RESOURCES

NATURAL

# Aquatic Lands Habitat Conservation Plan

August 2014

DRAFT

WASHINGTON STATE DEPARTMENT OF
**Natural Resources**
**Peter Goldmark** - Commissioner of Public Lands

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Washington DNR would also like to acknowledge the contributions of other current Aquatics Division/ District staff and former DNR Aquatics Division staff.

### Cover Photo Credits:
Clockwise from upper right: Eelgrass, Jeff Gaeckle; Boyce Creek on Hood Canal, Kelly Heinz; oyster cultch bag, Craig Zora; and Wenatchee River near the Columbia River, Battelle.

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***Also available at the time of publication are disks with the Appendices, Draft Habitat Conservation Plan, and Draft Environmental Impact Statement***

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# Introduction

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# Chapter 1. Introduction

The Washington State Department of Natural Resources (Washington DNR) has developed the Aquatic Lands Habitat Conservation Plan (Aquatic Lands HCP) in response to the listing of several species of animals as threatened or endangered under the federal Endangered Species Act. The Aquatic Lands HCP is programmatic in nature, addressing multiple species and habitats, and encompasses submerged lands managed by Washington DNR—excluding those areas managed by port management agreements (Revised Code of Washington [RCW] Section 79.105.420).

Washington DNR's authority for state-owned aquatic lands is governed by a hierarchy of laws, regulations, and guidelines that begin with the assertion of ownership in the Washington State Constitution (Article XVII). The laws granting Washington DNR the proprietary authority to manage state-owned aquatic lands are codified under Title 79 of the Revised Code of Washington (RCW). The state legislature directs Washington DNR management activities under RCW 79, 43.12, and 43.30. To fill gaps in statutory directive, Washington DNR adopted the rules published under Chapter 332-30 of the Washington Administrative Code (WAC), as well as internal policy statements (Standard Practice Memoranda and Guidelines) to provide consistency in the agency's management practices. Uses of state-owned aquatic lands are authorized under the agency's general authority to issue leases (RCW 79.105.210(4)), as well as its authority to issue easements (RCW 79.110 and 79.36.355), aquaculture leases (RCW 79.135), and permits to use waterways (RCW 79.120.040).

The scope and conservation strategy of the Aquatic Lands HCP were designed within the context of Washington DNR's proprietary authority and the agency's obligation to provide a balance of public benefits for current and future citizens of the state. Management guidelines for state-owned aquatic lands are identified within RCW 79.105.030 to include:

1. Encouraging direct public use and access.
2. Fostering water-dependent uses.
3. Ensuring environmental protection.
4. Utilizing renewable resources.

Generating revenue in a manner consistent with guidelines (1) through (4) is considered a public benefit.

The Aquatic Lands HCP includes the following:

- An executive summary that provides an overview of the elements in the document.
- A statement of purpose outlining the intent of the Aquatic Lands HCP.
- A description of the relationship between the Endangered Species Act and the benefits provided under Section 10(a)(1)(B) of the act; a description and quantification of the lands included; the process used for selecting activities to be covered under the Aquatic Lands HCP; the species covered under this HCP and a description of the process used to select species included in this HCP (Chapter 1).
- The history of aquatic land management in Washington State; the relationship of the Aquatic Lands HCP to other Washington DNR HCPs; and the regulatory environment affecting the Aquatic Lands HCP (Chapter 2).

- A description of how the covered activities occur on the landscape, and quantification of the land encumbered by the activities (Chapter 3).
- A description of covered species' distribution within Washington State and their life history requirements; a discussion of the environmental factors associated with covered activities and their effects on covered species; the direct and indirect effects covered by the Aquatic Lands HCP; and quantification of the area potentially affected by covered activities (Chapter 4).
- Washington DNR's goals and objectives under the Aquatic Lands HCP; the operating conservation program for the HCP; the implementation process and funding; compliance and effectiveness monitoring; and the HCP's adaptive management program (Chapter 5).
- A description of alternatives to the Aquatic Lands HCP that were considered and the reasons for their rejection (Chapter 6). The Environmental Impact Statement that accompanies this HCP includes a detailed discussion of the alternatives considered.

# 1.1 Purpose of the plan

Washington DNR developed the Aquatic Lands HCP to ensure that legally authorized, planned, and mandated management actions may continue to occur on state-owned aquatic lands without risk of violating the Endangered Species Act or resulting in an unlawful *take*[1] of threatened and endangered species. The Aquatic Lands HCP is a contractual agreement between the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries), U. S. Department of the Interior, U.S. Fish and Wildlife Service and Washington DNR. This HCP specifies the goals, strategies, and conservation measures Washington DNR will use to both protect and contribute to the recovery of species that depend on aquatic habitat.

The Aquatic Lands HCP formalizes Washington DNR's efforts to conserve and enhance submerged habitats on state-owned aquatic lands and provides a stable management framework for agency staff and those using state-owned aquatic lands. The HCP is programmatic in nature and covers multiple species, habitats, and activities. It addresses the protection of species through proprietary requirements that are included in the legal instruments (leases, etc.) authorizing uses of state-owned aquatic lands.

Generally stated, the goals for the Aquatic Lands HCP are to:

- Avoid and minimize effects to covered species and habitats.
- Improve and restore habitat conditions on state-owned aquatic lands.
- Identify and protect important habitats on state-owned aquatic lands.

## 1.1.1 Benefits

An aquatic HCP will help DNR protect sensitive, threatened, and endangered species that are native to Washington State and depend on aquatic habitat. An aquatic HCP will also ensure that activities authorized by DNR, such as leasing for marinas and aquaculture, can continue while avoiding and minimizing impacts to endangered species. By committing to the conservation

[1] Section 3 (18) of the Endangered Species Act defines *take* as "…to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

strategies in the aquatic HCP, DNR and entities that lease state-owned aquatic lands will receive federal assurances of compliance with the ESA.. The HCP will also provide assurances that authorized uses of state-owned aquatic lands may continue without jeopardizing covered species or their habitat. The citizens of the state will benefit from Washington DNR's continued ability to provide the balance of public benefits mandated by state law (RCW 79.105.030) and generate revenue managing state-owned aquatic lands. Other benefits include the potential to:

- Develop streamlined permit processes through applicable Aquatic Lands HCP conservation strategies.
- Minimize impacts from private residential docks through implementation of a management strategy (covered in Chapter 5, Section 2.4 of this document).
- Protect aquatic vegetation and forage fish spawning habitat (Chapter 5, Section 2.2).
- Conserve and restore important habitats (Chapter 5, Section 2.2).
- Develop landscape plans for identified priority landscapes (Chapter 5, Section 5.1).
- Increase understanding of the interactions between species, their habitats, and Washington DNR's activities through the HCP's monitoring and research commitments (Chapter 5, Section 4).
- Enhance Washington DNR management activities through implementation of the HCP's adaptive management process (Chapter 5, Section 4).

### 1.1.2 Term of the plan

Washington DNR is seeking an incidental take permit from NOAA Fisheries and U.S. Fish and Wildlife Service for a term of 50 years to run concurrently with the Aquatic Lands HCP. This term ensures that Washington DNR will be able to implement the defined conservation strategies and monitoring efforts for all activities covered by the HCP that currently exist on state-owned aquatic lands. At the termination of the permit, Washington DNR and the federal agencies may consider renewal of the permit with additional or amended conditions that reflect future circumstances and public involvement.

## 1.2 Endangered Species Act and assurances

The Endangered Species Act provides for the designation and protection of plants and animals that are in danger of becoming extinct and provides a means to conserve the ecosystems on which such species depend. Section 2(b) of the act defines its purpose as providing ". . . a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species."[2] The act prohibits the take of threatened or endangered species under Section 9(a) making it unlawful to take a species that is listed as endangered or threatened[3] without a permit from U.S. Fish and Wildlife Service, NOAA Fisheries, or both of these agencies that share responsibility for

[2] Endangered Species Act, 16 U.S.Code § 1531-1544, 87 Stat. 884, as amended.
[3] *Endangered species* are defined as those species in danger of becoming extinct throughout all or a significant portion of their range, with threatened species defined as species that are likely to become endangered in the foreseeable future.

administering the Endangered Species Act. Generally, U.S. Fish and Wildlife Service—acting on behalf of the secretary of the U.S. Department of the Interior—is responsible for terrestrial and freshwater aquatic species, while NOAA Fisheries—acting on behalf of the secretary of the U.S. Department of Commerce—is responsible for marine species and anadromous fish.

Under Section 10(a)(1)(B) the U.S. Fish and Wildlife Service or NOAA Fisheries may permit any taking otherwise prohibited by section 9(a)(1)(B) if such taking is incidental to, and not the purpose of, the carrying out of otherwise lawful activities. In order for such an incidental take permit to be issued, the applicant must submit a habitat conservation plan that specifies:

- The impact which will likely result from such taking (addressed in Chapter 4, Section 4.2 of this document).
- What steps the applicant will take to avoid, minimize and compensate for the impacts (Chapter 5, Section 5.2.) and the funding that will be available to implement the specified steps (Chapter 5, Section 5.3).
- What alternatives the applicant considered and why those alternatives are not acceptable (Chapter 6).
- Such other measures or conditions that the secretary of the interior and the secretary of commerce may require as being necessary or appropriate for purposes of the plan.

## 1.2.1 Issuance criteria

When the U.S. Fish and Wildlife Service or NOAA Fisheries (or both agencies, as appropriate) determine that all criteria for a habitat conservation plan have been met and there has been an opportunity for public comment, an incidental take permit shall be issued if the applicant meets the following criteria (16 U.S.C. 1539(a)(2)(B)):

- The taking will be incidental.
- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking.
- The applicant will ensure that adequate funding for the plan will be provided.
- The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild.
- Such measures that the secretary of the interior and the secretary of commerce may require as being necessary or appropriate to meet the purposes of the plan.

Providing the activities comply with the permit conditions, issuance of an incidental take permit allows the holder to conduct otherwise lawful activities in the presence of listed species without being liable for criminal or civil penalties that may result from an unauthorized taking.

## 1.2.2 Section 7

Section 7(a)(2) of the ESA requires all federal agencies to consult with the U.S. Fish and Wildlife Service and NOAA Fisheries to ensure that “. . . any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or

threatened species or result in the destruction or adverse modification . . . ” of designated critical habitat.[4] If the action is determined to have incidental take, agency actions will include the issuance of an incidental take permit, after the U.S. Fish and Wildlife Service and NOAA Fisheries conduct an intra-agency Section 7 consultation. The regulations implementing Section 7 (50 CFR 402) require, among other things, a biological consultation to analyze the direct and indirect effects of the proposed action; the cumulative effects of other activities on listed species; and where applicable, the effects of the action on critical habitat. For the Aquatic Lands HCP, an effects analysis on covered, unlisted species is required and a statement of incidental take is required for all covered (listed and unlisted) species. Information in the Aquatics Lands HCP and the associated environmental impact statement will assist the U.S. Fish and Wildlife Service and NOAA Fisheries in their consultation process.

For the purpose of Section 7, agency actions also include permits issued by a federal agency for construction or development of a single project such as building a dock. These single project consultations narrowly address avoidance, minimization, and compensation for the construction or development activities associated with the specific project; the Aquatic Lands HCP will not eliminate this requirement. In contrast, a Section 7 consultation conducted for a habitat conservation plan addresses avoidance, minimization, and compensation for take associated with an ongoing program of operation; the approved habitat conservation plan must address long-term monitoring and contributions to the recovery of listed species.

# 1.2.3 No surprises and unforeseen circumstances

## No surprises

The federal government provides the No Surprises assurances through the section 10(a)(1)(B) process to non-federal landowners. Through No Surprises, if unforeseen circumstances arise, the U.S. Fish and Wildlife Service and NOAA Fisheries will not require the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources beyond the level agreed to in the habitat conservation plan without the consent of the permittee. The federal government will honor these assurances as long as a permittee is implementing the terms and conditions of the habitat conservation plan, permit, and other associated documents in good faith [No Surprises Rule, 63 Fed. Reg. 8859 (Feb. 23 2998), codified at 50 C.F.R. § § 17.22, 17.32 and 222.307(g)] .

## Unforeseen circumstances

*Unforeseen circumstances* are those affecting either a species or the geographic area covered by the Aquatic Lands HCP that result in a substantial and adverse change in the status of a covered species and could not have been reasonably anticipated by Washington DNR or the permitting agencies at the time of developing and negotiating this HCP. In negotiating unforeseen circumstances, U.S. Fish and Wildlife Service and NOAA Fisheries will not require the

[4] Section 3(5)(A) of the Endangered Species Act defines *critical habitat* as specific areas occupied by a species at the time of its listing that contain the physical or biological features essential to the conservation of the species, and which may require special management considerations or protection.

commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources beyond the level otherwise agreed upon for the species covered by the conservation plan without the consent of the Washington DNR. Consistent with those limitations, if additional conservation and mitigation measures are deemed necessary to respond to unforeseen circumstances, the U.S. Fish and Wildlife Service and NOAA Fisheries may require additional measures of the Washington DNR. Additional measures may be applied when the conservation plan is being properly implemented, but only if such measures are limited to modifications within conserved habitat areas, if any, or to the conservation plan's operating conservation program for the affected species.

The original terms of the conservation plan will be maintained to the maximum extent possible. The U.S. Fish and Wildlife Service and NOAA Fisheries will have the burden of demonstrating that unforeseen circumstances exist, using the best scientific and commercial data available. These findings must be clearly documented and based upon reliable technical information regarding the status and habitat requirements of the affected species. U.S. Fish and Wildlife Service and NOAA Fisheries will consider, but not be limited to, the following factors:

- Size of the current range of the affected species.
- Percentage of range adversely affected by the conservation plan.
- Percentage of range conserved by the conservation plan.
- Ecological significance of that portion of the range affected by the conservation plan.
- Level of knowledge about the affected species and the degree of specificity of the species' conservation program under the conservation plan.
- The likelihood that survival and recovery of the affected species in the wild would be appreciably reduced if additional conservation measures were not adopted.

# 1.2.4 Changed circumstances

*Changed circumstances* are those affecting a species or the geographic area covered by this HCP that can reasonably be anticipated and that were taken into account by Washington DNR and U.S. Fish and Wildlife Service and NOAA Fisheries during the course of developing this HCP. Such changes include listing, delisting, or extirpation of a species; natural events such as floods or seismic events; introductions or increases in invasive species; global climate change; and spills of hazardous substances. Additionally, minor changes in the area of state-owned aquatic lands may occur through adjudication, sale, acquisition, or exchange. The incidental take permit will authorize the incidental take of covered species under ordinary circumstances and under changed circumstances, as long as Washington DNR is operating in compliance with this HCP and its associated documents.

## Change in species status

Over time, species status under the Endangered Species Act may change and additional species may be listed as threatened or endangered, delisted, declared extinct, or critical habitat for a species may be designated.

## Listing of species not covered by this HCP

When aquatic or aquatic-dependent species that occur within, or rely on, state-owned aquatic lands for significant portions of their life history become listed under the Endangered Species Act, the U.S. Fish and Wildlife Service and NOAA Fisheries will determine if there is a potential for incidental take of the species to occur as a result of the activities covered under the Aquatic Lands HCP. In instances where the U.S. Fish and Wildlife Service and NOAA Fisheries determine that there is the potential for take, Washington DNR can request that the newly listed species be added to the incidental take permit and amend the HCP or prepare a separate HCP to address the needs of that species. Under either circumstance, the U.S. Fish and Wildlife Service and NOAA Fisheries and Washington DNR will enter into discussions to develop the appropriate standards, programmatic strategies and activity-specific conservation measures to meet ESA Section 10(a) requirements for incidental take coverage.

## Delisting of covered species

If a species covered by this HCP is delisted (regardless of whether it has become extinct or is recovered), Washington DNR will evaluate whether it is in the best interest of the public to continue implementation of the standards, programmatic strategies, and activity-specific conservation measures designed to benefit the delisted species. If it is determined to continue with conservation strategies specific to the delisted species, Washington DNR will document the rationale, develop a plan for the species, and provide specific goals for public record.

## Extirpation of covered species

If there appears to be local extinction (extirpation) of a covered species from a distinct and isolated fragment of suitable habitat, Washington DNR, the U.S. Fish and Wildlife Service, and NOAA Fisheries will determine the appropriate study and survey protocols for evaluating the circumstances. If the study and survey conducted under the agreed-upon protocols show that the species is extirpated and that natural repopulation is unlikely, Washington DNR will evaluate whether it is in the best interest of the public to continue implementation of the standards, strategies, and measures designed to exclusively benefit the extirpated species in that area. If it is in the public interest, Washington DNR may continue implementation and, if feasible, may consider relocation of species from other habitat areas. Otherwise, Washington DNR will discontinue implementation of all standards, strategies, and measures that benefited only the extirpated species.

## Designation of critical habitat

When a critical habitat is designated for a listed species, whether covered by the HCP or not, the U.S. Fish and Wildlife Service and NOAA Fisheries will determine if there is a potential for critical habitat to be adversely modified as a result of the activities covered under the Aquatic Lands HCP. In instances where the U.S. Fish and Wildlife Service and NOAA Fisheries determine that there is this potential, Washington DNR can request that the covered lands be excluded from critical habitat designation. During the development of the rules for critical habitat, the U.S. Fish and Wildlife Service and NOAA Fisheries will take the request for exclusion into consideration based on the merits of the HCP's conservation strategy.

## Adjudication of ownership

The extent of state ownership may become more certain over the term of this HCP as the result of judicial decisions that particular freshwater lakes or rivers are, or are not, navigable for state title (see Section 1.3, Lands Covered). Rather than addressing changing conditions, such decisions correct erroneous assumptions about ownership; while Washington DNR can litigate the matter, the judicial courts make the final determination. If the question of navigability is fully litigated and a final decision is rendered by the court that aquatic land previously claimed by the state is actually owned by another entity, the Aquatic Lands HCP will no longer apply to the area litigated. If the court's final decision is that aquatic land not previously claimed by the state is actually state-owned, Washington DNR will apply the appropriate HCP standards, programmatic strategies, and activity-specific measures to the newly acknowledged lands.

## Sale, acquisition, and exchange of aquatic land

Washington DNR may sell, acquire, or exchange aquatic lands during the term of the Aquatic Lands HCP. Such conveyances are unlikely to result in significant changes to the land base of 2.6 million acres unless the legislature takes the unusual step of granting the agency substantially more discretion in conveyance of lands. The limitations on Washington DNR's authority to convey lands have been approximately the same for more than 40 years and are based on the classification of land as bedlands, tidelands, or shorelands (Section 1.3.1, Statutory Classification). The agency currently has no authority to convey bedlands; the agency does have the authority to sell shorelands and tidelands near cities to public entities for public purposes (RCW 79.125.200, 79.125.700 and 79.125.710). The agency may also sell shorelands to upland owners if the shorelands are more than two miles from cities and the sale is not contrary to the public interest (RCW 79.125.450). Washington DNR may exchange tidelands and shorelands with both private and public entities if the exchange is in the public interest (RCW 79.105.400) and can accept gifts of aquatic lands (RCW 79.105.410). Outright land purchase requires legislative approval and appropriation. Port districts can obtain management authority over state owned aquatic lands under RCW 790.125.420.

As directed by the legislature, Washington DNR will continue to consider the public interest when evaluating proposed sales, acquisition, or exchange of aquatic lands; the agency regards furtherance of the goals of the Aquatic Lands HCP to be in the public interest. When considering offers made to the state for purchase or exchange of lands owned by others, the agency will use the landscape planning process to identify lands most in need of acquisition and protection. Washington DNR will apply the appropriate HCP standards, strategies, and measures to the newly acquired lands. Washington DNR will avoid authorizing the use of aquatic lands that would be considered a conservation priority based on the Aquatic Lands HCP's land planning process unless the receiving entity commits to continued management in conformance with this HCP (Section 5.2.2, Programmatic Strategies).

# 1.2.5 Other methods of ESA compliance pertinent to state-owned aquatic land

## Section 7 of the Endangered Species Act

When a person or entity proposes an action on state-owned aquatic lands, the action may have a federal connection or nexus as a result of 1. issuance of a United States Army Corps of Engineers permit for in-water construction or for discharge of materials into the waters of the United States; 2. actions by the federal government; 3. actions carried out with federal funding; or 4. when federal environmental health and safety laws such as oil spill response and occupational safety are at issue. Where there is a federal nexus, the proposed action is subject to Section 7 of the Endangered Species Act (see Section 1.2.2) and a federal consultation is required to ensure that the proposed action does not jeopardize listed species or adversely modify critical habitat. This HCP does not replace this means of ESA compliance or relieve entities of the duty to consult under Section 7. Rather, Washington DNR will use the standards defined in the HCP as minimum conditions for new proposals occurring on state-owned aquatic lands.

## Section 4(d) Rules of the Endangered Species Act

For some activities on state-owned aquatic lands, compliance with the ESA may be achieved under rules promulgated by the secretary of the interior or secretary of commerce as necessary for the conservation of threatened species per Section 4(d) of the Endangered Species Act.. NOAA Fisheries has defined rules addressing habitat restoration as part of a watershed restoration plan; routine road maintenance activities; forestry activities; and select development/redevelopment for fourteen evolutionarily significant units (ESUs) of salmonids (65 CFR 132, 42422 to 42481; 50 CFR 223). U.S. Fish and Wildlife Service has defined rules for the accidental hooking or catching of bull trout. Under this particular 4(d) rule, bull trout hooked or caught and released by anglers that are fishing in compliance with state fishing regulations will not represent a violation of take prohibitions under Section 9 of the Endangered Species Act.

# 1.3 Lands covered

The Aquatic Lands HCP covers those lands directly owned by the state of Washington and managed by Washington DNR that underlie navigable freshwater, marine, and estuarine waters within the state of Washington. Under federal law, Washington received title to those lands upon statehood[5] and the State asserted ownership in Article XVII, Section 1 of the Washington State Constitution. This HCP does not cover areas managed under port management agreements, or aquatic lands sold into private ownership, managed by agencies other than Washington DNR, or under waters that are not navigable for the purpose of establishing state title.

Waters that are navigable for the purpose of establishing state title are those lands that are capable of serving as a highway for commerce in their natural and ordinary condition, using customary

[5] See *Pollard's Lessee v. Hagan*, 44 U.S. (3 How.) 212 (1845).

modes of travel and trade on water.[6] Washington DNR presumes ". . . all bodies of water meandered by government surveyors . . ." to be navigable for the purpose of establishing state title unless declared otherwise by a court (WAC 332-30-106(41)). If there is a dispute about whether a water body is navigable for the purpose of vesting title in the state, the judiciary makes the final determination.

While state ownership in saltwater is well established, the extent of state-owned aquatic lands underlying freshwater is less established because the navigability of some water bodies has yet to be analyzed or adjudicated. In addition, because state ownership, and thus Washington DNR's management authority, generally follows gradual changes in the boundary of the water body caused by natural accretion, erosion, and reliction, the location of water bodies managed by Washington DNR may change over time.[7]

The state manages approximately 2.6 million acres of submerged land (Figure 1.1), and the associated biological communities, such as submerged aquatic vegetation and *infauna* (animals or invertebrates that live within sediment). State-owned aquatic lands extend 5.6 kilometers (3 miles) waterward into the Pacific Ocean and includes:

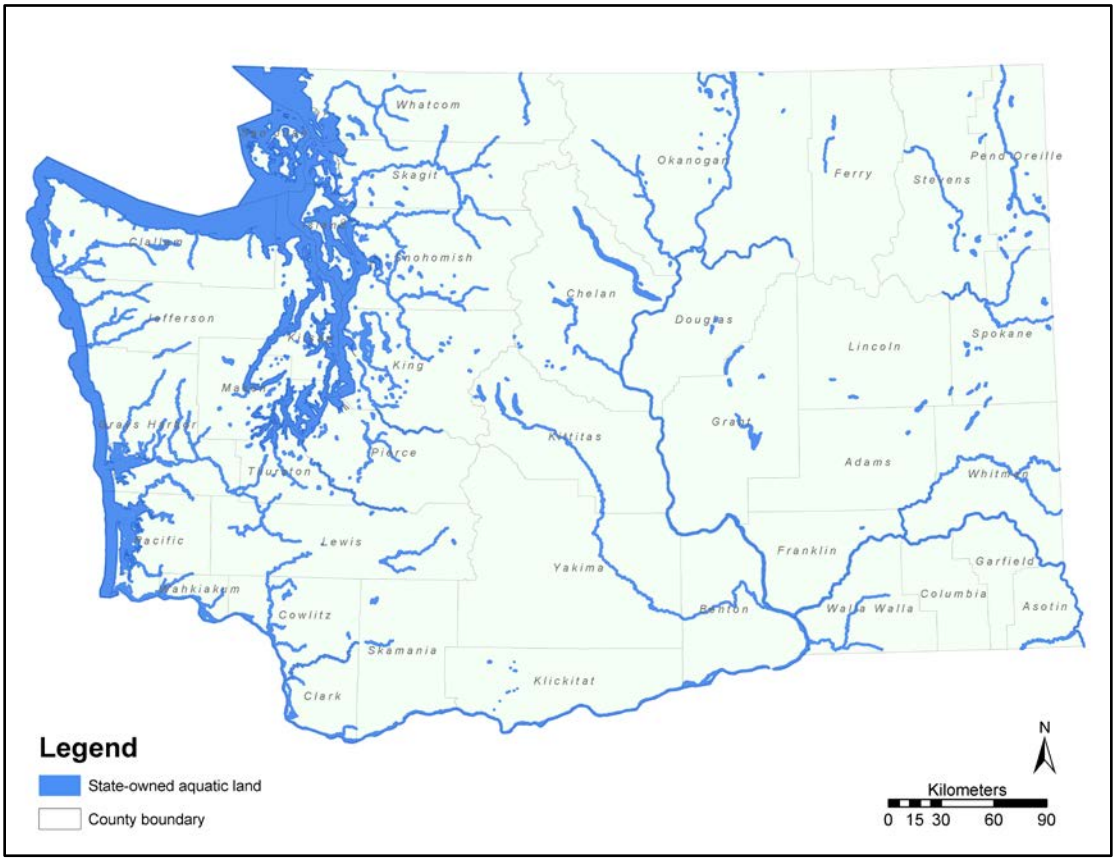
- Submerged lands and resources to the center of the Strait of Juan de Fuca, Haro Strait, Boundary Pass and the Strait of Georgia.
- Aquatic lands and resources surrounding the San Juan Archipelago.
- Lands and resources underlying Puget Sound and Hood Canal.
- Navigable rivers and lakes across the state.[8]

6 *Brewer-Elliott Oil & Gas Co. v. U.S., 260 U.S.* 77, 43 S. Ct. 60, 67 L. Ed. 140 (1922); U.S. v. Holt State Bank, 270 U.S. 49, 55-56, 46 S. Ct. 197, 70 L. Ed. 465 (1926); U.S. v. Utah, 283 U.S. 64, 75, 51 S. Ct. 438, 75 L. Ed. 844 (1931).

[7] See *Smith Tug & Barge Co. v. Columbia-Pacific Towing Corp.*, 78 Wn.2d 975, 482 P.2d 769 (1971).

[8] The federal *Submerged Lands Act* of 1953 grants states title to the natural resources located within three nautical miles of their coastline, with natural resources defined as minerals and marine animal and plant life.

**Figure 1.1.** Distribution of state-owned aquatic lands.




# 1.3.1 Statutory classification

Washington has three primary statutory classifications for aquatic lands: tidelands, shorelands, and bedlands (RCW 79.105.060). These lands are further classified as harbor areas or waterways, depending on the special uses to which the land is subject. Of the lands originally granted to the state by the federal government, nearly all freshwater and marine bedlands, approximately 30 percent of the tidelands, and 70 percent of the shorelands of the navigable lakes and rivers in the state remain in state ownership. Table 1.1 illustrates the approximate current distribution of state-owned aquatic lands by statutory classification.

**Table 1.1.** Approximate distribution of aquatic lands by statutory classification.

| Statutory Classification | Acreage | | Percent State-owned |
|---|---|---|---|
| | State-owned | Total | |
| **Bedlands** | | | |
| Lacustrine | 144,776 | 151,619 | 95% |
| Marine | 2,162,158 | 2,163,243 | 100% |
| Riverine | 174,977 | 207,506 | 84% |
| Subtotal | 2,481,910 | 2,522,368 | 98% |
| **Shorelands** | | | |
| Lacustrine | | | |
| First Class | 48 | 1,534 | 3% |
| Second Class | 11,324 | 16,958 | 67% |
| Unclassified | - | 71 | 0% |
| Subtotal | 11,372 | 18,563 | 61% |
| **Riverine** | | | |
| First Class | 21,831 | 22,064 | 99% |
| Second Class | 21,831 | 27,049 | 81% |
| Unclassified | - | 439,906 | 0% |
| Subtotal | 43,663 | 489,019 | 9% |
| **Tidelands** | | | |
| First Class | 6,895 | 23,307 | 30% |
| Second Class | 127,665 | 264,073 | 48% |
| Unclassified | - | 1,065 | 0% |
| Subtotal | 134,561 | 288,444 | 47% |
| Harbor Areas | 10,129 | 10,147 | 100% |
| Waterways | 1,760 | 1,770 | 99% |
| Other[9] | 578 | 3,883 | 15% |
| **Total** | **2,683,973** | **3,315,631** | **81%** |

[9] Includes abandoned tidelands, shorelands and canals.

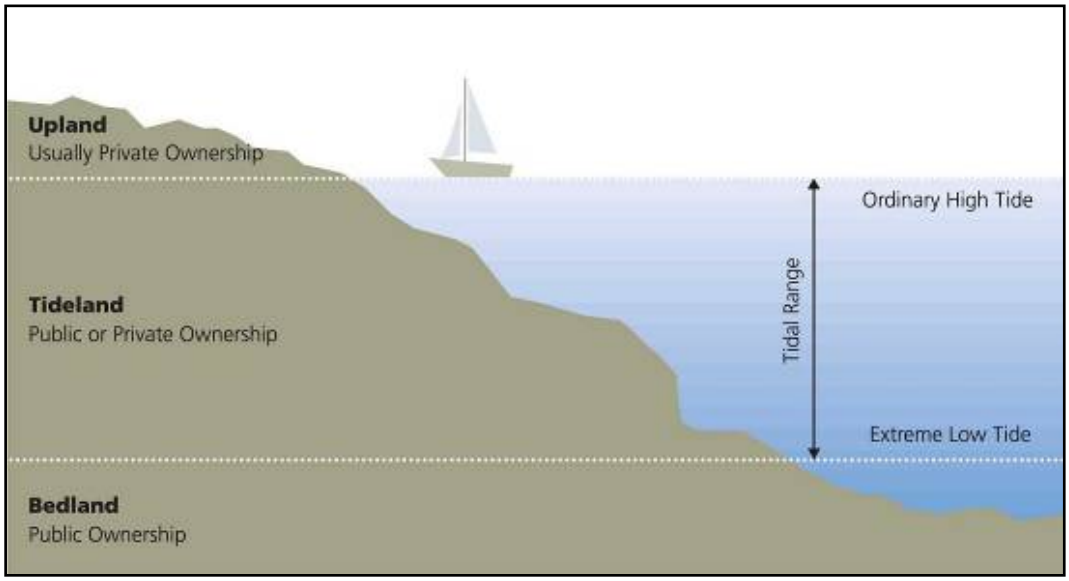
# Tidelands

Tidelands are those marine and estuarine waters affected by the ebb and flow of tides and located between the ordinary high tide and extreme low tide line (Figure 1.2).

State law defines first-class tidelands as " . . . the shores of navigable tidal waters belonging to the state, lying within or in front of the corporate limits of any city, or within one mile of either side and between the line of ordinary high tide and the inner harbor line; and within two miles of the corporate limits on either side and between the line of ordinary high tide and the line of extreme low tide" (RCW 79.105.060 (4)). Second-class tidelands are defined as " . . . the shores of navigable tidal waters belonging to the state, lying outside of and more than two miles from the corporate limits of any city, and between the line of ordinary high tide and the line of extreme low tide" (RCW 79.105.060 (18)).

As city limits change, the classification of a given area of state-owned tideland may also change. Besides location, the most important difference between first- and second-class tidelands is that the owners of terrestrial lands abutting first-class tidelands have a preference right, or right of first refusal, for use of the submerged lands adjacent to their property.

**Figure 1.2.** Marine tidelands and bedlands.




Graphic: Luis Prado, DNR

# Shorelands

*Shorelands* are generally submerged lands associated with navigable rivers and lakes not affected by the ebb and flow of tides. For purposes of ownership, shorelands are statutorily defined as lands located between the line of ordinary high water[10] and the line of navigability (Figure 1.3). The *line of navigability* is the ". . . measured line at a depth sufficient for ordinary navigation as

[10] Ordinary high water is determined either by the line of permanent terrestrial vegetation along the shore, or by a line impressed upon the soil by the action of the water over many years.

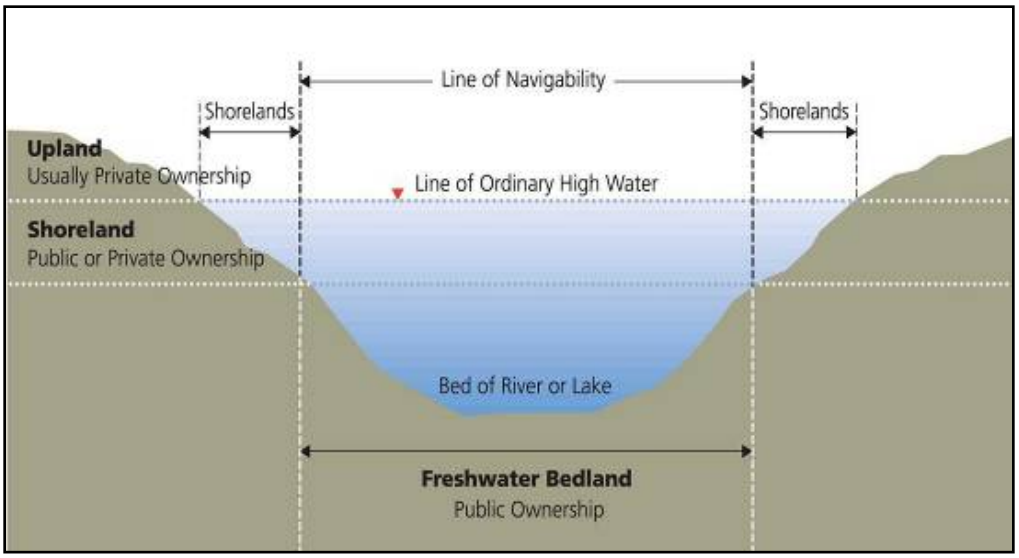
determined by the board of natural resources for the body of water in question" (WAC 332-30-106(33)).

State law defines *first-class shorelands* as ". . . the shores of a navigable lake or river belonging to the state, not subject to tidal flow, lying between the line of ordinary high water and the line of navigability, or inner harbor line where established and within or in front of the corporate limits of any city or within two miles of either side" (RCW 79.105.060 (3)).

*Second-class shorelands* are defined as ". . . the shores of a navigable lake or river belonging to the state, not subject to tidal flow, lying between the line of ordinary high water and the line of navigability, and more than two miles from the corporate limits of any city" (RCW 79.105.060 (17)).

Similar to the legal definitions for tidelands, the classification of state-owned shorelands may change as city limits change, with owners of abutting terrestrial lands having a preference right for authorized uses of first-class shorelands.

**Figure 1.3**. Freshwater shorelands and bedlands.




Graphic: Luis Prado / DNR

# Bedlands

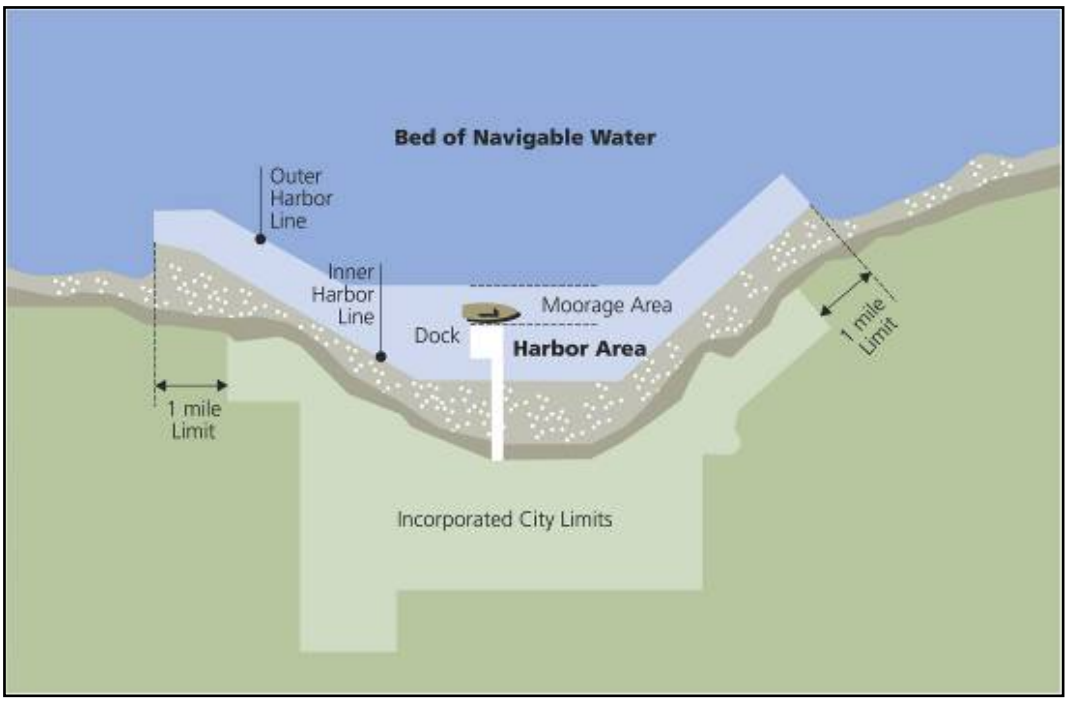
Bedlands, or *beds of navigable waters* (RCW 79 105.060 (2)), are submerged lands that lie waterward of adjoining tidelands or shorelands and below the line of extreme low tide or the line of navigability (see Figures 1.2 and 1.3).

# Harbor Areas

Under Article XV, Section 1 of the Washington State Constitution, *harbor areas* are ". . . forever reserved for landings, wharves, streets, and other conveniences of navigation and commerce." Harbor areas may extend up to one mile along the shoreline beyond incorporated city limits and are delimited by both an inner and outer harbor line (Figure 1.4). The state is prohibited from giving, selling or leasing lands beyond the outer harbor line. Washington DNR assists the Board of Natural Resources in its constitutional role as the Harbor Line Commission to locate and establish harbor lines.

Proposals to establish, relocate, and re-establish inner and outer harbor lines are submitted to the Washington DNR Aquatic Resources program. Staff reviews the proposals in accordance with specific procedures, forwarding both the proposal and staff recommendations to the Harbor Line Commission for final review and approval. Since 1890, the Harbor Line Commission has established 31 harbor areas (26 marine and tidal, and 5 freshwater areas) and approved approximately 60 harbor line changes (Ivey, 2004).

**Figure 1.4.** Limits of harbor areas.




Graphic: Luis Prado / DNR

## Waterways

Waterways are lands reserved for public access between terrestrial lands and open water. Their purpose is to provide public navigation routes between deep water and the land inside of the inner harbor line (RCW 79.120.010). Waterways are planned and platted as part of a harbor area designation; some state designations may overlap or adjoin waters where federal pierhead lines have been established to create a federal waterway (RCW 79.120.040) State law prohibits permanent structures that interfere with navigation and commerce in waterways, (RCW 79.120.010), except in areas where a boundary of a state waterway is landward of a pierhead line for a federal waterway (RCW 79.120.040). There are 102 state waterways adjoining 23 harbor areas throughout Washington State, with additional waterways owned and established by counties and cities, port districts, and commercial waterway districts pursuant to authority granted by the legislature.

# 1.4 Habitats covered

Washington DNR's management authority for state-owned aquatic lands includes the sediments and their attached biological communities. This section defines those habitats and the processes upon which they depend.

