream banks for invertebrate prey (Nussbaum et al. 1983; Stebbins 1985; O'Neill et al. 2001). This frog may be active throughout the year (O'Neill et al. 2001), but adult peak activity occurring from April to October (Stebbins 1985).

Spawning and incubation occur in the streams inhabited by adult frogs, with eggs attached to the undersides of large rocks. Metamorphosis occurs two to three years later, with tadpoles feeding on algae, pollen and insects (Nussbaum, et al. 1983; O'Neill et al. 2001). Although tadpoles have been observed in cascading water on very steep rock slopes of streams (Nussbaum et al.1983) and can adhere to rocks in swift streams with their modified oral disk (Nussbaum et al. 1983; Stebbins 1985), they prefer stream reaches with smooth surfaces and avoid silty areas and mossy rocks.

POPULATION TRENDS

Although populations of Rocky Mountain tailed frogs in Idaho and Montana appear to be stable (NatureServe 2005), population trends in Washington is currently unknown (O'Neill et al. 2001).

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4-2 Birds

4-2.1 Brandt's cormorant (*Phalacrocorax penicillatus)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Not listed
Washington State	Candidate Species
Natural Heritage Program	G5; S3B, S4N

RANGE

Brandt's cormorant is one of six cormorant species found in North America and one of four found on the Pacific Coast (Sibley 2000). Although it breeds from Alaska to Mexico, it is mainly found from Washington to California (Harrison 1983; Wallace and Wallace 1998). This species is endemic to the California Current, an oceanic nutrient supply system present along the Pacific Coast (Boekelheide and Ainley 1989). The highest breeding concentrations are found between Oregon and California where upwelling of the California Current is most predictable.

Within Washington, it is unlikely that the species was a numerous or widespread breeder. It occurs year-round along the outer coast, but is less numerous than in Oregon and California (Speich and Wahl 1989; Wallace and Wallace 1998; Sydeman et al. 2001; Couch and Lance 2004). This species is virtually exclusive to neritic and estuarine zones of the outer coast and is rarely observed inland (Kaufman 1996; Wallace and Wallace 1998; Sibley 2000). They have been observed nesting on the outer coast of the Olympic Peninsula between Copalis Rock and Cape Flattery (Dawson 1908; Speich and Wahl 1989, Wilson 1991) and Speich and Wahl (1989) reported 554 nests in four colonies (Cape Disappointment, Paahwoke-it, Willoughby Island and Split Rock) from 1979 to 1982 from various field survey efforts. In addition, Brandt's cormorants have recently been found nesting on a pile dike off of East Sand Island in the Columbia River estuary (Couch and Lance 2004).

HABITAT USE

Brandt's cormorants frequent marine subtidal and pelagic zones where coastal upwellings occur (Granholm 1983). They roost on prominent perch sites devoid of vegetation, usually rock outcroppings and pilings, or occasionally on sandy beaches (Granholm 1990; Wallace and Wallace 1998).

Nesting

Nesting occurs on in-shore or off-shore rocky islands and slopes of inaccessible shoreline cliffs (Wilson 1991; Speich and Wahl 1989; Kaufman 1996; Wallace and Wallace 1998). Although one colony has been established on a manmade pile dike within the Columbia River estuary (Couch and Lance 2004), it is uncharacteristic for this species to nest on manmade structures or within an estuary setting. Adults may mature during the second year of life, but typically do not breed until older (Wallace and Wallace 1988). Adults may live beyond ten years of age, but usually only breed three to eight seasons and fledge two to four young in their lifetime (Wallace and Wallace 1988). Annual breeding success varies with food availability and bird age (Wallace and Wallace 1988).

Wintering

Although some Brandt's cormorants remain in areas frequented during the nesting season, many disperse both northward and southward to take advantage of abundant fish and invertebrate populations provided by ocean current upwellings. Many overwinter in the Strait of Juan de Fuca and Active Pass, British Columbia (Wallace and Wallace 1998). A very limited number of Brandt's cormorants have been observed inland up coastal rivers in Oregon (Granholm 1990).

POPULATION TRENDS

Annual nesting can be highly variable because of close ties between the Brandt's cormorant nesting ecology and California Current perturbations. In years when ocean surface temperatures are warmed from El Niño events and prey decrease, numbers of nests may decline or nesting may be abandoned altogether (Wilson 1991). Also, the selection of inaccessible rocky islands and cliffs makes reproduction difficult to assess during ground-based survey efforts. These two factors make assessing population trends difficult without longer-term population monitoring efforts (Wilson 1991).

Currently, there are on-going nesting surveys performed within the Olympic Coast National Marine Sanctuary of the Washington coast, but population trend data are currently unpublished and unavailable at the time of this writing. However, in 1905, an estimated 310 nests among four breeding colonies were observed along the Olympic Peninsula outer coast (Dawson 1908). More recently (1979 to 1990), Brandt's cormorant nests numbers varied from 0 to almost 600 annually in the same general area (Speich and Wahl 1989; Wilson 1991). Undoubtedly, the use of aerial survey techniques limits comparisons between these surveys, but it does provide a general reference to historical versus present population size. Although breeding colonies have been lost from San Juan Island, the Strait of Juan de Fuca, Grenville Arch and Sea Lion Rock, colonies now exist on islets previously uninhabited (Dawson 1908; Wallace and Wallace 1998).

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4-2.2 Clark's grebe (*Aechmophorus clarkia)*

Until the early 1980s, Clark's grebe (*A. clarkii*) and the Western grebe (*A. occidentalis*) were thought to be two color morphs of the same species (Western grebe) because of the subtle differences in plumage and sympatric use of habitat (Storer and Nuechterlein 1992). Indication of the two color morphs being separate species came from evidence of assortative mating, reproductive isolating mechanisms and morphological differences (Ratti 1979; Nuechterlein 1981; Storer and Nuechterlein 1985). Thus, much of the published information about the natural history of these species refers to the light (now considered *A. clarkii*) and dark phases of the Western grebe. In the following review of, species-specific interpretations are made where applicable, but may also include biologically relevant information cited as or specific to *A. occidentalis*.

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Not listed
Washington State	Monitored
Natural Heritage Program	G5; S2B, SZN

RANGE

The primary range of the Clark's grebe includes most of western United States and Canada, extending as far east as the Dakotas, southern Minnesota, western Nebraska and Kansas (Sauer et al. 2004). Single birds or widely scattered small groups were recorded in southern Manitoba, Saskatchewan, Alberta and southern British Columbia (Storer and Nuechterlein 1992; Sauer et al. 2004). The highest occurrences of breeding colonies are found in southern Oregon, northern California, southwestern Idaho, northern Utah and southern North Dakota (Sauer et al. 2004).

In Washington, Breeding Bird Survey (BBS) results indicate Western/Clark's grebes are most common in the Columbia River Basin in eastern Washington (Sauer et al. 2004). Known breeding locations of Western/Clark's grebes include Sprague Lake in Lincoln County; Moses Lake, Potholes Reservoir; and Lake Lenore in Grant County (Yocom et al. 1958). Many of these birds winter in the Puget Sound vicinity (Puget Sound Action Team 2005).

HABITAT USE

This species is generally considered absent from Washington during the non-breeding season (Yocom et al. 1958). Although molt locations are generally larger bodies of water than those used for nesting, they may be within the species breeding range, winter range or both (Stout and Cooke 2003).

Nesting

Western/Clark's grebes build floating nests in or near open water and utilize nearby emergent vegetation for nest materials (Lindvall and Low 1982). Nests may also occur in

emergent vegetation or on dry land, but are usually within less than 1 meter of open water and other grebe nests (Nero et al. 1958; Lindvall and Low 1982). Ratti (1979) described Western grebe nest colonies in Utah and California as "partly segregated," in that light- and dark-phase grebes were not randomly distributed throughout the colony, yet they nested sympatrically. Nuechterlein (1981) confirmed these observations for breeding populations in Manitoba, Oregon and California, with Dickerman (1973) also providing evidence of spatial segregation in light- and dark-phase Western grebes breeding in Mexico. Little is known about age of maturity and fledgling success.

Foraging

Based on observations of diving behavior, Nuechterlein (1981) indicated that light-phase Western grebes (i.e., *A. clarkii*) may forage farther from shore and at greater depths than dark-phase grebes. Ratti (1985), with Nuechterlein and Buitron (1989) providing additional evidence. However, Ratti (1985) also noted that distance from shore did not always correspond to greater depths, especially in artificial impoundments. At two natural lakes (Upper Klamath Lake and Lake Ewauna) in Oregon, Clark's grebes forage more frequently in areas of greater depths than Westerns, but it is not known whether they actually dive to greater depths than Westerns (Nuechterlein and Buitron 1989).

Migration

While little is known about the migration of Western/Clark's grebes, migratory habitat most likely overlaps breeding habitat.

POPULATION TRENDS

Although little is known about population trends, analysis of BBS data for Western/Clark's grebes indicates a significant, slightly positive increase (0.9 percent) in the Western Region between 1966 and 2003 (Sauer et al. 2004). These data also suggest the period of greatest increase was 1980 to 2003, although this trend is not significant (Sauer et al. 2004). In Washington, available BBS data point toward a declining trend, but these data are unreliable because of a low number of routes (Sauer et al. 2004). Winter population counts around Puget Sound indicate dramatic decreases in western grebes since 1992 (Puget Sound Action Team 2005).