# 1.4.1 Environmental setting

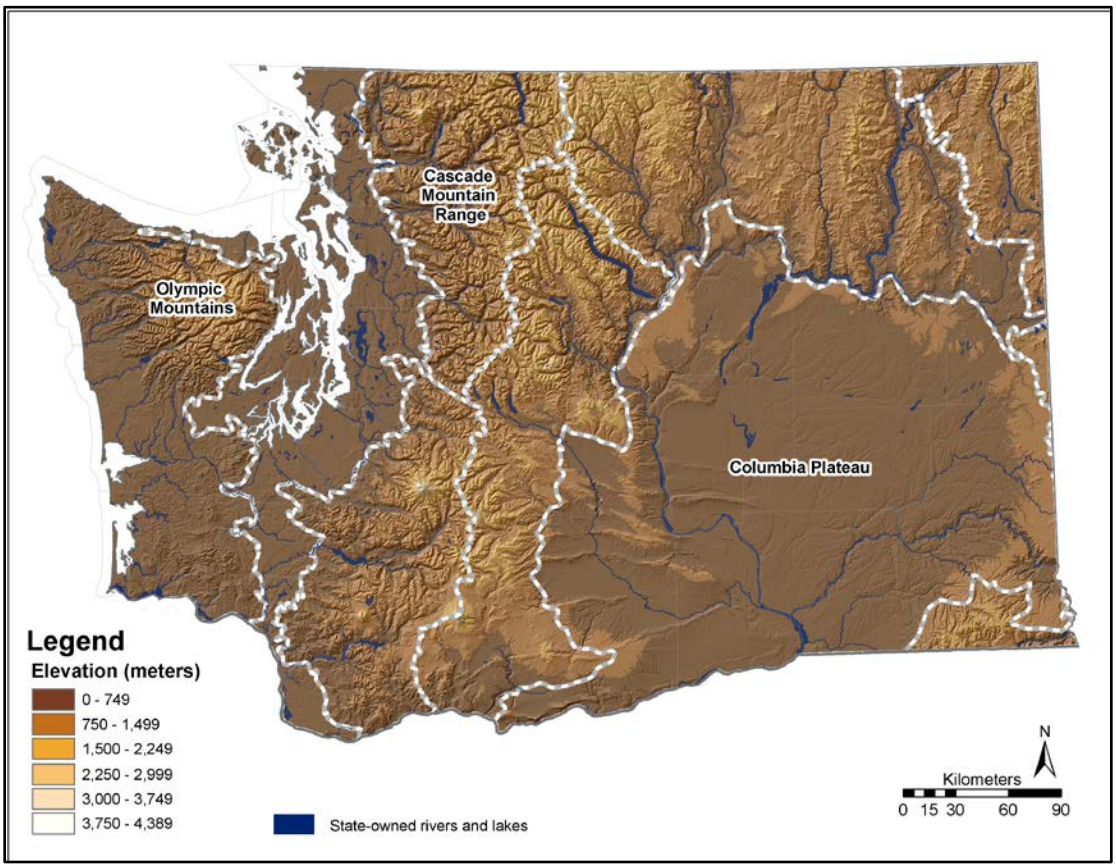
While individual water bodies have distinct biological, chemical, and physical characteristics, they can also be defined by commonalities in ecological and landscape patterns. This section defines and describes those commonalities and the condition of state-owned aquatic lands.

## Topography

The Cascade Mountain Range (Cascade Range) runs north-south through the state and is considered the division between eastern and western Washington (Figure 1.5). The mountains are the dominant feature of central Washington and the highest elevations in the state are found here; the highest mountain is Mount Rainier at 4,392 meters (14,410 feet). Eastern Washington is dominated by the high desert of the Columbia Plateau and the valleys of the Columbia River and its tributaries.

West of the Cascade Range are the coastal lowlands of the Puget Trough and Puget Sound. Western Washington also contains the Olympic Peninsula and the Olympic mountains, which are part of the Pacific Coastal Mountain Range that extends from Alaska to California. The shoreline of the Pacific Ocean forms the western boundary of the state; the lowest elevations in the state occur here where the land meets the ocean.

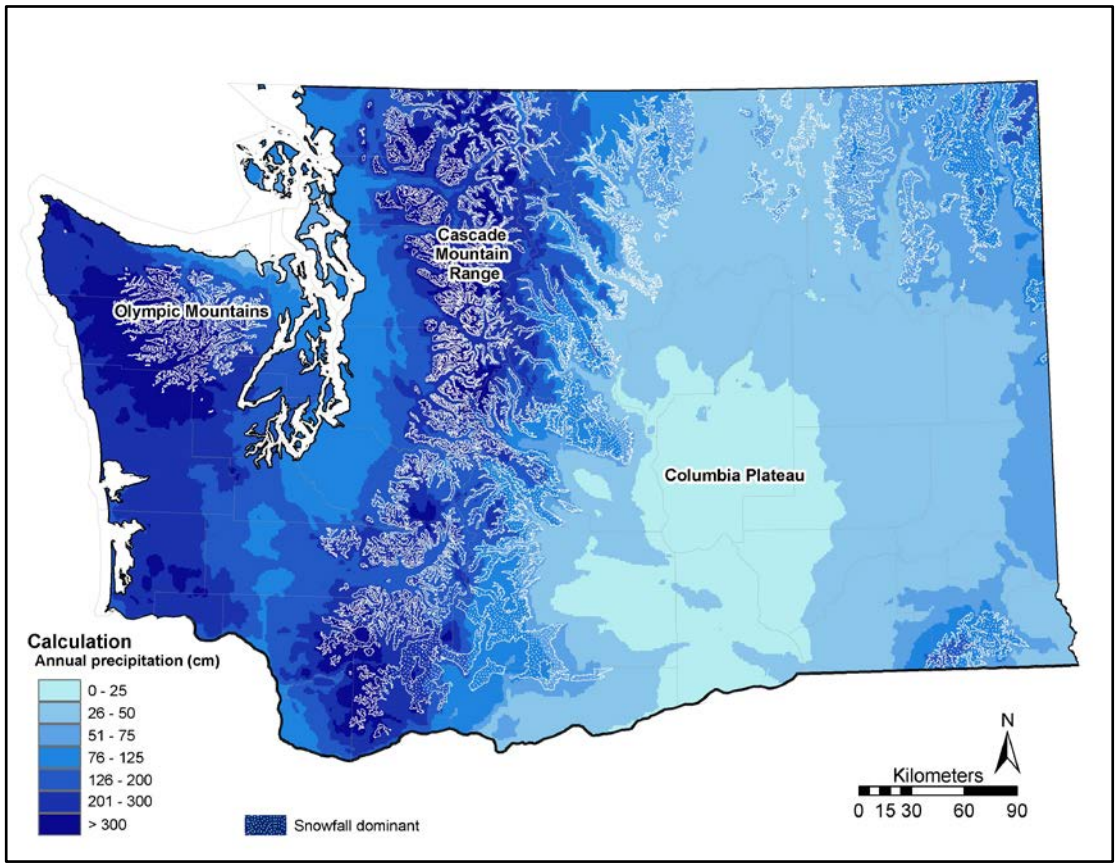
**Figure 1.5.** Topographic regions of Washington.



# Climate

The influences of the Pacific Ocean and Cascade Range result in distinct climatic differences between the eastern and western sides of the state (Figure 1.6). Air currents coming off the ocean bring warm, moist air and abundant rainfall to western Washington and result in a temperate climate. These maritime-influenced parts of the state are frequently cloudy with considerable fog and long-lasting periods of rain. Summers are sunny and mild with average high temperatures near 21 degrees Celsius (70 degrees Fahrenheit). Washington's coastal region is one of the wettest areas in the United States, receiving up to 3.8 meters (12.5 feet) of rain per year at the highest elevations; the western slopes of the Cascade Range receive over 5 meters (16 feet) of snow annually. Precipitation anomalies due to the rain shadow effect of the northeast Olympic Peninsula result in some western Washington areas receiving an average rainfall of less than 0.51 meters (20 inches) per year. The Cascade Range hinders the eastward movement of the warm ocean air, resulting in a semi-arid climate in eastern Washington. This side of the state is drier and has greater extremes in seasonal temperatures and precipitation. In addition to warmer summers, winters are colder and there is less precipitation than in the western side of the state.

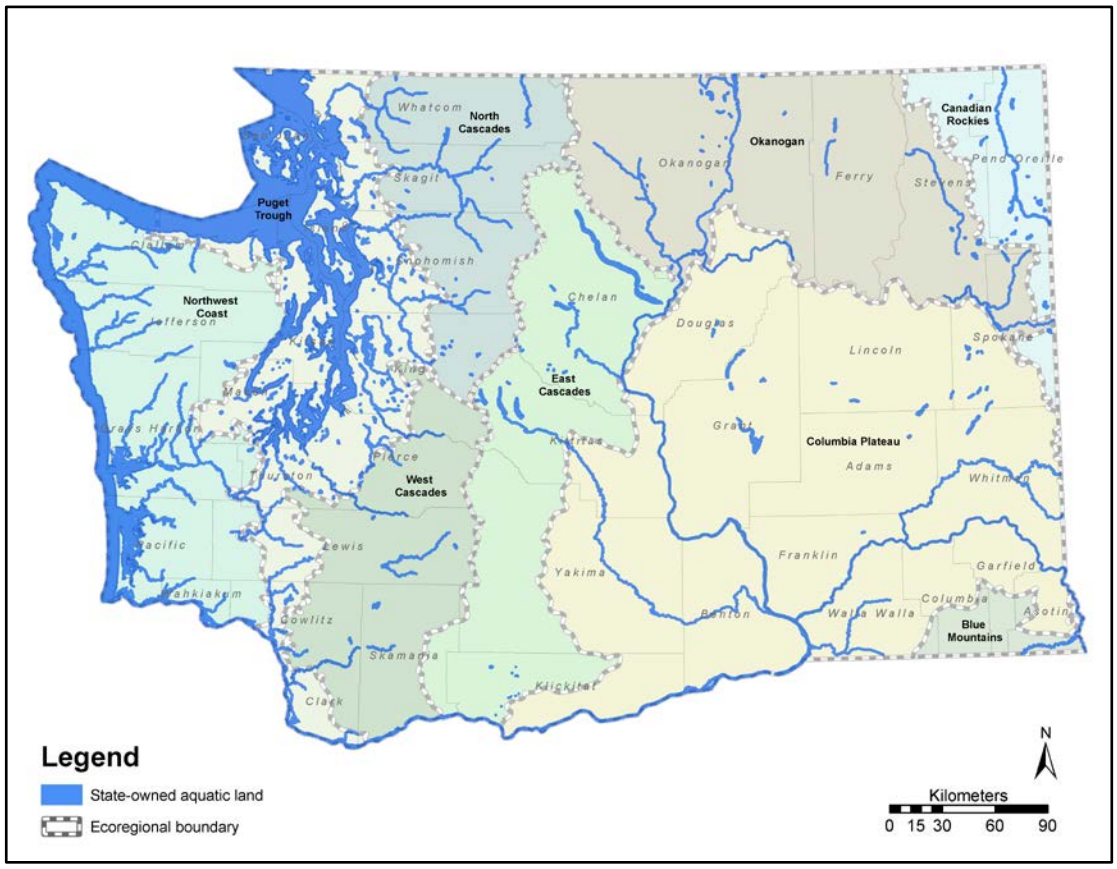
**Figure 1.6**. Climatic regions of Washington.



# 1.4.2 Ecoregional setting

The definition of an ecoregion includes biotic and abiotic factors within geographically distinct landforms. To reflect the diversity of habitat requirements of the HCP covered species, Washington DNR has chosen to report its conservation efforts using the Natural Heritage Program's defined ecoregions (Washington DNR, 2007a; Figure 1.7). The decision to use this system is primarily based on the resolution of the data and its compatibility with Washington DNR's leasing data, as well as its use by The Nature Conservancy for ecoregional assessments.

**Figure 1.7.** Natural Heritage program ecoregions.




## Blue Mountains

The Blue Mountains ecoregion extends from adjacent Idaho and Oregon into the southeast corner of Washington and includes the Grande Ronde and Snake River canyons. Annual precipitation varies from less than 25 centimeters (9.8 inches) in the Grande Ronde River canyon to more than 127 centimeters (50 inches) in the Wenaha-Tucannon Wilderness Area. While much of the region's precipitation occurs as snow, fall and spring rains frequently lead to floods. Approximately 1 percent of Washington is within this ecoregion.

## Canadian Rockies

The majority of this ecoregion occurs in adjacent British Columbia and Idaho; only 4 percent of Washington lies within this ecoregion. Annual precipitation ranges from 50 centimeters (20 inches) along the Columbia River to about 200 centimeters (79 inches) in the Salmo-Priest Wilderness Area. Heavily influenced by forming and retreating glaciers, this ecoregion is dominated by ice-carved valleys and isolated mountain peaks.

## Columbia Plateau

The hottest and driest ecoregion in Washington, the Columbia Plateau lies in the rain shadow of the Cascade Range and is bounded by the Cascade, Okanogan, Blue and Rocky mountains. Annual precipitation increases west to east from about 10 centimeters (4 inches) along the Columbia River's Hanford Reach to 63 centimeters (25 inches) in the Palouse Hills. The region's canyons and broad valleys were carved by glaciers; the coulees and scablands were formed by flood events associated with Lake Missoula and Lake Columbia. Approximately one-third of the state lies in this ecoregion.

## East Cascades

Influenced by alpine glaciers, steep mountain ridges, and broad valleys, this ecoregion lies east of the Cascade crest, from Sawtooth Ridge near Lake Chelan south to the Oregon border. The climate is wetter and colder in the western portion of the region and along the Cascade crest, and hotter and dryer in the foothills. Precipitation falls from November through April, with totals ranging from 51 to 305 centimeters (20 to 120 inches) annually and snow pack accumulating at higher elevations. Approximately 10 percent of Washington is included within this ecoregion.

## North Cascades

The North Cascades ecoregion includes the Cascade Range north of Snoqualmie Pass and west of the crest; elevations range between 152 meters and 3,048 meters (499 to 10,000 feet). Precipitation occurs as snow and rain from October through April, with totals ranging from 150 to 400 centimeters (59 to 157 inches) annually. Small streams and rivers originating in the mountains feed the larger systems in the Puget Trough; lakes are common in the region's glacial depressions. Approximately 10 percent of the state lies in this ecoregion.

## Northwest Coast

Approximately 11 percent of Washington's area occurs within the Northwest Coast ecoregion. The ecoregion is dominated by the Olympic Mountains, Pacific Ocean, coastal plain, and the Willapa Hills. Annual precipitation ranges from 150 to 600 centimeters (59 to 236 inches), with fog and cool temperatures common year-round. Streams and rivers typically begin in steep mountain drainages, forming large flat river systems on the coastal plain with natural lakes occurring in glacial depressions.

## Puget Trough

This ecoregion is nestled between the Cascade Range and Olympic Mountains and includes Puget Sound and the lowlands south to the Columbia River. Roughly 8 percent of Washington, and the bulk of the state's human population, is within this ecoregion. Precipitation primarily falls as rain in the winter, with annual totals ranging between 50 and 180 centimeters (20 to 71 inches). Large, low-gradient rivers begin in the adjacent mountains and flow through this ecoregion; freshwater lakes are common in the glaciated portions of the ecoregion.

## Okanogan

The Okanogan region of Washington extends from the Cascade crest in the northern Cascade Range east to the Selkirk Mountains; the southwestern border follows Sawtooth Ridge northeast of Lake Chelan. Annual precipitation ranges from less than 0.3 meters (1 foot) in the Okanogan Valley to between 130 and 230 centimeters (51 to 91 inches) in the Cascade Range. Approximately 14 percent of Washington is within this ecoregion.

## West Cascades

The West Cascades ecoregion extends west from the Cascade crest and Snoqualmie Pass southward to the Oregon border; elevations range from 15 meters (49 feet) in the Columbia River Gorge to over 4,392 meters (14,410 feet) at the summit of Mt. Rainier. Climate in the region is wet and relatively mild. Annual precipitation occurs as rain and snow and ranges from 140 to 350 centimeters (55 to 138 inches). This ecoregion consists of highlands modified by montane glaciers and associated river valleys. Small, steep-gradient streams typically feed major rivers to the west; the region's lakes were formed by glacial processes and landslides. Approximately 8 percent of the state is within in this ecoregion.

# 1.4.3 Ecosystems present

As with ecoregions, ecosystem definitions include biotic and abiotic factors but tend to be broader geographically, occurring across ecoregional boundaries. The Aquatic Lands Habitat Conservation Plan defines four general aquatic ecosystems: lacustrine, riverine, saltwater nearshore,[11] and saltwater offshore. These ecosystem categorizations are founded on scientifically based and commonly used classification systems (Cowardin, 1979; Dethier, 1990). The hierarchies were simplified to improve their utility in a statewide analysis and to accommodate the coarse spatial resolution of Washington DNR's leasing data layer. Because of the complexities associated with defining the geographic limits of estuaries and the fact Puget Sound is frequently classified as an estuary, it is difficult to define the geographic limits of tidal influence. As a result, estuaries and tidally influenced rivers have been included as part of the saltwater-nearshore ecosystem. Table

[11] Includes tidally influenced rivers.

1.2 illustrates the approximate distribution of state-owned aquatic lands by the ecoregions and ecosystems used within the Natural Heritage program. Table 1.3 summarizes the distribution of each defined ecosystem.[12] Appendix A summarizes habitat types and characteristics for each ecosystem.

**Table 1.2.** Approximate distribution of state-owned aquatic lands by Natural Heritage program ecoregion and defined ecosystem.

| | | Acreage | | Percentage | |
|---|---|---|---|---|---|
| **Ecoregion** | **Defined Ecosystem** | **State-owned** | **Statewide** | **State-owned[13]** | **State Ownership[14]** |
| Blue Mountains | Lacustrine | 356 | 381 | 94% | |
| | Riverine | 1,333 | 1,632 | 82% | |
| | Total | 1,689 | 2,013 | 84% | 0.1% |
| Canadian Rockies | Lacustrine | 15,541 | 22,067 | 70% | |
| | Riverine | 0 | 147 | 0% | |
| | Total | 15,541 | 22,214 | 70% | 1% |
| Columbia Plateau | Lacustrine | 95,437 | 220,771 | 43% | |
| | Riverine | 4,332 | 13,418 | 32% | |
| | Total | 99,769 | 234,190 | 43% | 4% |
| East Cascades | Lacustrine | 55,171 | 70,448 | 78% | |
| | Riverine | 1,506 | 6,606 | 23% | |
| | Total | 56,677 | 77,054 | 74% | 2% |
| North Cascades | Lacustrine | 5,894 | 31,875 | 18% | |
| | Riverine | 4,856 | 10,221 | 48% | |
| | Total | 10,751 | 42,096 | 26% | 0.4% |
| Northwest Coast | Lacustrine | 16,579 | 25,158 | 66% | |
| | Riverine | 4,861 | 23,103 | 21% | |
| | Saltwater | 226,990 | 295,742 | 77% | |
| | Saltwater | 528,013 | 528,123 | 100% | |
| | Total | 776,443 | 872,126 | 89% | 30% |
| Okanogan | Lacustrine | 14,416 | 114,867 | 13% | |
| | Riverine | 3,865 | 8,512 | 45% | |
| | Total | 18,281 | 123,380 | 15% | 1% |
| Puget Trough | Lacustrine | 48,435 | 66,374 | 73% | |
| | Riverine | 8,926 | 20,812 | 43% | |
| | Saltwater | 225,537 | 375,975 | 60% | |
| | Saltwater | 1,315,955 | 1,316,479 | 100% | |
| | Total | 1,598,854 | 1,779,640 | 90% | 62% |

[12] Discrepancies in the estimated acreage of legal and ecological classifications are attributable to differences in the data layers used.
[13] *Percentage State-owned* is calculated by dividing *State-owned Acreage* by *Statewide Acreage*
[14] *Percentage State Ownership* is calculated by dividing total *Ecoregion Statewide Acreage* by total *State-owned Acreage.*

| | | Acreage | | Percentage | |
|---|---|---|---|---|---|
| **Ecoregion** | **Defined Ecosystem** | **State-owned** | **Statewide** | **State-owned**[13] | **State Ownership**[14] |
| West Cascades | Lacustrine | 8,211 | 43,611 | 19% | |
| | Riverine | 1,839 | 11,849 | 16% | |
| | Saltwater - | 2,394 | 2,437 | 98% | |
| | Total | 12,753 | 58,206 | 22% | 0.5% |

**Table 1.3.** Approximate distribution of state-owned aquatic lands by defined ecosystem.

| | Acreage | | Percentage | |
|---|---|---|---|---|
| **Defined Ecosystem** | **State-owned** | **State-wide** | **State-owned** | **State Ownership** |
| Lacustrine | 260,042 | 595,552 | 44% | 10% |
| Riverine | 37,892 | 128,063 | 30% | 1% |
| Saltwater Nearshore | 452,527 | 671,717 | 67% | 17% |
| Saltwater Offshore | 1,843,968 | 1,844,602 | 100% | 71% |
| **Total** | **2,594,428** | **3,239,935** | **80%** | |

# Lacustrine

The lacustrine ecosystem, or lakes, is defined as a standing body of water located in a topographic depression that is not directly connected to the sea (Johnson *et al.*, 1985). Lakes are distinguished from rivers by the presence of relatively still waters (Horne & Goldman, 1994) and from saltwater ecosystems by the absence of ocean derived salt (Cowardin *et al.*, 1979). Of Washington's 7,800 lakes, ponds, and reservoirs (Sumioka & Dion, 1985), approximately 70 lakes are currently considered to include state-owned aquatic land.

## Physical properties

The geology of naturally occurring lakes is largely a product of tectonic, volcanic or glacial processes. Lakes formed by tectonic processes generally result from convergent fault blocks uplifting or slipping and creating a depression that fills with water. Volcanic lakes typically form through catastrophic events (caldera lakes) or through lava dams. Glacial lakes typically form by one of two processes: the scouring action of advancing glaciers, or by deposition of material forming dams across valleys and topographic depressions. While less frequent, lakes may also be formed by other processes, such as landslides, river migration (oxbow lakes), and animal activities (beaver dams) (Johnson *et al.*, 1985). Man-made lakes, or reservoirs, are the result of impounding rivers for power generation, water supply, flood control, irrigation, or recreation (Horne & Goldman, 1994).

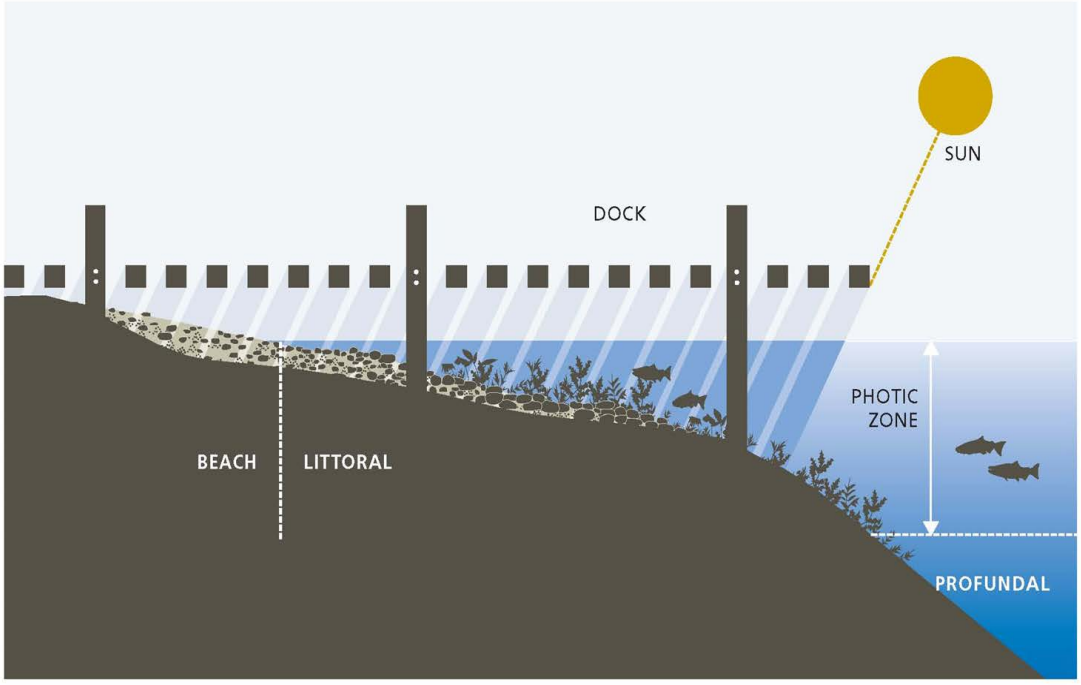
Wave action is an important physical process in maintaining the diversity of lake habitat types. The height and velocity of waves are determined by water depth, the distance of open water over which the wind blows (fetch), and both the speed and duration of the wind. Wind is also responsible for currents, upwelling, and most lake oscillations (Wetzel, 2001). Combined, these conditions can generate substantial wave energy; the direction of littoral currents will determine

whether wave energy will result in erosion or sediment deposition for a particular section of the shoreline (Herdendorf *et al.*, 1992).

In addition to the generation of waves, wind is the physical force responsible for currents, upwelling, and most lake oscillations (seiches). These processes may influence aquatic organisms in a variety ways, by facilitating mixing in the water column and nutrient exchange, which in turn influences primary production. For very large lakes, changes in water levels resulting from seiches may influence the distribution of aquatic vegetation in the littoral zone and along the shoreline. Seiches may also influence the distribution of fish (Levy *et al.*, 1991; Herdendorf *et al.*, 1992) and amphibians due both to wave energy and changes in water temperature that result from the water mixing during the seiche.

Lake benthos can be divided into two general classes (Figure 1.8): littoral and profundal. The littoral (nearshore) zone consists of shallow waters where sunlight reaching the benthos is sufficient to support the growth of submerged vegetation (Cowardin *et al.*, 1979; Mitsch & Gosselink, 1999; Wetzel, 2001). While substrate composition is largely the result of the formative processes of the lake (for example, glacial deposits or landslides), particle size is generally related to wave energy and currents (Herdendorf *et al.*, 1992); the size of the particles typically becomes smaller with increasing distance from shore. The array of species found in the littoral zone is generally more diverse than in the open water (limnetic) or profundal zones, which can be attributed to the variety of habitat substrates and vegetation types (Herdendorf *et al.*, 1992; Horne & Goldman, 1994). In addition to vegetative species, the littoral zone provides habitat for a variety of attached microbes (periphyton), infauna such as worms, invertebrates (crayfish, shrimp, insects), and both juvenile and adult fish.

**Figure 1.8.** Lacustrine ecosystem zones.



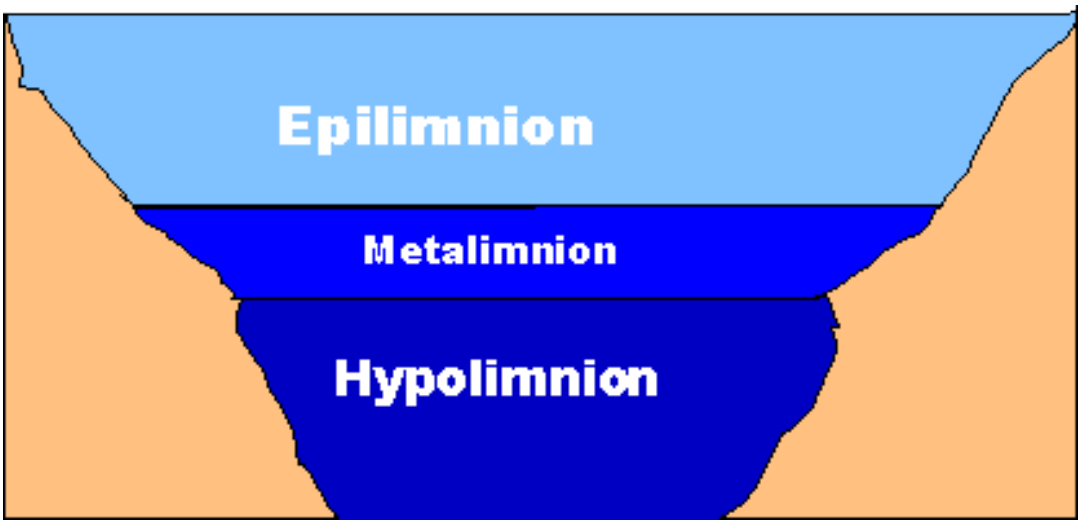

The profundal zone is below the maximum depth to which light penetrates in the water column and consists of benthic habitats that lack attached vegetation (Wetzel, 2001). The absence of high-energy disturbances in this zone leads to the deposition of finer-grained sediments. The resulting physical and chemical homogeneity allow species adapted to these conditions to competitively

exclude other species. Consequently, the species present in the profundal zone are generally from one of four major groups: oligachaete worms, amphipods, insect larvae, and sphaerid (fingernail) and unionid clams (Horne & Goldman, 1994). Fish presence in the profundal zone is influenced by factors such as dissolved oxygen, both chemical and thermal stratification.

## Water properties

While the surface temperature of a lake can be influenced by changes in ambient air temperatures, lacustrine thermal regimes are affected to a much greater degree by seasonal changes in solar radiation and physical properties such as water clarity and density. Lakes are generally thermally stratified and comprises three layers: an upper layer called the *epilimnion*, a lower layer called the *hypolimnion*, and a transitional middle layer known as the *metalimnion* (Figure 1.9). Thermal stratification occurs as a function of the density of water at different temperatures, with colder and denser water in the hypolimnion and warmer, less dense water in the epilimnion. As surface water temperatures equilibrate with ambient air temperatures, stratification may become less pronounced and may result in mixing, or turnover, of the lake's waters. Thermally stratified lakes may also be chemically stratified. Both stratification and the frequency of mixing events influence nutrient cycling and dissolved oxygen levels.

**Figure 1.9**. Lake layers.




Thermal stratification also influences the distribution of species within the water column. For example, cutthroat trout in Lake Washington were found in or below the metalimnion during the summer months when surface water temperatures were high, but were concentrated in shallow littoral habitats within the epilimnion when the lake was mixed and surface water temperatures were low (Nowak & Quinn, 2002). It is important to note that many windswept shallow lakes may never become thermally stratified.

Lake clarity is affected by materials that are suspended or are dissolved by wind and wave action, and by inputs of material from rivers, streams and the surrounding land mass. Clarity is generally lowest during warmer months when phytoplankton and zooplankton production is highest, and when stream runoff and overland flow is high.

Dissolved oxygen concentrations in the water column are controlled by gas exchange with the atmosphere through diffusion and wave action, production of oxygen by plants through photosynthesis, and consumption as a result of decomposition and respiration. Oxygen depletion and stratification is common in highly productive lakes where the demand from decaying phytoplankton may consume virtually all of the oxygen in the hypolimnion (Horne & Goldman, 1994).

## Productivity

Biological productivity in lakes is referred to as the lake's trophic status and is measured as the amount of organic material produced by algae and plants (primary production). Productivity is determined based on three primary factors: the transparency of the water column when measured with a Secchi disk, the concentration of chlorophyll in the water column, and the concentration of nitrogen and phosphorous in the water column. The productivity of a lake is related to land use practices, hydraulic residence time, atmospheric deposition, and soil characteristics and is generally limited by the availability of nitrogen and phosphorous in the lake (Birch *et al.*, 1980; Dillon, 1975; Horne & Goldman, 1994). Nitrogen is principally derived from the atmosphere, whereas phosphorous is derived from the soils or anthropogenic sources. Four primary classes are used to define trophic status (Carlson, 1977)

- *Oligotrophic*: Lakes that have low phosphorous and nitrogen inputs and, as a result, are characterized by low primary production rates and high dissolved oxygen concentrations.
- *Mesotrophic:* Lakes with moderate phosphorous and nitrogen inputs, primary production rates, and dissolved oxygen concentrations.
- *Eutrophic*: Lakes with an abundance of nutrients, high primary production rates dominated by cyanobacteria, and low dissolved oxygen concentrations.
- *Hypereutrophic:* These lakes are covered by dense mats of surface algae, are generally anoxic, and may frequently experience fish kills.

The biological characteristics of water bodies within each trophic classification vary with site-specific factors such as substrate, morphology, energy associated with water movement, precipitation, and climate. Small, shallow lakes generally tend to have higher rates of productivity than large, deep lakes because they have a greater proportion of their surface area in the photic zone (Herdendorf *et al.*, 1992). Increases in nutrients from human activities, however, may also lead to increases in production in oligotrophic and mesotrophic lakes; this process is known as cultural eutrophication.

**Table 1.4.** Relationships between trophic status and index values.

| Trophic Index | Trophic Status | Secchi Depth (meters) | Phosphorous (mg/L) | Chlorophyll (mg/L) |
|---|---|---|---|---|
| < 40 | Oligotrophic | > 4 | < 12 | < 2.6 |
| 40 to 50 | Mesotrophic | 4 to 2 | 12 to 24 | 2.6 to 7.3 |
| 50 to 70 | Eutrophic | 2 to 0.5 | 24 to 96 | 7.3 to 56 |
| > 70 | Hypereutrophic | < 0.5 | > 96 | > 56 |

## Aquatic habitat types

### Aquatic bed (littoral)

These habitat units are differentiated from other habitat units by the presence of aquatic vegetation that is attached to the substrate, or is floating at the surface. The surface area of the substrate in these habitat units primarily comprises algal beds, rooted vascular plants, and floating vascular plants.

### Rocky shore (littoral)

Rocky shore habitat units typically occur in high-energy areas of the littoral zone and are characterized by the dominance of exposed bedrock and rubble substrates resulting from exposure to wind and wave erosion.

### Unconsolidated shore (littoral)

These habitat units occur in the littoral zone and comprise small particles, scant vegetative cover, and varying degrees of periodic inundation.

### Rocky bottom (littoral, profundal)

These habitats are characterized by substrates comprising primarily stones, boulders, or bedrock and typically lack vegetative cover due to wind and wave energy. Rocky bottom habitat units are typically inhabited by organisms that employ attachment strategies such as hooks or suction devices in response to the high-energy environment (Cowardin *et al.*, 1979). These habitat units are similar to the rocky shore habitat units; however, rocky bottom habitat units also includes the profundal zone whereas rocky shore habitat units includes only the littoral zone.

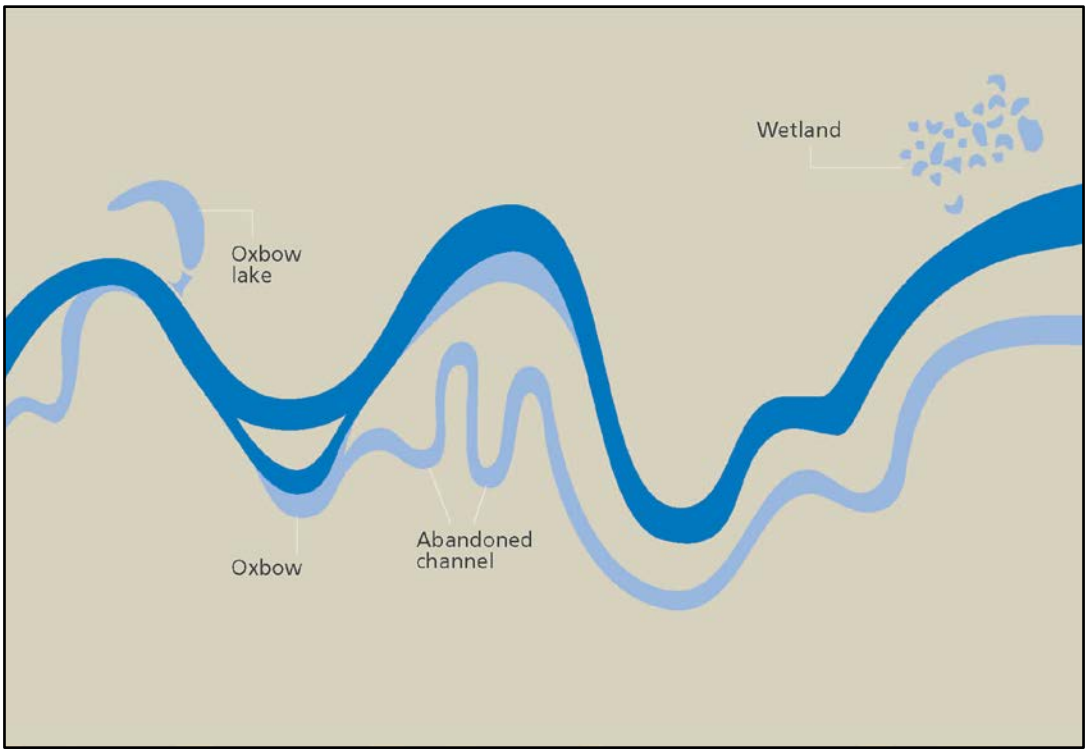
### Unconsolidated bottom (littoral, profundal)

Characterized by mud, sand, or gravel substrates, unconsolidated bottoms are common in the profundal zone of eutrophic lakes, where light penetration is insufficient for plant growth and dissolved oxygen levels are low.

# Riverine

Riverine habitat units includes stream channels, associated floodplains, and riparian areas found within the meander zone (Figure 1.10). This ecosystem is defined by the flow of water from higher to lower elevations, with the flow terminating in tidally influenced environments or in a lake. Riverine systems are essentially interconnected linear networks comprising patterns and processes that occur across their longitudinal, lateral, and vertical dimensions (Stanford & Ward, 1993; Townsend, 1996).

**Figure 1.10.** Riverine meander zone and features.




Graphic: Luis Prado / DNR

The longitudinal dimension refers to structural and functional changes that occur between headwater channels and the downstream reaches. The amount of water carried within the channel (discharge) typically increases with increasing drainage area. Other properties of rivers, such as width, depth, and velocity, also vary as a function of discharge and thus drainage area (Leopold & Maddock, 1953). Rivers typically decrease in gradient with longitudinal distance downstream.

In addition to the predictable changes in linear physical characteristics, some biological characteristics are also predictable in the longitudinal dimension (Vannote *et al.*, 1980). Changes in the type and quantity of biologically available energy sources increase with distance downstream, resulting in distinct behavioral and morphological adaptations in the species present. For example, small streams derive most of their energy from terrestrial sources; primary production is a small proportion of the total energy budget of these streams. As flow increases, litter from terrestrial vegetation comprises a smaller proportion of the energy budget and fine particulate organic matter becomes an increasingly important component of the food web, resulting in a change in the composition of species and functional feeding groups. In small streams, a high proportion of the total biomass is comprised of organisms adapted to directly

consume leaf litter and its associated microbes. In large rivers, organisms are adapted to utilize smaller particles of decomposed material.

The lateral dimension of riverine ecosystems typically refers to patterns and processes that occur perpendicular to the direction of flow and, as defined above, includes only riverine wetlands. Seasonal changes in discharge influence the width of the river, however, the likelihood that the margins of this zone will be inundated decreases as elevation and the distance from the low flow channel increase. Similar to changes in species composition along the length of the river, the organisms present along the lateral dimension reflect the magnitude, intensity, and duration of flood disturbances (Gregory *et al.*, 1991).

In the forests of the Pacific Northwest, vegetation within the active channel may consist only of flood-tolerant grasses and herbs, while the vegetation adjacent to the active channel generally consists of deciduous shrubs and younger stands of trees. With increasing distance from the channel, forest stands may increase in age and the proportion of flood-tolerant species decreases. Junk *et al.* (1989) and Bayley (1995) suggest that seasonal flood pulses that inundate the floodplains of large rivers facilitate the exchange of key nutrients, enhance productivity, and maintain biological diversity. Because of the high number of species that use riparian zones for all, or a portion of their life history, researchers have identified these areas as key to the conservation of biodiversity (Gregory *et al.*, 1991; Naiman *et al.*, 1993).

The vertical dimension refers to the connection between ground and surface water and is commonly referred to as the hyporheic zone. Stanford and Ward (1993) suggest that the aquatic invertebrate species that inhabit the hyporheic zone are uniquely adapted to utilize dissolved materials and the organic and inorganic matter in the spaces between sediment particles. The vertical dimension is of critical importance for a number of species, with upwelling playing a role in redd site selection for both Chinook and chum salmon (Geist & Dauble, 1998; Reub, 1987). Groundwater seeps or springs may also provide important thermal *refugia* for salmonids in streams that would otherwise be too warm for prolonged exposure (Torgersen *et al.*, 2001).

## Physical properties

Tectonic processes such as uplift, subduction, the characteristics of local rock formations, and climate history together affect the distribution of bedrock types, surface deposits, and topography; these in turn control geomorphic processes and stream channel response (Montgomery & Buffington, 2001; Montgomery, 1999). Regional geology also determines sediment supply and the gradient and sediment transport capacity of the stream. Regional geology may also influence the composition of plant communities and stream chemistry. Hillslope processes, such as landslides, slumps and earthflows, and debris avalanches and torrents, are also important mechanisms for the delivery of sediment and large woody debris to stream channels and in the creation of new land forms (Swanston, 1991).

A number of factors related to topography influence the structure of riverine networks, including basin size and shape, drainage density, the number of connecting streams, and the geometry of the connections (Benda *et al.*, 2004). Ultimately, the structure and variability of in-channel habitat is a function of channel slope, which is largely determined by topography (Montgomery, 1999). The type, frequency, and intensity of disturbance regimes depend on channel size and location within the watershed, which in turn vary with topography (Reeves *et al.*, 1995). Disturbances in the adjacent floodplain are characterized by seasonal inundation; bed mobility, and shifts in channel location are influenced by topography and the type, frequency, and intensity of the inundation.

Climatic regimes influence riverine habitat types on a number of scales; however, within Washington, climatic influences are generally related to the most recent glacial period, and seasonal variability in precipitation. Glacial deposits are generally responsible for the variety of river channel patterns observed in the Puget Lowlands, with some rivers for example the Nisqually, cutting multiple braided channels with islands in Pleistocene glacial deposits. Rivers created by sub-glacial runoff, such as the Snoqualmie River, are more contained and have single-thread channels that may be higher in elevation than the surrounding valley floor (Collins *et al.*, 2003). In eastern Washington, the advance of the continental ice sheet caused the formation of a large inland lake known as Glacial Lake Missoula. The ice dam that formed this lake breached episodically throughout the last ice age, causing massive floods with flows more than 10 times the combined flow of all the other rivers in the world (U.S. Geological Survey, 2005).

The interaction between moist air from the Pacific and the region's mountain ranges drives the annual variability in the quantity and timing of streamflow patterns in Washington. As moisture-laden air cools and passes over topographic barriers such as mountains, a phenomenon known as orographic lifting creates condensation and precipitation. Orographic lifting is most prevalent on the western side of mountain ranges within Washington; the eastern side of the mountains experiences a reversal of the process as the air mass loses elevation and becomes warmer resulting in a rain shadow effect. Within the rain shadow, snow is the dominant form of precipitation and is most prevalent at the higher elevations. Consequently, much of the mean annual discharge for streams and rivers within the rain shadow comes from snowmelt. Peak flows in these basins occur during the spring and summer months and do not necessarily coincide with precipitation events. Hydrographs for streams and rivers on the western side of the mountains (especially those at lower elevations) are driven by rainfall events, with peak precipitation occurring from fall through spring.

Precipitation patterns also influence vegetation patterns. Western Washington is generally forested at all elevations; the eastern side of the state is forested in higher and moister mountain elevations. As a result, both the quantity and type of organic matter delivered to river channels also varies west to east.

Research indicates that aquatic communities are structured by the magnitude, timing, frequency, duration, and rate of change of instream flows (Richter *et al.*, 1996). Aquatic and terrestrial organisms have anatomical, morphological, behavioral, and physiological adaptations that capitalize on the seasonal changes in flows (Junk *et al.*, 1989; Poff & Allen, 1995).

## Water properties

River temperatures are strongly correlated with air temperatures and vary with both season and time of day (Wetzel, 2001). River temperatures are also strongly influenced by the presence or absence of vegetative shading, solar radiation, and other hydrologic inputs such as groundwater, tributary inflow, and overland flow (Welch *et al.*, 1998). In the Pacific Northwest, a number of rivers are fed by glaciers and they tend to be cooler year-round as a result. While rivers rarely experience temperature stratification, benthic regions are generally cooler due to groundwater inputs and depth.

Like temperature, river clarity or transparency varies spatially and temporally. Clarity is strongly influenced by the amount of suspended sediment present and the ability of both suspended and dissolved matter to absorb light. Rivers with high sediment loads—those originating from glaciers and those either flowing through fine-grained materials or in watersheds with significant erosion—are less transparent than those with lower sediment loads or flowing through bedrock.

Washington's rivers generally have low concentrations of macronutrients such as phosphorous and nitrogen. As a result, they have low rates of primary productivity (Welch *et al.*, 1998). Naturally occurring inputs are the result of decomposition of organic material and they support the growth of attached algae, and submerged, emergent, and riparian plants. Unlike lakes, however, riverine nutrients are concentrated in detritus rather than in living plant or algal material; dissolved material is continually washed downstream (Welch *et al.*, 1998).

As in other aquatic ecosystems, dissolved oxygen is a critical factor in determining the types of organisms present in rivers. In addition to being influenced by site-specific conditions such as stream velocity, algal and plant respiration, and water chemistry, dissolved oxygen is also affected by daily and seasonal variation in water temperature. Dissolved oxygen levels are highest in fast, cool waters and forested reaches; slower and warmer reaches have lower levels.

## Habitat types

Riverine habitats are an interconnected continuum (Figure 1.11). Their biological communities shift with changes in flow, temperature, gradient, and organic inputs. In general, smaller and steeper gradient streams are dominated by organic input from terrestrial sources such as leaf litter, invertebrate communities that shred the detritus, and fish that consume the invertebrates. As flows increase and gradients decrease, primary energy sources move to algae; invertebrate communities shift to species that collect algae, and fish communities shift to species that either collect algae or consume invertebrates and other fish. Large rivers continue to be dominated by algal productivity, invertebrate collectors, and fish that consume invertebrates and other fish. Fish species that graze on algae become less common in large rivers and are replaced by fish that consume plankton. Five benthic habitat types have been defined for riverine systems: cascade, plane-bed, pool-riffle, and low-gradient valley.

### Cascade

For this classification system cascade stream reaches are defined as those with gradients greater than 8 percent. These reaches are characterized by beds comprised of large boulders and channels typically confined by valley walls (Montgomery & Buffington, 2001). Movement of bed material is rare in cascade habitats due to the large size of the dominant substrate and the relatively shallow water depths.

### Step-pool

Morphology of step-pool reaches is characterized by alternating sequences of relatively deep stream sections with flat, non-turbulent flow, and shallow, steep sections with turbulent flow. Pools are typically formed by a cluster of large boulders that restrict the flow of water, resulting in a backwater upstream of the restriction and a substantial drop in elevation downstream of the restriction. Step-pool gradients range between 4 and 8 percent.

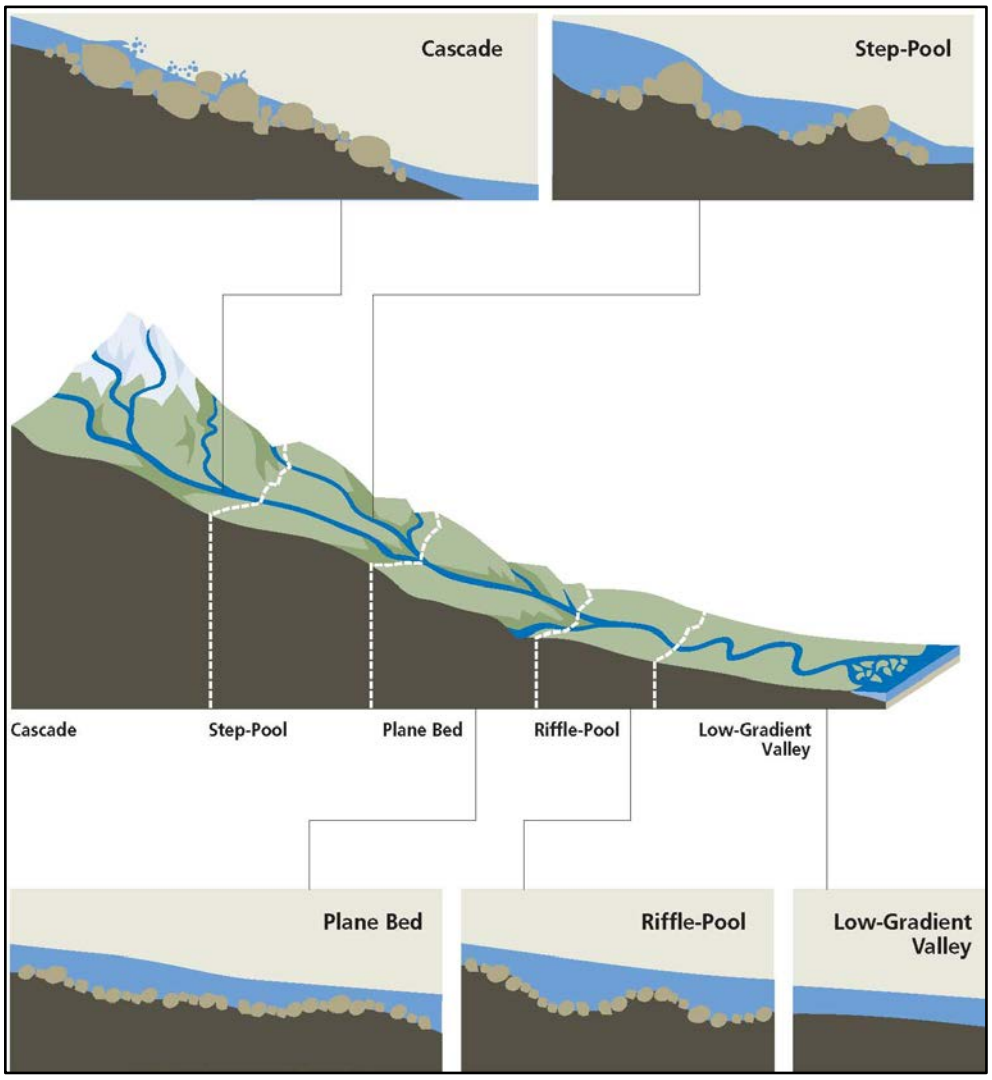
### Plane-bed

Stream reaches with gradient between 2 and 4 percent are plane-bed habitats. Plane-bed reaches are typically composed of intermediate substrate sizes (gravel to cobble) and lack the characteristic steps that are common in step-pool and cascade stream reaches.

### Pool-riffle

Comprised of alternating sequences of pools, gravel bars, and riffles, these habitats typically have moderately low gradients (0.1 to 2 percent) and are sinuous Pools in these reaches generally form on alternating banks of the channel and are created by scour resulting from the convergence of flow. Sediment deposition occurs either between pools in the riffles, or adjacent to the pools on

**Figure 1.11.** Riverine ecosystem longitudinal profile.




Graphic: Luis Prado, DNR

bars. Particle sizes in pool-riffle reaches are typically smaller than those observed in higher-gradient reaches comprised of gravel and cobble.

### Low-gradient valley

Low-gradient valley is the most common riverine habitat found on state-owned aquatic lands. These river sections typically have slopes less than 0.1 percent and occur in watersheds where sand supply is abundant. Stream beds consist of a series of mobile sand dunes whose length and height depend on the velocity of the river. Where sand supply is absent, the dominant bed material may be small gravel. Low-gradient valley channels commonly have multiple threads and the supply of sediment is typically greater than the river's sediment transport capacity.

Riverine habitats can also be described as two general classes of hydrodynamic units: fast water and slow water. Fast water can be further divided into turbulent and non-turbulent habitats. Fast turbulent water is characterized by emergent substrate and may include cascades, riffles, and pocket waters; non-turbulent fast water is characterized by sheet flow over broad flat areas. Slow water can be further divided by its formative mechanism: dammed pools result from hydraulic controls such as bedrock weirs (a row of boulders); debris dams and scour pools formed by erosive processes associated with woody debris, bedrock or boulders.

In large river systems, habitat features on the lateral margins of the channel and primary floodplain can be especially important for juvenile salmonids (Beechie *et al.*, 2005). These edge unit types include the stream banks, the lateral margins of exposed bars, backwater side channels, and valley-wall tributaries. Low-energy areas such as backwater side channels, deltas at tributary confluences, and pools on slow-moving streams often support the development of aquatic vegetation which provides refuge and forage opportunities for a wide variety of aquatic species (Cowardin *et al.*, 1979).

## Saltwater — common properties and processes

Washington's saltwater environments extend 5.6 kilometers (3 nautical miles) off the Pacific Coast (Neah Bay to the Columbia River), covering more than 9,800 square kilometers (3,784 miles$^2$) (Lanzer, 1999) with the total shoreline of the many islands, inlets and sub-estuaries along the Pacific Coast and in Puget Sound about 4,935 kilometers (3,066 miles) in length (Washington DNR, 2002). Saltwater habitats in the state are commonly classified by using Cowardin *et al.* (1979) and Dethier (1990), with both schemes providing significant detail in terms of the numbers of habitat types. While the classification system presented here incorporates many of the elements in both Cowardin and Dethier, it has also been simplified to reflect the coarseness of the leasing data available for Washington's state-owned aquatic lands.

Saltwater systems in the Pacific Northwest are influenced by mixed semidiurnal tides (two high and two low tides each lunar day with unequal amplitude). Within Puget Sound the tidal range increases from north to south, with tidal ranges in the north Sound less than 3 meters (10 feet) and more than 5 meters (16 feet) near Olympia. On the Pacific coast, the maximum tidal range is about 4 meters (13 feet), with an average range of approximately 2 meters (6 feet) (Komar, 1997).

Locally, tidal currents and wind events also affect inland circulation patterns. In Puget Sound wind flow is predominantly from south-southwest during the winter, before gradually reversing direction in the spring (Williams *et al.*, 2001). Highest net speeds are in the range of 6 to 9 meters per second (13 to 20 miles/hour) and wave conditions are generally mild, with both wave height and period limited by fetch (Williams *et al.*, 2001). Wind significantly influences the oceanography of interior waters by generating surface waves, mixing surface waters and forcing surface drift currents (Thomson, 1994).

In Puget Sound, stratification is greatest during the summer because of the combined effects of solar heating and river discharge, and lowest in the winter because of seasonal cooling and increased wind-induced mixing from storms (Thomson, 1994). Many of the deeper regions of Puget Sound exhibit persistent density stratification based on salinity and temperature (Williams *et al.*, 2001). In comparison, seasonal stratification in the Strait of Juan de Fuca is relatively uncommon and the waters are well-mixed vertically.

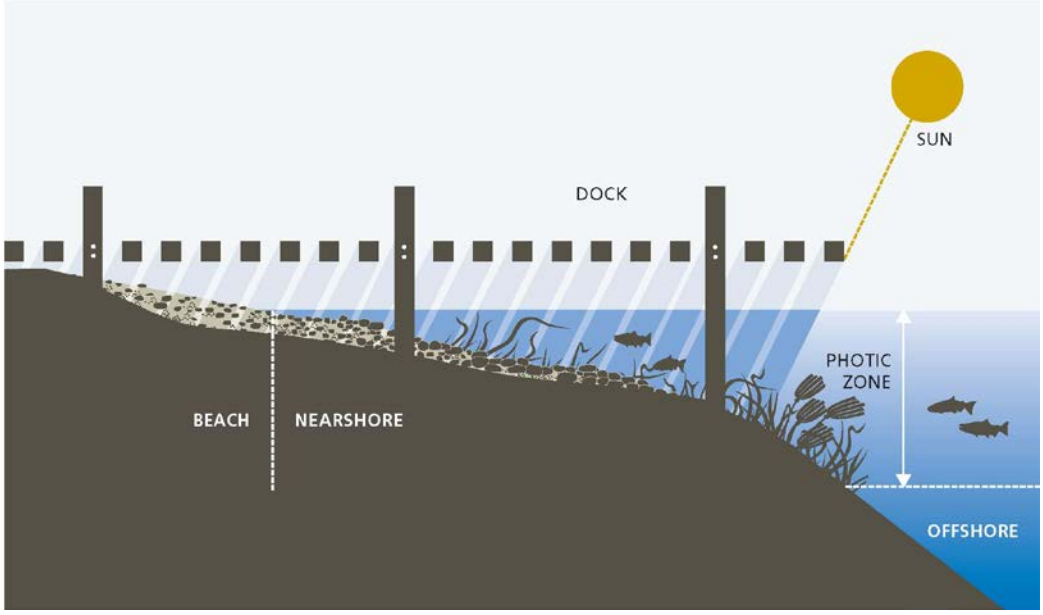
## Saltwater — nearshore

The saltwater-nearshore ecosystem extends inland from the offshore area boundary (20 meters or 66 feet in depth) to the shoreline at extreme higher high water (Figure 1.12), and includes estuarine and tidally influenced riverine habitat. Resource cycling in this ecosystem is fueled primarily by energy from benthic and terrestrial vegetation; the type and source of vegetative inputs influence both the species present and their ecological function (Simenstad & Wissmar, 1985; Valiela, 1984). While benthic habitats in the nearshore generally lie within the photic zone, the lower depth of light penetration is highly dependent on water clarity.

Within the nearshore ecosystem, the coastal region extends south from Cape Flattery along the outer coast to the mouth of the Columbia River; the inland region is comprised of the Strait of Juan de Fuca, the San Juan Archipelago north to the Canadian border, all of Puget Sound including Hood Canal, and the Columbia River from its mouth to the Bonneville Dam.

## Physical properties

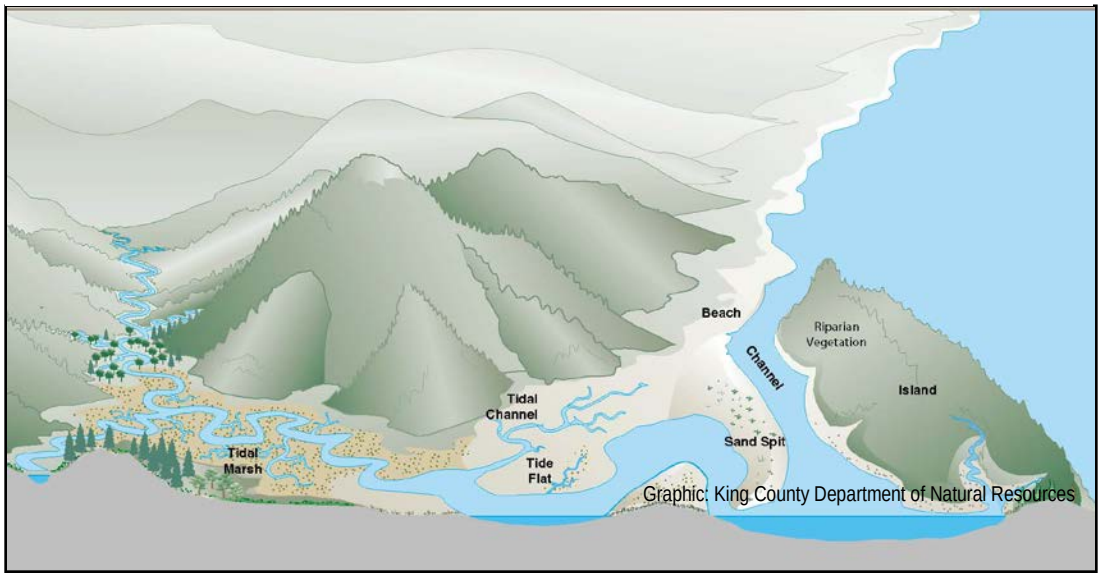
**Figure 1.12**. Saltwater ecosystem.




Graphic: Luis Prado / DNR

The bathymetry of the nearshore ecosystem varies with the characteristics of the surrounding landscape (Figure 1.13). In Puget Sound, much of this ecosystem is a narrow fringe along the edge of the steep-sided fjord that is interspersed with shallow inlets and back-bay areas. The

**Figure 1.13.** Nearshore landscape characteristics.

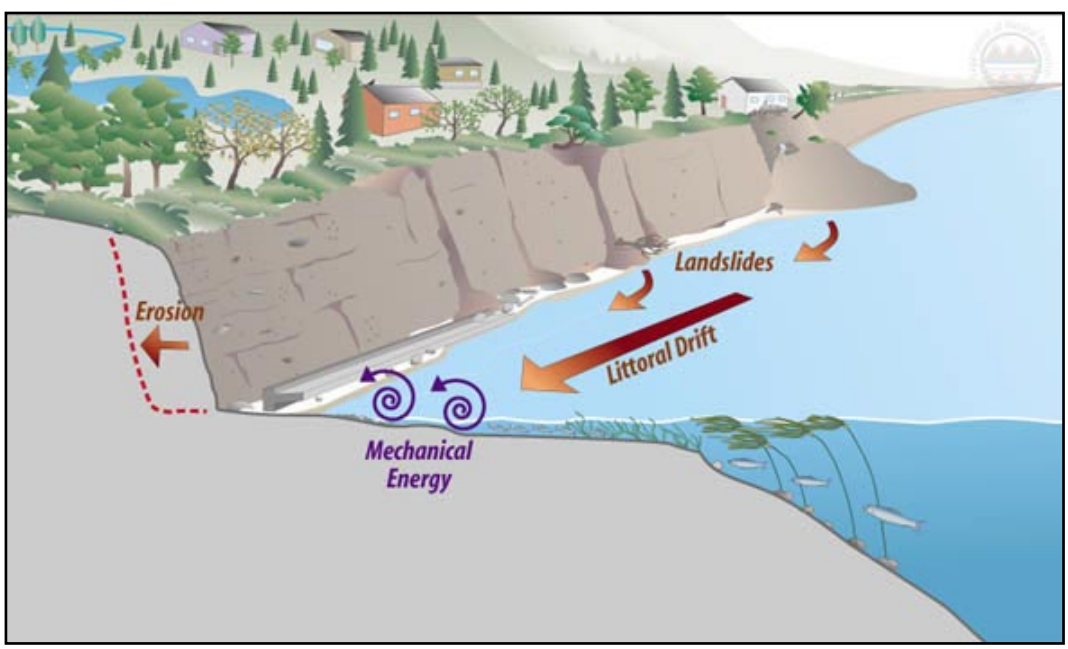


characteristics of these shallow areas vary from north to south. Estuaries and tidally influenced rivers are concentrated in the north (for example, Bellingham, Skagit, and Port Susan bays); inlets predominate at the southern end of Puget Sound (including Henderson, Budd, and Hammersley inlets) (Washington DNR, 2005a).

Water circulation and local bathymetry have a significant influence on the character of the nearshore system. Because of the proximity of the continental shelf, strong seasonal upwelling occurs along the coast of Washington and results in the movement of nutrient-rich waters into the photic zone and the nearshore ecosystem. This stimulates phytoplankton growth and thereby provides habitat and food for zooplankton. Tidal exchange also transports these highly productive waters into tidally influenced rivers and shallow embayments, providing foraging and refuge habitat for juvenile salmonids and other fish (Emmett *et al.*, 2000). During periods of low circulation, or stratification, the nearshore is most affected by the upper water column, which is generally warmer and nutrient poor in the summer and is less saline in the winter due to increased river flows.

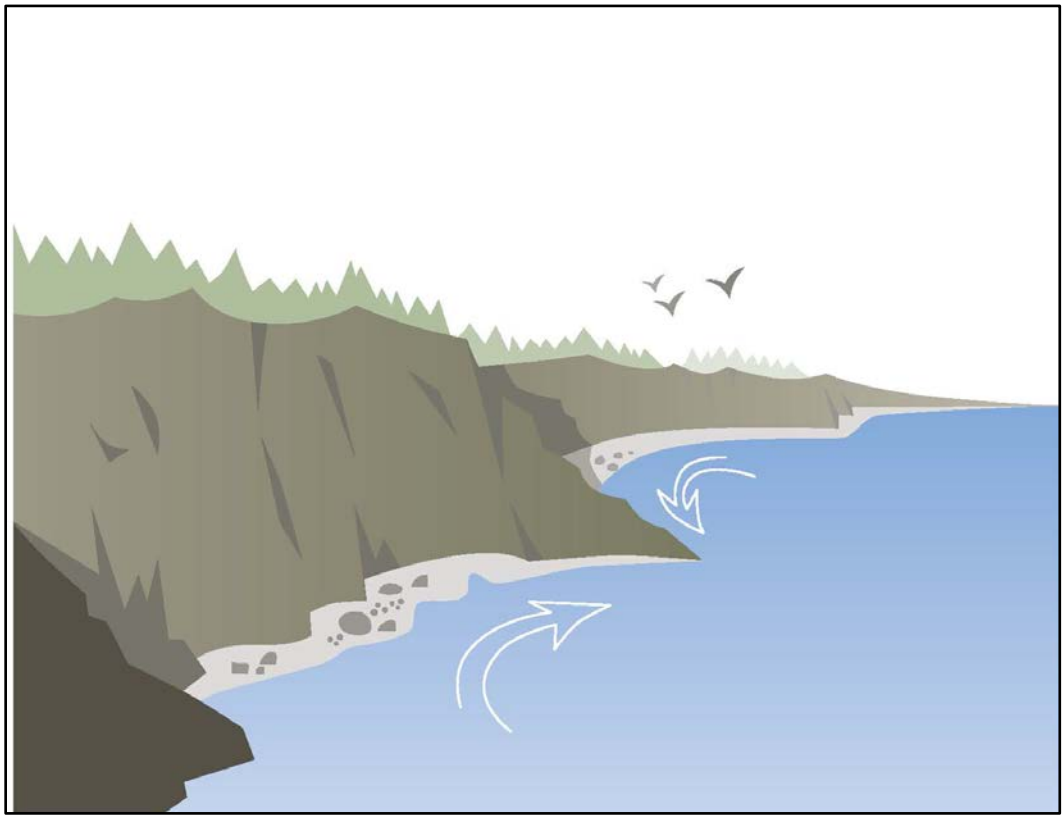
Glaciation shaped the general geomorphology of aquatic basins in Puget Sound, however, the morphology of the Northwest Coast ecoregion is largely the result of tectonic forces (Burns, 1985). Present-day sediment processes are responsible for forming and maintaining unconsolidated nearshore features such as dunes, marsh plains, and unvegetated beaches. Sediment transport in the nearshore is generally the result of waves and wave currents. Wave approach patterns determine the type of currents and resulting sediment movement (Figure 1.14). When waves approach the beach parallel to the shoreline, a series of rip currents develop causing erosion in pockets along the beach, while waves approaching at an angle form a longshore current or littoral drift (Figure 1.15). These currents can move along the shore for hundreds of miles; the direction of the prevailing winds determines the direction that the sediment is transported (Komar, 1997). Within the Puget Sound nearshore, sediment transport processes vary in their predominant direction and intensity, and are influenced by the complexities of tidal currents, wind-influenced wave patterns, and shoreline geomorphology.

**Figure 1.14.** Nearshore sediment transport processes.




Graphic: King County Department of Natural Resources.

**Figure 1.15.** Sediment drift process illustration.



Graphic: Luis Prado / DNR

## Water properties

Saltwater-nearshore temperature varies dramatically both seasonally and spatially. Solar energy heats the water and intertidal substrate at low tides, which results in a dramatic seasonal variation in water temperature. Saltwater-nearshore temperatures generally range from 6 to 9 degrees Celsius (43 to 48 degrees Fahrenheit) during winter and 16 to 19 degrees Celsius in summer (61 to 66 degrees Fahrenheit) (Thom and Albright, 1990). Summer temperatures in shallow embayments with restricted circulation reach 20 to 25 degrees Celsius (68 to 77 degrees Fahrenheit) during warm sunny days. Infrequent, long, cold periods can drive temperatures to as low as 2 degrees Celsius (36 degrees Fahrenheit), especially in shallow systems, and very shallow water will occasionally freeze.

River and stream flows can also affect temperature in the nearshore. Typically, warming of freshwater during summer will increase water temperature in the nearshore where flows impact the beach. In winter, freshwater flows can cool nearshore water temperatures. Winds that blow offshore cause vertical mixing of the water column and can create upwelling, which brings colder, deeper water from offshore into the nearshore environment. Stratification of the water column in the nearshore typically results in a warm surface layer during summer and a cold surface layer in winter. The most protected water and shallowest sites show the greatest extremes in temperature, whereas sites most exposed, deep and open to circulation (such as the outer coast) show the least extremes. The greatest range in water temperatures between winter and summer can occur during strong El Niño periods.

Salinity varies seasonally and spatially in the saltwater nearshore. Salinity is determined by the relative amounts of freshwater inputs from rivers and streams and saline ocean water. Winds and currents cause vertical and horizontal mixing of fresh and salt water. Nearshore areas along the outer coast that are not affected by freshwater typically have salinity levels that approximate open ocean conditions (30 to 35 parts per thousand).[15] Nearshore areas dominated by rivers can have periods of very low salinity. In central Puget Sound, salinity observations at the mouths of rivers can vary between about 15 parts per thousand in winter-spring to about 31 parts per thousand in late summer and early autumn. In the Columbia River estuary, extreme freshets[16] induced by high levels of precipitation and runoff can temporarily flush any salinity from the estuary.

Inorganic nutrients in the nearshore typically include the macronutrients nitrate, nitrite, ammonia and phosphate. These arrive in the nearshore by ocean inputs through upwelling, and freshwater inputs through overland flows of rainwater, rivers and streams. These macronutrients are important to the support of phytoplankton, seaweed, seagrass, and marsh plant growth in nearshore areas; low macronutrient concentrations can limit productivity. An overabundance of one or more of these nutrients can result in abnormal abundances of phytoplankton or seaweeds, the decay of which can create areas of low dissolved oxygen, also known as hypoxia. Plant use and uptake also affects the seasonal concentrations of nutrients. Nitrate concentrations in central Puget Sound vary from a high of about 35 micromoles per liter in winter to a low of less than 5 micromoles per liter in early summer (Thom & Albright, 1990).

Remineralization of nutrients from dead organic matter in the saltwater nearshore can also contribute to nutrient concentrations. In the summer, nutrient concentrations can become extremely low in shallow embayments with restricted circulation and no freshwater input, while open nearshore areas with upwelling and dynamic wave energies typically have much higher nutrient concentrations.

Dissolved oxygen concentrations in the saltwater nearshore are spatially and temporally variable. Because the water column is shallow, and often overlies very productive habitats, periods of high productivity can result in oxygen levels greater than 100 percent of the theoretical maximum oxygen concentration possible in water—this phenomenon is called supersaturation. In central Puget Sound, nearshore dissolved oxygen concentrations are typically greatest and most variable in spring and summer (11 to 16 milligrams per liter); the least variation occurs in autumn and winter (7 to 9 milligrams per liter; Thom & Albright, 1990). Oxygen demand by sediment-associated microbes and chemical processes can be great in embayments with low circulation (where sediments are high in organic matter concentration) and in areas with very high densities of large infauna such as clams.

## Habitat types

As in freshwater systems, the saltwater nearshore is home to many species of planktonic invertebrates and fishes and is responsible for much of the primary production in nearshore and offshore waters. Water column phytoplankton communities can be divided into three main groups: dinoflagellates, diatoms, and microflagellates. Diatoms are typically the most abundant group, particularly during algal spring blooms. Dinoflagellates are more common in calmer, low-energy environments (Strickland, 1983). Zooplankton consume phytoplankton and form the prey base for many species of fishes that inhabit the nearshore water column, particularly juvenile salmon.

[15] Parts of salt per thousand parts seawater, or grams of salt per kilogram of seawater.
[16] A flood resulting from heavy rain or a spring thaw.

Other species that feed primarily on zooplankton include juvenile and adult Pacific herring (*Clupea pallasi*), southern euchalon (*Thaleichthys pacificus*), stickleback (*Gasterosteus* spp.), sand lance (*Ammodytes hexapterus*), juvenile salmon (*Onchorhynchus* spp.), Pacific cod (*Gadus macrocephala*), Pacific hake (*Merluccius productus*), walleye pollock (*Theragra chalcogramma*), lingcod (*Ophiodon elongatus*), sablefish (*Anoploploma fimbria*), and spiny dogfish (*Squalus acanthias*) (Williams *et al.*, 2001). Several species of mammals and birds also depend on the nearshore water column, including harbor seals (*Phoca vitulina*), killer whale or orca (*Orcinus orca*), grey whales (*Eschrichtius robustus*), river and sea otters (*Lontra canadensis* and *Enhydra lutri* respectively) loons (*Gavia* spp.), grebes (Podicipedidae), cormorants (*Phalacrocorax* spp.), gulls (Laridae), and several species of ducks (Long, 1982).

Benthic nearshore habitats are divided into two general types: consolidated[17] and unconsolidated.18 The specific nature of the habitat and its associated communities are influenced by the substrate and the vegetation present (Dethier, 1990; Williams & Thom, 2001).

## Consolidated habitats

### Rocky shore assemblages

Rocky shores include those areas of the intertidal and shallow subtidal zone that are dominated by bedrock or boulder substrates. This habitat type is generally defined by relatively large-sized or abundant taxa dominated by kelp beds and other seaweed, or benthic invertebrates.

### Seaweed assemblages

Seaweeds are macroscopic algae that occur in the sea and are included within three taxonomic subgroups based on their dominant photosynthetic pigmentation: red, green and brown algae. Seaweeds occur throughout the photic zone, reaching their greatest abundance in areas where salinity is routinely above about 15 parts per thousand, with the greatest numbers of species occurring at salinities in the range of 31 to 35 (Thom, 1980).

Kelp (Laminariales) and other seaweeds that grow attached to rock generally dominate consolidated habitats in areas of bedrock and boulders. The distribution of these seaweeds occurs along a vertical-depth gradient and is controlled by a variety of species-specific factors, such as light requirements, tolerance for desiccation, thermal and physical stress (such as, log bashing, wave action and currents), competition with other native and non-native plants, and life-history strategies. Red algae are often found in the deepest waters because of their ability to use the wavelengths and energy levels of light that are found at these depths.

Floating kelps, such as bull kelp (*Nereocystis luetkeana*) and giant kelp (*Macrocystis integrifolia*), can form extensive canopies at or near the surface of the ocean and are most common in high-energy environments. In Washington, floating kelp beds are found on approximately 11 percent of the shoreline, primarily in the Northwest Coast ecoregion (Washington DNR, 2002). Kelp beds are used by sea otters and a variety of fishes and invertebrate species for rearing, feeding and predator avoidance. In some areas, herring may lay eggs on kelp fronds. Benthic diatoms are also an important photosynthetic component of rocky consolidated habitats and their primary productivity rates can be as high as that in beds of eelgrass (*Zostera marina*) (Thom *et al.*, 1989).

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[17] Coarse material includes boulders (rocks larger than 30.5 centimeters in diameter), bedrock, and consolidated clays (hardpan).
[18] Fine material includes cobble (7.5 to 30.5 centimeters in diameter), gravel (0.45 to 7.5 centimeters), sand (0.0075 to 0.45 centimeters), and mud (less than 0.0075 centimeters).

## Unconsolidated habitats

### Eelgrass meadows

In unconsolidated habitats, the primary vegetation is comprised of rooted flowering plants called seagrasses. Six species of seagrasses occur in Washington State; eelgrasses (*Z. marina* and the exotic *Z. japonica*) are the most widespread. Eelgrass is found in monotypic stands, or meadows, throughout much of Puget Sound and the San Juan Archipelago, areas along the Strait of Juan de Fuca, coastal estuaries, and in small areas in the outermost portion of the Columbia River estuary. These meadows harbor some of the richest assemblages of animals among all aquatic habitats in the state (Phillips, 1984). They provide important feeding and refuge habitat for salmonids, crabs , and birds, and provide spawning habitat for herring (Baldwin and Lovvorn, 1994; Holsman *et al.*, 2003; McMillan *et al.*, 1995; Phillips, 1984; Thom *et al.*, 1989); Wilson and Atkinson, 1995; McIntyre and Barr, 1997). While the vertical extent of eelgrass is controlled by light penetration and desiccation, it generally grows at depths of approximately plus 0.3 meters (0.9 feet) to minus 10 meters (33 feet) relative to mean lower low water (Thom *et al.*, 1998; Thom *et al.*, 2003).

### Flats

Mud or tidal flats consist of gently sloping lands that contain fine to coarse unconsolidated sediments. Deposition of fine material is largely influenced by riverine sediment load or by deposition of material eroded from the surrounding bluffs. Benthic diatoms are generally the major source of primary production in many flats; eelgrass, however, and other attached vegetation and drift seaweeds (ulvoids) may be present. Unconsolidated sediments provide habitat for a variety of infauna (worms, small crustaceans, and bivalves) that are important prey for shorebirds, fishes, and both marine and terrestrial mammals. These sediments are also home to recreationally and commercially important stocks of clams, crabs, sturgeon (*Acipenser* spp.) and flatfish (Pleuronectidae), including geoduck clam (*Panopea abrupta*), native littleneck clam (*Protothaca staminea*), and Dungeness crab, (*Metacarcinus magister*).

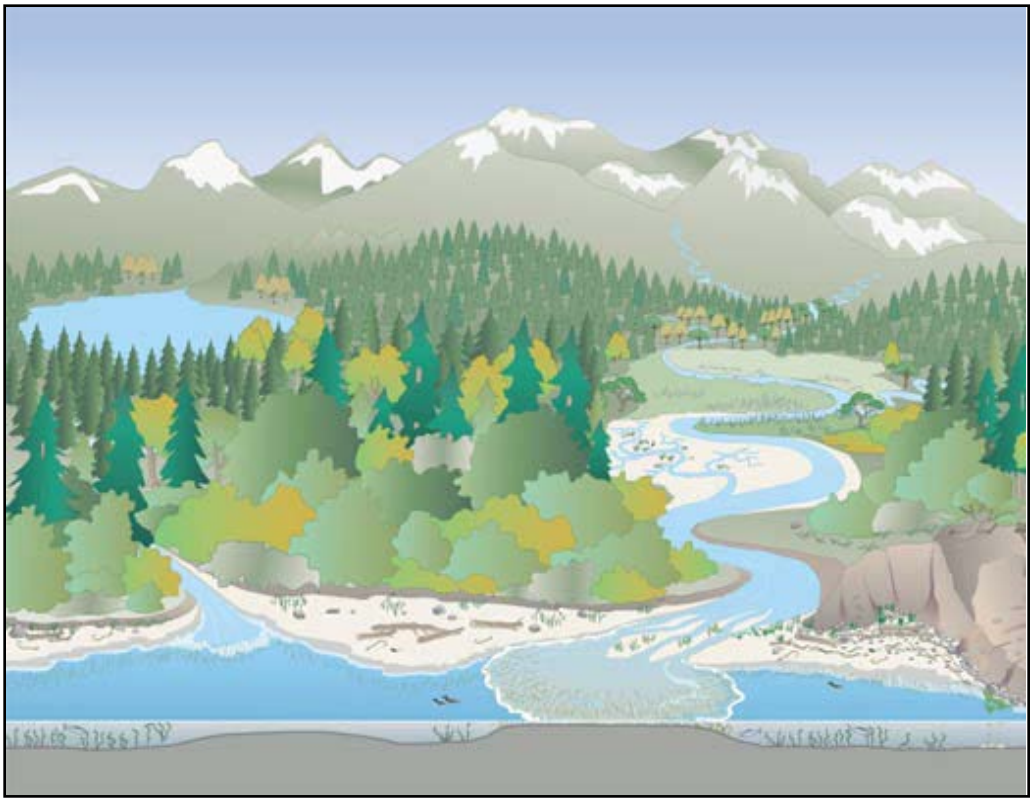
### Sub-estuaries and tidally influenced rivers

Rivers and streams that enter into larger estuarine and tidal systems, such as Puget Sound, the Columbia River, and Willapa Bay, can form distinct sets of habitats (Figure 1.16). At their mouths, these tidally influenced waters form deltas, which include channels through the mud flats that may contain water even at the lowest tides. Sub-estuaries are characterized by salinity concentrations that vary with river flows; estuarine character extends up river to the limit of tidal influence. Sub-estuaries also contain riparian habitat, dune habitat, tidal marshes, seaweed assemblages, eelgrass meadows, and limited rocky shore habitat. Sub-estuaries and tidally influenced rivers provide the transition between freshwater and saltwater for migratory salmonids. Recent studies indicate that juvenile salmonids spend considerable time in these habitats as they migrate to the ocean (Beamer *et al.*, 2005).