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4-2.3 Peregrine falcon (*Falco peregrinus)*

Subspecies names: American peregrine falcon (*F. p. anatum*); Arctic peregrine falcon (*F. p. tundrius*); Peale's peregrine falcon (*F. p. pealei*)

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	
F. p. anatum	Delisted taxon, Recovered
F. p. tundrius	Delisted taxon, Recovered
F. p. pealei	Not listed
Washington State	Sensitive
Natural Heritage Program	
F. p. anatum	G4, T3; S1B, S3N
F. p. tundrius	G4, T3, T4; SZN
F. p. pealei	G4, T3; S2B, S3N

RANGE

Historically, North American populations of the peregrine falcon were widespread and bred from Banks Island and the Labrador Coast in Canada, south to central Mexico (Johnsgard 1990; Sibley 2000). However, the peregrine was extirpated from much of its former North American breeding range between 1940 and 1970 (Johnsgard 1990).

In Washington, the peregrine's breeding range is primarily west of the Cascade Mountains, with the greatest number of nest sites in the San Juan Islands, Puget Sound lowlands and along the outer northern coast of western Washington (Johnsgard 1990; Hayes and Buchanan 2002) (Appendix G). They also nest on forested slopes of the Cascade Mountains and in the Columbia River Gorge, usually within close proximity to large lakes or river valleys (Hayes and Buchanan 2002; Sergio et al. 2004).

At this time, both American and Peale's peregrines are considered to breed in western Washington, although the amount of overlap in each subspecies' breeding range remains relatively unknown (Hayes and Buchanan 2002). Peale's peregrine was found mainly along the Pacific Coast; however, recent reintroductions of birds with Peale's characteristics have made it more widespread (Sibley 2000). Conversely, only American peregrines have been known to breed east of the Cascade Mountains, where the number of nest sites is substantially less than that in western Washington (Hayes and Buchanan 2002).

Winter ranges of peregrines in Washington are similar to their breeding ranges. In western Washington, peregrines often winter at locations such as Puget Sound estuaries, Grays Harbor, Willapa Bay, Columbia River estuary, outer coastal beaches, low-lying agricultural lands and some urban areas (Hayes and Buchanan 2002). Both American and Peale's peregrines winter in these areas during the winter (Hayes and Buchanan 2002), with the American peregrine also found in widely scattered localities in eastern Washington (Hayes and Buchanan 2002). The arctic peregrine is considered a migrant in Washington and may be an extremely rare winter resident (Hayes and Buchanan 2002).

HABITAT USE

Nesting

Nests are typically constructed on prominent cliffs that provide an unobstructed view of the surrounding landscape, protection from the elements and limited access by

mammalian predators (Johnsgard 1990). These sites, known as eyries, are usually located within close proximity to water (e.g., lakes, marshes, river valleys and ocean beaches), and most likely are associated with a prey base of smaller birds (Johnsgard 1990; Hayes and Buchanan 2002; Sergio et al. 2004). Peregrines may also use smaller cliffs and cut-banks, but these are considered lower-quality sites (Beebe 1960; Johnsgard 1990). Peregrine falcons may breed during their second year of life, but the age of first breeding is influenced by the availability of territories (White et al. 2002). Clutch size is typically three to four eggs, and fledging success has increased to one to two annually per nest since the 1980's as the population recovered from the effects of pesticides (White et al. 2002).

Non-breeding

Habitats used by peregrines during the non-breeding season are typically open areas that often support high densities of small- to medium-sized birds, such as shorebirds and waterfowl (Johnsgard 1990; Kaufman 1996; White et al. 2002). In western Washington, these areas may include coastal and estuarine habitats (e.g., beaches, tidal flats, islands and marshes), open ocean, agricultural fields, airports and urbanized areas where rock pigeons (*Columba livia*), a primary prey species, are abundant (Hayes and Buchanan 2002). The availability of perch and roost sites are also important winter-habitat requirements; however, these aspects have not been well-studied.

In Washington, a variety of artificial and natural perches are used, and selection of these sites is most likely related to proximity to foraging habitat (Hayes and Buchanan 2002). Although habitat requirements of peregrines wintering in eastern Washington have not been well-studied, it is likely they have similar habitat requirements as do peregrines in western Washington.

Discernable migration routes are evident in western Washington, and spring migrants often stage at Grays Harbor, Willapa Bay and numerous estuaries and associated habitats in Puget Sound, and autumn migration primarily along the outer coast and the Puget Sound basin (Hayes and Buchanan 2002). Limited data also suggest that migrants traveling through eastern Washington may follow a corridor along the Columbia River in Benton, Douglas, Grant and Walla Walla counties, with an increasing number of sightings in recent years (Hayes and Buchanan 2002). Knowledge of subspecies-specific movements on the west coast is limited; however, there is significant band-return data that suggest most peregrines migrating along the outer coast of Washington are Peale's falcons (Hayes and Buchanan 2002).

POPULATION TRENDS

Peregrine populations were believed to have declined in the Pacific Northwest as early as the 1930s and 1940s, reaching their lowest levels during the 1950s (Hayes and Buchanan 2002). The decline was primarily attributed to widespread contamination of organochlorine pesticides, which caused eggshell thinning and reduced productivity (White et al. 1973; Schick et al. 1987; Johnsgard 1990; Jarman et al. 1993; Henny et al. 1996; Johnstone et al. 1996; White et al. 2002). Following the ban of dichlorodiphenyltrichloroethane (DDT) in 1972 and the listing of peregrines as an Endangered Species in 1973, a network of captive breeding programs was initiated to help boost remaining populations (Hayes and Buchanan 2002). In Washington, captive-

bred American peregrines were released from 1982 to 1997 (Hayes and Buchanan 2002). Population-trend information based on annual surveys during 1980 to 2001 indicates a steady increase (approximately 14 percent) in Washington (Wilson et al. 2000; Hayes and Buchanan 2002). By the mid-1990s, peregrine populations had reached recovery goals (White et al. 2002) and were subsequently delisted in August 1999 (64 Code of Federal regulations Part 164, 1999).

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4-2.4 Purple martin (*Progne subis)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Candidate Species
Natural Heritage Program	G5; S3B, SZN

RANGE

The breeding range of the purple martin extends from the south-central and southeastern Canadian provinces into northern and central Mexico. In the United States, the species breeds south of the Canadian border and mainly east of the Rocky Mountains to southern Texas, the Gulf Coast and southern Florida. Purple martins do occur in western North America, mostly in the Upper Sonoran through Transition zones. Distribution is patchy and local in the United States west of 102nd parallel and east of the Cascade and Sierra Nevada mountains, except in the mountains of south-central and western New Mexico, portions of southern and northwest Arizona, western Colorado, north-central Utah, Klamath County, Oregon, and along eastern slopes of Cascade Mountains of California. Purple martins breed locally west of the Cascade and Sierra Nevada mountains from extreme southwest British Columbia south to extreme southwestern California. The species winters in the lowlands of South America (Columbia, Venezuela, Guiana, Surinam, northern Bolivia and Brazil) (De Tarso Zuquim Antas et al. 1986; Brown 1997).

In Washington, the purple martin breeds locally west of the Cascade Mountains (Brown 1997) near water around Puget Sound and the Columbia River. As of 1990, breeding pairs had been confirmed in San Juan, King, Pierce, Thurston, Mason, Clark, Skamania and Gray’s Harbor counties (Washington Fish and Wildlife 1990).

HABITAT USE

The purple martin is an insectivorous aerial forager, often at altitudes of at least 50 meters (Johnston and Hardy 1962), typically over open fields and waterways (Brown 1997).

Nesting

Although distribution was likely patchy and localized, purple martin populations historically inhabited forest edge and riparian areas. Purple martins in the western United States preferentially inhabit montane forest or Pacific lowlands (Brown 1997). They frequently nest solitarily, restricted to areas with natural cavities (Richmond 1953; Stutchbury 1991; Brown 1997), avoiding deserts and grasslands (Brown 1997). The species' apparent absence from many areas in the northern Rockies, intermountain region, California, Pacific Northwest and Mexican highlands may mean that the species has more specific habitat requirements in these areas that are unknown (Brown 1997).

In Washington, most of the reported martin nests were in manmade structures near cities and towns in west-side lowlands (Washington Fish and Wildlife 1990) Those that do nest in cavities use those located in old pilings and occasionally in snags with clear air space and easy access (Washington Fish and Wildlife 1990).

Purple martins are mature and will nest during their second year of life, typically laying three to six eggs. Fledging success is typically two to four young annually (Brown 1997).

Wintering

Purple martins of all ages flock to roosts before fall departure (Mitchell 1947; Morton and Patterson 1983; Brown 1997). Roosts are usually in stands of trees or underneath concrete bridges (Hill 1948; Brown 1997). In the eastern United States, most pre-migratory roosts were clearly associated with large bodies of water, such as lakes and rivers (Russell et al. 1998). Fall migration from its breeding range in North America to its winter range in South America occurs via Mexico and the Central American isthmus. Purple Martins are exclusively diurnal migrants, foraging as they move (Brown 1997). They migrate over the Gulf of Mexico and closer to beaches than other swallows and apparently avoid the highlands, at least in Mexico and Central America. In southern Brazil, the purple martin occupies largely savanna and agricultural areas, feeding widely during day and flocking into large roosts in cities and towns at night. Roosts are often located in trees in village plazas (Brown 1997).

POPULATION TRENDS

The North American Breeding Bird Survey (BBS) index indicates steady or slightly increasing populations in the Pacific Northwest, the western BBS region and over the entire United States (Sauer et al. 2004). The reversing of previously reported purple martin population declines may be the result of artificial nesting structures (Brown 1997).