# Saltwater - riparian areas

Saltwater riparian habitat plays an important role in the structure and function of the nearshore ecosystem. This area is primarily under private ownership and is immediately landward of the intertidal zone; it is often naturally vegetated with shrubs and trees that sometimes overhang the intertidal zone (Williams *et al.*, 2001). As with freshwater riparian areas, saltwater riparian areas play a key role in nutrient cycling. These habitats filter and detain stormwater runoff, stabilize soils, reduce erosion rates, decrease temperature impacts on shallow water and beach habitats, and provide both structure (large woody debris) and insect prey for aquatic species (Brennan and Culverwell, 2004).

**Figure 1.16.** Sub-estuary and tidally influenced riverine habitats**.**



Graphic: King County Department of Natural Resources.

# Saltwater - offshore

The offshore ecosystem (Figure 1.12) generally begins at water depths greater than 20 meters (65 feet) and is defined by levels of photosynthetically active radiation (wavelengths 400 to 700 nanometers) insufficient to support the long-term survival of attached submerged aquatic vegetation. As a result, the offshore ecosystem is primarily driven by energy derived from phytoplankton communities found in the water column.

The offshore ecosystem comprises a coastal and an inland region. The coastal region includes those areas along the outer coast of Washington from the mouth of the Columbia River to Cape Flattery. The inland region consists of the Strait of Juan de Fuca, the San Juan Archipelago north to the Canadian border, all of Puget Sound, and the Columbia River from its mouth to the Bonneville Dam.

## Physical properties

Bathymetry strongly influences water circulation and water chemistry of offshore ecosystems. Submarine ridges, or *sills*, define the geometry of interconnected basins in Puget Sound, drive upwelling and currents along the outer coast, and strongly affect water exchange and biological conditions for both areas (Burns, 1985; Thomson, 1994). The offshore ecosystem comprises three major bathymetric and hydrodynamic features: Puget Sound, the Strait of Juan de Fuca, and the

continental shelf on the outer coast. Puget Sound is defined at its northern end by the 65-meter sill at Admiralty Inlet and includes all of the marine waters south to Olympia, including Hood Canal. The Strait of Juan de Fuca connects Puget Sound to the Pacific Ocean. The Strait of Juan de Fuca's western end is affected by oceanic processes that create strong tidal currents; the eastern end is modified by intense tidal processes (Thomson, 1994). The continental shelf on the outer coast is wide and gently sloping, resulting in slower circulation and greater particle residence times (Hickey and Banas, 2003).

Water circulation has a significant influence on the character and biological productivity of this ecosystem. In the inland region, circulation is governed by the seaward movement of rainfall and snowmelt in the upper portion of the water column, and the landward inflow of saltwater in the lower water column (Thomson, 1994). In the coastal region, oceanic conditions influence seasonal fluctuations of upwelling and downwelling (Hickey and Banas, 2003). From late spring to early fall, northwesterly winds transport the upper 100 meters (328 feet) of the water column farther offshore (Thomson, 1994), enabling upwelling of relatively cold, high salinity, and nutrient rich waters. From late fall to early spring, coastal winds are primarily from the southeast, which causes a reversal of circulation patterns and results in downwelling.

Water flows and wave/current energies control sediment transport in the offshore ecosystem. In the inland region, flowing water is generally the most important process governing sediment transport; rivers and shoreline erosion represent the primary means of sediment transport (Burns, 1985). In the coastal region, large waves and strong ocean currents constantly erode and rebuild beaches, resulting in seasonal changes in sediment transport and substrate composition.

## Water properties

Surface water salinity and temperature vary by season. In the summer, salinity typically ranges between 29 parts per thousand and 33 parts per thousand; temperatures range between 8 and 19 degrees Celsius (46–66 Fahrenheit). In the winter, salinity and temperature are influenced more by riverine flows; salinity may be as low as 13, and water within the top 10 meters (33 feet) of the surface may stratify (Newton *et al.*, 2002).

Water clarity is affected by plankton concentration and suspended sediments. Secchi depth, a measure of water clarity, varies between 4 meters (13 feet) and more than 11 meters (36 feet), with the clearest waters often occurring during calm periods in winter, and after the massive phytoplankton blooms in spring and summer have died off (Newton *et al.*, 2002). In addition to phytoplankton blooms, widespread reduction in water clarity can occur during storms from suspension of fine sediment particles, or plumes of turbid water from larger rivers.

Nitrogen and phosphorus in coastal waters come from three primary sources: upwelling of nutrient rich water, input from land sources, and recycling of nutrients in surface waters and sediments (Harris, 1986). As previously noted, the upwelling of nutrient-rich water from the Pacific Ocean is the major source of macronutrients to coastal offshore ecosystems. Rich, oceanic waters are also the primary source of nutrients for the inland region; anthropogenic sources are considered negligible in well-flushed basins (Williams *et al.*, 2001). Inland primary productivity rates are generally considered to be very high, relative to those in other temperate estuaries. Inland primary productivity rates are primarily affected by sunlight, stratification, and water residence time (Williams *et al.*, 2001). Because all of these factors are highly variable in time and space, primary productivity and abundance can occur in extremes, characterized by phytoplankton blooms. Intense blooms largely occur in the spring and fall, with smaller blooms in summer and sparse growth in the winter. Major types of phytoplankton present in Puget Sound include diatoms

(Bacillariophyceae), dinoflagellates (Dinoflagellata), and microflagellates (Protozoa) (Strickland, 1983).

Both inland and coastal offshore dissolved oxygen concentrations reflect the influence of dense, high salinity, naturally low-oxygenated oceanic waters (Newton *et al.*, 2002). Concentrations range between 5 and 3 milligrams per liter.

## Habitat types

Many species that use the offshore ecosystem dwell within the water column or at the water's surface. In addition to free-floating plankton and pelagic fish eggs, these areas support a variety of fish larvae (for example, smelt (Osmeridae) and sculpin (*Artiedius* spp.); adult fish (such as spiny dogfish, Pacific herring, Pacific cod, and salmonids); and the marine mammals and birds that prey upon them (Long, 1982). At least 21 different species of marine mammals use the Strait of Juan de Fuca and northern Puget Sound alone for feeding and migration (Long, 1982). Large populations of birds, such as gulls (*Larus* spp.), loons (*Gavia* spp.), grebes (*Aechmophorus* spp.), and cormorants (*Phalacrocorax* spp.) also winter and feed in the offshore ecosystem.

As with the nearshore, there are two habitat divisions of inland and coastal offshore benthos—consolidated and unconsolidated.

### Consolidated

Consolidated habitats are primarily found in scattered pockets off the coast of the Olympic Peninsula, in larger aggregations west and southwest of Willapa Bay, off of Cape Flattery, in the San Juan Archipelago, off the west coast of Whidbey Island and Admiralty Inlet, and in the Tacoma Narrows channel. High-energy, consolidated habitats are predominantly characterized by non-motile invertebrate species—such as anemones (*Metridium senile* and *Urticina* spp.), purple-hinged rock scallops (*Hinnites giganteus*), and giant acorn barnacles *(Balanus nubilus*) (Dethier, 1990)—and mobile species, such as sea urchins (*Strongylocentrotus* spp.), rockfish (*Sebastes* spp.), gobies (*Coryphopterus* spp.), lingcod (*Ophiodon elongatus*), and sculpin (*Artiedius* spp.). Low-energy, consolidated habitats are characterized by glass sponges (*Hyalospongia*), polychaete worms (*Serpulid* spp.), squat lobsters (*Munida quadrispina*), a variety of planktivorous invertebrates (e.g., anemones (*Urticina* spp.), orange cup coral (*Balanophyllia elegans*), rockfish, longfin sculpin (*Jordania zonope*) and gobies.

### Unconsolidated

Unconsolidated, soft bottom is the predominant benthic habitat for both the coastal and inland region of the offshore system. The biological communities associated with high-energy, unconsolidated habitats are influenced by both substrate composition and size. Mixes of cobble and finer material, such as gravel, shell hash, and sand, are typically inhabited by horse mussels (*Modiolus modiolus*) and barnacles (*Balanus* spp.). Cobble substrates are generally dominated by sea urchins and rock scallops. Mixed-coarse substrates house a variety of infauna, including small bivalves—such as the hundred line cockle (*Nemocardium centifilosum*)—and amphipods such as the Bay ghost shrimp (*Callianassa californiensis*) and the stout coastal shrimp (*Heptacarpus brevirostris*). Sandy, unconsolidated habitats in high-energy regimes support small bivalves (for example, Tellina spp. and *Macoma* spp.), amphipods (including *Rhepoxynius abronius* and *Eohaustorius washingtonianus*) and polychaetes (such as *Maldane glebifex* and *Chaetozone setosa*) (Dethier, 1990). Low-energy, unconsolidated habitats typically support sea pens (*Ptilosarcus gurneyi*), sea whips (*Virgularia* spp.), tubeworms (*chaetopterid polychaetes*), many bivalve species, and mobile crustaceans, such as Dungeness crab and kelp crabs (*Pugettia* spp.) (Dethier, 1990).

# 1.5 Existing conditions

## 1.5.1 Water quality

### Freshwater

#### Lacustrine

The Washington State Department of Ecology staff and volunteers assess water quality in lakes by measuring Secchi depth, temperature, pH, dissolved oxygen, and conductivity (Smith *et al.*, 2000; Bell-McKinnon, 2002). Of the 48 lakes assessed for phosphorus and trophic status in 1999, 12 percent exceeded the established criteria for the region. Table 1.5 illustrates trophic status and total phosphorous ranges (Bell-McKinnon, 2002).

**Table 1.5.** Trophic status and total phosphorous ranges for lakes assessed in 1999.

| | Oligotrophic | Mesotrophic | Eutrophic |
|---|---|---|---|
| Trophic status assessed (number) | 20 | 23 | 5 |
| Exceed total phosphorous criteria (number) | 2 | 4 | |
| Total phosphorous range (micrograms/liter) | 4.9–17.2 | 12.5–72.5 | 18.5–44.8 |

#### Riverine

The Washington State Department of Ecology's freshwater monitoring unit has monitored Washington's rivers and streams for more than 30 years. Monthly sampling occurs at 62 monitoring sites and 20 basins for the following 12 parameters: ammonia, nitrate+nitrite, total nitrogen, total phosphorus, orthophosphate, temperature, pH, conductivity, oxygen, turbidity, suspended sediment, and fecal coliform bacteria. Assessments of water quality are based on a comparison of the state's water quality standards (WAC 173-201A) to the data collected.

The 62 long-term monitoring stations are generally located near the mouths of major rivers and downstream of major cities. The basin stations are selected to address site-specific water quality issues. Because the basin stations are typically monitored for only one year and are located in known problem areas, the data associated with these stations are not representative of water quality conditions statewide.

The Washington State Department of Ecology uses the stream Water Quality Index[19] to compare trends across stations and basins (Hallock, 2006). An analysis of trends for 1996 to 2005 shows

[19] The Water Quality Index expresses results relative to levels required to maintain beneficial uses as defined in Washington's Water Quality Standards (WAC 173-201A). It is expressed as a unitless number between 1 and 100; higher numbers indicate better water quality.

that adjusting data for flow improved the Water Quality Index at 15 of the long-term monitoring stations; declines noted at 4 stations (Hallock and Parsons, 2006). An analysis of ecoregional trends for the same period showed a statistical improvement in 4 of the 6 regions where data were collected and a decrease in the Water Quality Index statewide (Table 1.6) (Hallock and Parsons, 2006).

Water Quality Index scores for 2005 were also assessed, with the scores grouped in categories used by the Environmental Protection Agency (EPA). For both the basin and the long-term monitoring sites, 4 percent were categorized as "highest concern," 49 percent as "moderate concern," and 46 percent as "lowest concern" (Hallock and Parsons, 2006). Additional results for 2005 per Hallock (2006) are as follows:

- Aquatic life and recreational use: all criteria were met by 24 percent of the long-term stations and 29 percent of the basin stations.
- Stream temperature: approximately 87 percent of the stations exceeded criteria for 2005.
- Bacteria: No reduction in bacteria counts were required for 97 percent of the long-term stations and 61 percent of the basin stations.

**Table 1.6.** Ecoregional trends in the Water Quality Index. Positive Z scores indicate improving water quality, with significant trends (p<0.05) shown in bold (adapted from Hallock and Parsons, 2006).

| | | Trend in Monthly Water Quality Index Scores | | |
|---|---|---|---|---|
| **Ecoregion** | **Number of Stations** | **Regional Z score** | **Probability of Significant Trend** | **Mean Annual Change Last 10 years (WQI units)** |
| Northwest Coast | 6 | - 0.55 | 0.59 | Not significant |
| Puget Trough | 24 | + 5.40 | <0.01 | 0.28 |
| East Cascades | 4 | + 5.21 | <0.01 | 0.60 |
| Columbia Plateau | 22 | + 10.63 | <0.01 | 0.85 |
| Okanogan | 6 | + 5.92 | <0.01 | 0.61 |
| Statewide | 63 | - 0.55 | <0.01 | 0.51 |

In 2009, Washington Department of Ecology used data collected from 1994 to 2008 to assess trends in total nitrogen and nitrate+nitrite concentrations at 24 stations in Puget Sound area rivers. Total nitrogen concentrations were uniformly down; the Stillaguamish, Cedar, and Skokomish rivers displayed especially strong downward trends. The Cedar and Skokomish rivers also showed downward trends in annual nitrate+nitrite concentrations while the Deschutes and Elwha rivers showed upward trends. Summer nitrate+nitrite concentrations showed upward trends in the Snohomish, Green, and Deschutes rivers (Hallock, 2009).

## Saltwater

The Washington State Department of Ecology has conducted annual marine water quality monitoring at stations in Puget Sound and in coastal areas (Grays Harbor and Willapa Bay) since 1967. The program collected data on dissolved oxygen, nutrients, and fecal coliform bacteria. The report, covered data from 1998 to 2000 (Newton *et al.*, 2002), were reported bi-annually by the

Puget Sound Action Team (Puget Sound Action Team, 2007). The following discussion is a synthesis of the material published by the Washington State Department of Ecology and the Puget Sound Action Team.

While water quality varies seasonally and across years, general patterns in the levels of fecal coliform, nitrogen, ammonium, dissolved oxygen, and stratification can be used as indicators. For the 1998 to 2000 sampling period, the Washington State Department of Ecology reported that while water quality appeared to be generally good for the Puget Sound basin, several sites experienced decreases in overall water quality, including low dissolved oxygen, increases in fecal coliform bacteria, or a sensitivity to eutrophication based on stratification or nutrient conditions (Newton *et al.*, 2002). The eight areas of highest concern were southern Hood Canal, Budd Inlet, Penn Cove, Commencement Bay, Elliott Bay, Possession Sound, Saratoga Passage, and Sinclair Inlet. For the coastal estuaries, the primary water quality issue reported was chronic fecal coliform bacteria contamination in Grays Harbor and in Willapa Bay, adjacent to the Willapa River (Newton *et al.*, 2002). In 2005 all the sites sampled in Puget Sound were of concern for at least one parameter, with eight sites (Budd Inlet, South Hood Canal, Saratoga Passage, Possession Sound, Penn Cove, Commencement Bay, Elliott Bay, and Sinclair Inlet) considered "highest concern" due to exceedances of the standards for several or all parameters (Puget Sound Action Team, 2007). Bellingham Bay, Oakland Bay, Case Inlet, Discovery Bay, Strait of Georgia, Carr Inlet, Port Orchard, West Point, Skagit Bay and Port Susan were rated "high concern" due to exceedances of the standards for dissolved oxygen and fecal coliform bacteria (Puget Sound Action Team, 2007).

The Washington State Department of Ecology developed the Marine Water Condition Index (MWCI) in 2011 as a way to detect changes in water quality over time. The MWCI utilizes 12 variables to describe water quality conditions including temperature, salinity, nutrients, algae biomass and dissolved oxygen to assess local water quality and physical conditions in relation to broader oceanic water quality and natural variability. The NWCI trends show a continuing increase in nutrients, possibly due to the increase in population density since 2002, for the Puget Sound Central Basin, southern Hood Canal, Oakland Bay and Admiralty Inlet. Increases in population, particularly along Puget Sound's urbanized corridor correlate with increases in nutrient discharges from both point source and non-point sources in these areas (Washington State Department of Ecology, 2012).

## 303(d) Listed waters

In 2009, the Washington State Department of Ecology completed Washington State's Water Quality Assessment for 2007/2008. The results of the assessment were submitted to the Environmental Protection Agency as an integrated report to satisfy federal Clean Water Act requirements of sections 303(d) and 305(b). The assessment includes a list of the bodies of water in Washington known to be polluted. The list is available on the Department of Ecology's website and is included in the Environmental Protection Agency's Watershed Assessment, Tracking and Environmental Results System (WATERS) interactive database.

The report assesses 5 percent of the river and stream miles and 3 percent of the combined total number of lakes and gridded marine waters in Washington. Of the 26,000 segments assessed, 30 percent met all the tested water quality parameters (temperature, pH, dissolved oxygen, fecal coliform, total nitrogen, total phosphorous, total suspended sediment, and turbidity), 16 percent

were designated as waters of concern,[20] and 14 percent were placed on the 303(d) list. The number of segments assessed as Category 5 (standards for one or more pollutants have been violated, and there is no Total Maximum Daily Load (TMDL) established for the segment) increased by 919 from 2005. Of the 2008 key parameter exceedances, 33 percent were due to temperature, 27 percent were due to fecal coliform bacteria, 24 percent were due to dissolved oxygen, 10 percent were due to pH, 2 percent were due to total phosphorous, and 4 percent were due to metals, toxics and "other" pollutants. The Washington State Department of Ecology's Water Quality Program submitted the 2010 Candidate Assessment and 303(d) List to the Environmental Protection Agency in December 2011. Once approved, this list will replace the 2008 assessment and 303(d) list of impaired waters in Washington State.

# 1.5.2 Sediment quality

## Freshwater

Washington State does not currently have sediment criteria for freshwater. The Washington State Department of Ecology is, however, engaged in establishing sediment quality values based on apparent effect thresholds for bioassay endpoints. In 1998, the U.S. Geological Survey published results pertaining to the Puget Trough from the National Water Quality Assessment Program showing that several riverine systems had levels of metals and toxins that exceed both Canadian probable effects levels and New York State freshwater sediment standards for sediment and fish tissue (MacCoy and Black, 1998).

## Saltwater

Sediment quality plays an important role in the health and structure of *epibenthic* and *benthic* habitats, influencing food web dynamics, primary productivity, and species diversity and abundance. The Washington State Department of Ecology's Marine Sediment Monitoring Team and the National Oceanic and Atmospheric Administration (NOAA) cooperatively collected sediment samples for 300 Puget Sound sites between 1997 and 1999. The data characterize the quality of sediments throughout Puget Sound, the concentration of toxins present, and describe the biological communities present (Long *et al.*, 2004).

The Sediment Quality Triad Index summarizes the data results by frequency of occurrence categories by basin/region (Table 1.7) and by total area within Puget Sound (Table 1.8) (Long *et al.*, 2004). Most samples assessed as degraded were collected in the Whidbey Basin (Everett Harbor), Central Sound (Elliot Bay and Commencement Bay), and South Sound (Budd Inlet) regions.

The station samples were also analyzed using five strata based on the major geographic features and degree of anthropogenic activity (including harbor, urban embayments, passage, deep basin, and rural embayments). The largest percentage of samples with degraded sediment quality was associated with the harbor and urban embayment strata; the samples with the highest sediment quality were found in passages, deep basins and rural embayments.

[20] Evidence of a water quality problem, but not enough to require production of a total maximum daily load.

**Table 1.7.** Sediment Quality Triad Index for Puget Sound basins (Long et al., 2004).

| | Index Frequency (percent of samples) | | | |
|---|---|---|---|---|
| **Basin** | **High** | **Intermediate / High** | **Intermediate / Degraded** | **Degraded** |
| Strait of Georgia | 70 | 25 | 5 | 0 |
| Whidbey | 61 | 13 | 5 | 21 |
| Admiralty Inlet | 100 | | | |
| Central Sound | 23 | 37 | 20 | 20 |
| Hood Canal | 61 | 19 | 10 | 10 |
| South Sound | 46 | 33 | 19 | 2 |

**Table 1.8.** Sediment Quality Triad Index for Puget Sound (Long et al., 2004).

| | Stations | |
|---|---|---|
| **Sediment Quality Triad Index** | **Number** | **Percent** |
| High | 138 | 46.0 |
| Intermediate/high | 85 | 28.3 |
| Chemistry | 13 | 4.3 |
| Toxicity | 68 | 22.7 |
| Infauna | 4 | 1.3 |
| Intermediate/degraded | 40 | 13.3 |
| Chemistry | 19 | 6.3 |
| Toxicity | 1 | 0.3 |
| Infauna | 20 | 6.7 |
| Degraded | 37 | 12.3 |

In 2005, the Puget Sound Ambient Monitoring Program (PSAMP) summarized 12 years of data from 10 long-term monitoring stations to establish a record of sediment conditions for a variety of habitats and geographic locations throughout Puget Sound (Partridge *et al.*, 2005). The data associated with grain size, total organic carbon content, and the composition and structure of benthic invertebrate communities were collected annually. Sediments were analyzed for more than 180 priority pollutant metal and organic contaminants: for example, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides. (Partridge *et al.*, 2005)

While many of these parameters were stable over time, changes associated directly with anthropogenic sources were found in urban embayments. Analysis of the chemical contaminant data set indicated that, in general, concentrations of metals in 2000 were lower than in 1989-1996 more often than they were higher, while the opposite was true of PAHs (Partridge *et al.*, 2005). The decrease in concentrations of metals may reflect a decreased discharge of metals into Puget Sound; the increase in PAH concentrations is likely attributable to increased suburban runoff. Overall, Sinclair Inlet had the highest concentration of metals; PAH concentrations at the Thea Foss Waterway station was one to two orders of magnitude greater than at any other station (Partridge *et al.*, 2005).

While not measured in either of the reports discussed here, it is likely that other environmental variables such as the availability of oxygen, nutrient flux between the sediments and water column, and unregulated pollutants—such as polybrominated diphenyl ethers (PBDEs), which are flame retardants— affect sediment conditions and food web dynamics. Taken up through the food chain, PDBEs have been documented in fish tissue studies and are known endocrine disruptors. As of this report, there are no monitoring planning efforts, water or fish standards for PBDEs (Washington State Department of Ecology, 2007).

# 1.5.3 Vegetation

Aquatic vegetation is important habitat in both fresh- and saltwater systems. Submerged and emergent vegetation provides structure to shallow water benthic habitats and reduces wave energy, which stabilizes the sediment and shoreline, and slows erosion (Fonseca & Cahalan, 1992; Van den Berg *et al.*, 1998). Aquatic vegetation also removes nutrients from the water column—thereby reducing algal blooms and associated decreases in dissolved oxygen—and converts carbon dioxide into oxygen in both the water column and the sediment (Findlay *et al.*, 2006; Hemminga and Duarte, 2000; Hietala *et al.*, 2004; Laskov *et al.*, 2006; Van den Berg *et al.*, 1998). Aquatic vegetation can also be a major source of food for herptofauna, birds, fishes, and invertebrates, which may consume the vegetation itself or consume species that shelter in the vegetation (such as zooplankton and larval and juvenile fishes). Aquatic vegetation also serves as a food source indirectly by contributing detritus and dissolved organic matter to the system (Alvarez and Peckarsky, 2005; Hilt, 2006; Moore *et al.*, 2004). Species may also use vegetation for egg attachment, nursery and rearing areas, and refuge from predation (Kendall and Mearns, 1996; Munger *et al.*, 1998; Shaffer, 2004; Webb 1991).

## Freshwater

Washington's rivers and lakes contain a wide variety of vascular plants and freshwater algae. Freshwater aquatic plants can be categorized as rooted or unrooted. Rooted plants are further classified as submerged, emergent, or floating. Among the freshwater algae, stoneworts and brittleworts (Charophytes) achieve a size and structural complexity similar to vascular plants. Vegetative species include emergent species such as rushes (*Eleocharis* spp.) and arrowhead (*Sagittaria* spp.); floating species such as pond-lilies (*Nuphar* spp.), pondweed (*Potamogeton* spp.), pennywort (*Hydrocotyle ranunculiodes*), and duckweed (Lemnaceae); and submerged species such as western milfoil (*Myriophyllum hippuroides*), starworts (Callitrichaceae), hornworts (Ceratophyllaceae), and stoneworts (Characeae).

Freshwater vegetation is an important food web component. Species that directly consume freshwater vegetation include amphibian tadpoles, the western pond turtle (*Actinemys marmorata*),

snails, insects, and a variety of birds and fishes. In turn, these primary and secondary consumers are a valuable food source for adult amphibians (such as Columbia spotted frog (*Rana luteiventris*)), birds, and both juvenile and adult fish, including white sturgeon (*Acipenser transmontanus).* Vegetation also provides refuge and breeding habitat for a variety of species such as amphibians and aquatic insects.

The Washington State Department of Ecology has documented an increase in the density of native plant growth in some lakes and rivers. This is most likely related to an increase in nutrients resulting from human sources, including fertilizer runoff and leaky septic systems. While moderate growth of aquatic plants is generally a benefit to aquatic systems, too much can cause detrimental impacts; exceptionally dense growth of native plants can potentially affect fish and other native wildlife (Hallock, 2006).

### Riparian vegetation

In addition to shading the adjacent water body and helping to maintain cool water temperatures, riparian vegetation helps stabilize shorelines, thereby controlling erosion and sedimentation. Large diameter trees provide important perch sites for birds. Overhanging or partially submerged vegetation provides cover for fish and other aquatic species. The leaves, twigs, and insects that fall from the vegetation provide food and nutrients. Large trees that fall into lakes and rivers create cover and slow water habitats for spawning and rearing, and protection from predators. Large woody debris also helps form complex habitats by retaining gravel, contributing to floodplain development, and establishing pool/riffle sequences through transitional and depositional reaches. Understory riparian vegetation, soils, and the duff layer filter upland sediments and pollutants, which reduces detrimental inputs to aquatic systems. Vegetation also helps moderate stream volumes by reducing peak flows during flooding periods, and by storing and slowly releasing water into streams during low flows (Knutson and Naef, 1997).

Since the early 19th century, between 50 and 90 percent of Washington's riparian habitat has been lost or modified (Canning and Stevens, 1989; Knutson and Naef, 1997). The biologically productive lowlands have experienced an estimated 70 percent conversion of wetland and riparian areas; heavily urbanized areas experienced a 100 percent loss or severe alteration of wetland and riparian habitat (Canning and Stevens, 1989).

### Invasive aquatic vegetation

The term *invasive* is used in this document as defined under RCW 79A.25.310(4). Since 1994, the Washington Department of Ecology has sampled 445 rivers and lakes for invasive aquatic weeds. Of the 44 percent found to have invasive weeds, Eurasian water-milfoil (*Myriophyllum spicatum*) was the most prevalent (found in 77 percent of the rivers and lakes with invasive species), followed by Brazilian elodea *(Egeria densa*; 13 percent) and parrot feather (*Myriophyllum aquaticum*; 8 percent) (Hallock, 2006).

## Saltwater

### Seagrasses

Seagrasses are rooted flowering plants that live partially or completely submerged in marine and estuarine waters. Of the six seagrass species occurring in Washington, the two eelgrasses (the

native *Zostera marina* and the non-native *Z. japonica*) are the most widespread seagrasses: they are documented to occur along approximately 1,135 kilometers (705 miles) of shoreline (Washington DNR, 2002). North and central Puget Sound have the highest percentages of eelgrass; the southern end has the lowest percentage. Surfgrasses (*Phyllospadix* spp.) can also be found, but are generally less abundant than eelgrass and are restricted to the lower intertidal and shallow subtidal zone in high-energy (exposed), rocky, marine shorelines. Widgeon grass (*Ruppia maritima*) is even less common than the surfgrasses and inhabits the high intertidal in areas with brackish water.

Eelgrass meadows are a major source of carbon in the nearshore ecosystem and have one of the richest assemblages of animals among all aquatic habitats in the state. Eelgrass is used by a number of juvenile salmonids and other fish for foraging and refuge, by herring as a spawning substrate, and by a variety of crabs for feeding and refuge (Holsman *et al.*, 2003; McMillan *et al.*, 1995; Phillips, 1984).

As part of the Puget Sound Assessment and Monitoring Program (PSAMP),[21] Washington DNR's Submerged Vegetation Monitoring Project (SVMP) has been collecting data on the abundance and distribution of native eelgrass in greater Puget Sound since 2000. The study area is divided into five regions: central Puget Sound, north Puget Sound, San Juan Archipelago, Strait of Juan de Fuca, and the Saratoga-Whidbey Basin. More than a quarter of the total amount of eelgrass in Puget Sound is found in Padilla and Samish bays in the Puget Trough ecoregion.

Gaeckle *et al.*, (2009) provided recent data on eelgrass in Puget Sound, extending the overall data record to nine years (2000 to 2008). In Puget Sound overall, native eelgrass shows a pattern of slight decline; more sites display long-term decreases in eelgrass than increases; and more sites show one-year decreases in eelgrass than increases. However, this slight declining trend has not resulted in a decrease in the spatial extent of eelgrass across Puget Sound over the last nine years.

Sampling results from the Hood Canal region suggest that Hood Canal is showing the largest decline and is of highest concern for the decline in native eelgrass (*Z. marina*). The Strait of Juan de Fuca and central Puget Sound regions also show declining trends and are the second highest concern (Gaeckle *et al.*, 2009). In particular, several shallow embayments in the San Juan Archipelago have shown a pattern of sharp decline in eelgrass abundance, including some areas used as herring spawning sites (Dowty *et al.*, 2005). The Saratoga-Whidbey and north Puget Sound regions had the lowest frequency of change in eelgrass area—the number of decreasing sites matched the number of increasing sites—and this location is currently of low concern for native eelgrass decline (Gaeckle *et al.*, 2009).

While not the primary focus of the SVMP work, data on non-native eelgrass (*Z. japonica*) were also gathered. This introduced species tends to have a shorter growth form and different sheath morphology than the native species. Little is known, however, about differences in the ecological services of the two species. The non-native species tends to colonize shallower areas in upper intertidal zones and can co-occur with *Z. marina* (Dowty *et al.*, 2005). In 2009, *Z. japonica* was observed at 18 sites in all regions. Since 2000, non-native eelgrass has been observed at 68 different sites in Puget Sound (Gaeckle *et al.*, 2009).

[21] Formerly the Puget Sound Ambient Monitoring Program.

## Seaweeds

Seaweeds are macroscopic marine algae (macroalgae). Macroalgae are divided into three taxonomic subgroups based on their dominant photosynthetic pigmentation (red, green, and brown algae). These algae occur throughout the nearshore in saline waters where light levels are great enough to support their growth. Although most seaweed species grow attached to consolidated substrates, some seaweeds, such as ulvoids (flat green seaweeds) can live unattached to the bottom. The vast expanses of rocky shores along the Strait of Juan de Fuca, and rocky outcrops on the outer coast of Washington support many of the 633 species that occur throughout the Pacific Northwest (Gabrielson *et al.*, 2000). Central Puget Sound supports approximately 160 species; south Puget Sound supports only a few species (Thom *et al.*, 1976).

Along many rocky shores in Washington, the upper intertidal band of seaweeds consists of low growing turf and crust-forming species. Below this is a band of the fucoid brown seaweed (*Fucus* spp.), usually followed by a diverse mix of red, green, and brown seaweeds. In the shallow subtidal zone, larger brown algae can dominate and form an assemblage comprised of an understory of smaller species associated with large dominant species. As the photic zone deepens, the brown algae will give way to the more low-light tolerant red algae and invertebrates.

One group of brown algae includes all of the order Laminariales, commonly known as kelp. Kelp attach to the substrate by root-like holdfasts and are categorized into floating and non-floating kelp. Bull kelp and giant kelp are floating kelp that can form extensive canopies at or near the surface of the ocean. These beds are most common in rocky, high-energy marine environments. In Washington state, floating kelp beds are found on approximately 11 percent of the shoreline, primarily on the northwest coast of the Olympic Peninsula (Washington DNR, 2002). Washington DNR's Nearshore Habitat program has been monitoring the areal extent of kelp bed populations along the Strait of Juan de Fuca and the Olympic Peninsula coast annually since 1989 to evaluate natural variation and changes related to human impacts (Dowty *et al.*, 2005). Annual variability is high: The overall extent of kelp fluctuated between a high of 11,832 acres in 2000, and a low of 4,722 acres in 1989.

*Sargassum muticum* is a non-native brown alga from Asia that has been established in Washington for decades. *Sargassum* occurs in lower intertidal and shallow subtidal rocky habitats and displaces native macroalgae. This species is found most often along the shorelines of Hood Canal, the San Juan Archipelago and the Strait of Georgia, and is least common along the outer coast. Data collected by the ShoreZone Inventory program (Washington DNR, 2002) show that *Sargassum* is present along 18 percent of the state's shorelines.

## Marine riparian vegetation

While marine riparian areas generally receive less attention and study than freshwater riparian areas, an assessment of relevant literature by Brennan and Culverwell (2004) indicates that both freshwater and marine riparian systems serve almost identical functions for supporting biota and the integrity of nearshore/littoral habitats. Their assessment also indicates that a lack of attention to marine riparian areas and poor protective standards associated with shoreline development have resulted in substantial loss and degradation of marine riparian and nearshore ecosystems.

Recent work illustrates the value of saltwater riparian buffers: areas with less vegetation have decreased invertebrate diversity and decreased survival of surf smelt embryo (*Hypomesus pretiosus*) due to higher beach temperatures and lower humidities (Sobocinski, 2003; Rice, 2006).

Areas with older, more complex riparian vegetation provide more complex backshore structure, further stabilizing the bank (Tonnes, 2008).

### Invasive aquatic vegetation

Marine species of cordgrass (*Spartina* spp.), are aggressive weeds, severely disrupting estuarine ecosystems by outcompeting native vegetation. In some areas, these species have become well established and are rapidly raising tidal elevations, displacing eelgrass and native marsh plants, and reducing habitat for migratory waterfowl, invertebrates, and possibly fish.

In Washington, four different marine *Spartina* species grow in intertidal regions from high intertidal marshes to within 1 meter of mean lower low water. *Spartina patens* and *S. densiflora* are adapted to grow in upper marshes where they mix with native plants. *Spartina alterniflora* and *S. anglica* tend to invade bare mud in the lower tidal area. *Spartina* species infestations occur throughout Puget Sound, in Willapa Bay, and in Grays Harbor (Washington State Department of Agriculture, 2005).

In all, there are presently 11 counties in western Washington with one or more infestations of marine *Spartina* species: Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Pacific, San Juan, Skagit, Snohomish, and Whatcom counties. *Spartina anglica* was identified for the first time in Whatcom County in 2005. The infestation was found by a shoreline resident in Birch Bay at the northern boundary of Whatcom County (Murphy, 2005).

Aggressive, comprehensive treatment programs continue to be implemented and improved to address the control of *Spartina* species. Post-treatment evaluations indicate that most effective reductions occur in contiguous infested areas; reductions are more difficult to achieve in vegetative transition areas. Cooperative efforts include participation by the Washington State Department of Agriculture, Washington Department of Fish and Wildlife, Washington DNR, other state agencies, universities, U.S. Fish and Wildlife Service, counties, tribes, private organizations, and private landowners (Murphy, 2005).

Japanese eelgrass (*Zostera japonica*) was listed as a Class C noxious weed by the Washington State Noxious Weed Control Board in 2012. Japanese eelgrass was listed as a noxious weed because it is non-native, difficult to control, and negatively impacts the shellfish industry (WA State Noxious Weed Control Board, 2012).

Washington DNR will evaluate *Zostera japonica* presence on a site-by-site evaluation of the state-owned aquatic lands that it leases. Protections will apply if forage fish are utilizing *Zostera japonica* for spawning only.

# 1.5.4 Land uses and population

## Population distribution, growth, trends

Washington's population has almost doubled since 1970, with most of the growth occurring in the urban areas of western Washington. The Washington Office of Financial Management (OFM) has released its first population forecast since the 2010 Federal Census. The state’s population is currently estimated at 6,668,200. Nearly 70 percent of the population is concentrated in the counties surrounding Puget Sound (OFM, 2011). Over the 30-year forecast period, Washington

State's population is expected to grow by just over 2 million, reaching 8,791,000 in 2040 (OFM, 2011).

The state's population is expected to increase almost 40 percent in the next 20 years; the largest growth is projected to occur in Franklin County (southeast Washington), Stevens County (northeast Washington) and the less-developed regions surrounding Puget Sound (OFM, 2011). As the state's population grows, the demand for access to the water for recreation, commerce, and food production will increase. Development pressures will also increase the amount of impervious surface in the state, generating more storm water and non-point source pollution.

## Uses and modifications of aquatic lands

Aquatic lands are used for a variety of recreational (for example, private docks, and floats) and commercial purposes (such as marinas and shellfish culture). These activities occur on lands owned by the state as well as those outside state ownership. Human use of aquatic land is also associated with modifications of the aquatic landscape through the introduction of exotic species; alteration of flowing waters for hydropower, flood control, or irrigation; dredging to create and maintain navigational channels; shoreline armoring; filling aquatic land to create terrestrial land; and placement of structures in nearshore and littoral areas. The resulting changes in the landscape include the loss of wetlands and deltas; the channelization of waterways; altered river flows and flow patterns; changes in land cover; interruption of small drainages; increased runoff; altered shoreline structure and function; and disruption or elimination of sediment transport and nutrient processes (Redman *et al.*, 2005; Williams and Thom, 2001).

## Lacustrine ecosystem

In addition to changes in light, wave energy, and sediment transport associated with the placement of structures, lacustrine ecosystems are modified through:

- **Cultural eutrophication:** Activities such as wastewater treatment discharges, failing septic tanks, timber harvest, agricultural practices, and residential development may increase the loading of nutrients to a lake. This increased supply of nutrients often causes an increase in productivity and a shift in trophic status.
- **Shoreline modification and fill:** The concentration of shoreline modifications, including shoreline armoring, overwater structures, and road and bridge construction, may alter the structure and function of lake ecosystems. The effects are particularly severe in urbanized areas, with littoral habitats impacted most heavily. In general, these modifications cause alteration of substrate composition, natural water movement processes (for example, wave energy), and water chemistry (such as increased nutrient supply); loss of riparian vegetation; artificial shading of benthic habitat; and reduced productivity.
- **Invasive aquatic vegetation:** While not all species become an ecological threat, in some cases they have significantly altered the structure and function of lake ecosystems. Aquatic weeds such as the Eurasian water milfoil (*Myriophyllum spicatum*), Brazilian elodea, parrot-feather, hydrilla (*Hydrilla verticillata*), and fanwort (*Cabomba caroliniana*) became established in lakes and are outcompeting native plant species (Washington Department of Fish and Wildlife, 1997a).

## Riverine ecosystem

As with nearshore ecosystems, modification of riverine systems occur through changes in light, hydrologic processes such as wave and current energy, and sediment transport associated with structures, fill, and dredging. In addition, modifications to riverine systems result from damming, channel alteration, and changes in adjacent land use. Specific modifications include:

- **Dams:** Effects associated with many large dams include migration barriers, isolating species behind the barriers; altered aquatic thermal regimes; encroachment of terrestrial vegetation into channels; and sediment trapping. Hundreds of miles of riverine ecosystems have been converted to lake-like systems rendering them unsuitable for organisms that require flowing water or lengthy migration corridors.
- **Channel alteration:** Simplification of riverine ecosystems results from adjacent land use practices such as levees, bank armoring, channel simplification, dredging, and removal of woody debris. Flood control structures (including levees and tidegates) disconnect floodplain and secondary channels from the stream channel, thereby reducing or eliminating wetland and shallow water refuge habitat for amphibians, fish, and birds. The practice of straightening river channels to increase flood conveyance has reduced habitat complexity and eliminated high flow refuges. Bank armoring to prevent channel migration and bank erosion has altered the dynamic equilibrium of riverine ecosystems and riparian succession. Many of the federally navigable water bodies were historically subjected to systematic removal of large woody debris to promote settlement; this further reduced refuge habitat and altered flow dynamics throughout the state.
- **Agriculture and livestock grazing:** Agriculture and livestock grazing continue to be a significant factor in the degradation of riverine ecosystems. Increased nutrient inputs from agricultural fertilizers and livestock waste stimulate algal and plant growth, resulting in an increase in biological oxygen demand. Irrigation diversions increase summertime water temperatures, and reduce the quantity and quality of instream habitat for aquatic organisms. Livestock grazing and trampling eliminate riparian vegetation, increasing erosion and sedimentation. Loss of riparian vegetation negatively impacts water temperature, reduces wood recruitment potential, and decreases the quality of salmonid spawning habitat (Wissmar *et al.*, 1994).
- **Urban/suburban development:** Impacts associated with urbanization include altered hydrograph and increased likelihood of channel instability; degraded water quality; loss of wetlands; loss of riparian forests; loss of instream habitat; and reduced habitat connectivity (Booth and Jackson, 1997; Gregory and Bisson, 1997).

## Saltwater-nearshore ecosystem

Human alteration of the nearshore ecosystem generally occurs through changes in key controlling factors such as light, wave energy, riparian vegetation, and both sediment transport and delivery (Nightingale and Simenstad, 2001). Specific modifications include:

- **Overwater structures:** Structures can decrease available light, affecting the ability of vegetation to grow, and causing behavioral changes in fish migrating along the shoreline. The structures also change wave energy and currents, which alters sediment transport mechanisms and associated habitat-forming processes.
- **Shoreline armoring:** The installation of bulkheads, breakwaters, and similar structures can greatly change the functional capacity of the nearshore ecosystem by altering wave energy patterns. There are approximately 1,476 kilometers (917 miles) of shoreline

armoring in the nearshore of Washington State, excluding the Columbia River (Washington DNR, 2002).

- **Fill and dikes:** Filling has occurred historically in the urbanized areas of Puget Sound and the Strait of Juan de Fuca because these areas were developed to meet the needs of port facilities and other economic activities on the waterfront. In parts of Puget Sound, over 95 percent of tidal wetlands have been lost or isolated from the adjacent estuaries by dikes (Frenkel and Morlan, 1991; Gregory and Bisson, 1997). In some cases tidal wetlands have been completely or partly filled to accommodate a variety of land uses, including agriculture, recreation, residential development, and industry. These modifications may also affect nearshore flushing rates by altering or eliminating freshwater input (Alberti and Bidwell, 2005; National Ocean Service, 2004).
- **Dredging:** Maintenance dredging of working ports and federal navigation channels is a necessary activity to maintain the usability and economic viability of these resources. In addition, dredging is an important option for the complete removal of contaminated sediments in aquatic cleanup sites. Dredging occurs primarily in the Columbia River navigation channel and in some urban areas where large port facilities are located. There have been several dredging projects greater than 100,000 cubic yards within Puget Sound, including two in Seattle and two in Tacoma. The largest of these is the Blair Inner Reach Cutback and Turning Basin Expansion, which removed 2.6 million cubic yards of material (Science Applications International Corporation, 2005).
- **Aquaculture:** The major aquaculture activities in the nearshore ecosystem target growing shellfish near the sediment surface in ground or line culture. Concerns related to aquaculture activities include the effect of shellfish culture on eelgrass.

# 1.6 Covered activities

Washington DNR has examined the types of current and logically foreseeable future activities permitted on state-owned aquatic lands to determine what activities will be covered under an incidental take permit. Only those activities listed as “covered” in this HCP will receive protection under an Incidental Take Permit from challenges brought by Section 10 of the federal Endangered Species Act. After examining all uses of state-owned aquatic lands (Washington DNR 2005b, 2007b), Washington DNR has decided to seek coverage for three groups of activities under this HCP (Table 1.9). The selection of covered activities involved a detailed set of analyses:

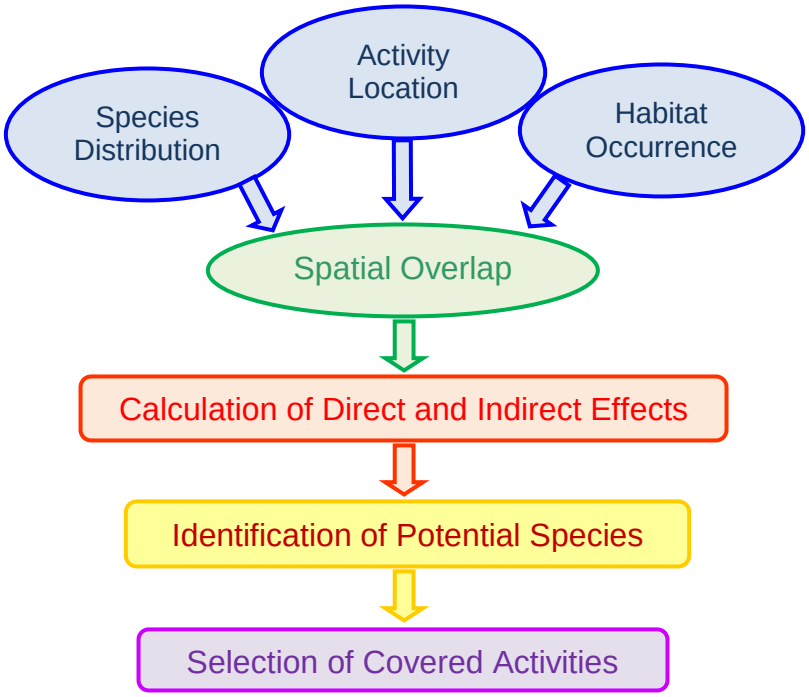
- Categorization of the types of uses authorized on state-owned aquatic land (Washington DNR, 2005b).
- An analysis of the activity categories’ spatial overlap with sensitive species and calculation of the activity categories’ direct and indirect effects on these species (Washington DNR, 2007b).
- An assessment of the agency’s ability to affect change in both the way the activities occur on the landscape, and their effects on sensitive species and their habitats (Figure 1.17).

This section provides a brief summary of the selection process. Detailed descriptions can be found in Washington DNR 2005b, and 2007b. Chapter 3 of this document fully describes how the covered activities occur on state-owned aquatic lands.

**Table 1.9.** Activities covered by this plan.

| Activity Category | Included structures and activities |
|---|---|
| Aquaculture | Shellfish (mussels, clams, oysters) |
| Log booming and storage | All in-water structures and operations |
| Overwater structures | Boat ramps, launches, hoists; docks and wharves; floating homes; rafts; marinas; mooring buoys; nearshore buildings; shipyards and terminals |

**Figure 1.17.** Conceptual illustration of the selection process for covered activities.




# 1.6.1 Categorization

DNR tracks authorized uses[22] of state-owned aquatic lands in a financial management database (NaturE) that employs 86 unique commodity codes to classify both the use and the revenue stream. Because these codes have no ecological significance, the uses were sorted into 35 classes based on the nature of the structure or activity (such as shellfish culture and stormwater outfalls). These classes were then grouped into eight activity categories based on similarities in attributes and effects (for example, aquaculture and outfalls) for potential inclusion in this HCP. Table 1.10 lists the categories evaluated in the analysis, the definition of each category, and the specific structures/activities included in each category (Washington DNR, 2005b; 2007b).

[22] Authorized uses are those uses specifically granted as a general lease, easement, aquaculture lease, or waterway permit.

**Table 1.10.** Categorization of authorized uses.

| Activity Category | Definition | Included Structures/Activities |
|---|---|---|
| Aquaculture | The commercial production or harvest of aquatic plants and animals | Finfish and shellfish culture |
| Flood, wave, and erosion control | Structures used to control the movement of water and protect human property | Breakwaters; dikes and dams; fill and bank armoring |
| Miscellaneous nearshore | Dissimilar activities that occur in nearshore/littoral areas with the potential to stress biotic and abiotic factors | Log booming and storage; public access; sediment removal |
| Mitigation and enhancement | Structures/activities that strive to improve, enhance, stabilize, and monitor aquatic habitats | Artificial habitat; conservation/preservation; remediation of contamination |
| Outfalls | Structures designed to discharge wastewater into aquatic ecosystems | Combined sewer overflow; desalinization; industrial and municipal; storm water |
| Overwater structures | Structures built over, or placed in, state-owned aquatic lands at or below ordinary high tide in saltwater ecosystems and ordinary high water in freshwater systems | Multiple element[23]—marinas; shipyards & terminals |
| | | Single element—boat ramps, launches, hoists; docks and wharves; floating homes; rafts; mooring buoys; nearshore buildings |
| Transportation | Structures that support the movement or transport of motorized vehicles | Bridges; ferries; railroads; highways and roads |
| Utilities | Linear structures that carry water, electricity, telecommunications, and petroleum products | Oil and gas pipelines; power and cable lines; sewer and waste lines; water pipelines and intakes |

[23] Multiple element overwater structures comprise separate and distinct structures that support the use.

# 1.6.2 Determination of spatial overlap

Washington DNR assessed spatial overlap by determining which of the 35 activity classes were likely to co-occur with each of the 86 species evaluated. The number of activities overlapping with a species' distribution was converted into a rank score of low (1), medium (2), or high (3). Next, the spatial extent of the species' distribution relative to the spatial extent of all authorized uses of state-owned aquatic lands was determined. The calculated percentage of each species' habitat within townships with authorized uses is referred to as *coincident habitat*; the coincident habitat is used as an indicator of the likelihood of interaction between species and activity classes (Washington DNR, 2007c). The results of the analysis were used to refine the list of potential species (see Section 7, Covered Species, within this chapter). Species experts used best professional judgment to arrive at a final recommendation of potential species (Washington DNR, 2007b). Table 1.11 illustrates the ranking criteria and metrics used for the species/life stage and activity overlap, and coincident habitat metrics.

**Table 1.11.** Ranking criteria for species and activity overlap and coincident habitat metrics.

| **Species/Life Stage and Activity Overlap** | | **Coincident Habitat** | |
|---|---|---|---|
| Activity Class Count | Rank | Percent of Townships | Rank |
| 0 – 22 | Low (1) | 0 – 34 | Low (1) |
| 23 – 30 | Medium (2) | 35 – 66 | Medium (2) |
| 31 – 35 | High (3) | 67–100 | High (3) |

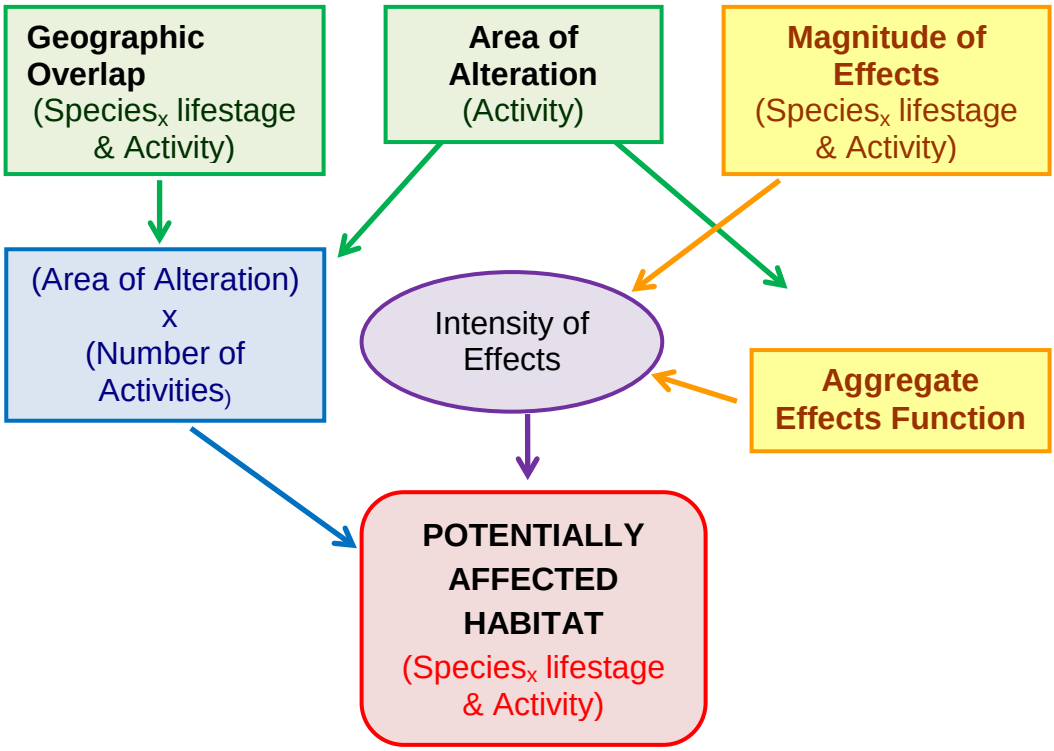
# 1.6.3 Determination of direct and indirect effects

The determination of direct and indirect effects is based on the impacts associated with currently authorized uses and does not include effects from the construction of new structures, or effects from unauthorized and/or illegal uses of state-owned aquatic lands. The following text provides a brief summary of the process, with a more complete discussion provided in Chapter 4, Section 4.2 (Direct and Indirect Effects of Covered Activities) of this document.

Calculations of direct and indirect effects used a qualitative model that assessed the physical, chemical, and biological impacts associated with existing authorized activities (Washington DNR 2007b). In the first step of the process, species experts determined whether there was a nexus for each activity class between defined risk pathways and individual species life-history stages. Next, rankings for groups of effects (direct—species and habitat; indirect—habitat loss and habitat degradation) were assigned using a scale of no or trace effects (0) to a total loss (1). The ranks were then used to calculate the "Magnitude of Effects" on each species life history stage from each activity.

To quantify the amount of each species habitat affected by an activity class, the total area altered by the activity (Area of Alteration) was estimated using best available science. An "Aggregate Effects Function" was also created and combined with the Magnitude of Effects score to reflect impacts associated with shoreline development (Intensity of Effects). The metrics were then combined to calculate the amount of habitat for each species that is affected by the activity class (Potentially Affected Habitat). Figure 1.18 illustrates the conceptual process for determining effects.

**Figure 1.18.** Conceptual illustration of the determination of direct and indirect effects.




# 1.6.4 Ability to affect change

The final step in the process to select covered activities was an evaluation of Washington DNR's ability to affect the factors controlling direct and indirect effects. This step considered the following factors when determining if an activity would be included for coverage in the HCP. Washington DNR was more likely to include an activity under the following circumstances:

- If the effect would not otherwise be addressed as part of a consultation with U.S. Fish and Wildlife Service and NOAA Fisheries required under the Endangered Species Act for "… any action authorized, funded, or carried out by a Federal agency . . ." (16 U.S. Code Section 1536(a)(2)).
- If Washington DNR has a high degree of control over how the activity occurs on the landscape and how the activity affects sensitive species and habitats.

- If the activity has the potential to reach the threshold of incidental take under the Endangered Species Act.

**Table 1.12.** Decisions made and rationale regarding activities to be covered under the Aquatic HCP.

| Activity Group | Activity Class | Washington DNR's Ability to Affect Change | Decision | Rationale for Decision |
|---|---|---|---|---|
| Aquaculture | Finfish | Low—siting only | Exclude | Regulatory entities control water and sediment quality, species cultured, and siting (Section 7) |
| | Shellfish (mussels, clams, oysters) | High—siting and operations | Include | High degree of control if this activity occurs on state lands |
| Flood, wave, and erosion control | Bank armoring | Low to none | Exclude | Generally occurs on private land |
| | Breakwaters | Low to none | Exclude | Discourage as a standard |
| | Dikes and dams | Low to none | Exclude | Permitting controlled by federal entities |
| | Fill | Low to none | Exclude | Disallow new fill as a standard |
| Miscellaneous nearshore | Log booming and storage | High—Siting, operations, and maintenance | Include | High degree of control |
| | Public access | Low | Exclude | Conservation measures associated with structures, not humans |
| | Dredging | Low | Exclude | Requires federal consultation (Section 7) |
| | Sand and gravel removal; recreational mining | Low | Exclude | Disallow sand and gravel removal programmatically; Little knowledge about the extent of recreational mining |

| Activity Group | Activity Class | Washington DNR's Ability to Affect Change | Decision | Rationale for Decision |
|---|---|---|---|---|
| Mitigation and enhancement | Artificial habitat | High—siting | Exclude | Disallow programmatically |
| | Remediation of contamination | Low | Exclude | ; Regulated by established federal and state programs; Requires federal consultation (Section 7) |
| | Conservation / preservation | High | Exclude | Minimal risk |
| Outfalls | Combined sewer overflow; storm water; industrial and municipal | Low—siting only | Exclude | Regulatory entities control water and sediment quality; New construction involves federal consultation (Section 7). |
| | Desalinization | Low—siting only | Exclude | Extent minimal |
| Overwater structures | Boat ramps, launches, hoists; docks and wharves; floating homes; rafts; marinas; mooring buoys; nearshore buildings; shipyards and terminals | High—siting, operations and maintenance | Include | High degree of control |
| Transportation | Bridges; ferries; railroads; roads and highways | Low | Exclude | New construction requires federal consultation (Section 7); Washington State Department of Transportation has standards to manage potential impacts.[24] |

[24] Non-state ferry terminals and docks are included in overwater structures.

| Activity Group | Activity Class | Washington DNR's Ability to Affect Change | Decision | Rationale for Decision |
|---|---|---|---|---|
| Utilities | Oil and gas pipelines; power and cable lines; sewer and waste lines; water pipelines and intakes | Low | Exclude | Minimal impact from existing facilities; requires federal consultation for new construction (Section 7); no identifiable conservation measures |

# 1.7 Species covered by this HCP

The Aquatic Lands Habitat Conservation Plan addresses 29 species of fish, birds, amphibians, and turtles (Table 1.13). While Washington DNR is asking for coverage for all 29 species, the agency recognizes that U.S. Fish and Wildlife Service and NOAA Fisheries may not find that impacts to a given species from covered activities meet the definition of take and may deny coverage for that species. Chapter 4, Section 4 of this document provides information about the life history for each of the 29 species.

**Table 1.13.** Species Covered by the Aquatic Lands HCP.

| Species | Listing Status | Natural Heritage Rank[25] |
|---|---|---|
| **Amphibians and Turtles** | | |
| Columbia spotted frog (*Rana luteiventris)* | State candidate | G4, S4 |
| Northern leopard frog (*Rana pipiens)* | Federal concern; state endangered | G5, S1 |
| Oregon spotted frog *Rana pretiosa)* | Federal candidate; state endangered | G2, S1 |
| Western toad (*Anaxyrus boreas)* | Federal concern; state candidate | G4, S3 |

[25] *Key to Natural Heritage program ranks:*

G = Global
S = State
B = Breeding populations
N = Non-breeding populations

1 = Critically imperiled
2 = Imperiled
3 = Rare locally or with a restricted range
4 = Apparently secure
5 = Demonstrably secure

GNR = not ranked globally
SNR = not state ranked.

| Species | Listing Status | Natural Heritage Rank[25] |
|---|---|---|
| Western pond turtle (*Actinemys marmorata)* | Federal concern; state endangered | G3G4, S1 |
| **Birds** | | |
| Black tern (*Chlidonias niger*) | State monitor | G4, S4B |
| Common loon (*Gavia immer)* | State sensitive | G5, S2B, S4N |
| Harlequin duck (*Histrionicus histrionicus*) | Not listed | G4, S2B, S3N |
| Marbled murrelet (*Brachyramphus marmoratus*) | Federal threatened; state threatened | G3G4, S2 |
| Western snowy plover (*Charadrius alexandrinus nivosus*) | Federal threatened; state endangered | G3, S1 |
| **Forage Fish** | | |
| Eulachon/ Pacific smelt (*Thaleichthys pacificus)* | Federal threatened; state candidate | G5, S4 |
| Pacific herring (*Clupea pallasi)* | Federal concern; state candidate | GNR, SNR |
| Pacific sand lance (*Ammodytes hexapterus*) | Not listed | None |
| Surf smelt (*Hypomesus pretiosus*) | Not listed | G5, SNR |
| **Lamprey** | | |
| Pacific lamprey (*Entosphenus tridentatus)* | Federal species of concern; State monitor | G4, S1 |
| **Rockfish** | | |
| Bocaccio (*Sebastes paucispinis*) | Federal endangered; state candidate | G4, SNR |
| Canary rockfish (*Sebastes pinniger*) | Federal threatened; state candidate | GNR, SNR |
| Yelloweye rockfish (*Sebastes ruberrimus)* | Federal threatened; state candidate | GNR, SNR |

| Species | Listing Status | Natural Heritage Rank[25] |
|---|---|---|
| **Salmonids** | | |
| Bull trout (*Salvelinus confluentus*) | Federal threatened (Columbia River; coastal Puget Sound); state candidate | G4, S3 |
| Chinook salmon (*Oncorhynchus tshawytscha*) | Federal endangered (Upper Columbia—spring Chinook); Federal threatened (Lower Columbia River; Puget Sound; Snake River—spring, summer, and fall Chinook); state candidate | G5, S3S4 |
| Chum salmon (*Oncorhynchus keta*) | Federal threatened (Lower Columbia River; Hood Canal); state candidate | G5, S3 |
| Coastal cutthroat trout (*Oncorhynchus clarki clarki*) | Federal species of concern | G4, SNR |
| Coho salmon (*Oncorhynchus kisutch*) | Federal threatened (Lower Columbia River); federal species of concern (Puget Sound) | G4, S3 |
| Pink salmon (*Oncorhynchus gorbuscha*) | Not listed | G5, S3 |
| Sockeye/Kokanee salmon (*Oncorhynchus nerka)* | Federal endangered (Snake River), Federal threatened (Lake Ozette), state candidate (sockeye); not listed (kokanee) | G5, S2S3 |
| Steelhead trout (*Oncorhynchus mykiss*) | Federal threatened (Snake River Basin, Upper Columbia, Middle Columbia, and Lower Columbia River); Puget Sound); state candidate | G5, S5 |
| **Sturgeon** | | |
| Green sturgeon (*Acipenser medirostris*) | Federal threatened (Southern Distinct Population Segment) | G3, S2N |
| White sturgeon (*Acipenser transmontanus*) | Not listed | G4, S3B, S4N |
| **Marine Mammal** | | |
| Southern resident killer whale (orca) (*Orcinus orca* pop. 5*)* | Federal and state endangered | G4G5, SNR |

A three-step process was used to evaluate which species would be included in the Aquatic Lands HCP (Washington DNR, 2007c).

**In Step 1**, project scientists developed a general list of 90 species that were endangered, threatened, of concern, or rare, and that potentially occurred on state-owned aquatic lands. The list of species was refined to 86 based on the following factors:

- The probability that the species would occur on state-owned aquatic lands.
- The degree to which the species, in any life stage, is dependent on aquatic habitat.
- The level of vulnerability of the species, in any life stage, to activities authorized by Washington DNR.

**In Step 2,** Washington DNR gathered additional information on the historic and current distribution of the species (based on predicted and observed data); habitat use; population trends; threats; and potential effects from activities authorized by Washington DNR. These data, combined with the decision matrix (Table 1.14), support DNR's decision to assign species to the following proposed categories:

***Covered species***—Species for which sufficient biological information exists, and for which existing conservation measures—or conservation measures that could be easily defined and implemented—support an application for Section 10(a)(1)(B) incidental take permit under the Endangered Species Act. This category includes species that lack adequate information for conservation planning if there is a close habitat association to other covered species, and therefore a benefit sufficient to support application for a Section 10(a)(1)(B) permit. This category also includes those species for which 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 those for which conservation measures to support application for a Section 10(a)(1)(B) permit could not be easily defined. Should the listing status of these species change during the term of the Aquatic Lands HCP, or if additional information that supports conservation planning becomes available, Washington DNR will re-evaluate the decision to exclude them from coverage under this HCP and, where warranted, seek amendments to this HCP for inclusion of the species.

***Watch list species***—Species that are either not considered to be at risk during the term of the incidental take permit, or that lack adequate information regarding habitat, distribution, status, or conservation potential. As with evaluation species, watch list species could be considered for inclusion under the Aquatic Lands HCP if they are deemed to be at risk in the future.

**Table 1.14.** Decision matrix for preliminary designation of potentially covered species.

| Potential to be Affected by Covered Activities | Species Listing Status or Conservation Ranking | | | |
|---|---|---|---|---|
| | **Currently Federally Listed as Endangered or Threatened** | **Federally or State Listed Species of Concern** | **Designated Global or State Conservation Ranking of "Imperiled" (G1 or S1)** | **Not Designated** |
| High | Covered | Covered | Evaluation | Evaluation |
| Medium | Evaluation | Evaluation | Evaluation | Watch List |
| Low | Evaluation | Evaluation | Watch List | Watch List |

**In Step 3** of this process, species that Washington DNR recommended for the categories of covered or evaluation underwent a screening for spatial and temporal overlap with authorized activities. Potential effects were determined based on review of the available literature, the factors controlling ecosystem function, and quantification of the impacts to species' habitat (Washington DNR, 2007b). In instances where Washington DNR recommended that a species be categorized as an evaluation species and would clearly benefit from an activity-specific or programmatic conservation measure, they have been included as a species of concern.

Appendix B contains a summary of the species considered, their coverage recommendations, and the reasons for their inclusion or exclusion from the Aquatic Lands HCP. Documentation of the methods used in analyzing effects from covered activities on species and habitats, and the results of this analysis, is contained in the Potential Effects and Expected Outcomes Technical Paper (Washington DNR, 2007b).

# 1.8 Federally listed species not addressed

Although federally listed, it is determined that the species in Table 1.15 have little or no overlap with state-owned aquatic lands or with the activities covered under this plan.

**Table 1.15.** Federally listed species not addressed by this plan.

| | | Listing Status | | Federal Agency with Jurisdiction | Reason for Exclusion |
|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **Federal** | **State** | | |
| Leatherback sea turtle | *Dermochelys coriacea* | Endangered | Endangered | NOAA Fisheries | No covered activities nexus |

| | | | | | |
|---|---|---|---|---|---|
| Blue whale | *Balaenoptera musculus* | Endangered | Endangered | NOAA Fisheries | Presence accidental |
| Bowhead whale | *Balaena mysticetus* | Endangered | Not Listed | NOAA Fisheries | Presence accidental |
| Humpback Whale | *Megaptera noveangliae* | Endangered | Endangered | NOAA Fisheries | Presence accidental |
| North Pacific right whale | *Eubalaena japonica* | Endangered | Not Listed | NOAA Fisheries | Presence accidental |
| Steller sea lion | *Eumetopias jubatus* | Threatened | Threatened | NOAA Fisheries | Presence accidental |
| Streaked horned lark | *Eremophila alpestris strigata* | Proposed Threatened | Endangered | U.S. Fish & Wildlife | Section 7 nexus protections |

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# Chapter 2
# Planning Context

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# Chapter 2. Planning Context

Aquatic land management involves compliance with a number of federal, tribal, state, and local laws and regulations. This chapter provides a synopsis of the regulatory context in which the Washington State Department of Natural Resources (Washington DNR) provides proprietary land management of state-owned aquatic lands.

## 2.1 History of aquatic land management

At statehood, Washington received title to all the land underlying navigable fresh, marine, and estuarine waters within the state. To manage the land underlying navigable waters and understand the role of Washington DNR as proprietary manager of state-owned aquatic lands, one must have a general understanding of the concept of *navigability* and the rights that others have in such lands.

### 2.1.1 Ownership and other rights associated with aquatic lands

When the United States was formed in 1789, the lands under all of the navigable waters within the 13 original colonies were reserved for the states and were not granted by the United States Constitution to the federal government. The U.S. Supreme Court case of Pollard v. Hagen of 1845 established that the *equal footing doctrine* holds that all subsequent states shall take title to navigable waters on the same basis as the original 13 states (Ivey, 2002).[1] Washington State did not give up ownership, but instead asserted ownership to the beds and shores of all navigable waters up to the line of ordinary high tide in tidal waters and up to the line of ordinary high water in navigable rivers and lakes.[2] The only lands the state did not claim are "tide, swamp, and overflowed lands" that the federal government conveyed to individuals before statehood in 1889 (known as *federal patents*).[3]

[1] *Phillips Petroleum Company v. Mississippi,* 484 U.S. 469, 482-83, 108 S. Ct. 791, 98 L. Ed. 877 (1988) quoting *Shively v. Bowlby*, 152 U.S. 1, 26, 14 S. Ct. 548, 38 L. Ed. 331 (1894).
[2] Wash. Const. art. XVII, § 1.
[3] Wash. Const. art XVII, § 2.

## Navigability

Under federal law, the aquatic lands that the state received at statehood were under *navigable* waters.[4] Whether a particular water body is navigable for the purposes of establishing title (*navigable for title*) is a question that must be answered by federal common law.[5] Under federal law, a water body is navigable for title if it is, in its natural and ordinary condition, susceptible for use as a highway for commerce using customary modes of travel and trade on water.[6] In Section 332-30-106(41) of the Washington Administrative Code (WAC), Washington DNR defines navigability or navigable in a manner generally consistent with the federal test and further identifies ". . . all bodies of water meandered[7] by government surveyors as navigable unless otherwise declared by a court."

In marine and estuarine waters, the extent of state-owned lands is easily determined because the state received title to all lands under waters subject to the ebb and flow of the tide, regardless of whether the particular location is navigable.[8] Therefore, the state owns the land under all tidal waters—including otherwise non-navigable marine water sloughs and channels—unless the state has sold the land since statehood or the federal government either reserved the land or conveyed it to others before statehood.

In the case of freshwater, whether a particular body of water is *navigable for state title* is less certain, although some water bodies, such as the Columbia River, are clearly navigable. Washington DNR decided to assert state ownership over particular bodies of water on a case-by-case basis. The agency presumes that meandered waters are navigable, but meandering is not conclusive. The federal test for navigability determines title by analyzing the capacity of a water body to support the customary modes of trade or travel. This is supplemented by documented history of use and investigation of any artificial improvements that may have altered the flow of the waterway—such as channel straightening.

A history of actual use supports a finding of navigability for state title, but the absence of historical use will not nullify the finding. This is because, under federal common law, *susceptibility* of use determines navigability, rather than manner and extent of actual use.[9] Any person who disagrees with Washington DNR's determination that a water body is navigable for state title can challenge the agency in court, and the judiciary makes the final determination.

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[4] In law, the term *navigability* has more than one meaning. Under federal law, there are three major categories of navigability: (1) for admiralty jurisdiction, (2) for federal regulatory jurisdiction under the Commerce Clause, and (3) for title which establishes whether the state owns the lands underlying water bodies. States also may recognize navigability for different purposes, such as navigability for floating rights.

[5] *Oklahoma v. Texas*, 258 U.S. 574, 586; 42 S.Ct.. 574, 66 L. Ed. 771 (1922); *Brewer-Elliott Oil & Gas Co. v. U.S.*, 260 U.S. 77, 88, 43 S. Ct. 60, 67 L. Ed. 140 (1922); *U.S. v. Holt State Bank*, 270 U.S. 49, 55-56, 46 S. Ct. 197, 70 L. Ed. 465 (1926).

[6] *Brewer-Elliott Oil & Gas Co. v. U.S.,* 260 U.S. 77, 43 S. Ct. 60, 67 L. Ed. 140 (1922); *U.S. v. Holt State Bank,* 270 U.S. 49, 55-56, 46 S. Ct. 197, 70 L. Ed. 465 (1926); *U.S. v. Utah,* 283 U.S. 64, 75, 51 S. Ct. 438, 75 L. Ed. 844 (1931).

[7] Meander lines are boundaries created by government surveyors. They are used to define the *sinuosity* of the shore so that fractional subdivisions can be calculated. Meander lines are not natural boundaries and are often imprecise.

[8] See *Phillips Petroleum Company v. Mississippi*, 484 U.S. 469, 476, 108 S. Ct. 791, 98 L. Ed. 877 (1988).

[9] *U.S. v. Utah,* 283 U.S. at 82-83; *see Utah v. U.S.,* 403 U.S. at 12.

## Verification of navigability

Washington DNR is developing a method that will serve as the first step toward determining whether rivers are navigable. Because physical characteristics and exploration, as well as actual uses, indicate the potential navigability of rivers, Washington DNR developed a table of physical river-channel characteristics that can serve as criteria for assessing whether a river is likely to be navigable (Table 2.1).

**Table 2.1.** Physical criteria for initial navigability determination.

| | Navigability | | |
|---|---|---|---|
| **Physical Criteria** | **Probably Not Navigable for State Title** | **Navigability Depends on a Balance of Factors** | **Probably Navigable for State Title** |
| Depth is Generally… | Less than 0.6 meters | 0.6 to 1.1 meters | More than 1.1 meters |
| Surface Width is Generally… | Less than 7.3 meters | 7.3 to 12.2 meters | More than 12.2 meters |
| Bottom Width is Generally…. | Less than 5.5 meters | N/A | Greater than 5.5 meters |
| Gradient is Generally*…. | Greater than 7.6 meters/kilometer* | 3.1 to 7.6 meters/kilometer | 0 to 3.1 meters/kilometer |

* There may be exceptions.

In order to use Table 2.1, one must have data on depth, surface width, bottom width, and general gradient. Because these data do not exist for all water bodies across the state, Washington DNR approached the U.S. Geological Survey to see if there was a way to use other available data to estimate the physical criteria needed to determine navigability using this table.

The U.S. Geological Survey found that it was possible to estimate the physical criteria with reasonable confidence from available statewide channel-characteristic data, such as that provided by the Enhanced River Reach File, a geographic information system coverage (map layer) that contains a network of stream reaches with attributes, including mean annual discharge, mean velocity, and other information. Washington DNR is working in collaboration with the U.S. Geological Survey to develop a method to estimate the physical criteria related to navigability (as defined by Washington DNR) from these available statewide data.

This work is an initial step towards developing a better method of establishing ownership of state-owned aquatic land.

## Riparian and preference rights

Many states observe common law riparian rights, which allow the landowners bordering the water to use the adjacent aquatic lands for purposes such as accessing the water and building a dock for certain uses. In navigable waters, however, Washington State law does not vest riparian rights in the upland landowner at a waterfront boundary. Instead, the owner of the aquatic land at a waterfront boundary enjoys such rights.[10] Thus, riparian rights do not impose any practical

[10] *Spath v Larsen,* 20 Wn.2d 500, 508, 148 P.2d 834 (1944); *Sturtevant,* 76 Wn. at 164 citing *Bilger v. State,*

limitation on Washington DNR's ability to implement this habitat conservation plan (HCP) on state-owned aquatic lands. Nonetheless, where the state still owns first-class tidelands or shorelands (those within or near to cities and towns), owners of adjoining uplands have a right of first refusal to lease state-owned aquatic lands (Chapter 79.125 Revised Code of Washington). This is a statutory preference right, not a common law riparian right.

## Public Trust Doctrine

The *public trust doctrine* is an ancient and universal legal principle that recognizes the need for public access to water and aquatic resources. It acts like an easement over the aquatic lands. Under the trust, no matter who owns the land below, the public has the right to use navigable waters.

While a state cannot abolish the public trust doctrine, a state can, to a degree, define the rights protected by the trust.[11] In Washington, the interest protected by the trust includes ". . . the right of navigation, together with its incidental rights of fishing, boating, swimming, water skiing, and other related recreational purposes generally regarded as corollary to the right of navigation and the use of public waters."[12]

The practical effect of the public trust doctrine is that any limitation Washington DNR wants to impose on the rights protected by the trust must be accomplished through a rule-making process under the Washington Administrative Procedures Act (RCW 34.05).

## Federal interests

The federal government retains an interest in state-owned aquatic lands under the Commerce Clause of the United States Constitution. The Commerce Clause gives Congress the power to promote and regulate interstate commerce; this, in turn, gives Congress the authority to control navigation. Called *federal navigational servitude*, this means that the government is empowered to regulate and control submerged lands of the U.S. in the interest of commerce. The servitude is like an easement that the federal government may exercise for the purpose of improving or protecting navigation on navigable water bodies.[13] For example, the U.S. Army Corps of Engineers may, without approval from Washington DNR, build a jetty on state-owned aquatic lands to protect a navigational channel, because the jetty is within the scope of the federal navigational servitude.

## Tribal interests

Under federal treaties, many Pacific Northwest tribes retain the right to harvest fish, including shellfish, at all "usual and accustomed" grounds and stations. These usual and accustomed fishing areas cover the marine aquatic lands of Puget Sound, the Strait of Juan de Fuca, and most of the Pacific Coast and Columbia River (together with many associated freshwater lakes, streams, and rivers). In terms of state-owned aquatic lands, the treaty right to harvest includes the ability to access usual and accustomed grounds and stations to harvest up to one half of both embedded shellfish and free swimming fish and shellfish. However, the treaty right to harvest embedded

63 Wn. 457, 465, 116 P. 19 (1911).

[11] *State of Washington v. Longshore,* 141 Wn.2d 414, 427-28, 5 P.3d 1256 (2000) quoting *Phillips Petroleum Company v. Mississippi,* 484 U.S. 469, 475, 108 S. Ct. 791, 98 L. Ed. 877 (1988)

[12] *Caminiti v. Boyle,* 107 Wn. 2d 662, 669, 732 P.2d 989 (1987) quoting *Wilbour v. Gallagher,* 77 Wn.2d 306, 316, 462 P.2d (1969).

[13] *Kingsport Horizontal Prop. Regime v. United States,* 46 Fed. Cl. 691 (2000)

shellfish does not include the right to shellfish from artificial beds created by private shellfish growers or the enhanced production of shellfish created from naturally occurring shellfish beds through private aquaculture practices.[14] Settlement agreements between Washington State and the Treaty Tribes have further defined how the treaty right to harvest shellfish is implemented in those cases where the state has leased its aquatic lands for commercial aquaculture.

In the early 1970s, federal and tribal authorities initiated the case known as United States v. Washington to secure treaty fishing rights. The Boldt Decision (1974) and Rafeedie Decision (1994) are two prominent decisions in the ongoing case affecting state-owned aquatic lands. The state, through both the Washington Department of Fish and Wildlife and Washington DNR, continues to work with tribal authorities and other affected parties to reach agreement on management and harvest issues.

## United States v. State of Washington, 384 F. Supp. 312 (W. D. Washington, 1974) (Boldt Decision)

The United States District Court (Judge Boldt) upheld the right of the Treaty Tribes in the Northwest to take up to 50 percent of the harvestable surplus of anadromous fish that pass through the usual and accustomed fishing areas of the various tribes. Subsequent proceedings in this continuing case have extended this principle to other marine species of fish and have further delineated the scope of the treaty harvesting rights.

## United States v. State of Washington, 873 F. Supp. 1422 (W. D. Washington, 1994) (Rafeedie Decision)

The United States District Court (Judge Rafeedie) held that the Treaty Tribes' reserved harvest rights extend to intertidal and subtidal shellfish populations. The treaty right applies to all shellfish species, including species that were not present in Washington at the time the treaties were signed. Adoption of a shellfish implementation order and several settlement agreements as consent decrees further describe harvesting rights.

The Commissioner of Public Lands Order on Tribal Relations, signed on September 10, 2010 (Commissioner's Order # 201029) recognizes the sovereign status accorded to the 29 federally recognized tribes in the state of Washington. Washington DNR will encourage partnerships with tribes by pursuing opportunities for information exchange, collaborative problem solving, issue resolution, periodic meetings, and continuing collaboration and communication.

[14] *United States v. Washington*, 157 F.3d 630, 651-653 (9th Cir. 1998)

# 2.1.2 Washington DNR's responsibilities for managing state-owned aquatic lands

The Washington State Legislature delegated to Washington DNR proprietary authority over the state's aquatic lands. The control of Washington DNR's authority to manage state-owned aquatic lands is established through a hierarchy of laws, regulations, and guidelines, starting with the Washington State Constitution. The Washington State Legislature grants Washington DNR proprietary authority to manage state-owned aquatic lands under Title 79 of the Revised Code of Washington (RCW).

The primary source of directive for Washington DNR's management activities is under Revised Code of Washington Chapters 79.105–.145. Other statutes affecting state-owned aquatic lands are in RCW Title 79 and Revised Code of Washington Chapters 43.12 and 43.30. To fill gaps in statutory directive, Washington DNR adopts rules published under Chapter 332-30 of the Washington Administrative Code (WAC). The agency also observes standard practice memoranda and guidelines, which are internal policy statements that, while they do not have the force of law, help ensure that the agency's management practices are consistent.