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4-3 Fish

4-3.1 Margined sculpin (*Cottus marginatus)*

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Species of Concern
Washington State	Sensitive
Natural Heritage Program	G3; S1

RANGE

The margined sculpin is endemic to Washington and Oregon (Wydoski and Whitney 2003). While its historic distribution is unknown, it is currently found in headwater tributaries of the Columbia River within the Blue Mountains. In Washington, it is only found in parts of the Tucannon, Touchet and Walla Walla drainages (Mongillo and Hallock 1998; Wydoski and Whitney 2003).

HABITAT USE

Margined sculpin can be found in stream pools where water temperature may reach 20° Celsius (Mongillo and Hallock 1998). The species prefers small gravel and silt substrates, with adults typically found in deeper, faster water than juveniles (Mongillo and Hallock 1998; Wydoski and Whitney 2003). While little is known regarding the species' life history and habitat requirements, it is likely that spawning occurs in the spring under rocks similar to that of other sculpin species (Wydoski and Whitney 2003). Spring spawning is implied by the presence of young of the year in fall electro-fishing surveys (Mongillo and Hallock 1998). Prey items are also likely similar to those of other sculpins, with the species opportunistically consuming aquatic insects, crustaceans, other fish eggs and larvae and terrestrial insects (Wydoski and Whitney 2003). Margined sculpins co-occur with rainbow, bull and brook trout, chinook and speckled dace (Wydoski and Whitney 2003).

POPULATION TRENDS

The past and current population status of the margined sculpin is unknown, however it is locally common within the known range. Even if present populations are healthy, its extremely restricted distribution poses concern for the future as local disturbances may have profound effects on its persistence (Mongillo and Hallock 1998). In addition, much of its habitat is degraded and faces an uncertain future. Because of its small range and degraded habitat conditions, it is vulnerable and likely to become Threatened or Endangered in a significant portion of its range without cooperative management (Mongillo and Hallock 1998).

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4-3.2 Westlope cutthroat trout (*Oncorhynchus clarki lewisi)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Species of Concern
Washington State	Species of Concern
Natural Heritage Program	G4, T3; S?

RANGE

Westslope cutthroat trout are found in many eastern Washington lakes and streams and are also stocked in many high-country lakes, including some lakes west of the Cascade Crest (Downen 2004; Washington Fish and Wildlife 2005) most of which are small, isolated water bodies in mountainous areas (US Fish and Wildlife 2000).

HABITAT USE

Like other salmonids in the Pacific Northwest, good water quality, low nutrients, and low water temperatures are generally preferred habitats, especially for spawning and rearing. Besides the high mountain lakes, they are often found in the well-oxygenated waters of headstream and tributaries (Washington Fish and Wildlife 1992), where adults tend to prefer deeper water than do juveniles, and are often found in the same streams with other species, such as bull trout and mountain whitefish.

POPULATION TRENDS

It is now estimated that in Washington State alone the westslope cutthroat trout are found in more than 493 streams and 311 lakes (Fuller 2002 in US Fish and Wildlife 2003). Because of stocking programs, mostly in the twentieth century, it is estimated that the westslope cutthroat trout are more widely distributed today than prior to European settlement (US Fish and Wildlife 1999). Throughout its current range, westslope cutthroat trout are found in approximately 4,275 tributaries comprised of more than 23,000 linear miles of stream habitat in 12 major drainages within the Columbia, Missouri, and Saskatchewan River basins (US Fish and Wildlife 2000). Because most of the land in which the majority of the westslope cutthroat are found is controlled by federal agencies and many areas are roadless or designated wilderness areas, several layers of protection already exist for the westslope cutthroat trout (US Fish and Wildlife 1999)

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4-4 Invertebrates

4-4.1 Idaho springsnail (*Pyrgulopsis idahoensis)*

Common Name(s): Idaho Springsnail, Jackson Lake Springsnail, Harney Lake Springsnail and Columbia Springsnail.

Due to recent taxonomic reappraisal, it is not possible to assign specific nomenclature for this species. In the past, it has been referred to as *Pyrgulopsis idahoensis, Amnicola idahoensis* and *Fontelicella idahoensis*. Currently, it may be known as *Pomatiopsis robusta*, to be included in the subgenus *Natricola*.

STATUS AND RANK

Entity	Status/Rank
US Fish and Wildlife Service	Endangered
Washington State	Not Listed
Natural Heritage Program	G1; State Not Ranked

RANGE

The Idaho springsnail is known to occur in the mainstem Snake River, upstream of Bancroft springs and adjacent to the headwaters of the C.J Strike Reservoir. As of 1995, individuals had only been collected at ten sites within the middle Snake River and they

had not been found in any Snake River tributaries or in its associated cold water springs (US Fish and Wildlife 1995). Although Idaho springsnails have not been observed outside of Idaho, a recently described species (the Columbia springsnail) has been found in the Hanford reach of the Columbia River in Washington State (Bowler et al. 2004). Pending taxonomic review, the Idaho springsnail may eventually be classified as the same species as the Columbia springsnail, which would alter its distribution to include the State of Washington. Because the Idaho springsnail as it is currently known does not occur in the state, a figure representing the distribution of this species in Washington has not been produced.

HABITAT USE

As an aquatic snail, the Idaho springsnail uses gills for respiration and requires cold flowing water with low turbidity, typically residing in shallow areas near the banks of spring influenced rivers. The Idaho springsnail utilizes interstitial spaces on substrates ranging from mud, sand, gravel and boulder (Hershler 1998). Due to specific adaptations to cold flowing spring influenced environments, it has been suggested that springsnails are extremely sensitive to changes in water conditions (Hershler 1998).

POPULATION TRENDS

Idaho springsnail populations have been, and are currently, in decline. In 1995, U.S. Fish and Wildlife determined that the range of the Idaho springsnail had been reduced by up to 80 percent, and they had been reduced to “small and fragmented” populations.

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4-5 Marine Mammals

4-5.1 Blue whale (*Balaenoptera musculus)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Endangered
Washington State	Endangered
Natural Heritage Program	G3, G4; State Not Ranked

RANGE

The blue whale occurs throughout the world's oceans, and while it is a migratory species it is rarely found in coastal areas. Blue whales found off the coats of Washington are likely part of the northeastern Pacific population that migrates from wintering grounds off Mexico and Central America to summer/fall feeding areas in higher latitudes, particularly off California and Vancouver Island, British Columbia (Burtenshaw et al. 2004; Carretta et al. 2004). Acoustic data from arrays placed at six locations along the Pacific Coast showed that blue whales migrate northward from feeding grounds in California beginning in June and pass Washington from September through February, but are probably well offshore (Burtenshaw et al. 2004). Modeling efforts, although focused on British Columbia waters, also indicated a low probability for the occurrence of blue whales off Washington (Gregr and Trites 2001) and it seems unlikely that they occur within Washington State waters.

HABITAT USE

Blue whales are highly selective plankton feeders, primarily consuming euphausiid crustaceans (Fiedler et al. 1998; Moore et al. 2002) and are most frequently associated with oceanographic conditions and topographic features that concentrate plankton into dense aggregations. Thus, they occur in cold, highly productive waters such as areas of strong coastal upwelling or sea-surface temperature fronts (Fiedler et al. 1998, Moore et al. 2002; Burtenshaw et al. 2004).

POPULATION TRENDS

Barlow et al. (1994) reported that it appeared that blue whale abundance increased off the coast of California through about 1991, although this may have reflected increased use of California feeding grounds rather than in increase in the population, and there is no indication the population has increased since (Calambokidis et al. 2004a). There are no separate population data for blue whales occurring near Washington and surveys conducted between 1989 and 2002 failed to document the animals off Washington (Calambokidis and Barlow 2004; Calambokidis et al. 2004b; Carretta et al. 2004).

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4-5.2 Bowhead whale (*Balaena mysticetus*)

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Endangered
Washington State	Not Listed
Natural Heritage Program	G3; State Not Ranked

RANGE

The bowhead whale has a circumpolar distribution (Shelden and Rugh 1995) with two of the five recognized stocks occurring in the North Pacific. The Okhotsk Sea stock spends summers in the Okhotsk Sea, but its winter range is not well understood (Shelden and

Rugh 1995). The Bering Sea stock spends summers in the Beaufort Sea, with uncommon occurrences in the Chukchi Sea, and winters in the southwestern Bering Sea (Shelden and Rugh 1995; Wynne 1997).

There are no reliable records of this species occurring in Washington and its presence is likely accidental.

HABITAT USE

Bowhead whales are strongly associated with ice (Wynne 1997), particularly marginal ice fronts and areas of open water surrounded by sea ice, in the Bering Sea (Shelden and Rugh 1995).

POPULATION TRENDS

By the time commercial whaling stopped in 1914, bowhead whale populations were severely depleted. The Okhotsk Sea stock is a small population of about 300 to 400 whales that has shown little recovery (Shelden and Rugh 1995). The Bering Sea stock, also known as the western Arctic stock, is the largest of the five world-wide stocks, with a population estimated at about 8,200 individuals (Raftery and Zeh 1998). The apparent recovery shown by this stock led Shelden et al. (2001) to suggest that the five stocks be considered separately for ESA listing and that the Bering Sea stock should be delisted.