In Section 79.105.030 of the Revised Code of Washington, the legislature provides direction to Washington DNR regarding how it should fulfill its management responsibilities:

> The management of state-owned aquatic lands shall be in conformance with constitutional and statutory requirements. The manager of state-owned aquatic lands shall strive to provide a balance of public benefits for all citizens of the state. The public benefits provided by aquatic lands are varied and include:
>
> (1) Encouraging direct public use and access;
>
> (2) Fostering water-dependent uses;
>
> (3) Ensuring environmental protection;
>
> (4) Utilizing renewable resources.

Generating revenue in a manner consistent with subsections (1) through (4) of this section is a public benefit.

To implement this directive, Washington DNR adopted Section 332-30-100 of the Washington Administrative Code, which restates the statute and clarifies that this regulation incorporates other statutory obligations to:

> (d) Promote production on a continuing basis of renewable resources.
>
> (e) Allow suitable state-owned aquatic lands to be used for mineral and material production.

## Sales of State-owned Aquatic Lands

Between statehood and 1971, the state sold approximately 70 percent of tidelands and approximately 30 percent of shorelands to private entities. Since August 9, 1971, state-owned aquatic lands ". . . shall not be sold except to public entities as may be authorized by law and they shall not be given away" (RCW 79.125.200).

### Proprietary authorizations for use of state-owned aquatic land

In fulfillment of its statutory duty to balance public benefits, Washington DNR issues to persons seeking to use state-owned aquatic lands authorizations such as leases, easements or rights-of-way, and licenses, such as rights of entry and waterway permits. Any person can apply for an authorization. The Aquatic Resources Division of Washington DNR is responsible for issuing the authorizations to qualified applicants. In issuing authorizations, the legislature directs Washington DNR to favor water-dependent uses over nonwater-dependent uses. Washington DNR uses a statutory formula to develop rental rates for water-dependent, non-aquaculture uses. Rental rate for aquaculture uses can be by bid or negotiation. Washington DNR bases calculations of rental rates for nonwater-dependent uses on fair market value.

A lease grants to the lessee (or tenant) the temporary right to possess the leased property (leasehold), subject to the terms and conditions of the lease agreement. A lease is the most comprehensive legal instrument for granting use of state-owned aquatic land. A lease is not revocable at will, but may be terminated by expiration, mutual agreement, or breach of the lease terms. Usually, a lessee has exclusive use of the leasehold and can exclude others from using it. This right is limited in lease agreements for state-owned aquatic lands, in that Washington DNR typically reserves the right to grant other uses such as easements within the leasehold that do not unreasonably interfere with the lessee's use. In addition, the lessee's possession is subject to third-party interests, such as those covered by the public trust doctrine.

An easement, also known as a right-of-way, is a more limited grant of authority compared to a lease. An easement does not grant a right to possess the land, only a right to use the land for a specific purpose. Typically, easements are for utility lines or similar uses that do not fully encumber the land. Like a lease, an easement is not revocable at will. Termination occurs through expiration, mutual agreement, breech, or non-use. Traditionally, many easements are perpetual and are intended to benefit another parcel of land, regardless of who owns the land (easement appurtenant). Washington DNR's current practice is to issue easements only for a specific term and only to a specific easement holder. Typically easements issued by Washington DNR are not exclusive. In appropriate circumstances, Washington DNR will permit an assignment of easements.

The most limited form of authorization is a license. Like the easement, a license does not grant the right to possess land, only the temporary use of the land for a specific purpose. Unlike easements, licenses are revocable at will. A license holder (or licensee or grantee) cannot assign the license to another person. Washington DNR issues two types of licenses: a waterway permit and a right-of-entry. Typically, a waterway permit is for temporary use of an area reserved for navigation. Washington DNR can issue a right-of-entry for any aquatic lands.

## 2.2 Relationship to Washington DNR's other Habitat Conservation Plans

Washington DNR has completed three other habitat conservation plans (HCPs). **The State Trust Lands Habitat Conservation Plan** (1997) covers "...all DNR-managed forest lands within the range of the northern spotted owl, excluding those lands designated as urban or leased for commercial, industrial, or residential purposes and those lands designated as agricultural. All DNR management activities on these lands are covered" (Washington DNR, 1997).

As a *programmatic* habitat conservation plan, the **Forest Practices Habitat Conservation Plan** (FPHCP 2005) is linked to Washington's Forest Practices program, which regulates forest practices activities on primarily non-federal and non-tribal forestlands in the state. Forest practices activities on these lands must comply with the state's Forest Practices Act (RCW 76.09) and rules (WAC 222). "The purpose of the FPHCP is to assure those conducting forest practice activities, covered by or subject to the Forest Practices program, will also be in compliance with the Endangered Species Act (ESA) for covered, threatened, and endangered species (Washington DNR, 2005c).

The Habitat Conservation Plan for **Washington DNR's Wildstock Geoduck Fishery** covers activities related to the commercial harvest of wildstock geoduck clams from subtidal tracts of state-owned aquatic lands in the Puget Sound where geoduck grow in commercial quantities. The commercial geoduck tracts comprise approximately 6,000 acres of state owned aquatic lands.

This Aquatic Lands Habitat Conservation Plan complements the two previous HCPs by covering state-owned aquatic lands and the activities that occur there. The Aquatic Lands HCP covers some of the same species as the State Trust Lands HCP and the Forest Practices HCP. All three together encompass a large portion of the land base in Washington.

# 2.3 Regulatory framework

The following sections provide a synopsis of regulations that overlap with Washington DNR's management of state-owned aquatic land and the entities with an instrumental role in implementing these regulations.

# 2.3.1 Federal authorities

## Endangered Species Act
## (U.S. Fish and Wildlife Service and NOAA Fisheries)

Initially passed in 1973, the Endangered Species Act (ESA), provides for the special designation and protection of invertebrates, wildlife, fish, and plant species that are in danger of becoming extinct (16 U.S.C. § 1531-1544, 87 Stat. 884, as amended). A fundamental purpose of the act is to protect and recover endangered and threatened species and to provide a means to conserve the ecosystems on which they depend.

The ESA defines an *endangered* species as any species that is in danger of becoming extinct throughout all or a significant portion of its range (16 U.S.C. § 1532(6)). A *threatened* species is one that is likely to become endangered in the foreseeable future (16 U.S.C. § 1532(20)).

The U.S. Fish and Wildlife Service and NOAA Fisheries share responsibility for administering the ESA. Generally, the U.S. Fish and Wildlife Service is responsible for terrestrial species and freshwater aquatic species, while NOAA Fisheries is responsible for marine mammals, anadromous fish, and other marine species.

Section 9 of the ESA makes it unlawful to take a species that is listed as endangered. The term *take* under the act is defined as ". . . to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture,

or collect, or to attempt to engage in any such conduct" (16 U.S. Code § 1532 (19)). By federal regulation, the take prohibitions can be extended to species listed as threatened as well (16 U.S.C. § 1538(a)).

Section 10 of the ESA provides an exception to the take prohibition in Section 9. It states that the secretary of the interior or the secretary of commerce (depending on the species involved) may permit any taking otherwise prohibited by Section 9, if such taking is incidental to, and not the purpose of, carrying out an otherwise lawful activity (16 U.S.C. § 1539(a)). A landowner can obtain an incidental take permit under this provision if he or she submits a conservation plan (i.e., an HCP) that meets certain requirements (16 U.S.C. 1539(a)(2)(A)).

The plan must specify:

- The impact that will likely result from the take.
- What steps the applicant will take to avoid, minimize, and compensate for such impacts; the funding available to implement such steps; and the procedures to be used to deal with changed and unforeseen circumstances.
- What alternative actions to such taking the applicant considered and the reasons why such alternatives are not being utilized.
- Other measures that the secretary of the interior or the secretary of commerce may require as necessary or appropriate for purposes of the plan.

## Issuance criteria

The U.S. Fish and Wildlife Service and NOAA Fisheries will determine when Washington DNR meets all criteria for a habitat conservation plan. After an opportunity for public comment, the U.S. Fish and Wildlife Service and NOAA Fisheries will issue an incidental take permit if they find that:

- The taking will be incidental.
- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking.
- The applicant will ensure that adequate funding for the plan will be provided.
- The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild.
- Any measures that the secretary of the interior and the secretary of commerce deem necessary or appropriate for the purposes of the plan will be met (16 U.S.C. 1539(a)(2)(B)).

Section 7 of the ESA outlines the procedures for federal interagency cooperation to conserve federally listed species and designated critical habitats (16 U.S.C. 1531 *et seq.*). In particular, Section 7, 16 U.S.C. Section 1536(a)(2), requires all federal agencies to consult with NOAA Fisheries regarding marine and anadromous species or with the U.S. Fish and Wildlife Service regarding freshwater and terrestrial wildlife, if the agencies are proposing an action that may affect listed species or their designated habitat. *Action* is defined broadly to include funding, permitting, and other regulatory actions. Any project that requires a federal permit or receives federal funding is subject to Section 7.

Each federal agency is to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse

modification of designated critical habitat. Federal agencies are required to consult with the U.S. Fish and Wildlife Service and NOAA Fisheries about their actions. If such species may be present, the project proponent must conduct a biological assessment to analyze the potential effects of the project on listed species and critical habitat to establish and justify an *effect determination*. (Assistance and coordination may be available from the state, especially in the case of transportation projects.) The federal agency reviews the biological assessment, and, if it concludes that the project may adversely affect a listed species or its habitat, the agency prepares a *biological opinion*. The biological opinion may recommend "reasonable and prudent alternatives" to the proposed action to avoid jeopardizing or adversely modifying habitat.

## Fish and Wildlife Coordination Act (U.S. Fish and Wildlife Service)

The Fish and Wildlife Coordination Act (FWCA) was enacted in 1934 (16 U.S.C. §§ 661 et seq.). It requires consultation with the U.S. Fish and Wildlife Service to prevent loss or damage to wildlife resources:

> . . . whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license… (16 U.S.C. § 662 (a)).

In connection with the required consultation, the U.S. Fish and Wildlife Service and NOAA Fisheries provide comments and recommendations to prevent loss of, and damage to, fish and wildlife populations and their habitats. The U.S. Fish and Wildlife Service does not have authority under this act to require any entity to implement recommended measures.

## Magnuson-Stevens Fishery Conservation and Management Act (NOAA Fisheries)

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) provides for the conservation and management of fishery resources within 200 miles of the coasts of the United States, throughout the migratory range of anadromous species spawned in the United States and on the continental shelf contiguous with the United States beyond the 200-mile limit (16 U.S.C. §§ 1801 *et seq*.). The act established eight regional fishery management councils to manage and conserve the fishery resources within their regions and to prepare a fishery management plan (FMP) for each fishery. As amended by the Sustainable Fisheries Act, the act also requires each council to designate essential fish habitat for any species managed under a fishery management plan (SFA, P.L. 104-297, 1996). Essential fish habitat means ". . . those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity . . ." and covers the entire life history of that species. Federal agencies are required, under section 305(b)(2) of the Magnuson-Stevens Act and its implementing regulations (50 CFR 600 Subpart K), to consult with NOAA Fisheries regarding actions that the agencies authorize, fund, or undertake that may adversely affect the quality or quantity of essential fish habitat. NOAA Fisheries then provides recommendations to the federal agencies regarding measures to avoid, minimize, compensate for, or otherwise offset any adverse effects to essential fish habitat that would result from the agencies' actions. Essential fish habitat consultations are often conducted concurrently with considerations in Section 7 of the ESA.

## Marine Mammal Protection Act
## (U.S. Fish and Wildlife Service and NOAA Fisheries)

The Marine Mammal Protection Act (MMPA) provides authority for the conservation and protection of marine mammals (16 U.S.C. §§ 1361 *et seq*.). The act prohibits, with certain exceptions, the take of marine mammals in United States waters and by United States citizens on the high seas and the importation of marine mammals and marine mammal products into the United States. Under the Marine Mammal Protection Act, take means to ". . . harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal." The act allows NOAA Fisheries to authorize take of marine mammals incidental to commercial fishing operations.

## Coastal Zone Management Act
## (Office of Ocean and Coastal Resource Management and Environmental Protection Agency)

The purpose of the Coastal Zone Management Act is to encourage states to protect and preserve coastal resources (including "fish and wildlife, and their habitat") and to allow for economic growth, reduce coastal hazards, improve water quality through a non-point pollution plan approved by the Environmental Protection Agency, and plan for sensible coastal development (16 U.S.C. §§ 1461 *et seq*.). Coastal states develop coastal zone management programs that are reviewed by NOAA for compliance with applicable state and federal laws. Once a coastal zone management program is approved (§ 1455), projects with a federal nexus located in a coastal county must conform to it to the "maximum extent practicable" (§ 1456) if any of the state or federal laws are triggered. A federal consistency review specifies if a project is consistent with the enforceable policies or requires further consultation. The Washington State Department of Ecology has the authority to object at the federal level to a project, if it finds that the project is not consistent with the enforceable policies of the Washington State Coastal Zone Management Program and the proponent is not willing to negotiate changes to the design of the project. No federal license or permit shall be granted by a federal agency until the Department of Ecology has concurred with the applicant's consistency certification (Washington State Department of Ecology, 2001).

In Washington, the approved coastal zone management program has six enforceable "authorities and enforceable policies" for actions in coastal counties with a federal nexus (permit, funding, or agency):

- The Shoreline Management Act
- The Washington State Environmental Policy Act (SEPA)
- The Ocean Resources Management Act
- The Clean Water Act
- The Clean Air Act

Decisions made by the Energy Facility Site Council

Many of these statutes and policies are described elsewhere in this chapter.

## Migratory Bird Treaty Act
(U.S. Fish and Wildlife Service)

The Migratory Bird Treaty Act establishes protection and take prohibitions for migratory birds in North America, based upon treaties between the United States, Great Britain, Mexico, Japan, and Russia (16 U.S.C. §§ 703-712). The U.S. Fish and Wildlife Service may issue permits for taking protected birds based on specified criteria intended to protect the abundance of the species at issue. The act provides both criminal and civil penalties for violation.

## Bald and Golden Eagle Protection Act
(U.S. Fish and Wildlife Service)

Although now delisted, bald eagles are still protected by the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and the Lacey Act. Under the Bald and Golden Eagle Protection Act (16 U.S.C. § 668), it is a violation to:

> …take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner, any bald eagle commonly known as the American eagle, or golden eagle, alive or dead, or any part, nest or egg thereof…(16 U.S.C. § 668b).

The act provides both criminal and civil penalties for violation.

## Federal Clean Water Act
(U.S. Army Corps of Engineers and Environmental Protection Agency)

The purpose of the Federal Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 U.S.C. §§ 1251 *et seq*.). The Clean Water Act focuses primarily on pollution and the adverse impacts of pollution on wildlife and their habitat. The U.S. Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA) work together to administer the federal Clean Water Act. The Corps is responsible for Section 404 (33 U.S.C. § 1344), regarding issuance of permits to discharge dredged or fill materials into waters of the United States (33 U.S.C. § 1344).

The EPA has authority under the act to review and comment on impacts of all proposed permits and to prohibit any activity that has an unacceptable impact on municipal water supplies, shellfish beds, fishery areas, wildlife, and recreational areas. The EPA, in consultation with the Corps, develops guidelines for evaluating discharges subject to Section 404 (40 C.F.R. Part 230).

The EPA administers the regulation and discharge of pollutants under the National Pollutant Discharge Elimination System (NPDES) (Section 402; 33 U.S.C. § 1342). Discharges into the territorial sea[15] also require a permit (Section 403; 33 U.S.C. § 1343). The 1987 amendments to

[15] Defined by the 1982 United Nations Convention on the Law of the Sea , is a belt of coastal waters extending at most twelve nautical miles (22.224 km) from the baseline (usually the mean low-water mark) of a coastal state.

the federal Clean Water Act included the "non-point source" pollution program for pollutants such as stormwater runoff (Section 319; 33 U.S.C. § 1329).

The act has very strong enforcement mechanisms, including the ability to obtain injunctions, assess civil penalties, and pursue criminal actions against offenders (33 U.S.C. § 1319). The act also allows for private enforcement through citizen suits in federal court (33 U.S.C. § 1365).

## Rivers and Harbors Act
## (U.S. Army Corps of Engineers)

Sections 9 and 10 of the Rivers and Harbors Act authorize the U.S. Army Corps of Engineers to regulate construction in navigable waters, including building canals, boat ramps, navigational aids, marinas, outfalls, or bank stabilization projects (33 U.S.C. §§ 401 *et seq*.). The act provides for criminal charges against violators and issuance of injunctions requiring removal of structures constructed without a permit (33 U.S.C. § 406).

## Oil Pollution Act
## (U.S. Coast Guard and Environmental Protection Agency)

The Oil Pollution Act of 1990 streamlined and strengthened the federal government's ability to prevent and respond to catastrophic oil spills (33 U.S.C. §§ 2701-2729). It provides funds when the responsible party is incapable or unwilling to clean up the spill. The act requires oil storage facilities and vessels to submit detailed petroleum spill response plans. Area contingency plans (ACPs) are necessary under the act for oil spill response on a regional scale (33 U.S.C. § 4202 and § 1321). These area contingency plans require consideration of listed species and habitat, and a Section 7 consultation with the U.S. Fish and Wildlife Service and NOAA Fisheries under the ESA.

## National Environmental Policy Act
## (Council on Environmental Quality, Environmental Protection Agency)

The National Environmental Policy Act (NEPA) requires that federal agencies analyze and publicly disclose the social, economic, and environmental effects associated with major federal actions (42 U.S.C. §§ 4321 *et seq*.; § 4332). This analysis can take the form of an Environmental Assessment[16] (EA), an Environmental Impact Statement (EIS), or both. The issuance of an incidental take permit under the ESA is a federal action subject to NEPA compliance. NEPA generally requires a broader analysis of environmental impacts and of alternatives to the proposed action than the analysis done in a habitat conservation plan. While NEPA does not contain any express penalty provisions, many federal agencies may not receive federal funding until NEPA is

[16] Serves to briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact. The environmental assessment aids an agency's compliance with the NEPA when no environmental impact statement is necessary, and facilitates preparation of a statement when one is necessary.

completed, and courts have routinely invalidated federal actions for failure to comply. The Environmental Protection Agency is required to review and publicly comment on the environmental impacts of major federal actions. If the Environmental Protection Agency determines an action to be environmentally unsatisfactory, it reports its objections to the agency in question and to the Council on Environmental Quality.

### Federal Power Act
(Federal Energy Regulatory Commission)

The Federal Energy Regulatory Commission (FERC) issues licenses to nonfederal entities (primarily utilities) pursuant to the Federal Power Act for interstate transmission of electricity, natural gas, and oil and for construction and operation of hydroelectric projects (16 U.S.C. §§ 791a *et seq*.). Those who apply for a hydropower license or seek to renew an existing license must consult with all relevant state and federal fish and wildlife agencies and tribes regarding measures necessary to protect fish and wildlife resources impacted by the hydropower project (§ 808).

### Comprehensive Environmental Response, Compensation, and Liability Act
(Environmental Protection Agency)

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Environmental Protection Agency has broad authority to require contaminated sediment cleanup and remediation activities by polluters and other responsible parties (42 U.S.C. §§ 9601 *et seq*.). CERCLA provides substantial penalties for noncompliance (§§ 9608 and 9609). The act also authorizes citizen suits to compel compliance and recover damages (§ 9659).

## 2.3.2 State and local authorities

### Water Pollution Control Act
(Washington State Department of Ecology)

The Water Pollution Control Act prohibits the discharge of pollution into waters of the state and establishes the jurisdictional authority of the Washington State Department of Ecology to set water quality standards (RCW 90.48). The Water Pollution Control Act designates the Washington State Department of Ecology as the state agency responsible for implementing and enforcing all programs necessary for the state to comply with the federal Clean Water Act.

### Puget Sound Water Quality Protection Act
(Puget Sound Partnership)

The legislature enacted the Puget Sound Water Quality Protection Act on July 1, 2007 (RCW 90.71). Through this act, the legislature created a new agency, the Puget Sound Partnership, to coordinate and lead the effort to restore and protect Puget Sound. The legislature intends that all governmental entities, including federal and state agencies, tribes, cities, counties, ports, and special purpose districts, will support and help implement the partnership's restoration efforts. The

Puget Sound Partnership is not a regulatory authority and does not have the authority to transfer the responsibility for, or implementation of, any state regulatory program, unless otherwise specifically authorized by the legislature. The primary duties of the Puget Sound Partnership are to:

- Define a strategic action agenda that prioritizes necessary actions, both basin-wide and within specific areas, and create an approach that addresses all of the complex connections among the land, water, web of species, and human needs. The action agenda shall be based on science and include clear, measurable goals for the recovery of Puget Sound by 2020.
- Determine accountability for performance, oversee the efficiency and effectiveness of money spent, educate and engage the public, and track and report results to the legislature, the governor, and the public.

## Shoreline Management Act
(Washington State Department of Ecology, counties, and cities)

The purpose of the Shoreline Management Act of 1971 (SMA) is to prevent the harm caused by uncoordinated and piecemeal development of shorelines (RCW 90.58). The act provides the framework for federal, state, and county entities to engage in joint planning for shorelines. It requires shoreline master programs to assist counties with land use planning. Under the act, a permit is required for shoreline alteration within 200 feet of the shoreline.

Counties are responsible for developing shoreline management plans that reflect their unique geographic, environmental, and economic needs per the guidance provided in Shoreline Management Guidelines (WAC 173-26).

In Section 79.105.040 of the Revised Code of Washington, the legislature specifies that the general provisions of the aquatic lands statutes do not modify, alter, or affect the applicability of the Shoreline Management Act. Washington DNR adopted WAC 332-30-107 to address planning under the act and directing the agency to:

- Use shoreline management planning as a primary tool for identifying “the best combination of aquatic uses” (WAC 332-30-107(2)).
- Coordinate with other jurisdictions and their shoreline management efforts (WAC 332-30-107(4)).
- Supplement the shoreline master program planning process as necessary to meet constitutional and statutory proprietary responsibilities for aquatic lands (WAC 332-30-107(5)).
- Mitigate for unavoidable adverse impacts (WAC 332-30-107(6)).

## State Environmental Policy Act

The State Environmental Policy Act (SEPA) is intended to ensure that environmental values are considered when state and local agencies make decisions (RCW 43.21C). Its federal counterpart is the National Environmental Policy Act (NEPA). Under SEPA, state and local agencies must consider environmental information (impacts, alternatives, and mitigation) before committing to a

particular course of action. At the direction of the legislature, the Washington State Department of Ecology adopted Chapter 197-11 of the Washington Administrative Code to implement SEPA.

The State Environmental Policy Act requires that Washington DNR consider conducting a SEPA review before the agency decides to make a purchase, sale, lease, transfer, or exchange of state-owned land or natural resources. Washington DNR is exempt from this requirement when considering a lease of state-owned aquatic lands that will not change the use of the property from its existing use. A lease for pleasure craft mooring buoys is also exempt from SEPA. Although Washington DNR must consider SEPA review, the agency is excused from serving as lead agency for all private projects in which the sale or lease of state-owned aquatic lands is incidental to a larger project for which one or more licenses from other state or local agencies is required. In such circumstances, the other state or local agency is the lead agency; however, Washington DNR can assume lead agency status within 14 days of the other agency's threshold determination, if Washington DNR is not content with the other agency's process or determination.

## Growth Management Act
(Washington State Department of Commerce)

The Growth Management Act (GMA) requires cities and counties that meet certain criteria (set forth in RCW 36.70A.040) to develop comprehensive growth management plans (RCW 36.70A). The legislature adopted the Growth Management Act in response to concerns that ". . . uncoordinated and unplanned growth, together with a lack of common goals expressing the public's interest in the conservation and wise use of our lands, pose a threat to the environment, sustainable economic development, and the . . . high quality of life enjoyed by residents of this state" (RCW 36.70A. 010). All counties and cities of the state are required to designate and protect critical areas and designate natural resource lands. Other elements include designating urban areas, shorelines, transportation, harbor areas, and utilities (Washington State Department of Commerce, 2006). Consequently, these plans affect local jurisdictions' priorities for the use of state-owned aquatic lands.

## Watershed Planning Act
(Washington State Department of Ecology)

The purpose of the Watershed Planning Act is to develop a more thorough and cooperative method of assessing water resources for an inventory area (Water Resource Inventory Area or WRIA), through the creation of comprehensive watershed management plans (RCW 90.82).

## State Endangered Species Authority
(Washington Department of Fish and Wildlife)

Chapter 77.12 of the Revised Code of Washington lists the powers and duties of the Washington Department of Fish and Wildlife. The Washington Fish and Wildlife Commission may designate a species of wildlife as protected (RCW 77.12.020 (5)) or as endangered (RCW 77.12.020 (6)). In April 2012, the Washington Department of Fish and Wildlife published its annual report on threatened and endangered wildlife. It listed 28 endangered species, 10 threatened species, and 7 sensitive species; it removed 2 species. Endangered species are designated under Section 232-12-

014 of the Washington Administrative Code; threatened species are designated under Section 232-12-011 (Washington Department of Fish and Wildlife, 2012).

## Salmon Recovery Act
(Washington State Recreation and Conservation Office and Washington Department of Fish and Wildlife)

Chapter 77.85 of the Revised Code of Washington establishes a Governor's Salmon Recovery Office, residing within the Recreation and Conservation Office, to coordinate salmon recovery efforts statewide among regional salmon recovery regions, state agencies, tribes, local governments, lead entities, and non-profit organizations. The Governor's Salmon Recovery Office also works with federal agencies to ensure the statewide salmon recovery strategy is consistent with federal salmon recovery objectives and requirements of the ESA.

## Hydraulic Code
(Washington Department of Fish and Wildlife)

Section 77.55.100 of the Revised Code of Washington gives the Washington Department of Fish and Wildlife the authority to require a hydraulic project approval (HPA) permit for construction activities in or near state waters. Such a permit is required for the performance of work that will use, divert, obstruct, or change the natural flow or bed of any waters of the state. The purpose of the permit is to ensure the protection of fish life, including shellfish.

## Sanitary Control of Shellfish
(Washington State Department of Health)

The Washington State Department of Health determines shellfish closure zones, issues certifications for sanitary commercial shellfish areas, and conducts biotoxin studies (RCW 69.30 and WAC 246-282). The Washington State Department of Health administers the Recreational Shellfish Program and provides information to the public about where and how to safely harvest recreational shellfish, free of contamination, in Washington State.

## Oil Spill Prevention and Response
(Washington State Department of Ecology)

The Washington State Department of Ecology is responsible for oil and hazardous substance spill prevention and response (RCW 90.56). Washington DNR participates in spill responses and damage assessments.

## Model Toxics Control Act
(Washington State Department of Ecology)

The Washington State Department of Ecology is the lead agency for conducting investigations and leading cleanup of contaminated sediments (RCW 70.105D). Chapter 173-204 of the Washington Administrative Code sets sediment management standards.

## Food Fish and Shellfish: Commercial Licenses
(Washington Department of Fish and Wildlife)

The Washington Department of Fish and Wildlife regulates licenses for the commercial harvest of food fish and shellfish (RCW 77.65). Chapter 77.32 of the Revised Code of Washington regulates recreational fishing, shellfishing, and hunting.

## Aquaculture Disease Control
(Washington Department of Fish and Wildlife)

Chapter 77.115 of the Revised Code of Washington sets requirements for control of diseases from aquaculture operations and provides for registration of aquatic farmers.

## Transportation Authorities
(Washington State Department of Transportation)

The Washington State Constitution grants municipalities the right to extend streets across tidelands and harbor areas. Chapter 47.12 of the Revised Code of Washington sets requirements for the Washington State Department of Transportation's acquisition and disposition of state highway property, including state-owned aquatic lands.

## Port Districts
(Washington DNR)

Section 79.105.420 of the Revised Code of Washington states that a port district and Washington DNR may enter into an agreement authorizing the port district to manage state-owned aquatic lands ". . . abutting or used in conjunction with and contiguous to uplands owned, leased, or otherwise managed by a port district, for port purposes . . . ."

## Counties, cities, and towns

Counties, cities, and towns have the power to police activities on the waters within their jurisdiction (RCW 36.04; RCW 35.21.160). This includes the authority to regulate navigation, vessel speed, and anchorage.

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# Chapter 3
# Description of Activities

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# Chapter 3. Description of Activities

Washington DNR's goal in developing the Aquatic Lands Habitat Conservation Plan is to provide a programmatic process for managing state-owned aquatic lands that meets both the applicable requirements of the Endangered Species Act, and DNR's duty to manage the lands in a way that achieves a balance of public benefits. This includes ensuring that there is no appreciable reduction in the likelihood of the survival or recovery of a covered species in the wild where incidental take or habitat degradation results from specific activities authorized by Washington DNR. The habitat conservation plan provides a programmatic method for habitat management on state-owned aquatic lands that supports the recovery of species, thereby reducing the risk of extinction.

Three general categories of authorized activities are included in the habitat conservation plan: shellfish aquaculture, log booming and storage, and overwater structures. Each category has an associated array of operations, as well as a geographic distribution of occurrence. This chapter provides brief descriptions of the activities that Washington DNR is requesting under an incidental take permit. The activities are described as they currently exist and operate prior to the implementation of the habitat conservation plan. For a description of the changes that would be made to the design and operation of these activities as a result of the implementation of the habitat conservation plan, see Chapter 5. A more detailed discussion of the current designs and operations of all of the activities authorized on state-owned aquatic lands may be found in the Potential Covered Activities Technical Paper (Washington DNR, 2005b).

## 3.1 Washington DNR's authority

The Washington State Legislature has delegated to Washington DNR proprietary authority over the state's aquatic lands. Washington DNR's management of aquatic lands is guided generally by the state constitution and by Title 79 (Public Lands) of the Revised Code of Washington (RCW), as well as by regulations promulgated by the Board of Natural Resources. State-owned aquatic lands are also subject to other statutes and regulations governing the management of all real property in Washington State. Specific authorities related to state-owned aquatic lands are listed in Table 3.1.

**Table 3.1** Summary of statutory authority specifically associated with state-owned aquatic lands.

| Chapter | Title | Content |
|---|---|---|
| RCW 79.105 | Aquatic lands—General | Sets basic definitions and authorities for managing state-owned aquatic lands. Gives Washington DNR authority to sell, lease, and exchange certain aquatic lands, as well as the authority to sell valuable materials (*e.g.* sediment and geoducks) from those aquatic lands. |
| RCW 79.110 | Aquatic lands—Easements and rights of way | Sets Washington DNR's authority to grant easements and rights-of-way for specific activities on and over the state's aquatic lands. |
| RCW 79.115 | Aquatic lands—Harbor areas | Stipulates that harbor areas are to be established by the Board of Natural Resources. Harbor areas are to be reserved for navigation and commerce and for facilities that promote navigation and commerce (*e.g.* docks and wharves). |
| RCW 79.120 | Aquatic lands—Waterways and streets | Stipulates that Washington DNR must plat waterways at the same time it establishes harbor areas. Waterways are generally reserved from sale or lease so they can remain free as public highways for watercraft. |
| RCW 79.125 | Aquatic lands – Tidelands and shorelands | Sets Washington DNR's authority to lease tidelands and shorelands for a variety of uses. Also stipulates that Washington DNR may exchange these lands if such an exchange is in the public interest and of benefit to the state and prohibits sale of tidelands and first class shorelands except to public entities. |
| RCW 79.130 | Aquatic lands—Beds of navigable waters | Sets Washington DNR's authority to lease (for up to 55 years) beds of navigable waters that lie waterward of the extreme low tide mark. Washington DNR may not, however, lease or grant authority for anyone to use aquatic lands that lie waterward of outer harbor lines. |
| RCW 79.135 | Aquatic lands—Oysters, geoducks, shellfish, and other aquaculture uses | In coordination with the Washington Department of Fish and Wildlife and Washington Department of Health, sets Washington DNR's authority to lease lands for shellfish harvesting and aquaculture. The Washington Department of Fish and Wildlife regulates commercial shellfish growers and their harvesting, while the Washington Department of Health monitors beaches and shellfish tracts for pollution and other issues that affect human health. Also confirms Washington DNR's authority to sell geoducks as valuable materials and enter into agreements with the purchasers on the terms and conditions deemed necessary. |
| RCW 79.100 | Derelict vessels | Gives Washington DNR and other public authorities certain powers to abate hazards posed by derelict vessels. |
| WAC 332-30 | Aquatic land management | Defines rules for Washington DNR's land management. |

Note: RCW = Revised Code of Washington; WAC = Washington Administrative Code

# 3.2 Shellfish aquaculture

The Washington Administrative Code (WAC) defines aquaculture as ". . . the culture and/or farming of food fish, shellfish, and other aquatic plants and animals in fresh water, brackish water, or salt water areas . . . ." (WAC 332-30-106). Washington DNR authorizes the use of state-owned intertidal and shallow subtidal lands in fulfillment of its duties to provide public benefits through the use of renewable resources and to foster uses of aquatic environments (RCW 79.105.030 and .050).

For the purposes of the habitat conservation plan, shellfish aquaculture includes the operations, facilities, and structures associated with the commercial planting and harvesting of shellfish that Washington DNR authorizes on state-owned aquatic lands. The harvesting of wildstock shellfish is not covered. Finfish aquaculture is a separate activity that is not covered by this habitat conservation plan.

## 3.2.1 Rationale for inclusion of shellfish aquaculture in the habitat conservation plan

Washington DNR selected shellfish aquaculture as a covered activity for the following reasons:

- The opportunity to improve ecosystem functions and support recovery of species. A condition of the incidental take permit under Section 10 requires improvements to habitat over the term of the agreement. The incidental take statement under Nationwide Permit 48, on the other hand, does not require improvements to habitat. The ability of Washington DNR to set limits or requirements for pesticide application on state-owned aquatic lands allows for greater protection of aquatic species and habitat. Pest management has the potential to result in take. One pesticide in particular, carbaryl, was determined by NOAA Fisheries to ". . . jeopardize the continued existence of [some] endangered or threatened species" (National Marine Fisheries Service, 2009b).
- Washington DNR retains a high degree of control over where shellfish aquaculture occurs on state-owned aquatic lands.
- Washington DNR is able to influence (through terms in an agreement) the methods used in shellfish aquaculture.
- All shellfish aquaculture activities occur (sometimes for continuous distances) in the intertidal and shallow sub-tidal areas, which are critical habitat for spawning, foraging, cover, and migration of covered species.

The requirements of the habitat conservation plan will be used for siting shellfish aquaculture operations and related facilities, designing structures and sites, operating and maintaining structures, and removing abandoned structures at the termination of a lease.

# 3.2.2 Legal framework for shellfish aquaculture

## Washington DNR's authority

Section 79.105.050 of the Revised Code of Washington (WAC) obligates Washington DNR to ". . . Foster the commercial and recreational use of the aquatic environment for production of food, fiber, income, and public enjoyment from state-owned aquatic lands. . . ." The statute also states that ". . . the department may develop and improve production and harvesting of seaweeds and sea life attached to or growing on aquatic lands or contained in aquaculture containers . . . ."

In accordance with Washington Administrative Code, aquaculture is considered a water-dependent use, and, as such, it is a preferred use of state-owned aquatic lands (WAC 332-30-100). Table 3.1 lists the general authorities that apply to state-owned lands, while Table 3.2 lists authorities that are specifically related to aquaculture.

**Table 3.2** Washington DNR's authority specifically related to shellfish aquaculture.

| Law/Rule | Title | Content |
|---|---|---|
| RCW 79.105 | Aquatic lands—General | Describes the general provisions; the use, sale, and lease provisions; the leasing and rental rates; and other management provisions for aquatic lands. |
| RCW 79.135 | Aquatic lands—Oysters, geoducks, shellfish, other aquacultural uses, and marine aquatic plants | Describes the general provisions and laws for leasing aquatic lands for shellfish cultivation and other aquaculture. |
| WAC 332-30-106 | Definitions | Defines aquaculture as the culture and/or farming of food fish, shellfish, and other aquatic plants and animals in fresh water, brackish water, or salt water areas. Aquaculture practices may include, but are not limited to, hatching, seeding or planting, cultivating, feeding, raising, harvesting of planted crops or of natural crops so as to maintain an optimum yield, and processing of aquatic plants or animals. |
| WAC 332-30-122 | Aquatic land use authorization | Stipulates general requirements for authorizations; considerations for application review, rents, and fees; criteria for structures and improvements; and insurance, bonds, and security requirements. |
| WAC 332-30-128 | Rent review | Stipulates rights of Washington DNR and lessees related to rents, and provides a process for requesting a rent review. |

| Law/Rule | Title | Content |
|---|---|---|
| WAC 332-30-157 | Commercial clam harvesting | States conditions, boundaries, and methods by which commercial clam harvesting can occur under lease. |

Note: RCW = Revised Code of Washington; WAC = Washington Administrative Code

### Leases for shellfish aquaculture

Washington DNR authorizes shellfish aquaculture using a standardized lease agreement specific to the culture of oysters, clams, and mussels. Agreement terms, as recorded in Washington DNR's financial management database (NaturE), ranged from 3 to 39 years, with 10-year terms being most common, followed by 20-year terms, and then 15-year terms.

## Regulatory oversight of shellfish aquaculture

The U.S. Army Corps of Engineers regulates shellfish aquaculture under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Table 3.3 outlines the regulatory entities involved, as well as their legal authority.

In 2007, the U.S. Army Corps of Engineers issued Nationwide Permit 48 for existing shellfish aquaculture sites. Nationwide Permit 48 was reissued in March 2012. This permit does not cover the use of pesticides or shellfish aquaculture operations established after the revision of the permit in March 2012. As part of their permitting process for actions that may affect a federally listed species or its designated critical habitat, the U.S. Army Corps of Engineers is required to initiate Endangered Species Act consultation with NOAA Fisheries and the U.S. Fish and Wildlife Service.

In 2009, the Seattle District of the U.S. Army Corps of Engineers initiated programmatic consultation with NOAA Fisheries and the U.S. Fish and Wildlife Service regarding Nationwide Permit 48. The biological assessment prepared for Nationwide Permit 48 in Washington State assessed impacts from an environmental baseline that included existing shellfish aquaculture. The biological opinions issued in 2009 by the U.S. Fish and Wildlife Service and NOAA Fisheries for the activities addressed under Nationwide Permit 48 in Washington State did identify adverse effects on listed species, but determined that the effects of shellfish aquaculture activities would not cause take, jeopardize listed species, or result in adverse modification of designated critical habitat (National Marine Fisheries Service, 2009a; United States Fish and Wildlife Service, 2009). The U.S. Army Corps of Engineers reinitiated consultation with the U.S. Fish and Wildlife Service in 2010 to address effects from methods of geoduck farming and harvesting and changes to bull trout critical habitat. This consultation resulted in a determination of no adverse modification (United States Fish and Wildlife Service, 2009). The U.S. Army Corps of Engineers must evaluate all nationwide permits every five years.

Nationwide Permit 48 authorizes existing commercial shellfish aquaculture activities. It also authorizes commercial shellfish aquaculture activities in new areas, provided that those activities have received a valid agreement from a state or local government agency and do not directly affect more than 1/2-acre of submerged aquatic vegetation beds (for example, eelgrass). Nationwide permits are re-authorized every five years. Standard or individual permits administered by the U.S. Army Corps of Engineers cover actions that do not meet the conditions of Nationwide Permit 48, but also typically expire within 10 years of issuance. For existing shellfish aquaculture, the U.S. Army Corps of Engineers has programmatic Endangered Species Act coverage until March 18,

2017, and not for the anticipated term of the habitat conservation plan. New operations require individual Endangered Species Act coordination.

**Table 3.3** Regulatory oversight of shellfish aquaculture.

| Agency | Permit, Approval, or Regulatory Requirement | Permit, Approval, or Regulatory Requirement Needed |
|---|---|---|
| Local city or county planning office | Shoreline substantial development permit, Shoreline conditional use permit, Shoreline variance permit. Some jurisdictions do not require shoreline permits for shellfish aquaculture. | All development/activities either within 200 feet of the shorelines of the state and above a set value, or meeting other criteria. |
| NOAA Fisheries | Marine Mammal Protection Act Marine Mammal Take Authorization | All projects affecting marine mammals. |
| U.S. Army Corps of Engineers | Rivers and Harbors Act Section 10 Permit | Construction in navigable waters. Nationwide Permit 48 available to existing aquaculture sites. |
| Environmental Protection Agency | Clean Water Act Section 404 Permit | Discharge of dredged or fill materials in navigable waters. |
| US Food and Drug Administration | Federal Food, Drug, and Cosmetic Act | Consumer protection of seafood. |
| Washington State Department of Ecology | Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) Permit | Regulates point and non-point sources of pollutants. |
| | Clean Water Act Section 401 Water Quality Certification | For all projects requiring a Section 401 permit, the state assesses whether the discharge being authorized will or will not violate state water quality standards. |
| | Shoreline Management Act | All development/activities within 200 feet of the shorelines of the state. |
| Washington Department of Fish and Wildlife | Commercial shellfish licenses | Licenses commercial shellfish harvesters. Through this licensing scheme, regulates the amount, methods, and location of harvest. |
| | Aquatic farm registrations | Requires registration for *aquatic farms*: Registration regulates the cultivation of aquatic *products* (*i.e.* shellfish) and requires detailed reports from aquatic farmers. |
| Washington State Department of Health | Shellfish growing area monitoring | Monitoring of shellfish beds for risks associated with human health. |

## Scope of shellfish aquaculture

The incidental take permit will cover existing and future shellfish aquaculture activities that are authorized by Washington DNR and approved. Existing agreements will be included at the time of renewal or amendment, and future agreements will be included at the time of signature.

# 3.2.3 Shellfish aquaculture: activity description

## General description

Shellfish aquaculture techniques vary based on the species being grown, local site conditions, and the desired marketable product. For the purposes of this habitat conservation plan, a distinction is made between ground-based techniques and floating techniques. Existing ground-based aquaculture occurs in both the intertidal and subtidal areas and involves growing shellfish directly on or in the substrate (bottom culture), either in bags laid on racks or directly on the substrate (bag culture), or on longlines staked into the ground to raise the shellfish above the substrate (longline culture). Floating aquaculture involves placing shellfish in trays, baskets, or nets suspended from floats, rafts, or longlines so that they hang in the water column and remain suspended above the substrate during low tides.

### Timing

Shellfish seeding occurs from early spring to late summer. Growth to maturity can take two to four years, depending on local conditions and the growing method. Because harvest is tailored to meet market demand, harvesting can occur at any time of the year.

Ground-based culture activities generally occur when tides are low enough to expose the culture bed. The lowest low tides (minus tides) typically occur for several days twice each lunar month, at the full moon and again at the new moon. These tides occur near midnight in December, near noon in June, and at corresponding intermediate times in the other months. In order to capitalize on the minus tides, some culture activities occur day and night (whenever the minus tides occur). During culture activities, workers or mechanical harvesters may be on the bed for three to six hours before tidelands re-flood an area.

### Species cultured

Although the predominant shellfish species cultured on state-owned aquatic lands is the Pacific oyster (*Crassostrea gigas*), Washington DNR also leases land for culture of Manila clams (*Venerupis philippinarum*), littleneck clams (*Protothaca staminea*), butter clams (*Saxidomus gigantea*), Kumamoto oysters (*Crassostrea sikamea*), European flat oysters (*Ostrea edulis*), Olympia oysters (*Ostrea lurida*), Puget Sound blue mussels (*Mytilus trossulus*), and Mediterranean mussels (*Mytilus galloprovincialis*). Of the species cultured, only four are native: Olympia oysters, littleneck clams, butter clams, and Puget Sound blue mussels. Washington DNR has 11 total sites proposed for geoduck aquaculture located in Jefferson, Mason, Pierce and Thurston counties. Washington DNR anticipates entering into agreements for the culture of geoducks (*Panopea abrupta*) with existing applicants once all environmental review and permitting processes are complete.

## Seed set

Methods for setting seed vary. Aquatic farmers use hatchery-produced seed for Mediterranean mussels, geoduck clams, and all other clam species. For Puget Sound blue mussels, aquatic farmers use natural seed set from older beds. Oysters are grown from both natural and hatchery seed.

Natural seed set is collected on bags of fragmented shell (cultch) or gravel and placed in the intertidal zone prior to the spawning season. The bags are laid directly onto the ground or placed on racks set on the ground. Once the shellfish larvae have set on the hard substrate and become spat, they are kept there until they reach a suitable size for planting (generally 0.6 to 1 centimeter or 0.2 to 0.4 inches). Hundreds to thousands of cultch bags are required to sustain commercial inventories.

Figure 3.1 Oyster bottom culture in Grays Harbor. Photo: Washington DNR

Hatcheries can be on-site or off-site. In hatcheries, adult shellfish are induced to spawn and the larvae are raised until they set and become spat. Oyster larvae are released into tanks to settle on the cultch, which is then removed and used as seed. Oyster seed can be sold as spat attached to cultch in mesh bags, or as spat attached to shell threaded on longlines. Clam larvae are allowed to set on screens. Clam seed is often sold by the bag. Mussel spat is sold on longlines. The spat of any shellfish species may be held in the middle to lower intertidal area for up to several months until they reach a suitable size for planting.

Spat size can also be increased by using a secondary nursery, or floating upweller system (FLUPSY), to take advantage of naturally occurring algal food sources. Floating upweller systems are generally located in water deeper than 6 meters (20 feet) to eliminate variations in food supplies associated with tidal movements and to minimize impacts on aquatic vegetation. Shellfish spat are placed in bins, which are lowered into a floating frame called a silo and suspended in the seawater. Several bins are placed in a row on either side of a centrally enclosed channel that ends at a paddlewheel or pump that circulates the water past the shellfish. The water flow is constant, so the spat feed constantly. Once the juvenile shellfish reach a suitable size, they are transplanted to a grow-out site.

With few exceptions, an aquaculture leaseholder will not be allowed to transfer or import shellfish marine organisms, shellfish aquaculture products, or shellfish aquaculture equipment, unless the leaseholder has first obtained a permit through the Washington Department of Fish and Wildlife. To reduce the introduction of disease or pests into Washington state waters, permits may be approved with conditions, or denied—depending on the possible risk factors. (WAC 220-72-076)

# Types of culture proposed for coverage

## Ground-based culture

### Bottom culture

Bottom culture involves growing clams or oysters (or both) directly on or in the substrate of intertidal areas, typically between tidal elevation +0.6 and -0.6 meters (+ 2 and -2 feet; Figure 3.1).

#### Site preparation

Oyster beds are typically laid out in the intertidal areas, as allowed by sloughs or channels, to capitalize on natural nutrient flow patterns. Prior to planting a new crop of oysters, workers prepare the beds by removing remaining shellfish, built-up mud, organic debris, rocks, and predators, such as native sea stars (Asteroidea),the native moon snail (*Polinices lewisii*), and the two introduced snails—the eastern oyster drill (*Urosalpinx cinerea*) and the Japanese oyster drill (*Ocinebrellus inornatus*). Grading of the site is done either by hand, or with a hydraulic dredge. Beds may also be harrowed. The harrow is a skidder with tines towed along the substrate by a boat when the bed is submerged.

For clam culture, the substrate may be enhanced by using a pump and high pressure hose to spray crushed shell, washed gravel, or a combination of the two (called frosting) from the deck of a barge when the bed is submerged. Several passes are made over the bed when applying the material to ensure even distribution. Some of these activities can be repeated on a plot several times a year.

#### Seeding

After the bed is prepared, it is seeded with shellfish spat. Seeding methods vary by species and by site-specific factors, such as predator occurrence and weather conditions. Some oyster beds are seeded by spraying spat attached to cultch from the deck of barges when the bed is submerged, or evenly dispersing them by hand during minus tides. In other cases, lessees rely solely on the natural set of oyster seed onto existing beds.

Seeding may occur at any time during the year to meet a particular shellfish grower’s needs. Seeded cultch or larger natural catch seed is normally planted onto an oyster bed anytime between February and October. Oyster shell for natural recruitment is normally placed when natural recruitment conditions are optimal (July and August).

Older clam beds are often seeded through natural seed set, but some beds require seeding of hatchery spat. After each growing season, clam beds are typically surveyed during low tides to assess seed survival and distribution and to estimate future harvest yield. If additional clam seed is required, it can be spread by hand onto exposed substrate at low tide, during an incoming tide when the water is approximately 10 centimeters (4 inches) deep, or during an outgoing tide when the water is approximately 0.6 to 1 meter (2 to 3 feet) deep. Seed can also be spread from a boat at high tide. Anti-predator netting is spread over the bed after seeding to exclude crabs, moon snails, and diving ducks. Clam growers may remove the predator netting over the clam beds a few days to a few weeks later, when the clams have burrowed into the substrate sufficiently to avoid most predators.

### Grow-out

During oyster grow-out, oyster beds undergo periodic raking by hand or by mechanical harrowing to maintain the even distribution of oysters on the plot and avoid reduction in size through overcrowding. Oysters may also be dredged up and moved to an area of higher food resources to improve growth rates. In areas where the substrate is soft, the oysters may sink into the mud either due to their own weight, or as a result of bioturbation[1] by ghost shrimp (*Neotrypaea californiensis*) or blue mud shrimp (*Upogebia pugettensis*). Oysters must stay on the surface to survive, so such beds are harrowed periodically to pull the oysters back to the surface. Harrowing may be done at any time of the year, depending on the needs of the crop, but most often occurs between February and May. Clams are allowed to bury themselves and are left buried to grow out for 1.5 to 4 years.

### Harvest

The harvest of bottom cultured oysters is done by hand or mechanically. Hand harvest occurs during minus tides, with workers either picking the oysters by hand, or loosening them with rakes. Crews deposit the oysters in bushel-sized containers (Figure 3.2) that are periodically emptied into larger containers (15 to 20 bushels) equipped with ropes and buoys to allow them to be lifted with a boom crane onto the deck of a barge at high tide. Smaller containers are sometimes placed or dumped on the decks of grounded scows[2] for retrieval at high tide or are carried off the beach at low tide. Single oysters are often hand harvested into mesh bags or baskets to minimize handling and damage to shells.

Figure 3.2 Hand harvest of bottom cultured oysters in Grays Harbor. Photo: Washington DNR

Mechanical harvest by a dredge harvester or a hydraulic harvester occurs when beds are submerged. Dredge harvest boats use a boom crane or hydraulic winch to lower a bag dredge onto the bed. Bag dredges have a leading edge (blade) consisting of a steel frame with teeth and a steel mesh collection bag attached to the frame. The dredge is towed across the surface of the substrate, loosening and pulling up the shellfish and guiding them into the bag. The bag is then lifted onto the boat deck, emptied and redeployed (Figure 3.3). Generally, two bag dredges are deployed by each boat, one off each side.

[1] The displacement and mixing of sediment particles by benthic animals and plants.

[2] A flat-bottomed boat with a blunt bow that can navigate in shallow waters and can be beached for loading and unloading.

Hydraulic harvesters, or escalator dredges, consist of a generator, operating controls, and hydraulic apparatus mounted on a floating barge or platform that is towed through the water. The hydraulic apparatus contains a conveyor belt system and an arm with a water jet and rollers extending below the water surface to the substrate. Hydraulic harvesters are used to harvest large quantities of oysters and are most appropriate for harvesting larger oysters. Smaller oysters and oysters less than three years old, as well as residual shells, are screened out mechanically and returned to the bottom.

Mechanical harvest often takes place in the fall, winter, and early spring, when the minus tides occur at night, but it can take place year round. Mechanical harvest typically occurs two to four hours per day and three to four days per week. Hand harvesting occurs in spring, summer, and early fall, when the minus tides occur during the day.

Clams are usually hand harvested during low tide using a clam rake. Depending on the level of productivity of the beds, multiple ages of clams may be in the ground, and undersized clams are left in beds for future harvests. Market-size clams are put in buckets, bagged, tagged, and transported to processing plants. Harvesting may occur annually, or as infrequently as once every four years.

Clams can also be mechanically harvested using a specialized piece of equipment called a clam harvester that rakes up the clams with spinning, circular rakes and sieves out the gravel. Clam harvesters can be as large as a boat and float on the water over the clam beds at high tides, or they can be as small as a rototiller and be pushed over the clam beds at low tides.

Figure 3.3 Mechanical harvest of bottom cultured oysters in Willapa Bay. Photo: Washington DNR

## Bag culture

In ground-based bag culture, shellfish are contained within semi-rigid mesh bags placed directly onto the ground (Figure 3.4) or laid on rebar racks designed to hold four bags at a time (Figure 3.5). Shellfish grown in bags are protected from predators. Clams and oysters are grown with this method. Juvenile oysters are put into spat bags, which are then put into the mesh bags. Larger oysters are put directly in the mesh bags. Clam seed is placed into the bags and sediment is allowed to penetrate the bags and cover the clam seed.

Figure 3.4 Shellfish bags on the substrate in Totten Inlet. Photo: Washington DNR

### Site preparation

Beds are prepared during low tides by removing organic debris, rocks, and predators (such as sea stars, moon snails, and two species of oyster drills). In some cases, operators broadcast crushed oyster shells, gravel, or a combination of the two onto the site to harden the ground (frosting). The growing plot may be marked with stakes. Some operators install longlines and polyvinyl chloride (PVC) pipe or metal stakes on the bed to secure the bags. Alternatively, trenches 5 to 10 centimeters (2 to 4 inches) deep can be dug to provide a more secure foundation for the bags.

### Seeding

Seed is placed in reusable, semi-rigid plastic mesh bags closed with plastic ties or galvanized metal rings. Bags are typically 0.6 by 1 meter (2 by 3 feet) in size and have mesh openings measuring 0.3 to 2.5 centimeters (0.1 to 1 inch). Substrate consisting of pea gravel and shell fragments may be added to the bags. Oyster bags laid directly on the substrate may be anchored with metal stakes or attached to a line that is anchored to the substrate. Clam bags are placed in shallow trenches and allowed to work into the substrate.

Figure 3.5 Shellfish bags on racks in Grays Harbor. Photo: Washington DNR

### Grow-out

The shellfish are allowed to grow out in the bags. The bags are checked periodically during low tides to ensure that they remain secured to the bottom and may be turned as often as every two weeks to control fouling of the upper mesh surface and to optimize growth. Oysters may be periodically redistributed among bags to reduce their density, and bags of progressively larger mesh size may be substituted.

### Harvest

Oyster and clam bags are harvested by hand. Bags can be loaded into a boat when beds are submerged by hooking them with a rake and pulling them on board. Alternatively, during low tides, a wheelbarrow can be used to transport the bags to shore.

## Longline culture

In longline culture, oysters are grown in clusters on rope lines suspended one meter (3 feet) or less off the bottom between upright stakes of PVC or metal pipe (Figure 3.6). The longlines keep the oysters from sinking into soft substrates and protect them from benthic pests and predators.

### Site preparation

Prior to planting (or replanting) oyster longlines, operators use hand tools to level off areas where silt has built up and remove from the lines any remaining oysters from the previous harvest. They prepare the site by removing organic debris, rocks, sand dollars (Clypeasteroida), and predators, such as sea stars, moon snails, and two species of oyster drill. If the longline pipes or stakes were removed to make it easier to clean and level the site, they are reinstalled. These actions are performed by hand during low tides.

### Seeding

Polypropylene or nylon lines are extended between the pipes or stakes, and a piece of seeded oyster cultch is attached roughly every 0.3 meters (1 foot).

### Grow-out

The oysters are grown out over two to three years. The longline system is checked periodically during low tides to ensure that the lines remain secured to the pipes and that the pipes remain in place.

Figure 3.6 Oyster longline culture in Grays Harbor. Photo: Washington DNR

### Harvest

Longline-cultured oysters are harvested by hand or mechanically. Hand harvest entails cutting the clusters of oysters off the lines at low tide and placing them in harvest tubs. Large tubs are equipped with buoys for retrieval at a higher tide by a vessel equipped with a boom crane or hydraulic hoist. Small tubs are carried off the bed by hand.

With mechanical harvesting, buoys are attached at intervals along the lines at low tide. On a high tide, the buoys are hooked to a special reel mounted on a vessel that pulls the lines off the pipes and reels them onto the boat. Once on the boat, the oyster clusters are cut from the lines.

## Geoduck aquaculture

In 2003, the Washington State Legislature directed Washington DNR to develop a pilot project to assess the feasibility of conducting geoduck aquaculture on state-owned aquatic lands. In 2005, a report responding to this direction was presented by Washington DNR to the legislature. The report recommended limited leasing for the activity, requested a statute revision regarding the sale of geoduck aquaculture product, and requested funding for further research. The legislature accepted the recommendation to move forward on geoduck aquaculture leasing and revised the statute; however, funding was not granted for further research.

Washington DNR went ahead with the program and, in June 2006, advertised an initial request for offers to lease state-owned aquatic lands for geoduck aquaculture. A second competitive bidding process was advertised in October 2007. Proponents submitted applications describing how they

proposed to conduct operations; Washington DNR scored the applications and selected potential lessees.

Washington DNR originally intended to lease 10 hectares (25 acres) of state-owned aquatic lands per year for 10 years, up to a maximum of 101 hectares (250 acres) under lease at any one time. However, the 2007 Legislature directed Washington DNR to lease no more than 6 hectares (15 acres) per year for this activity through 2013. All present sites under consideration for authorized geoduck aquaculture on state-owned aquatic lands were selected using the following criteria:

A preference for no adjacent residential development.

- A preference for high bank.
- Suitable substrate sediment.
- Absence of eelgrass.
- Low natural stock densities of shellfish.
- Low recreational or tribal shellfish use.
- More than 61 meters (200 feet) from wild geoduck tracts.
- Approved or potential to be approved for health certification.

Washington DNR has 11 total sites proposed for geoduck aquaculture located in Jefferson, Mason, Pierce and Thurston counties. Washington DNR anticipates entering into agreements for the culture of geoducks (*Panopea abrupta*) with existing applicants once all environmental review and permitting processes are complete.

### Site preparation

Geoduck aquaculture generally takes place between -0.6 and + 0.6 meters (-0.0 and +2.0 feet) mean lower low water (MLLW). Bed preparation may include removing organic debris, rocks, mussel mats, and other marine species that would compete with the geoducks. Anti-predator PVC tubes are then inserted into the substrate. The tubes are generally 22 centimeters (8.5 inches) long and 10 to 15 centimeters (4 to 6 inches) in diameter. They are worked 15 centimeters (6 inches) into the substrate during low tide, leaving 7 to 8 centimeters (2.5 to 3 inches) of the tube above the surface of the substrate. Insertion of the tubes is done by stomping them in by foot or with a hydraulic tube planter that uses a jet of water powered by a gasoline engine to ease the insertion process (Davis, 2004). The tubes are placed 31 to 46 centimeters (12 to 18 inches) apart in rows for a typical density of 40,000 tubes per 0.4 hectare (1 acre). (Figure 3.7)

### Seeding

Geoduck seed obtained from a hatchery is often acclimated to local site conditions prior to planting. Once the geoduck spat has acclimated, seeding into the PVC tubes takes place by manually placing two to four seed geoducks in each tube for a typical density of 80,000 to 160,000 geoduck seeds per 0.4 hectare (1 acre). Once the seeds have been placed in the tubes, the top of each tube is covered with a small piece of netting secured in place with a rubber band. Alternatively, the entire bed may be covered with large pieces of anti-predator canopy nets anchored at the edges. In some cases, the individual coverings and the canopy nets are both applied.

### Grow-out

The tubes and netting remain in place for six months to three years (the duration is based on pressure from predator species) to allow the young clams to burrow into the substrate to a depth adequate to evade predators. The tubes and netting are then removed. Netting that becomes fouled prior to removal may be replaced with new netting.

Figure 3.7 Geoduck farm in Zangle Cove. Photo: Washington DNR

The geoducks are left to grow to a marketable size (about 2 pounds) for an additional four to seven years. By the time they are harvested, they may be as far as 1 meter (3 feet) down in the substrate.

### Harvest

Geoducks are harvested either at low tide by harvesters on the beach, or at high tide by divers. Individual geoducks are extracted by loosening the substrate around each clam using pressurized seawater (about 20 gallons per minute delivered at about 40 pounds per square inch) via a water jet (a hose fitted with a nozzle). (Figure 3.8)

Water pumps powered by gasoline engines are used to operate the pressurized water hose. These water pumps are located in boats near the area under harvest. The water intakes are fitted with screens to prevent fish from getting trapped, and pumps are often encased to dampen the noise. Harvesters create temporary depressions of varying depths and harvest in an up-slope direction to allow the water from the pressure hose to flow away behind them (Davis, 2004).

## Floating culture

In floating culture, mussels are grown on longlines suspended from rafts (Figure 3.9), and oysters are grown on longlines suspended from rafts or placed in trays, baskets, or nets suspended from floats or rafts so that they hang below the surface of the water.

Figure 3.8 Geoduck harvest in Totten Inlet. Photo: Washington DNR

Mussel and oyster rafts are generally constructed of floating steel frames with wood poles (pole rafts) or ropes (rope rafts) laid in rows across the top of the frame. The poles or ropes are hung at approximately 40-centimeter (16-inch) intervals with 6-meter (20-foot) long ropes with shellfish attached. Rafts generally range in size from 10 meters (33 feet) square (rope rafts) to 12 meters (39 feet) square (pole rafts) and are typically clustered together in groups of two or three. A single pole raft can support 660 longlines, and a single rope raft can support 480 longlines. Anti-predator nets are hung around the edges of both types of raft to exclude diving ducks. These nets are continually in place.

Figure 3.9 Floating mussel culture on Penn Cove. Photo: Washington DNR

### Site preparation

Prior to reseeding the rafts, mussel growers clean and repair them. This is done in late March and early April, just before mussel spawning begins. Mussel growers who will be

using natural seed set hang coiled 6-meter (20-foot) long seed collector lines from the mussel rafts at intervals of approximately 40 centimeters (16 inches).

### Seeding

On mussel rafts that use natural seed set, mussel larvae set on the coiled longlines in May and grow to a visible size by August. At that point, the coiled lines are uncoiled for grow-out. Mussel growers who use hatchery seed acquire the seed on longlines encased in tubular cotton or plastic mesh "socks" to hold the spat onto the longline. The sock rots away, but not until the mussel spat have adhered to the longline. The encased longlines are hung from the ropes or poles at intervals of approximately 40 centimeters (16 inches). Oyster growers who use hatchery seed for trays, baskets, and net grow-out methods acquire the seed on cultch; for longline rafts, they acquire the seed on longlines encased in socks or as cultch strung on longlines.

### Grow-out

Approximately three weeks after setting out new longlines, round disks that are 20 centimeters (8 inches) in diameter are added to each longline at 40-centimeter (16-inch) intervals to help prevent shellfish from falling off. Anti-predator netting below the water excludes diving ducks and marine mammals. Mussels are grown for approximately one year and are harvested when they have reached a shell length of 5 to 6 centimeters (2 to 2.5 inches). Oysters are harvested after 15 to 18 months and sold as specialty oysters, due to their small size, or are transferred to growth plots in bottom culture areas for another growing season.

### Harvest

Oyster and mussel rafts are harvested either by pulling in the longlines using a boat equipped with a hoist and winch, or by maneuvering a sink float underneath the raft, cutting the longlines, and allowing them to fall onto the sink float.

# 3.2.4 Activities interrelated with shellfish aquaculture

## Pesticide use

Carbaryl (Sevin™) has been used for more than 30 years to control ghost and blue mud shrimp populations in areas of oyster cultivation in Willapa Bay and Grays Harbor (Dumbauld et al., 2001; Feldman et al., 2000). Carbaryl is applied by spraying it as a soluble powder onto the intertidal area during low tides. Spraying is done by helicopter or by hand. Carbaryl is a neurotoxin that targets insects, crabs, and shrimp and causes paralysis and death. It breaks down into 1-napthol, which is toxic to fish and mollusks (Stonick, 1999). The use of carbaryl is regulated by the Washington State Department of Ecology through a National Pollutant Discharge Elimination System (NPDES) permit that is issued directly to the Willapa Bay/Grays Harbor Oyster Growers Association. The current NPDES permit contains the provision that no more than 243 hectares (600 acres) in Willapa Bay and no more than 81 hectares (200 acres) in Grays Harbor will be treated with carbaryl in any given year.

In 2009, NOAA Fisheries found that carbaryl application caused jeopardy to species listed as threatened under the Endangered Species Act (National Marine Fisheries Service, 2009b). In addition, the use of carbaryl was scheduled to be phased out by the end of 2012 as a result of a

litigated settlement agreement. The NPDES permit from the Department of Ecology to apply carbaryl does not consider the 2009 NOAA findings regarding the potential for impacts to ESA listed species and continues to be valid.

## Removal of fouling material

Fouling occurs when invertebrates or algae attach themselves to shellfish or equipment. Fouling can seriously affect the growth and survival of shellfish by blocking water flow. The main fouling organisms include sponges, tunicates, mussels, algae, and barnacles. These organisms are most commonly removed by scraping or scrubbing the bags and equipment with sea water on site. Alternatively, the fouled equipment is sometimes moved upland to dry out, and the fouling is then removed.

## Supporting structures

Some aquaculture sites also include supporting structures, such as docks, mooring buoys, bulkheads, bank armoring, and nearshore buildings associated with the transfer and processing of shellfish. These supporting structures are discussed in Section 3 (Overwater Structures) of this chapter.

## Vessels and vehicles

Barges, scows, and other vessels are used in support of harvest operations to access beds from the water and to collect and transport the harvested shellfish. All-terrain vehicles (ATVs) may be used to access sites during low tides.

# 3.2.5 Spatial extent of shellfish aquaculture

In March 2013, Washington DNR had a combined total of 111 agreements and applications for shellfish aquaculture in 10 counties (Table 3.4), encumbering approximately 834.07 hectares (2,059.17 acres) of state-owned aquatic lands. These activities occur in the Northwest Coast and Puget Trough ecoregions. In order to predict how this activity might expand in the future, current agreement numbers from Washington DNR and population projections from the Washington State Department of Commerce were used to calculate an estimate in each ecoregion where the activity is currently present. By 2040, for shellfish aquaculture, Washington DNR estimates an additional eight new agreements in the Northwest Coast ecoregion and seven new agreements in the Puget Trough ecoregion.

**Table 3.4** Shellfish aquaculture agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Northwest Coast | Clallam | 6 |
| | Grays Harbor | 16 |
| | Jefferson | 16 |
| | Pacific | 48 |
| Puget Trough | Island | 1 |
| | Kitsap | 1 |
| | Mason | 16 |
| | San Juan | 6 |
| | Whatcom | 1 |
| **Total Agreements** | | **111** |

# Ground-based culture

## Clams

As of March 2013, Washington DNR is managing 16 shellfish aquaculture agreements for clams encumbering 38 hectares (94 acres) of state-owned aquatic lands. These activities occur in the Northwest Coast and Puget Trough ecoregions including Willapa Bay, Hood Canal, South Puget Sound, and Strait of Juan de Fuca waterbodies (Table 3.5).

**Table 3.5** Clam agreements (ground-based) by ecoregion and waterbody.

| Ecoregion | Waterbody | Number of Agreements | Hectares (Acres) Encumbered |
|---|---|---|---|
| Northwest Coast | Willapa Bay | 1 | 11ha (27ac) |
| Puget Trough | Hood Canal | 6 | 21ha (52ac) |
| | South Puget Sound | 4 | 2ha (6ac) |
| | Strait of Juan de Fuca | 5 | 4ha (9ac) |

## Oysters

As of March 2013, DNR is managing 81 ground-based culture agreements for oysters encumbering 736 hectares (1,816 acres) of state-owned aquatic lands. These activities occur in the Northwest Coast and Puget Trough ecoregions including Grays Harbor, Willapa Bay, Hood Canal, South Puget Sound, San Juan, and Strait of Juan de Fuca waterbodies (Table 3.6).

**Table 3.6** Oyster agreements (ground-based) by ecoregion and waterbody.

| Ecoregion | Waterbody | Number of Agreements | Hectares (Acres) Encumbered |
|---|---|---|---|
| Northwest Coast | Grays Harbor | 16 | 188ha (463ac) |
| | Willapa Bay | 46 | 430ha (1,063ac) |
| Puget Trough | Hood Canal | 9 | 70ha (174ac) |
| | South Puget Sound | 5 | 3ha (8ac) |
| | San Juan | 2 | 5ha (11ac) |
| | Strait of Juan de Fuca | 3 | 40ha (98ac) |

### Geoduck aquaculture

Washington DNR has 11 total sites proposed for geoduck aquaculture located in Jefferson, Mason, Pierce and Thurston counties. Washington DNR anticipates entering into agreements for the culture of geoducks (*Panopea abrupta*) with existing applicants once all environmental review and permitting processes are complete.

**Table 3.7** Geoduck applications by ecoregion and waterbody.

| Ecoregion | Waterbody | Number of Agreements | Hectares (Acres) Encumbered |
|---|---|---|---|
| Puget Trough | Hood Canal | 3 | unknown |
| | South Puget Sound | 8 | unknown |

## Floating culture

### Mussels

As of March 2013, there were 8 shellfish aquaculture agreements for mussels encumbering 34 hectares (85 acres) of state-owned aquatic lands. These activities occur only in the Puget Trough ecoregion including Hood Canal, South Puget Sound, and San Juan waterbodies (Table 3.8).

**Table 3.8** Mussel agreements by ecoregion and waterbody.

| Ecoregion | Waterbody | Number of Agreements | Hectares (Acres) Encumbered |
|---|---|---|---|
| Puget Trough | Hood Canal | 1 | 2ha (6ac) |
| | South Puget Sound | 5 | 28ha (70ac) |
| | San Juan | 2 | 4ha (9ac) |

## Oysters

As of March 2013, DNR was managing six floating-culture agreements for oysters encumbering 26.07 hectares (64.17 acres) of state-owned aquatic lands. These activities occur in the Northwest Coast and Puget Trough ecoregions including Willapa Bay, Hood Canal, South Puget Sound, and San Juan waterbodies (Table 3.9).

**Table 3.9** Oyster agreements (floating) by ecoregion and waterbody.

| Ecoregion | Waterbody | Number of Agreements | Hectares (Acres) Encumbered |
|---|---|---|---|
| Northwest Coast | Willapa Bay | 1 | 13ha (31ac) |
| Puget Trough | Hood Canal | 1 | 4ha (10ac) |
| | South Puget Sound | 2 | 0.07ha (0.17ac) |
| | San Juan | 2 | 9ha (23ac) |

# 3.3 Log booming and storage

Section 79.105.060 of the Revised Code of Washington (RCW) defines log booming as "… placing logs into and taking them out of the water, assembling and disassembling log rafts before or after their movement in water-borne commerce . . . ." The definition includes water-based sorting and temporary holding of the logs. The same section also defines log storage as ". . . the water storage of logs in rafts or otherwise prepared for shipment in water-borne commerce . . . ." Log booming is also defined as a water-dependent use (WAC 332-30-145(7)) and, as a result, is a preferred use of state-owned aquatic lands.

The use of aquatic lands for these activities occurs as part of larger commercial logging operations. Because the two activities are closely related, Washington DNR frequently combines them into a single agreement.

## 3.3.1 Rationale for inclusion in the habitat conservation plan

Log booming and storage was selected as a covered activity for the following reasons:

- There are no federal permitting requirements for existing sites, which means no oversight via Endangered Species Act Section 7 consultation. Installation of new log booms will require a permit from the U.S. Army Corps of Engineers, which triggers Endangered Species Act Section 7 consultation, but this does not cover the lifespan of the operation or agreement.
- The potential for impacts is associated with loss of benthic habitats due to effects of shading, debris piles, water quality impairment, and dredge activities. Washington DNR retains a high degree of control over where log booming and storage occurs on the landscape.
- Washington DNR has the ability to influence log booming and storage operations through terms in an agreement.

## 3.3.2 Legal framework for log booming and storage

### Washington DNR's authority

Log booming is defined as a water-dependent use and is therefore a preferred use of state-owned aquatic lands (WAC 332-30-145). The general authorities are listed in Table 3.1; Table 3.10 lists authorities that apply specifically to log booming and storage.

**Table 3.10** Washington DNR's authority specifically related to log booming and storage.

| Law/Rule | Title | Content |
|---|---|---|
| RCW 79.105.060(9),(10) | Definitions | Defines log storage and booming. |
| RCW 79.105.250 | Log storage rents | Specifies log storage rents. |
| RCW 79.125.220 | Second-class tidelands or shorelands—Lease for booming purposes | Defines the circumstances under which Washington DNR can lease second-class tidelands or shorelands for booming purposes and the duties and liabilities imposed on lessees. |
| RCW 79.125.410;<br>RCW 79.130.010(2) | First-class unplatted tidelands and shorelands—Lease preference right to upland owners—Lease for booming purposes | Describes when first-class tidelands may be leased to the abutting upland owner and when they may be leased to others for booming purposes.<br><br>In case the abutting tidelands or shorelands or the abutting uplands are not improved or occupied for residential or commercial purposes, Washington DNR may lease the beds to any person for a period not exceeding ten years for booming purposes |
| WAC 332-30-145 | Booming, rafting, and storage of logs | Defines the requirements for log booming and storage activities authorized by Washington DNR. |

Note: RCW = Revised Code of Washington; WAC = Washington Administrative Code

# Leases for log booming and storage

Log booming and storage is authorized through a lease specific to the activity. Terms of agreement—as recorded in Washington DNR's financial management database (NaturE)—ranged from 5 to 100-plus years, with 10-year terms being the most frequent, followed by 15-year terms, and then 30-year terms.

## Regulatory oversight of log booming and storage

Regulatory oversight for existing log booming and storage sites on state-owned aquatic lands is limited to those actions associated with spills and clean-up of debris and contamination, with new in-water structures required to obtain regulatory permits for construction (Table 3.11).

**Table 3.11.** Regulatory oversight of log booming and storage.

| Agency | Permit, Approval, or Regulatory Requirement | Permit, Approval, or Regulatory Requirement Needed |
|---|---|---|
| Local city or county planning office | Shoreline substantial development permit, shoreline conditional use permit, shoreline variance permit | All development/activities either within 200 feet of the shorelines of the state and above a set value, or meeting other criteria. |
| U.S. Coast Guard | Regulation of navigation under 14 U.S. Code §§ 1 et seq. | Location of rafts in or near navigational channels. |
| U.S. Army Corps of Engineers | Regulation of navigation under 14 U.S. Code §§ 1 et seq. | Location of rafts in or near navigational channels. |
| The Environmental Protection Agency | Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Consent Decree | Contaminated sediment cleanup and remediation activities under federal jurisdiction. |
| Washington State Department of Ecology | Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) Permit | Point and non-point sources of pollutants that discharge into waters of the state from log handling both in the water, and in the log handling area of the site (runoff). |
| | Model Toxics Control Act (MTCA) Policy Advisory Committee | Cleanup for contaminated sediments. |
| | Shoreline Management Act | All development and activities within 200 feet of the shorelines of the state. |
| Washington Department of Fish and Wildlife | Washington Hydraulic Code Hydraulic Project Approval (HPA) | Construction or other work that affects the bed or flow of waters of the state. |

## Scope of log booming and storage

For the purposes of this habitat conservation plan, log booming and storage includes the operations, facilities, and structures associated with in-water handling, sorting, and storage of commercial timber logs that Washington DNR authorizes on state-owned aquatic lands. The scope of covered log booming and storage activities includes agreements in existence at the time that the incidental take permit is signed and all future log booming and storage agreements that are signed during the term of the permit. Existing agreements will be included at the time of renewal or amendment, and future log booming and storage agreements will be included at the time of

signature. The transportation of logs by using a tug boat or other vessel to tow rafts of log bundles, flat log rafts, or barges loaded with logs is not in Washington DNR's jurisdiction and is not included as part of the covered activity.

# 3.3.3 Log booming and storage: activity description

## Log booming

Log booming involves placing individual logs or secured bundles of logs into the water or removing them from the water using heavy machinery, sorting them, and assembling rafts for in-water transport or in-water storage. Companies that lease state-owned aquatic lands for this activity may have log shipments arriving on trucks at an upland facility or delivered by ships or barges. Logs arriving on land are placed into the leased area from shore at designated transfer sites using ground-based machinery (Figure 3.11). This loader has its engine situated on the back of the unit, which lowers the risk that the machine will pollute the water with fuel when the front end enters the water to pick up or remove log bundles. Logs that are brought into the leased area by water on barges are transferred into the water using cranes or hoists mounted on the barges.

Figure 3.11. Loading logs at Port Angeles Harbor. Photo: Washington DNR

Many log booming facilities bundle logs prior to putting them in the water. Logs can be bundled prior to transport on trucks, or they can be transported loose and then bundled on land prior to in-water storage. Other facilities bundle logs in the water. Log bundles are held with wire, cable, or metal bands (Figure 3.12).

The number of logs in a bundle ranges from three to dozens and depends on the diameter of the logs. An average bundle size is 35 logs, assuming logs are approximately 20 centimeters (8 inches) in diameter. An average bundle is 2 meters (6 feet) in diameter and about 12 meters (39 feet) long. A log raft is made up of anywhere from 20 to 70 bundles, or 700 to 2,450 total logs.

Figure 3.12 Boomed logs on Hylebos Waterway. Photo: Washington DNR

## Log storage

Log storage refers to temporarily holding logs, log bundles, or log rafts in designated areas either after sorting and raft assembly and prior to transportation, or after transportation and prior to removal for processing (Figure 3.13). The volume of logs in a storage area at any one time varies and is influenced by the timing of log deliveries, changes in timber market conditions, the size of the overall operation, and other economic factors, but there are generally some logs being stored at all times. Individual log bundles may remain in a storage area for three months to a year.

Storage times are shorter in saltwater if there is a known presence of shipworms (*Bankia setacea*), or teredos (*Teredos spp*.), at the site. Shipworms, or teredos, are worm-like, wood-boring bivalves that ingest submerged, untreated wood. Their presence varies according to local environmental conditions, such as dissolved oxygen levels and salinity. Where teredos are thought to occur, the logs are generally not stored longer than a few weeks.

Figure 3.13. Log storage on Hylebos Waterway. Photo: Washington DNR

Containment booms are used to hold stored logs. They are made of floating logs chained or cabled to each other and chained to pilings or to an anchor at either end (Figure 3.14). Within a configuration of pilings in a leased area, the containment booms are used to create sections that allow for sorting of log shipments by species, receiver, or purchaser. Most containment booms are not anchored to the bottom, so the configuration can be easily changed as needed.

State-owned aquatic lands that are leased for log storage are generally in the vicinity of shipping ports and lumber processing plants, but this is not always the case. For example, there are authorized sites in the vicinity of timber harvest areas to facilitate in-water holding and sorting before transport to a mill or other destination.

Figure 3.14. Containment boom on Commencement Bay. Photo: Washington DNR

# 3.3.4 Log booming and storage: interrelated activities

## Supporting structures

Log booming and storage activities may require docks for the vessels that are used to manipulate and transfer logs, ramps to aid in the delivery of logs to the water, and pilings, dolphins[3], floats, and buoys for securing the logs in the storage area. Existing, permanent pilings and dolphins can be made of treated wood (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)) or untreated wood, steel, or concrete. Shoreline modifications can

[3] Dolphins typically consist of a number of piles driven into the seabed or riverbed and connected above the water level to provide a platform or fixing point.

include breakwaters and bulkheads. These supporting structures are discussed in Section 3 (Overwater Structures) of this chapter.

## Vessels

Log booming and storage requires the use of tugboats to assemble and move the log rafts. In Washington, two kinds of tugboats are used:

- Harbor tugs that assemble the log rafts for towing to a processing facility (Figure 3.15).
- Log broncs that manipulate, sort, and position the logs and log bundles for assembly into rafts. Their use is limited by low tides.

Figure 3.15. Harbor tugs in Swinomish Channel. Photo: Washington DNR

# 3.3.5 Spatial extent of log booming and storage

In March 2013, Washington DNR had a combined total of 29 agreements and applications for log booming and storage in 13 counties, encumbering approximately 192.41 hectares (475.46 acres) of state-owned aquatic lands (Table 3.12). Agreements ranged in size from one-fifth of an acre to about 115.6 acres (Table 3.13). These activities occur in the North Cascades, Northwest Coast, Okanogan, and Puget Trough ecoregions. By 2040, for log booming and storage, DNR estimates one new agreement in the North Cascades ecoregion, no new agreements in the Northwest Coast or Okanogan ecoregions, and an additional six new agreements in the Puget Trough ecoregion.