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4-5.3 Gray whale (*Eschrichtius robustus)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Delisted 1994
Washington State	Sensitive
Natural Heritage Program	G4; S?B

RANGE

While gray whales historically occurred in both the north Atlantic and Pacific Oceans, only two stocks remain - one in the western North Pacific and one in the eastern North Pacific (Reeves et al. 2002; Angliss and Lodge 2004). Only the eastern stock occurs within the waters of Washington State, migrating between 16,000 and 22,000 kilometers from their calving grounds off Baja California to their feeding grounds in the Chukchi and Bering.

A small portion of the eastern North Pacific stock takes up residency in the Pacific Northwest during the summer feeding season. Although these seasonal residents are known to range from southeast Alaska to northern California, the focal point of the residency seems to be along the Washington coast to central Vancouver Island (Calambokidis and Quan 1999; Gosho et al. 1999; Calambokidis et al. 2002) and many of the same whales reappear across years. Migration northward begins in February with seasonal residents arriving in Washington at about the time the overall migratory group reaches the area and leaving when the main southward migration passes in the fall (Calambokidis et al. 2002). Gray whales may also enter Willapa Bay and Grays Harbor (Richardson 1997), with Calambokidis et al. (2002) recording seven individuals in Grays Harbor from late March to early May during their 1998 study.

HABITAT USE

Eastern gray whale populations primarily forage on the highly productive sea floor in the Bering and Chukchi Seas (Highsmith and Coyle 1992; Rugh et al. 1999). Feeding sites typically include larger bays with shallow waters and sandy bottoms, and generally extending from the intertidal zone to a depth of about 30 meters. While primary benthic prey include amphipods (*Ampelisca*) and ghost shrimp (*Callianassa*) (Dunham and Duffus 2001), gray whales may shift between planktonic and benthic feeding, depending on the availability of prey.

The prey and habitats exploited by the seasonal resident group in the Washington-British Columbia area appear to be more diverse than those of whales feeding in Arctic waters (Darling et al. 1998; Dunham and Duffus 2001), and are easily grouped into three types: herring eggs and larvae, planktonic prey and benthic prey (Darling et al. 1998). Whales off the coast of Washington generally remain within 5 kilometers of shore foraging in waters about 20 meters deep (Calambokidis et al. 2004). While foraging behavior is less understood for those gray's entering Puget Sound, animals in the northern Sound appear to show strong, but temporary site fidelity (Calambokidis and Quan 1999), while those in the southern Sound often experience high rates of mortality.

Gray whales may reach a length of 15 meters, weigh 35,000 kilograms and live at least 40 years (Reeves et al. 2002).

POPULATION TRENDS

Although the western stock remains a highly endangered population (Clapham et al. 1999), the eastern stock showed such a dramatic population recovery that it was removed from the U.S. List of Endangered and Threatened Wildlife in 1994 (Angliss and Lodge 2004). Overall, the eastern stock increased by approximately 2.5 percent/year from the

mid-1960s to 1999 when the population was estimated at 26,600 (Rugh et al. 1999). reported the stock to be increasing in number at a rate of about 2.5 percent per year and estimated the population to consist of about 26,600 whales. In March of 2002 populations were estimated at about 24,500 whales (Angliss and Lodge 2004), however, recent information indicates that this estimate is probably too high and that numbers may actually be closer to 17,000 to 18,000 animals (Rugh 2004). Rugh speculated that the lower estimates may have resulted from fewer whales migrating south through the California observation site, or represented a real population decline resulting form high mortality observed in 1999 and 2000. Evidence of this high mortality was provided by Norman et al. (2004) who documented gray whale strandings in the northwest region that were four to five times greater than the annual average rangewide. In addition, some researchers have offered that the eastern North Pacific stock may be reaching its carrying capacity (Rugh et al. 1999).

Calambokidis et al. (2002) estimated the size of the seasonal resident gray whale group to be about 180 individuals, but did not discuss any yearly trends in abundance.

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4-5.4 North pacific right whale (*Eubalaena japonica)*

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Endangered
Washington State	Endangered
Natural Heritage Program	G1; State Not Ranked

RANGE

Right whales are distributed throughout the oceans and the historic range of the North Pacific right whale probably included much of the northern Pacific (National Marine Fisheries Service 2002). A small area on the middle shelf of the southeastern Bering Sea, north of the Aleutian Islands (Goddard and Rugh 1998) has provided the most consistent sightings of North Pacific right whales since 1980 (Sheldon et al. 2005) and the area has become a focal point for acoustic and population surveys (Tynan et al. 2001; McDonald and Moore 2002).

There are no recent records documenting the presence of the species in Washington State waters, with only three record sightings occurring off the Oregon and Washington coasts

since the 1950s (North Pacific Right Whale Recovery Team 2004). Only the 1967 sighting just west of Cape Flattery, appeared to be in Washington State waters. The most recent sighting was made in 1992 northwest of Gray's Harbor and well off the coast (Rowlett et al. 1994). One unconfirmed sighting was recorded in 1983 in British Columbia waters at the entrance to the Strait of Juan de Fuca (North Pacific Right Whale Recovery Team 2004).

HABITAT USE

North Pacific right whales are often found in relatively shallow waters (50 to 80 meters depth) associated with ocean-temperature fronts and water-column stratification that may help concentrate their prey (Tynan et al. 2001). Their habitat is largely determined by the occurrence of the dense groups of zooplankton, particularly calanoid copepods, on which they feed (Tynan et al. 2001; North Pacific Right Whale Recovery Team 2004).

POPULATION TRENDS

Based on records from the 1840s, National Marine Fisheries Service (1991) estimated that pre-whaling populations of North Pacific right whales exceeded 11,000 individuals. Currently, the eastern Pacific population is considered to be among the most endangered baleen whale populations (Clapham et al. 1999), and in 2002 the National Marine Fisheries Service reported that a reliable estimate of the minimum population size could not be made and that only 14 individuals had been observed during aerial surveys conducted from 1998 to 2000.

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4-6 Plants

4-6.1 Kalm's or brook lobelia (*Lobelia kalmii)*

STATUS AND RANK

Entity	Status/Rank
Federal Government	Not Listed
Washington State	Endangered
Natural Heritage Program	G5; S1

RANGE

Kalm's lobelia occurs throughout the northeastern United States, much of Canada, and may occur in all of the states along the northern tier of the U.S. (NatureServe 2005). It is considered frequent in southeast and northern British Columbia, but infrequent in the south-central region (Klinkenberg 2004). Although it has not been confirmed to exist in either Idaho (Idaho Fish and Game 2005) or Oregon, in Washington it is known only from one extant site in northeastern Yakima County (Washington DNR 2005), with Hitchcock and Cronquist (1973) suggesting that it may also occur in northeastern Washington.

HABITAT USE

In much of its range, lobelia habitat appears to be correlated with calcareous soils or limestone. The habitat of Kalm's lobelia is described as "calcareous shores and swamps" (Gleason and Cronquist 1991), "wet or springy places in limestone regions" (Newcomb 1977) and "wet to moist calcareous fens, shorelines and meadows in the montane zone" (Klinkenberg 2004). Hitchcock and Cronquist (1973) describe the habitat as marl or peat bogs along shores and in other wet places. The Yakima county population is located in a densely-vegetated perennial spring (Washington DNR 2005), where it co-occurs with several other taxa that are rare in Washington State. Although the site may not be strictly calcareous, it is likely that the soil and water are at least slightly alkaline.

Kalm's lobelia is a perennial species that will often occur at sites with standing water, such that the basal leaves are submerged while the upper leaves and flower are emergent. However, it can also occur at sites where there is little or no standing water (Washington DNR 2005). It flowers from July through August (Hitchcock et al. 1959).

POPULATION TRENDS

Globally, Kalm's lobelia is considered to be secure and stable (G5). However, in North America it is considered imperiled (S1) in several states, mostly on the southern edge of the species range, including Washington State. The trend for the extant population in Washington is not known, because it has not been revisited since 1994 (Caplow, Personal communication. March 18, 2005).

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4-6.2 Pygmy water-Lily (*Nymphaea tetragona*)

STATUS AND RANK

Entity	Status/Rank
NOAA Fisheries	Not Listed
Washington State	Not Listed
Natural Heritage Program	G5; SH

RANGE

Nymphaea tertagona has been reported in only two locations within one small area in the contiguous United States - Whatcom County in extreme northwestern Washington. The species was collected by W.C. Muenscher in 1939 (Burke Museum 2005) and was also collected in 1966 (Caplow, Personal communication. March 18, 2005). Both of the previous collection locations are now dominated by *Phalaris arundinacea* and *N. tetragona* no longer exists at either site (Caplow, Personal communication. March 18, 2005). The species is now believed to be extirpated from both the State of Washington and the contiguous United States (Flora of North America Committee 1997; NatureServe 2005; Washington DNR 2005).

Although *N. tetragona* is distributed broadly over northwestern North America, it is not common anywhere in its New World range (Flora of North America Committee 1997). It is considered imperiled (S2) or critically imperiled (S1) in Canada (NatureServe 2005), where it occurs across central Manitoba and northern Saskatchewan, extreme northeast Alberta and in British Columbia (Flora of North American Committee 1997). In British Columbia, it is found at a few sites along the coast and in the central portion of the province (Klinkenberg 2004). It can also be found in south central Alaska (Flora of North America Committee 1997). The NatureServe (2005) database indicates that it is vulnerable (S3) in Alaska, but the Alaska Natural Heritage Program does not include it in its list of tracked plant species (ANHP 2004). The species is probably more common in Eurasia and is found in Finland, Russia, China and Japan (NatureServe 2005).

HABITAT USE

Pygmy water-lily are similar to other water lilies in that it is a perennial aquatic plant, rooted in the underlying sediment, with elliptical, floating leaves and bowl-shaped flowers that float on the surface. The leaves are about 12 centimeters diameter and smaller than the more common *N. odorata* (up to 40 centimeters) (Flora of North America Committee 1997); with the flowers similarly smaller. The leaves have an individual lifespan of approximately 31 days (Kunii and Aramaki 1992), whereas the tuberous rhizomes persist for more than 5 years (Kunii 1993).

Pygmy water-lily occurs in ponds, lakes and quiet streams (Flora of North America Committee 1997) and has acclimated to both human- and beaver-created impoundments (NatureServe 2005). It flowers in summer.

POPULATION TRENDS

The global population trend is probably stable. In Washington State, however, it is believed to be extirpated.

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Appendix A - Species Selection Chronology

Appendix A - Washington DNR species selection chronology

Master Species.xls

- Combined state and federal lists
- Eliminated species that don't occur in Washington
- Eliminated terrestrial species

Possible SpeciesV_1.xls

- Added habitat, life history requirements

Possible Species V_2.xls

- Added five criteria:
  - Probability of being listed during the lifetime of the HCP
  - The occurrence of the species within the planning area
  - Degree of species dependence on submerged lands for habitat
  - Vulnerability from WA DNR authorized activities
  - Critical benefit to species from coverage

Possible Species V_3.xls

- Assigned numeric values to 3 criteria (Degree of species dependence on submerged lands; Vulnerability from WA DNR authorized activities; Critical benefit to species)
- Summed scores

Species Citeria.db

- Imported Possible Species V_3 (worksheet Possible V3) to Access
- Ran query (species list 1, Raw species list 1) based on the following criteria:
  - All species ranked H for probability of listing and occurring in WA
  - All species ranked H or M for probability of listing, occurring in WA and with a summed score of 5 or greater

Possible Species V_4.xls

- Imported Species Criteria Queries (species list 1 and raw species list 1)
- Checked for errors

Possible Species V_5.xls

- Compared V_4 list to species addressed in existing HCPs
- Based on species covered in existing HCPs, added 18 species to look at

Possible Species V_6.xls

- Added columns for Threats; Food Habitats and Special Habitat needs; WA DNR take mechanism; and Existing Recovery plans; Put WA Priority areas back in

Possible Species V_7.xls

- Eliminated Foskett speckled dace, Interior redband trout, Lake chub (not in WA); Lahotan cutthroat trout and Mountain sucker (introduced); added Margined sculpin (deleted by error)
- Ran plants and animals suggested by Natural Heritage Program through criteria
- Added Kalm's lobelia, Persistentsepal yellowcress, Pygmy water-lily, Water lobelia (Florence Caplow), Eared grebe, Sandhill crane, Western ridge mussel, Pink salmon to look at (suggested by John Fleckenstein).

Possible Species V_8.xls

- Applied "Include in Planning?" criteria of:
    - Yes = Criteria score >5 **and** uses state-owned aquatic land; **and/or** G3 or S3 and above
    - Possible = Criteria score >5 **and** uses state-owned aquatic land; **and/or** G3 or S3 and above; **But** use is limited
    - No = Criteria score <5; **or** not on state-owned aquatic land

Possible Species V_9.xls

- Added 5 original criteria columns

Possible Species V_10.xls

- Corrected errors IDed by NOAA Fisheries and US Fish and Wildlife
- Added Green sturgeon and Western Pearls shell for consideration
- Eliminated Species considered "Nos

Possible Species V_11.xls

- Added Associations

Appendix B - Species / Activities Interactions Matrix by Ecosystem

Appendix B - Species / activities interactions matrix by ecosystem.

Association	Common Name	Life Stage	Vulnerability to activities authorized by Washington DNR			Vulnerable to defined activities (Count of yeses)					
						Marine			Fresh Water		
			Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
Amphibians	Cascades Frog	all	2	2	M	0	0	0	9	9	8
	Columbia spotted frog	all	2	3	H	0	0	0	12	12	8
	Coastal tailed frog	all	1	3	H	0	0	0	12	0	0
	Northern leopard frog	all	3	3	H	0	0	0	12	12	8
	Northern red-legged frog	all	3	2	M	0	0	0	11	11	8
	Oregon spotted frog	all	3	2	M	0	0	0	12	12	8
	Rocky Mountain tailed-frog	all	1	2	M	0	0	0	10	0	3
	Western toad	all	1	2	M	0	0	0	6	9	8
Birds	American white pelican	nesting	2	3	H	0	0	0	2	12	8

[1] Not cumulative scores, based on an individual column exceeding defined values of Yes > 12 = 3; Yes >7 but <12 = 2; Yes <7 = 1
[2] H = new rank of 3; M = new rank of 2; L = new rank of 1

						Vulnerable to defined activities (Count of yeses)					
			Vulnerability to activities authorized by Washington DNR			Marine			Fresh Water		
Association	Common Name	Life Stage	Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
	American white pelican	wintering	2	3	H	0	0	9	12	12	8
	Bald Eagle	adult	2	3	H	14	14	10	12	12	8
	Bald Eagle	nesting	2	3	H	0	0	0	12	12	0
	Black tern	nesting	3	3	H	0	0	7	12	12	8
	Black tern	migration	3	3	H	0	0	7	12	12	8
Birds	Brandt's cormorant	nesting	3	2	M	6	6	11	0	0	0
	Brandt's cormorant	wintering	3	2	M	6	6	11	0	0	0
	Brown pelican	nesting	3	2	M	0	0	0	0	0	0
	Brown pelican	wintering	3	2	M	0	0	9	0	0	0
	Cassin's auklet	nesting	1	1	L	0	0	0	0	0	0
	Cassin's auklet	wintering	1	1	L	0	0	0	0	0	0
	Clark's grebe	nesting	2	3	M	0	0	0	0	10	7
	Clark's grebe	wintering	2	3	H	13	13	11	0	0	0
	Common loons	nesting	3	3	H	0	0	0	0	12	8
	Common loons	wintering	3	3	H	10	10	8	12	12	0

			Vulnerability to activities authorized by Washington DNR			Vulnerable to defined activities (Count of yeses)					
						Marine			Fresh Water		
Association	Common Name	Life Stage	Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
	Common murre	nesting	2	3	H	13	13	0	0	0	0
	Common murre	wintering	2	3	H	13	13	0	0	0	0
	Eared grebe	nesting	2	3	H	0	0	0	0	12	8
	Eared grebe	wintering	2	3	H	10	10	8	12	0	0
	Harlequin duck	adult	2	3	H	13	13	0	0	0	8
	Harlequin duck	nesting	2	3	H	0	0	0	12	12	8
	Marbled murrelet	nesting	1	3	H	0	0	0	0	12	0
	Marbled murrelet	wintering	1	3	H	13	13	7	0	0	0
	Peregrine falcon	adult foraging	2	3	H	14	14	10	12	12	8
	Peregrine falcon	nesting	2	3	H	0	0	0	12	12	8
	Purple martin	adult foraging	2	3	H	0	0	0	12	12	6
	Purple martin	nesting	2	3	H	0	0	0	12	12	6
	Tufted puffin	nesting	1	2	M	10	10	0	0	0	0
	Tufted puffin	wintering	1	2	M	10	10	0	0	0	0

			Vulnerability to activities authorized by Washington DNR			Vulnerable to defined activities (Count of yeses)					
						Marine			Fresh Water		
Association	Common Name	Life Stage	Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
	Western snowy plover	all	2	1	L	4	4	4	0	0	0
Freshwater & Anadromous Fish	Bull trout / Dolly varden	adult foraging	3	3	H	13	13	10	12	12	0
	Bull trout / Dolly varden	spawn / incub / juv	3	3	H	0	0	0	12	12	0
	Chinook salmon	adult foraging	3	3	H	15	15	12	11	12	0
	Chinook salmon	spawn / incub / juv	3	3	H	0	0	0	12	12	0
	Chum salmon	adult foraging	3	3	H	14	14	11	12	0	0
	Chum salmon	spawn / incub / juv	3	3	H	0	0	0	12	0	0
	Coastal cutthroat	adult foraging	3	3	H	14	14	11	12	12	0
	Coastal cutthroat	spawn / incub / juv	3	3	H	0	0	0	12	12	0
	Coho salmon	adult foraging	3	3	H	14	14	11	12	12	0

						Vulnerable to defined activities (Count of yeses)					
			Vulnerability to activities authorized by Washington DNR			Marine			Fresh Water		
Association	Common Name	Life Stage	Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
	Coho salmon	spawn / incub / juv	3	3	H	0	0	0	12	12	0
	Kokanee	adult foraging	3	3	H	0	0	0	12	12	0
	Kokanee	spawn / incub / juv	3	3	H	0	0	0	12	12	8
	leopard dace	all	3	3	H	0	0	0	12	0	0
	Margined sculpin	all	3	3	H	1	1	1	12	0	0
	Olympic Mudminnow[3]	all									
	Pacific lamprey	adult foraging	3	3	H	3	3	0	0	0	0
	Pacific lamprey	spawn / incub / juv	3	3	H	0	0	0	12	0	0
	Pink salmon	adult foraging	3	3	H	14	14	11	12	0	0
	Pink salmon	spawn / incub / juv	3	3	H	0	0	0	12	0	0

[3] These species were added after the Preliminary Species Selection was completed.

			Vulnerability to activities authorized by Washington DNR			Vulnerable to defined activities (Count of yeses)					
						Marine			Fresh Water		
Association	Common Name	Life Stage	Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
	Pygmy whitefish	adult foraging	3	3	H	0	0	0	12	12	0
	Pygmy whitefish	spawn / incub / juv	3	3	H	0	0	0	12	12	0
	River lamprey	adult foraging	3	3	H	3	3	0	0	0	0
	River lamprey	spawn / incub / juv	3	3	H	0	0	0	12	0	0
	Sockeye salmon	adult foraging	3	3	H	15	15	12	12	12	0
	Sockeye salmon	spawn / incub / juv	3	3	H	0	0	0	12	12	0
	Steelhead	adult foraging	3	3	H	14	14	11	12	12	0
	Steelhead	spawn / incub / juv	3	3	H	0	0	0	12	12	0
	Umatilla dace	all	3	3	H	0	0	0	12	0	0
	Westslope cutthroat	adult foraging	3	3	H	0	0	0	12	12	0
	Westslope cutthroat	spawn / incub / juv	3	3	H	0	0	0	12	12	0

			Vulnerability to activities authorized by Washington DNR			Vulnerable to defined activities (Count of yeses)					
						Marine			Fresh Water		
Association	Common Name	Life Stage	Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
Invertebrates	California floater[1]	all									
	Giant Columbia River limpet	all	3	3	H	0	0	0	12	0	0
	Great Columbia River spire snail	all	3	3	H	0	0	0	12	0	0
	Idaho Springsnail	all	3	3	H	0	0	0	12	0	0
	Lynn's clubtail	adult foraging	3	3	H	0	0	0	12	1	0
	Lynn's clubtail	breeding	3	3	H	0	0	0	12	1	0
	Masked dusky snail[1]	all									
	Nerite Rams-Horn[1]	all									
	Newcomb's littorine snail	all	3	2	M	0	10	11	0	0	0
	Olympia Oyster	all	3	3	H	5	13	3	0	0	0
	Olympia pebblesnail[1]	all									
	Pinto abalone	all	3	3	H	0	12	0	0	0	0

			Vulnerability to activities authorized by Washington DNR			Vulnerable to defined activities (Count of yeses)					
						Marine			Fresh Water		
Association	Common Name	Life Stage	Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
	Washington dusky snail[1]	all									
	Western ridgemussel	all	2	3	H	0	0	0	12	0	0
Marine Fish	Black rockfish	all	3	2	M	8	6	1	0	0	0
	Bocaccio rockfish	all	3	2	M	8	6	1	0	0	0
	Brown rockfish	all	3	2	M	8	6	1	0	0	0
	Canary rockfish	all	3	2	M	8	6	1	0	0	0
	China rockfish	all	3	2	M	8	6	1	0	0	0
	Copper rockfish	all	3	2	M	8	6	1	0	0	0
	Eulachon	adult foraging	2	3	H	1	0	10	1	0	0
	Eulachon	spawn / incub / juv	2	3	H	0	0	0	12	0	0
	Green sturgeon	all	1	3	H	1	1	2	12	0	0
	Greenstriped rockfish	all	3	2	M	8	6	1	0	0	0
	Pacific cod	all	3	3	H	13	11	0	0	0	0

			Vulnerability to activities authorized by Washington DNR			Vulnerable to defined activities (Count of yeses)					
						Marine			Fresh Water		
Association	Common Name	Life Stage	Original Rank	New rank[1]	New rank category[2]	Nearshore	Offshore	Estuarine-Wetlands	Riverine	Lakes	Wet-lands
	Pacific hake	all	3	3	H	13	12	0	0	0	0
	Pacific herring	all	3	3	H	13	13	12	0	0	0
	Quillback rockfish	all	3	2	M	8	6	1	0	0	0
	Redstripe rockfish	all	3	2	M	8	6	1	0	0	0
	Tiger rockfish	all	3	2	M	8	6	1	0	0	0
	Walleye pollock	all	3	3	H	13	3	0	0	0	0
	White sturgeon	adult foraging	3	3	H	0	0	1	12	12	0
	White sturgeon	spawn / incub / juv	3	3	H	0	0	0	12	12	0
	Widow rockfish	all	3	2	M	8	6	1	0	0	0
	Yelloweye rockfish	all	3	2	M	8	6	1	0	0	0
	Yellowtail rockfish	all	3	2	M	8	6	1	0	0	0
Marine Mammals	Blue whale	all	1	1	L	0	0	0	0	0	0
	Bowhead whale	all	1	1	L	0	0	0	0	0	0

						Vulnerable to defined activities (Count of yeses)					
			Vulnerability to activities authorized by Washington DNR			Marine			Fresh Water		
Association	**Common Name**	**Life Stage**	**Original Rank**	**New rank[1]**	**New rank category[2]**	**Nearshore**	**Offshore**	**Estuarine-Wetlands**	**Riverine**	**Lakes**	**Wet-lands**
	Gray whale	migratory	1	1	L	6	6	3	0	0	0
	Killer whale	all	2	1	L	6	6	0	0	0	0
	North Pacific Right whale	all	1	1	L	0	0	0	0	0	0
	Northern sea otter	all	2	2	M	8	8	11	0	0	0
	Steller sea-lion	wintering	2	2	M	8	8	5	0	0	0
	Kalm's lobelia	all	3	2	M	0	0	0	0	10	8
Plants	Persistent-sepal yellowcress	all	3	3	H	0	0	0	12	0	0
Plants	Pygmy water-lilly	all	3	3	H	0	0	0	12	12	8
Plants	Water howellia	all	2	3	H	0	0	0	12	12	8
Plants	Water lobelia	all	3	3	H	0	0	0	0	12	8
Reptiles	Western pond turtle	all	3	3	H	0	0	0	12	12	8

Appendix C – Species Data Origins

Appendix C – Species data origins.

Association	Common Name	Species Observation Data (Point Observations) *file name*	Modeled/Predicted Habitat Data (Polygons or Lines) *file name*	Generalized Distribution Data (Polygons) *file name*	Suitable Habitat Distribution *file name*	Date Acquired
Amphibian	Cascades frog	WDFW observations (Herps dataset) *herps_RANCA.shp*	Washington GAP data *ranca_pd*	ICBEMP Data *rancas_c*		2005
	Columbia spotted frog	NONE	Washington GAP data *ralu_pd*	ICBEMP Data *ranlut_c*		2005
	Northern leopard frog	WDFW observations (Herps dataset) *herps_RAPI.shp*	Washington GAP data *rapi_pd*	ICBEMP Data *ranpip_c*		2005
	Northern red-legged frog	see Red-legged frog	see Red-legged frog	see Red-legged frog		2005
	Oregon spotted frog	WDFW observations (Herps dataset) *heritage_RAPR.shp & herps_RAPR.shp*	Washington GAP data *rapr_pd*	NONE		2005
	Red-legged frog	WDFW observations (Herps dataset) *herps_RAAU.shp*	Washington GAP data *raau_pd*	ICBEMP Data *ranaur_c*		2005

Association	Common Name	Species Observation Data (Point Observations) ***file name***	Modeled/Predicted Habitat Data (Polygons or Lines) ***file name***	Generalized Distribution Data (Polygons) ***file name***	Suitable Habitat Distribution ***file name***	Date Acquired
	Rocky Mountain tailed-frog	NONE	Washington GAP data *astr_pd*	ICBEMP Data *asctru_c*		2005
	Western toad	WDFW observations (Herps dataset) *herps_BUBO.shp*	Washington GAP data *bubo_pd*	ICBEMP Data *bufbor_c*		2005
Birds	American white pelican	WDFW observations (Natural Heritage dataset) *heritage_PEER.shp*	NONE	ICBEMP Data *pelery_c*		2005
	Bald eagle	WDFW observations (natural heritage, PSAMP Puget Sound observations, additional WDFW observations) *heritage_HALE.shp, w93-04point_BAEA.shp, wdfwbird_HALE.shp*	Washington GAP data	ICBEMP Data *halleu_c*		2005
	Black tern	WDFW observations (Natural Heritage dataset) *heritage_CHNI.shp*	Washington GAP data *chni_pd*	ICBEMP Data *chlnig_c*		2005

Association	Common Name	Species Observation Data (Point Observations) *file name*	Modeled/Predicted Habitat Data (Polygons or Lines) *file name*	Generalized Distribution Data (Polygons) *file name*	Suitable Habitat Distribution *file name*	Date Acquired
	Brandt's cormorant	WDFW observations (PSAMP Puget Sound Surveys) *w93-04point_BRCO.shp*	Washington GAP data *phpen_pd*	NONE		2005
	Brown pelican	WDFW observations (Natural Heritage and PSAMP) *heritage_PEOC.shp, w93-04point_BRPE.shp*	NONE	NONE		2005
	Cassin's auklet	NONE	NONE	NONE		2005
	Clark's grebe	WDFW observations (Natural Heritage dataset) *heritage_AECL.shp*	NONE	ICBEMP Data *aeccla_c*		2005
	Common loon	WDFW observations (Natural Heritage and PSAMP) *heritage_GAIM.shp, w93-04point_COLO.shp*	Washington GAP data *gaim_pd*	ICBEMP Data *gavimm_c*		2005

Association	Common Name	**Species Observation Data (Point Observations)** ***file name***	**Modeled/Predicted Habitat Data (Polygons or Lines)** ***file name***	**Generalized Distribution Data (Polygons)** ***file name***	**Suitable Habitat Distribution** ***file name***	**Date Acquired**
	Common murre	WDFW observations (PSAMP Puget Sound Surveys) *w93-04point_COMU.shp*	Washington GAP data *uraa_pd*	NONE	Project Staff input *murre_forage.shp*	2005
	Eared grebe	NONE	Washington GAP data *podni_pd*	ICBEMP Data *podnig_c*		2005
	Harlequin duck	WDFW observations (Natural Heritage dataset) *heritage_HIHI.shp*	NONE	ICBEMP Data *hishis_c*	Project Staff input *duck_wintering.shp*	2005
	Marbled murrelet	WDFW observations (MMDETS dataset, Natural Heritage dataset, PSAMP) *mmdets, wdfwbird_BRMA.shp, w93-04point_MAMU.shp*	Washington GAP and MMST dataset *brma_pd*	NONE	Project Staff input *murrelet_foraging.shp*	2005
	Peregrine falcon	WDFW observations (Natural Heritage and PSAMP) *heritage_FAPE.shp, w93-04point_PEFA.shp*	Washington GAP *fape_pd*	ICBEMP Data *falper_c*		2005

Association	Common Name	Species Observation Data (Point Observations) ***file name***	Modeled/Predicted Habitat Data (Polygons or Lines) ***file name***	Generalized Distribution Data (Polygons) ***file name***	Suitable Habitat Distribution ***file name***	Date Acquired
	Purple martin	WDFW observations (Natural Heritage dataset) *heritage_PRSU.shp*	Washington GAP *prsu_pd*	ICBEMP Data *prosub_c*		2005
	Tufted puffin	WDFW observations (Seabird colonies)	Washington GAP *frci_pd*	NONE		2005
	Western snowy plover	WDFW observations (Natural Heritage dataset) *heritage_CHAL.shp*	Washington GAP *chal_pd*	ICBEMP Data *chaani_c*		2005
Fish	Black rockfish	NONE	NONE	Puget Sound Atlas data		2005
	Bocaccio rockfish	NONE	NONE	Puget Sound Atlas data		2005
	Brown rockfish	NONE	NONE	Puget Sound Atlas data	Project Staff input *brown.shp*	2005
	Bull trout/Dolly Varden	NONE	Streamnet Anadramous Fish Data *fishd83*	ICBEMP Data for eastern Washington watersheds		2005
	Canary rockfish	NONE	NONE	Puget Sound Atlas data		2005

Association	Common Name	Species Observation Data (Point Observations) *file name*	Modeled/Predicted Habitat Data (Polygons or Lines) *file name*	Generalized Distribution Data (Polygons) *file name*	Suitable Habitat Distribution *file name*	Date Acquired
	China rockfish	NONE	NONE	Puget Sound Atlas data	Project Staff input *china.shp* & Reef-dwelling groundfish data *gfreef*	2005
	Chinook salmon	NONE	Streamnet Anadramous Fish Data *fchin.shp, spchin.shp, suchin.shp*	ICBEMP Data for eastern Washington watersheds		2005
	Chum salmon	NONE	Streamnet Anadramous Fish Data *fishd83 - renamed to ChumSel031105.shp*	ICBEMP Data for eastern Washington watersheds		2005
	Coastal Cutthroat	NONE	Streamnet Resident Fish Data and Anadramous Fish Data *fishd83, anadfish_SRCT.shp, resfish_CCT.shp*	ICBEMP Data for eastern Washington watersheds		2005
	Coho salmon	NONE	Streamnet Anadramous Fish Data *coho.shp*	ICBEMP Data for eastern Washington watersheds		2005

Association	Common Name	Species Observation Data (Point Observations) *file name*	Modeled/Predicted Habitat Data (Polygons or Lines) *file name*	Generalized Distribution Data (Polygons) *file name*	Suitable Habitat Distribution *file name*	Date Acquired
	Copper rockfish	NONE	NONE	Puget Sound Atlas data	Project Staff input *copper.shp* & Reef-dwelling groundfish data *gfreef*	2005
	Eulachon	NONE	NONE	NONE		2005
	Green sturgeon	NONE	NONE	NONE		2005
	Greenstriped rockfish	NONE	NONE	Puget Sound Atlas data	Project Staff input *greenstriped.shp* & Reef-dwelling groundfish data *gfreef*	2005
	Kokanee	See Sockeye Salmon	See Sockeye Salmon	See Sockeye Salmon		2005
	Leopard dace	WDFW observations (Natural Heritage dataset) *heritage_RHFA.shp*	Streamnet Resident Fish Data *resfish_LED.shp*	ICBEMP Data for eastern Washington watersheds		2005
	Margined sculpin	WDFW observations (Natural Heritage dataset) *heritage_COMA.shp*	NONE	ICBEMP Data for eastern Washington watersheds		2005

Association	Common Name	Species Observation Data (Point Observations) ***file name***	Modeled/Predicted Habitat Data (Polygons or Lines) ***file name***	Generalized Distribution Data (Polygons) ***file name***	Suitable Habitat Distribution ***file name***	Date Acquired
	Pacific cod	NONE	NONE	NONE	Project Staff input *pacific_cod.shp*	2005
	Pacific hake	NONE	NONE	NONE	Project Staff input *pacific_hake.shp*	2005
	Pacific herring	Spawning and Holding Areas from WDFW *herrspwn, herrhold*	NONE	NONE		2005
	Pacific lamprey	WDFW observations (Natural Heritage) *heritage_LATR.shp*	Streamnet Resident Fish Data *resfish_PLP.shp*	NONE		2005
	Pink salmon	NONE	Streamnet Anadramous Fish Data *pink.shp*	ICBEMP Data for eastern Washington watersheds		2005
	Pygmy whitefish	WDFW observations (Natural Heritage) *heritage_PRCO.shp*	Streamnet Resident Fish Data	NONE		2005

Association	Common Name	Species Observation Data (Point Observations) *file name*	Modeled/Predicted Habitat Data (Polygons or Lines) *file name*	Generalized Distribution Data (Polygons) *file name*	Suitable Habitat Distribution *file name*	Date Acquired
	Quillback rockfish	NONE	NONE	Puget Sound Atlas data	Project Staff input *quillback.shp,* Reef-dwelling groundfish data *gfreef,* and eelgrass habitat *eellineprj.shp*	2005
	Redstripe rockfish	NONE	NONE	Puget Sound Atlas data	Project Staff input *redstripe.shp* & Reef-dwelling groundfish data *gfreef*	2005
	River lamprey	WDFW observations (Natural Heritage) *heritage_LAAY.shp*	Streamnet Resident Fish Data *resfish_XLP.shp*	ICBEMP Data for eastern Washington watersheds		2005
	Sockeye/Konanee salmon	NONE	Streamnet Anadramous Fish Data *sockeye.shp*	ICBEMP Data for eastern Washington watersheds		2005
	Steelhead	NONE	Streamnet Anadramous Fish Data *ssteel.shp & wsteel.shp*	ICBEMP Data for eastern Washington watersheds		2005

Association	Common Name	Species Observation Data (Point Observations) *file name*	Modeled/Predicted Habitat Data (Polygons or Lines) *file name*	Generalized Distribution Data (Polygons) *file name*	Suitable Habitat Distribution *file name*	Date Acquired
	Tiger rockfish	NONE	NONE	Puget Sound Atlas data	Project Staff input *tiger2.shp* & Reef-dwelling groundfish data *gfreef*	2005
	Umatilla dace	WDFW observations (Natural Heritage) *heritage_RHUM.shp*	NONE	NONE		2005
	Walleye pollock	NONE	NONE	NONE	Project Staff input *walleye_pollock2.shp*	2005
	Westslope cutthroat	NONE	Streamnet Resident Fish Data and Anadramous Fish Data *resfish_WCT.shp*	ICBEMP Data for eastern Washington watersheds		2005
	White sturgeon	WDFW observations (Natural Heritage)	Streamnet Resident Fish Data *Dist_White_sturgeon.shp*	ICBEMP Data for eastern Washington watersheds		2005
	Widow rockfish	NONE	NONE	Puget Sound Atlas data		2005
	Yelloweye rockfish	NONE	NONE	Puget Sound Atlas data		2005

Association	Common Name	Species Observation Data (Point Observations) ***file name***	Modeled/Predicted Habitat Data (Polygons or Lines) ***file name***	Generalized Distribution Data (Polygons) ***file name***	Suitable Habitat Distribution ***file name***	Date Acquired
	Yellowtail rockfish	NONE	NONE	Puget Sound Atlas data		2005
Invertebrate	Ashy (Columbia) pebblesnail	Neitzel, D.A. and T.J. Frest 1989, and NatureServe 2005 *columbia_pebblesnail.shp*	NONE	NONE		2005
	Columbia River tiger beetle	WDFW observations (Natural Heritage) *heritage_CICO.shp*	NONE	NONE		2005
	Lynn's clubtail	NONE	NONE	NONE	Project Staff input *clubtail.shp*	2005
	Newcomb's littorine snail	NONE	NONE	NONE	Project Staff input *littorine_snail.shp*	2005
	Olympia oyster	Baker, P., N. Richmond, N. Terwilliger 1999, and WDFW 2005. *olympia_oyster_point.shp*	NONE	NONE	Project Staff input *olympia_oyster_line.shp*	2005
	Pinto (Northern) abalone	NONE	NONE	Puget Sound Atlas data *abalone*		2005

Association	Common Name	Species Observation Data (Point Observations) ***file name***	Modeled/Predicted Habitat Data (Polygons or Lines) ***file name***	Generalized Distribution Data (Polygons) ***file name***	Suitable Habitat Distribution ***file name***	Date Acquired
	Nerite Rams-Horn	NONE	NONE	NONE	Project Staff input *nerite_ramshorm.shp*	2005
	Western ridgemussel	NONE	Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2003 *western_ridgemussel.shp*	NONE		2005
Marine Mammal	North pacific right whale	NONE	NONE	NONE		2005
Marine Mammal	Blue whale	OBIS-SEAMAP data	NONE	NONE		2005
Marine Mammal	Bowhead whale	NONE	NONE	NONE		2005
Marine Mammal	Gray whale	Washington Department of Fish and Wildlife, Puget Sound Ambient Monitoring Project (PSAMP) *w93-04point_GRWH.shp*	NONE	Puget Sound Atlas data *whgray*		2005
Marine Mammal	Killer whale	The Whale Museum *orca.shp*	NONE	Puget Sound Atlas data *w93-04point_KIWH.shp*		2005

Association	Common Name	Species Observation Data (Point Observations) *file name*	Modeled/Predicted Habitat Data (Polygons or Lines) *file name*	Generalized Distribution Data (Polygons) *file name*	Suitable Habitat Distribution *file name*	Date Acquired
	Northern sea otter	WDFW observations (PSAMP, Natural Heritage Dataset) *heritage_ENLU.shp, w93-04point_SEOT.shp*	NONE	NONE		2005
	Steller sea-lion	WDFW observations (Seal Haulouts and PSAMP data) *steller.shp*	NONE	NONE		2005
Plant	Kalm's lobelia	Washington DNR, Washington Natural Heritage Program *wnhp-aquatics.shp*	NONE	NONE		2005
	Persistentsepal yellowcress	Washington DNR, Washington Natural Heritage Program *wnhp-aquatics.shp*	NONE	NONE		2005
	Pygmy water-lily	NONE	NONE	NONE		2005

Association	Common Name	Species Observation Data (Point Observations) ***file name***	Modeled/Predicted Habitat Data (Polygons or Lines) ***file name***	Generalized Distribution Data (Polygons) ***file name***	Suitable Habitat Distribution ***file name***	Date Acquired
	Water howellia	Washington DNR, Washington Natural Heritage Program *wnhp-aquatics.shp*	NONE	NONE		2005
	Water lobelia	Washington DNR, Washington Natural Heritage Program *wnhp-aquatics.shp*	NONE	NONE		2005
Reptile	Western pond turtle	WDFW observations (Herps dataset, Natural Heritage Dataset) *heritage_CLMA.shp, herps_CLMA.shp*	Washington GAP *clma_pd*	ICBEMP Data *clemar_c.shp*		2005

Appendix D – Interim Species Designations

Appendix D - – Interim list of species identified as Covered (C), Evaluation (E), and Watch (W) list species.

Species				
Association	**Common Name**	**Scientific Name**	**Initial Category**	**Final Category**
Amphibians	Cascades frog	Rana cascadae	E	W
	Coastal tailed frog	*Ascaphus truei*	E	E
	Columbia spotted frog	*Rana pretiosa (spp. B)*	C	C
	Northern leopard frog	*Rana pipiens*	C	C
	Northern red-legged frog	*Rana aurora aurora*	C	W
	Oregon spotted frog	*Rana pretiosa (spp. A)*	E	E
	Red-legged frog	*Rana aurora*	C	Removed
	Rocky Mountain tailed-frog	*Ascaphus montanus*	E	W
	Western toad	*Bufo boreas (spp. A)*	E	E
Birds	American white pelican	*Pelecanus erythrorhynchos*	C	E
	Bald eagle	*Haliaeetus leucocephalus*	C	C
	Black Tern	*Chlidonias niger*	C	C
	Brandt's cormorant	*Phalacrocorax penicillatus*	E	W
	Brown pelican	*Pelecanus occidentalis*	E	E
	Cassin's auklet	*Ptychoramphus aleuticus*	E	E
	Clark's grebe	*Aechmophorus clarkii*	E	W
	Common loons	*Gavia immer*	C	C
	Common murre	*Uria aalge*	C	C
	Eared grebe	*Podiceps nigricollis*	C	E

Species			Initial Category	Final Category
Association	Common Name	Scientific Name		
	Harlequin duck	*Histrionicus histrionicus*	E	C
	Marbled murrelet	*Brachyramphus marmoratus*	C	C
	Peregrine falcon	*Falco peregrinus*	C	W
	Purple martin	*Progne subis*	C	W
	Tufted puffin	*Fratercula cirrhata*	E	C
	Western snowy plover	*Charadrius alexandrinus nivosus*	E	C
Fish - Anadromous	Bull trout/Dolly Varden	*Salvelinus confluentus*	C	C
	Chinook salmon	*Oncorhynchus tshawytscha*	C	C
	Chum salmon	*Oncorhynchus keta*	C	C
	Coastal cutthroat	*Oncorhynchus clarki clarki*	E	C
	Coho salmon	*Oncorhynchus kisutch*	C	C
	Eulachon	*Thaleichthys pacificus*	C	E
	Green sturgeon	*Acipenser medirostris*	W	E
	Pacific lamprey	*Lampetra tridentata*	C	E
	Pink salmon	*Oncorhynchus gorbuscha*	E	E
	River lamprey	*Lampetra ayresi*	C	E
	Sockeye salmon	*Oncorhynchus nerka*	C	C
	Steelhead	*Oncorhynchus mykiss*	C	C
	White sturgeon	*Acipenser transmontanus*	C	E
- Fresh	Leopard dace	*Rhinichthys falcatus*	C	E

Species			Initial Category	Final Category
Association	Common Name	Scientific Name		
	Margined sculpin	*Cottus marginatus*	C	E
	Olympic mudminnow	*Novumbru hubbsi*	E	E
	Pygmy whitefish	*Prosopium coulteri*	C	E
	Umatilla dace	*Rhinichthys umatilla*	C	E
	Westslope cutthroat	*Oncorhynchus clarki lewisi*	C	W
	Black rockfish	*Sebastes melanops*	E	E
	Bocaccio rockfish	*Sebastes paucispinis*	E	E
Fish - Marine	Brown rockfish	*Sebastes auriculatus*	E	E
	Canary rockfish	*Sebastes pinniger*	E	E
	China Rockfish	*Sebastes nebulosus*	E	E
	Copper rockfish	*Sebastes caurinus*	E	E
	Greenstriped rockfish	*Sebastes elongatus*	E	E
	Pacific cod	*Gadus macrocephalus*	C	E
	Pacific hake	*Merluccius productus*	C	E
	Pacific herring (Cherry Point, Discovery Bay)	*Clupea pallasi*	C	E
	Quillback rockfish	*Sebastes maliger*	E	E
	Redstripe rockfish	*Sebastes proriger*	E	E
	Tiger rockfish	*Sebastes nigrocinctus*	E	E
	Walleye pollock	*Theragra chalcogramma*	C	E
	Widow rockfish	*Sebastes entomelas*	E	E
	Yelloweye rockfish	*Sebastes ruberrimus*	E	E

Species			Initial Category	Final Category
Association	**Common Name**	**Scientific Name**		
	Yellowtail rockfish	*Sebastes flavidus*	E	E
Invertebrates	Ashy snail	*Fluminicola fuscus*	C	E
	California floater	*Anodonta californiensis*	E	E
	Columbia pebblesnail	*Fluminicola =Lithoglyphus columbianus*	C	Removed
	Columbia River tiger beetle	*Cicindela columbica*	E	Removed
	Fender's soliperlan stonefly	*Soliperla fenderi*	C	Removed
	Idaho Springsnail	*Pyrgulopsis idahoensis*	C	W
	Lynn's clubtail	*Gomphus lynnae*	E	E
	Masked duskysnail	*Lyogyrus sp. 2*	E	E
	Nerite rams-horn	*Vorticiflex neritoides*	E	E
	Newcomb's littorine snail	*Algamorda subrotundata*	E	E
	Olympia oyster	*Ostrea lurida*	C	E
	Olympia pebblesnail	*Fluminicola virens*	E	E
	Pinto (Northern) abalone	*Haliotis kamtschatkana*	C	C
	Rams-Horn Valvata	Valvata mergella	E	Removed
	Shortfaced Lanx	Fisherola nuttalli	C	E
	Washington duskysnail	*Amnicola sp. 2*	E	E
	Western ridgemussel	*Gonidea angulata*	E	E
Marine Mammals	Black right whale	*Balaena glacialis*	E	Removed
	Blue whale	*Balaenoptera musculus*	E	W
	Bowhead whale	*Balaena mysticetus*	E	W

Species			Initial Category	Final Category
Association	Common Name	Scientific Name		
	Gray whale	*Eschrichtius robustus*	E	W
	Humpback Whale	*Megaptera novaeangliae*	E	E
	Killer whale - Offshore	*Orcinus orca*	E	W
	Killer whale - Southern Resident	*Orcinus orca*	E	C
	Killer whale - Transient	*Orcinus orca*	E	E
	Northern sea otter	*Enhydra lutris kenyoni*	E	E
	Right whale	*Eubalaena japonica*	E	W
	Steller sea-lion	*Eumetopias jubatus*	E	E
Plants	Columbia yellow-cress	*Rorippa columbiae*	E	Removed
	Kalm's lobelia	*Lobelia kalmii*	E	W
	Persistentsepal yellowcress	*Rorippa calycina*	C	E
	Pygmy water-lily	*Nymphaea tetragona*	C	W
	Water howellia	*Howellia aquatilis*	C	C
	Water lobelia	*Lobelia dortmanna*	C	E
Reptile	Western pond turtle	*Clemmys marmorata*	C	C