**Table 3.12.** Log booming and storage agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| North Cascades | Skagit | 2 |
| Northwest Coast | Clallam | 1 |
| | Grays Harbor | 3 |
| Okanogan | Okanogan | 1 |
| | Clark | 3 |
| | Cowlitz | 4 |
| | King | 1 |
| Puget Trough | Kitsap | 1 |
| | Mason | 4 |
| | Pierce | 2 |
| | San Juan | 3 |
| | Snohomish | 2 |
| | Thurston | 2 |
| | **Total Agreements** | **29** |

**Table 3.13.** Size of log booming and storage sites.

| Size Hectares (Acres) | Number of Sites |
|---|---|
| < 4 (< 10) | 10 |
| 4 to 7.9 (10 to 19) | 6 |
| 8 to 11.9 (20 to 29) | 2 |
| 12 to 15.9 (30 to 39) | 2 |
| 16 to 19.9 (40 to 49) | 2 |
| 20 to 27.9 (50 to 69) | 3 |
| 28 to 31.9 (70 to 79) | 0 |
| 32 to 40 > (80 to 99) | 4 |

# 3.4 Overwater structures

Washington DNR authorizes the use of state-owned aquatic lands for a variety of over- and in-water structures used for recreation, industry, or habitation. This activity group includes:

- Boat ramps, launches, hoists, and lifts
- Docks and wharves
- Floating homes
- Marinas
- Mooring buoys
- Nearshore buildings
- Rafts
- Shipyards and terminals

## 3.4.1 Rationale for inclusion of overwater structures in the habitat conservation plan

Overwater structures were selected as a covered activity for the following reasons:

- The limited federal permitting requirements for ongoing operations covering the lifespan of the operation.
- The potential for incidental take from habitat loss or alteration associated with the structures and associated operations.
- The high degree of control that Washington DNR retains over where overwater structures occur on state-owned aquatic lands.
- The ability of Washington DNR to include in the terms of an agreement requirements regarding the operation and maintenance of facilities and structures.

While adequate coverage for impacts associated with construction and removal of structures exists through Section 7 consultations in the U.S. Army Corps of Engineers' permitting process, inclusion in the habitat conservation plan allows Washington DNR to avoid or minimize impacts associated with ongoing operations and maintenance of the structures. It also allows Washington DNR to reduce the effects of the structures themselves on all covered species when the lessee performs required maintenance or the lease is up for renewal. The requirements of the incidental take permit will be used for:

- Siting and design of new overwater structures to avoid or minimize the potential for incidental take of covered species.
- Minimizing take associated with existing structures.
- Removing abandoned structures and facilities at the termination of an agreement.

# 3.4.2 Legal framework for overwater structures

## Washington DNR's authority

With the exceptions of floating homes and nearshore buildings, overwater structures are water-dependent and are therefore considered preferred uses of state-owned aquatic lands. Water-dependent use means a use that cannot logically exist in any location but on the water. Examples include, but are not limited to, waterborne commerce; terminal and transfer facilities; ferry terminals; watercraft sales in conjunction with other water dependent uses; watercraft construction, repair, and maintenance; moorage and launching facilities; aquaculture; log booming; and public fishing piers and parks (WAC 332-30-106 (75)). The general authorities are listed in Table 3.1; Table 3.14 lists authorities that apply specifically to overwater structures.

**Table 3.14.** Washington DNR's authority specifically related to overwater structures.

| Law/Rule | Title | Content |
|---|---|---|
| RCW<br>79.105.060 (6), (11), (21), (24), (25) | Definitions | Defines *improvements* as anything considered a fixture placed within or upon or attached to aquatic lands that has changed the value of the land; defines a *terminal* as "a point of interchange between land and water carriers, such as a pier, wharf, or group of such, equipped with facilities for care and handling of cargo and/or passengers." Also defines *water-dependent, non-water dependent* and *water-oriented* uses. |
| RCW 79.105.200–.230, .260-.360; RCW 79.115–.130;<br>RCW 79.125.400-460;<br>RCW 79.130.010. | General aquatic statutes | Proscribes the manner and type of authorizations for aquatic lands, including preference rights, persons with a right to lease, and limitations on leasing for specific locations. |
| RCW<br>79.105.210 | Aquatic lands—Preservation and enhancement of water-dependent uses—Leasing authority | Directs Washington DNR to place a high priority on water-dependent uses, such as navigation. |
| RCW 79.105.430 | Private recreational docks—Mooring buoys | Specifies that residential owners of uplands adjoining state-owned aquatic lands may qualify for a recreational mooring buoy or dock (or both) free of charge and defines the criteria for such uses. |

| Law/Rule | Title | Content |
|---|---|---|
| WAC<br>332-30-106 (10), (11), (15), (23) (25), (38) (43) (44) (45) (62) (75) (77) | Definitions | Defines concepts concerning overwater structures. |
| WAC 332-30-115 | Harbor area use classes | Discusses overwater structures relative to constitutionally required uses in harbor areas. |
| WAC 332-30-122 | Aquatic land use authorization | Describes requirements and means of securing authorizations. |
| WAC 332-30-139 | Marinas and moorages | Sets design criteria for moorage facilities on state-owned aquatic lands. |
| WAC 332-30-144 | Private recreational docks | Defines the conditions and limitations applying to private recreational docks on state-owned aquatic lands. |
| WAC 332-30-148 | Swim rafts and mooring buoys | Specifies the size, number, placement, location, and design of mooring buoys. |
| WAC 332-30-171 | Residential use on state-owned aquatic lands | Addresses residential uses of state-owned aquatic lands, including floating houses, moorage facilities, and vessels. |

Note: RCW = Revised Code of Washington; WAC = Washington Administrative Code

### Leases for overwater structures

Washington DNR authorizes overwater structures using three standardized contracts: a commercial agreement (boat ramps, commercial mooring buoys, docks, rafts, marinas, nearshore buildings, shipyards, and terminals); a floating home agreement; and a mooring buoy license for recreational mooring buoys not adjacent to the licensee's property. Recreational mooring buoys that are adjacent to a resident's upland parcel are also subject to a registration process. Agreement terms—as one year to more than 100 years, with 5-year terms being most common for mooring buoy licenses. The most common terms for other uses are either 12 or 30 years.

## Regulatory oversight of overwater structures

In addition to the regulations and requirements of Washington DNR, overwater structures on state-owned aquatic lands are subject to the regulations of several federal, state, and local government agencies (Table 3.15).

**Table 3.15** Regulatory oversight of overwater structures.

| Agency | Permit, Approval, or Regulatory Requirement | Permit, Approval, Process or Regulatory Requirement Needed |
|---|---|---|
| Local city or county planning office | Shoreline substantial development permit, shoreline conditional use permit, shoreline variance permit | All development/activities either within 200 feet of the shorelines of the state and above a set value, or meeting other criteria. |
| | Floodplain development permit | Filling or grading within the 100-year floodplain. |
| NOAA Fisheries | Endangered Species Act Section 10 (Incidental Take Permit) | All projects affecting threatened or endangered species that have either federal funding or permits. |
| | Marine Mammal Protection Act Marine Mammal Take Authorization | All projects affecting marine mammals. |
| U.S. Army Corps of Engineers | Rivers and Harbors Act; Nationwide Permit | Locating a structure, excavating, or discharging dredged or fill material; transporting dredged material or ocean dumping. |
| | Rivers and Harbors Act Section 10 Permit | Construction in navigable waters. |
| Environmental Protection Agency | Clean Water Act Section 404 Permit;<br>Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Consent Decree | Contaminated sediment cleanup and remediation activities under federal jurisdiction. |
| U.S. Fish and Wildlife Service | Endangered Species Act Section 10 Incidental Take Permit | All projects affecting threatened or endangered species that have either federal funding or permits. |
| Washington State Department of Ecology | Clean Water Act National Pollutant Discharge Elimination System (NPDES) Permit | Point source and non-point discharges of pollutants into waters of the state. |
| | Coastal Zone Management Act (CZMA) Consistency Determination | Approval for activities requiring a federal permit, undertaken by a federal agency, or using federal funding—the state indicates whether the project is consistent with the state's CZMA. |

| Agency | Permit, Approval, or Regulatory Requirement | Permit, Approval, Process or Regulatory Requirement Needed |
|---|---|---|
| | Clean Water Act Section 401 Water Quality Certification | For all projects requiring a Section 401 permit, Ecology reviews the project to determine if the work will meet state water quality standards. |
| | Oil and Hazardous Substance Spill and Prevention and Response | Zero-spill strategy to prevent any oil or hazardous substance from entering the state's waters. |
| | Shoreline Management Act | All development/activities within 200 feet of the shorelines of the state. |
| Washington Department of Fish and Wildlife | Washington Hydraulic Code Hydraulic Project Approval (HPA) | Construction or other work that affects the bed or flow of waters of the state. |

## Scope of the overwater structures

For the purposes of the habitat conservation plan, overwater structures include the operations, facilities, and structures associated with recreation, industry, or habitation that Washington DNR authorizes on state-owned aquatic lands. The scope of the overwater-structures activity includes overwater-structure agreements in existence at the time that the incidental take permit is signed and all future overwater-structure agreements that are signed during the term of the permit. Existing agreements will be included at the time of renewal or amendment, and future overwater structure agreements will be included at the time of signature.

# 3.4.3 Overwater structures: activity description

Overwater structures are defined as structures associated with recreation, industry, or habitation that are built over, under, or floating on the water. The group is broken into two categories: **single-element structures** (meaning those with only one associated structure) and **multiple-element structures** that contain a complex of interrelated structures at a single facility. Activities associated with overwater structures typically occur year-round, although use of recreational facilities is heavier in the summer. While a majority of the structures are permanent, structures such as mooring buoys, floating docks, or rafts may be removed in the winter.

Although agreements for overwater structures vary in duration, the structures themselves may remain indefinitely. This is particularly true for multiple-element structures, because these structures are often valuable enough to remain in place through multiple lease terms and business operators.

## Single-element structures

Single-element structures are those with no other associated structures or uses. They may be attached directly to the shore (docks and wharves; boat ramps, launches, hoists, lifts and rails; and

nearshore buildings), or they may lack a direct connection to the shore (mooring buoys, rafts, and floating homes).

## Boat ramps, launches, hoists, lifts, and rails

Boat ramps, launches, hoists, boat lifts, and rails can be associated with recreational boating and single family homes. These activities—when associated with vessel repair, storage, or sales—are authorized as part of a marina, shipyard, or terminal. A boat ramp or launch is a sloping incline or short egress that extends into the water to provide for the launching and retrieval of boats (Figure 3.15) and is typically built abutting a road or parking area. The area immediately waterward of the ramp or launch has often been dredged, and a layer of soft sediment (such as sand) is occasionally placed in this area. The boat ramp or launch itself is usually a concrete slab resting on the substrate. In most cases, one or more docks for temporary moorage are associated with these structures. If a boat hoist or lift is also present, the term boat launch would be more appropriate than boat ramp.

Figure 3.15 Boat ramp on the Snake River. Photo: Washington DNR

Because boat ramps and launches are usually associated with vehicles that deliver the vessel to the water, their width is largely governed by the width of access roads. Their length is determined by potential changes in water level, the slope of the shoreline, and the displacement volume of the vessel, and therefore varies with location.

Boat hoists and lifts are equipment for moving vessels into and out of the water or storing boats above the water. They consist of a structure to support the boat and a mechanical or manual system for raising or lowering the boat (Figure 3.16). The overwater footprint of a hoist depends on the size of the vessel it is designed to move, with smaller hoists found in marinas and larger hoists found in shipyards and terminals. They may be attached to pilings or a dock, installed in a boathouse, or moored separately. In general, boat lifts are for smaller vessels, and boat hoists are for larger vessels.

Marine rails are another type of boat launching facility, similar in function and purpose to a boat ramp. Marine rails are typically a pair of rails set parallel and running into the water, with a winch at the top. A boat is winched into or out of the water and the rails guide the boat. Generally, either a boat ramp or marine rails are found at a facility, but not both.

Figure 3.16 (a) Recreational boat lift on Long Lake and (b) commercial boat hoist on Lake Washington. Photo: Washington DNR

## Docks and wharves

Docks and wharves support industrial activities, commercial shipping, recreational boating, vessel fueling, moorage, and vessel repair. Structures in this category are typically attached to shore via fixed piers or gangways that are perpendicular to shore and have a T or L shape, with a portion of the structure parallel to shore.

These structures are either platforms raised above the water, or platforms floating on the water (Figure 3.17). They generally extend to water depths sufficient for berthing one or more vessels, but are occasionally located where moored vessels and even the floating dock itself can ground out at low water. Raised docks are supported by pilings driven into the substrate and are often located in water bodies with little or no regular fluctuation in water level. Floating docks, often called floats, are usually located where water levels change frequently. They are supported by floatation devices and are usually attached to pilings by means of movable wooden collars or chains that wrap around the pilings. Raised docks may also have skirting covering the open space between the decking and the water. Skirting is used to limit access to areas under the dock, to prevent flotsam from accumulating under the dock, for safety purposes, or for esthetic reasons. Skirting may be made of treated (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)) or untreated wood, metal, plastic, or a combination of materials. Skirting is frequently used on docks in lakes, but is rarely used on docks on other water bodies.

Figure 3.17 Dock with a float, pier, and gangway on the Cowlitz River. Photo: Washington DNR

Wharves are very similar to docks, but because the associated vessels tie up to load or unload cargo and passengers, wharves are always raised above the water on pilings, are attached directly to shore, and include no floating docks. Additional terminology applied to docks and wharves includes:

- Piers—Raised platforms attached to shore and supported by pilings driven into the substrate. These structures are usually connected to a floating dock by a gangway, but do not provide moorage.
- Gangway or walkway—A ramp that connects a dock to piers or to the shore. Gangways and walkways may be made of treated (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)) or untreated wood, metal, plastic, or a combination of these materials. As with decking, they may be grated or solid.

## Floating Homes

Floating homes are structures that serve primarily as residences and are typically not designed for navigation (WAC 332-30-106 (23)) . ( Figure 3.18) While the floating homes themselves are not attached to shore, they are usually permanently moored to pilings, with a gangway or dock providing access to the home from the shoreline. Floating homes may include ancillary structures for storage, work, or mooring small boats. These ancillary structures are described separately under the sections on those structures. Floating homes are made from a variety of materials, but are typically wooden buildings supported by platforms, rafts, or barges made of some combination of treated wood (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)), steel, plastic, and foam (to provide floatation).

Figure 3.18 Floating homes on Lake Union. Photo: Washington DNR

## Mooring Buoys

Washington's laws subdivide mooring buoys into two categories: commercial and recreational (RCW 79.105.430). Commercial buoys are typically used for temporary moorage of a vessel that is awaiting transit or is loading or offloading cargo. Recreational buoys are used as semi-permanent moorage for recreational vessels. Unlike other agreements, agreements for mooring buoys do not include ingress or egress, and the encumbrance is based on the square acreage of the swing of the vessel.[4]

A mooring buoy typically consists of an anchoring system (anchor and anchor line) and a float marking the location of the anchoring system, with a fitting to receive a vessel's mooring chain or hawser. Mooring buoy floats are generally made of plastic and filled with foam. Mooring buoys placed on state-owned aquatic lands include single buoys associated with a private residence, commercial buoys used for barge moorage, and buoy fields for temporary moorage near marinas, harbors, and parks.

## Nearshore buildings

A nearshore building is any building built partly over or near the water (Figure 3.19). Nearshore buildings support commercial uses (for example, boat rentals and supplies, offices, restaurants, and boat houses) and residential uses. These buildings are often wood-clad and require frequent exterior maintenance due to their proximity to water. Their foundations are built on filled tidelands and supported on pilings over the water. Associated structures often include a deck or dock that extends waterward from the building. In lacustrine (lake-related) systems, boathouses are generally permanent structures built partially on the uplands and are therefore also considered to be nearshore buildings (Figure 3.20).

[4] Vessel swing = (Square root [Anchor Line Length$^2$] – [Water Depth at Extreme Low Tide]$^2$) + Mooring Line Length + Vessel Length.

Figure 3.19 Nearshore building on Elliott Bay. Photo: Washington DNR

Figure 3.20 Boathouse on Long Lake. Photo: Washington DNR

## Rafts

Rafts are floating platforms that are not attached to shore and are used for recreational purposes (Figure 3.21). While the existing decking is typically treated wood (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)), the floatation is constructed of wood, steel, plastic, concrete, rubber tires, or foam that is either encapsulated to contain debris, or un-encapsulated. Rafts are anchored to the substrate or a dock and sometimes ground out at low water.

Figure 3.21. Rafts on Summit Lake. Photo: Washington DNR

# Multiple-element structures

Multiple-element structures are a complex of interrelated structures at a single facility, such as a marina, shipyard, or terminal. In addition to structures such as docks and piers, marinas, shipyards, and terminals may also include components such as fueling facilities, utility cables and pipelines, erosion control structures (for example, bulkheads and breakwaters), covered moorage, and outfalls.

## Marinas

Marinas typically include a series of connected docks and vary substantially in overall size (Figure 3.22). Marinas may include other overwater structures and interrelated activities that support boating activities, including boat ramps, launches, hoists, floating homes, mooring buoys, nearshore buildings, covered moorage, stormwater outfalls, treated water outfalls, sewage pump-out stations, fueling facilities, bulkheads, breakwaters, bank armoring, utility cables and pipelines, and dry docks.

Marina docks are mostly floats arranged in a variety of configurations and are attached to piers by gangways. They also typically have slips of varying sizes to provide moorage for different sized vessels. These slips can either be leased long term from the marina or used for transient or guest moorage.

Figure 3.22. Marina on Budd Inlet. Photo: Washington DNR

Some marinas provide covered moorage (Figure 3.23a) or floating boathouses (Figure 3.23b) that cover the docks with roofs so that both the dock and associated slips are sheltered. The existing roof and the supports may be made of treated (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)) or untreated wood, metal, plastic, or a combination of materials. Roofs may incorporate skylights, smoke and heat vents, and lights, and there may be walls or curtains around the perimeter.

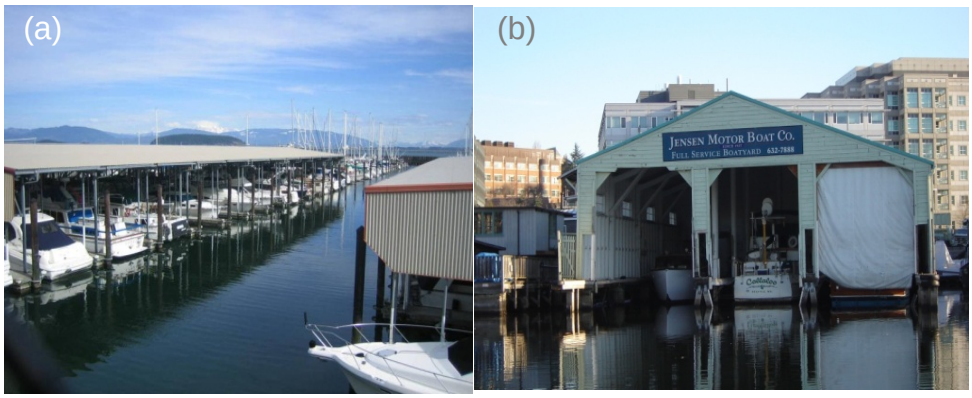


Figure 3.23. Covered moorage on Fidalgo Bay (a) and Lake Union (b). Photo: Washington DNR

## Shipyards and Terminals

Shipyards are defined as facilities for the maintenance and repair of vessels, and terminals are defined as facilities that are either used exclusively for the transfer of cargo between boats and land, or include both cargo transfer and recreational moorage (Figure 3.24). The two types of facilities are combined in this sub-group due to similarities in both function and associated structures.

Figure 3.24. Terminal on Fidalgo Bay. Photo: Washington DNR

As with marinas, shipyards and terminals may include boathouses, boat hoists, cranes, nearshore buildings, fueling facilities, dry docks, outfalls, and utility cables and pipelines. Both the physical configuration and the number of elements at a shipyard or terminal are specific to the type of watercraft involved, the location of the facility, and the type of activity conducted at the site.

Docks associated with shipyards and terminals are generally raised above the water on pilings and are wider than recreational or marina docks. These docks may be capable of accommodating commercial vehicles, cranes, and other mechanical equipment that assist with loading and unloading operations. Docks that extend into deeper water for the mooring large vessels can be greater than 120 meters (394 feet) in length.

Shipyards and terminals can be generally categorized as the following types of operations:

- Repair and maintenance facilities that service commercial or pleasure boats (or both).
- Transfer facilities that load and unload products from large container ships, moving the products and materials to and from adjacent terrestrial distribution points. Transfer facilities authorized by Washington DNR include those used for the transfer of petroleum products (oil, gasoline, natural gas, and propane), alumina, agricultural commodities, sand, and gravel. While the facilities for processing are rarely located on or over submerged habitats, they may be located on adjacent, filled, state-owned aquatic lands or private parcels.
- Refinery facilities used for processing raw materials. Washington DNR currently leases land to both oil and aluminum refineries. While the facilities for processing are rarely located on or over submerged habitats, they usually include transfer facilities.
- Seafood processing terminals for unloading and processing fish and shellfish and lumber processing terminals associated with log booming and storage sites.
- Ferry terminals.[5]

[5] The ferry terminals in Washington that are run by the Washington State Department of Transportation are considered a transportation activity and are not covered by the habitat conservation plan. Ferry terminals that are not run by the Washington State Department of Transportation have a lease with Washington DNR and are covered by the habitat conservation plan.

# General structural components

Although each type of overwater structure has unique structural components, there are also common components. These common features include pilings, dolphins, decking, floatation, anchoring systems, breakwaters, and bank armoring.

## Anchoring systems

Anchoring systems attach overwater structures to the substrate. The systems comprise both anchors and anchor lines:

- Anchors may be either embedded into the substrate or placed on the surface of the substrate. They must have sufficient weight or connection to the substrate to hold the structure in place. Anchors may be made of metal, concrete, rock, or other heavy materials.
- Anchor lines are generally made of nylon, polypropylene, elastic, metal chains, or a combination of materials. For example, the anchor lines of mooring buoys may consist of a length of high-strength nylon rope, with a length of metal chain on the end nearest the buoy to keep the line from floating to the surface during slack water and to provide additional stability to the anchor.

## Breakwaters and bank armoring

Breakwaters, bank armoring, bulkheads, and seawalls are used to control erosion or attenuate wave action as part of multiple-element structures. Fixed structures are generally constructed of riprap, gabions, pilings, concrete, rock, plastic, logs, or some combination of these materials (Figure 3.25). Existing floating breakwaters are anchored to pilings or the substrate and may be made of treated wood (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)), abandoned vessels, concrete, or logs. Waveboards are another type of floating breakwater and consist of a floating wall of boards.

Figure 3.25 Fixed breakwater on Fidalgo Bay. Photo: Washington DNR

Figure 3.26. Partially grated walkway on Gig Harbor. Photo: Washington DNR

## Decking

Decking refers to the flat surface of an overwater structure used for walking or sitting (Figure 3.26). Existing decking may be made of treated (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)) or untreated wood, metal, plastic, fiberglass, concrete, wood-plastic composites, or a combination of these materials and can be either grated or solid. Although grating may be used in place of solid decking to increase light transmission underneath the structure, the amount of open space in the grating may vary.

## Dolphins

Dolphins are groups of two or more pilings bound together into a single unit. They are used for mooring boats, protecting docks or the shoreline, and guiding boats. The existing pilings may be bound with rope or metal bands, and the pilings may be made of concrete, steel, reinforced plastic, treated wood (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)), or untreated wood, such as cedar. Dolphins can include bumpers or fenders made of recycled tires, rubber, plastic, rope, or timber.

## Flotation

Buoyant floatation structures are used to help keep decking above the water (Figure 3.27). The materials used to construct them vary with the type of dock and decking. For docks with concrete decking, the floatation devices consist of a foam core encased in concrete. Other types of floatation include sealed plastic tubs filled with foam, foam enclosed in a coating of elastomer, foam that is not enclosed, or tires filled with foam. The casings that enclose foam are frequently black, but some permits issued by the U.S. Army Corps of Engineers specify that floatation be encased in white plastic tubs to increase the reflection of light and minimize overall shading effects.

Figure 3.27. Flotation made of foam-filled white plastic tubs on the Skagit River. Photo: Washington DNR

## Pilings

Pilings are long, thin structures standing vertically out of the water (Figure 3.28). They are used as structural components of a facility or to mark boundaries. Existing pilings may be made of concrete, steel, reinforced plastic, treated wood (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)), or untreated wood, such as cedar.

Figure 3.28. Steel pilings on the Willapa River. Photo: Washington DNR

# 3.4.4 Overwater structures: interrelated activities

## Pump-outs

Pump-outs are facilities used to empty vessels' holding tanks of sewage and gray water. Pump-outs often consist of a vacuum pump located on a dock, which pumps the waste upland to a storage tank or treatment facility. Some facilities provide pump-out services that are mounted on small vessels (Figure 3.29). The waste collected by both vessel- and dock-mounted services is discharged into the adjacent upland treatment facility or hauled away to a site that can handle the wastewater.

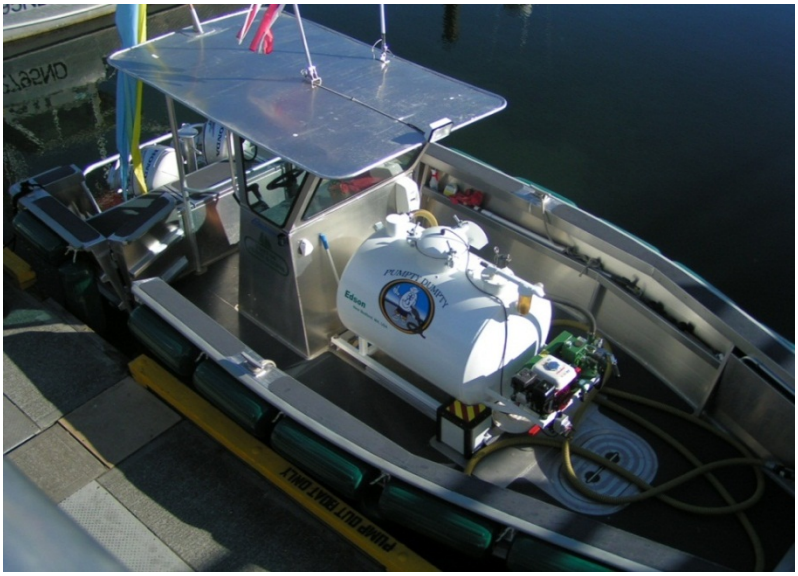

Figure 3.29. Vessel-mounted pump-out system in Friday Harbor. Photo: D. Roberts

## Fueling facilities

Fueling facilities transfer engine and motor fuel to vessels and are part of multiple-element structures. Fueling facilities include a nearshore building on the dock and fuel pumps—attached by pipelines to upland storage tanks—that pump marine grade gasoline and diesel (Figure 3.30).

Figure 3.30. Fuel dock in Gig Harbor. Photo: Washington DNR

## Utilities

Utilities associated with multiple-element structures include power and telecommunication cables, as well as pipelines that transport wastewater, oil, gas, and drinking water. Utilities may be attached to a structure (such as a dock), laid on or buried in the substrate within the leasehold, or, occasionally, suspended in the water column underneath the structure (Figure 3.31). Submerged lines and cables are typically buried when crossing *littoral* or intertidal zones and lie on top of the substrate in *limnetic* or subtidal zones, with or without ballast material. Erosion control structures, such as bank armoring, may be associated with utilities in areas where they connect to terrestrial environments or in areas of high current or wave energy.

Figure 3.31. Utility lines on a dock in Gig Harbor. Photo: Washington DNR

# Outfalls

Outfalls are open pipes that discharge liquids to the aquatic environment (Figure 3.32). Multiple-element structures often include storm water outfalls that discharge runoff from the upland portion of the facility. The outfall, with the associated pipeline and structures (such as bank stabilization), may be made of concrete, metal, or high density polyethylene (HDPE) and may range from 0.15 to more than 2 meters (6 inches to more than 6 feet) in diameter.

Figure 3.32. Outfall on the Columbia River. Photo: Washington DNR

# Dry docks

A dry dock is a structure used for building, repairing, or deconstructing vessels (Figure 3.33). In general, dry docks are used for vessels that are too large to be moved upland. Existing dry docks may be constructed of concrete, treated wood (creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA Type C)), untreated wood, metal, or a combination of materials. They may be floating, or they may rest on the substrate. They may include marine rails and boat hoists to facilitate moving vessels into and out of the dry dock. Dry docks can trap fishes when they are raised or removed from the water.

Figure 3.33. Floating dry dock on Lake Washington. Photo: Washington DNR

## Vessels

Most overwater structures provide access to, and moorage, storage, construction, and repair of, vessels. Vessels may be made of wood, metal, composite material, or fiberglass.

## Maintenance

Maintenance of overwater structures can include cleaning, removal of fouling organisms, painting, and in-water and above-water construction.

# 3.4.5 Spatial extent of overwater structures

In March 2013, Washington DNR had a combined total of 1,872 agreements and applications for overwater structures in 30 counties, and all ecoregions, encumbering approximately 9,862 hectares (24,370 acres) of state-owned aquatic lands (Table 3.16).

**Table 3.16.** Overwater structures agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Blue Mountains | Asotin | 4 |
| Canadian Rockies | Pend Oreille | 8 |
| Columbia Plateau | Benton | 3 |
| | Douglas | 11 |
| | Franklin | 1 |
| | Grant | 1 |
| | Yakima | 4 |
| East Cascades | Chelan | 28 |
| | Kittitas | 2 |
| North Cascades | Skagit | 76 |
| Northwest Coast | Clallam | 37 |
| | Grays Harbor | 17 |
| | Jefferson | 96 |
| | Pacific | 39 |
| | Wahkiakum | 9 |
| Okanogan | Okanogan | 9 |
| | Spokane | 3 |
| Puget Trough | Clark | 23 |
| | Cowlitz | 27 |
| | Island | 39 |
| | King | 244 |

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| | Kitsap | 254 |
| | Lewis | 8 |
| | Mason | 43 |
| | Pierce | 150 |
| | San Juan | 631 |
| | Snohomish | 30 |
| | Thurston | 42 |
| | Whatcom | 30 |
| West Cascades | Skamania | 3 |
| | **Total Agreements** | **1872** |

# Single-element structures

## Boat ramps, launches, hoists, lifts, and rails

In March 2013, Washington DNR had a combined total of 57 agreements and applications for boat ramps, launches, hoists, lifts, and rails in 23 counties, encumbering approximately 10 hectares (24 acres) of state-owned aquatic lands (Table 3.17). The lease terms of 10 of those agreements are longer than the term of the incidental take permit and will not be covered by the habitat conservation plan. These activities were found in the Blue Mountains, Canadian Rockies, Columbia Plateau, East Cascades, North Cascades, Northwest Coast, Okanogan, Puget Trough, and West Cascades ecoregions. Washington DNR estimates that by 2040 there will be no new agreements for boat ramps, launches, hoists, and lifts in the Blue Mountains, Canadian Rockies, East Cascades, Okanogan, and West Cascades ecoregions. The agency anticipates one additional agreement for these activities in the Columbia Plateau and Northwest Coast ecoregions, and two new agreements in the North Cascades ecoregion. And seven new agreements in the Puget Trough ecoregion.

**Table 3.17.** Boat ramp, launch, hoists, lift, and rails agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Blue Mountains | Asotin | 2 |
| Canadian Rockies | Pend Oreille | 1 |
| Columbia Plateau | Douglas | 1 |
| | Yakima | 2 |
| East Cascades | Chelan | 1 |
| | Kittitas | 1 |
| North Cascades | Skagit | 7 |
| | Clallam | 6 |

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Northwest Coast | Grays Harbor | 3 |
| | Jefferson | 2 |
| Okanogan | Okanogan | 2 |
| Puget Trough | Cowlitz | 3 |
| | Island | 2 |
| | King | 4 |
| | Kitsap | 1 |
| | Lewis | 3 |
| | Mason | 1 |
| | Pierce | 2 |
| | San Juan | 2 |
| | Snohomish | 6 |
| | Thurston | 1 |
| | Whatcom | 3 |
| West Cascades | Skamania | 1 |
| | **Total Agreements** | **57** |

## Docks and wharves

In March 2013, Washington DNR had a combined total of 188 agreements and applications for docks and wharves in 25 counties, encumbering approximately 8,508 hectares (21,025 acres) of state-owned aquatic lands (Table 3.18). The lease terms of 12 of those agreements are longer than the term of the incidental take permit and will not be covered by the habitat conservation plan. These activities were found in the Blue Mountains, Canadian Rockies, Columbia Plateau, East Cascades, North Cascades, Northwest Coast, Okanogan, and Puget Trough ecoregions. Washington DNR estimates that by 2040, there will be no new agreements for docks and wharves in the Blue Mountains and Canadian Rockies ecoregions. The agency expects one additional agreement for these activities in the Columbia Plateau, East Cascades, and Okanogan ecoregions; two new agreements in the Northwest Coast ecoregion; seven new agreements in the North Cascades ecoregion, and 33 new agreements in the Puget Trough ecoregion.

**Table 3.18.** Dock and wharf agreements, by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Blue Mountains | Asotin | 1 |
| Canadian Rockies | Pend Oreille | 5 |
| Columbia Plateau | Benton | 1 |
| | Douglas | 1 |
| East Cascades | Chelan | 6 |

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| North Cascades | Skagit | 21 |
| Northwest Coast | Clallam | 5 |
| | Grays Harbor | 4 |
| | Jefferson | 4 |
| | Pacific | 5 |
| | Wahkiakum | 1 |
| Okanogan | Okanogan | 1 |
| | Spokane | 2 |
| Puget Trough | Clark | 4 |
| | Cowlitz | 2 |
| | Island | 5 |
| | King | 29 |
| | Kitsap | 6 |
| | Lewis | 2 |
| | Mason | 4 |
| | Pierce | 17 |
| | San Juan | 38 |
| | Snohomish | 11 |
| | Thurston | 3 |
| | Whatcom | 10 |
| **Total Agreements** | | **188** |

## Floating homes

In March 2013, Washington DNR had a combined total of 57 agreements and applications for floating homes in four counties, encumbering approximately 20 hectares (50 acres) of state-owned aquatic lands (Table 3.19). These activities were found in the Northwest Coast and Puget Trough ecoregions. Washington DNR estimates that by 2040 there will be one new agreement for floating homes in the Northwest Coast ecoregion and seven new agreements in the Puget Trough ecoregion.

**Table 3.19.** Floating home agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Northwest Coast | Pacific | 25 |
| Puget Trough | Clark | 1 |
| | Cowlitz | 4 |
| | King | 27 |
| **Total Agreements** | | **57** |

## Mooring buoys

In March 2013, Washington DNR had a combined total of 1,058 agreements and applications for mooring buoys in 17 counties, encumbering approximately 424 hectares (1,047 acres) of state-owned aquatic lands (Table 3.20). The lease terms of 18 of those agreements are longer than the term of the incidental take permit and will not be covered by the habitat conservation plan. These activities were found in the Blue Mountains, Columbia Plateau, East Cascades, North Cascades, Northwest Coast, Okanogan, and Puget Trough ecoregions. Washington DNR estimates no new agreements for mooring buoys by 2040 in the Blue Mountains and Okanogan ecoregions. The agency expects there will be two new agreements for this activity in the Columbia Plateau and East Cascades ecoregions, four new agreements in the North Cascades ecoregion, 12 new agreements in the Northwest Coast ecoregion, and 235 new agreements in the Puget Trough ecoregion.

**Table 3.20** Mooring buoy agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Blue Mountains | Asotin | 1 |
| Columbia Plateau | Douglas | 8 |
| | Yakima | 1 |
| East Cascades | Chelan | 12 |
| North Cascades | Skagit | 11 |
| Northwest Coast | Clallam | 5 |
| | Jefferson | 80 |
| Okanogan | Okanogan | 1 |
| Puget Trough | Island | 28 |
| | King | 35 |
| | Kitsap | 209 |
| | Mason | 27 |
| | Pierce | 59 |
| | San Juan | 545 |
| | Snohomish | 3 |
| | Thurston | 29 |
| | Whatcom | 4 |
| | **Total Agreements** | **1058** |

## Nearshore buildings

In March 2013, Washington DNR had a combined total of 33 agreements and applications for nearshore buildings in nine counties, encumbering approximately 172 hectares (424 acres) of state-owned aquatic lands (Table 3.21). These activities were found in the North Cascades, Northwest Coast, Puget Trough, and West Cascades ecoregions. Washington DNR estimates that by 2040 there will be one new agreement for nearshore buildings in the Northwest Coast ecoregion, three new agreements in the North Cascades ecoregion, and five new agreements in the Puget Trough ecoregion.

**Table 3.21** Nearshore building agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| North Cascades | Skagit | 8 |
| Northwest Coast | Clallam | 3 |
| | Jefferson | 1 |
| Puget Trough | Clark | 2 |
| | King | 14 |
| | Kitsap | 2 |
| | Lewis | 1 |
| | San Juan | 1 |
| | Snohomish | 1 |
| | **Total Agreements** | **33** |

## Rafts

In March 2013, Washington DNR had a combined total of nine agreements and applications for rafts in seven counties, encumbering approximately 0.6 hectares (1.5 acres) of state-owned aquatic lands (Table 3.22). These activities were found in the North Cascades, Northwest Coast, Okanogan, and Puget Trough ecoregions. Washington DNR estimates no new agreements by 2040 for rafts in the North Cascades, Northwest Coast, and Okanogan ecoregions, and one additional agreement for the Puget Trough ecoregion.

**Table 3.22.** Raft agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| North Cascades | Skagit | 1 |
| Northwest Coast | Clallam | 1 |
| | Grays Harbor | 1 |
| Okanogan | Okanogan | 1 |
| Puget Trough | King | 2 |
| | Pierce | 1 |
| | San Juan | 2 |
| | **Total Agreements** | **9** |

# Multiple-element structures

## Marinas

In March 2013, Washington DNR had a combined total of 347 agreements and applications for marinas in 25 counties, encumbering approximately 274 hectares (677 acres) of state-owned aquatic lands (Table 3.23). The lease terms of two of those agreements are longer than the term of the incidental take permit and will not be covered by the habitat conservation plan. These activities were found in the Canadian Rockies, Columbia Plateau, East Cascades, North Cascades, Northwest Coast, Okanogan, Puget Trough, and West Cascades ecoregions. Washington DNR estimates no new agreements by 2040 for marinas in the Canadian Rockies and West Cascades ecoregions; one new agreement in the Columbia Plateau, East Cascades, and Okanogan ecoregions; three new agreements in the Northwest Coast ecoregion; eight new agreements in the North Cascades ecoregion; and 71 new agreements in the Puget Trough ecoregion.

**Table 3.23.** Marina agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Canadian Rockies | Pend Oreille | 2 |
| | Benton | 1 |
| Columbia Plateau | Douglas | 1 |
| | Grant | 1 |
| East Cascades | Chelan | 7 |
| North Cascades | Skagit | 23 |
| | Clallam | 9 |
| | Jefferson | 6 |
| Northwest Coast | Pacific | 3 |
| | Wahkiakum | 4 |
| Okanogan | Okanogan | 4 |
| | Spokane | 1 |
| | Clark | 8 |
| | Cowlitz | 14 |
| | Island | 2 |
| | King | 97 |
| | Kitsap | 33 |
| Puget Trough | Lewis | 1 |
| | Mason | 10 |
| | Pierce | 55 |

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| | San Juan | 40 |
| | Snohomish | 7 |
| | Thurston | 9 |
| | Whatcom | 7 |
| West Cascades | Skamania | 2 |
| | **Total Agreements** | **347** |

## Shipyards and terminals

In March 2013, Washington DNR had a combined total of 123 agreements and applications for shipyards and terminals in 22 counties, encumbering approximately 454 hectares (1,123 acres) of state-owned aquatic lands (Table 3.24). These activities were found in the Columbia Plateau, East Cascades, North Cascades, Northwest Coast, and Puget Trough ecoregions. Washington DNR estimates one new agreement by 2040 for shipyards and terminals in the Columbia Plateau and East Cascades ecoregions, two new agreements in the North Cascades ecoregion, three new agreements in the Northwest Coast ecoregion, and 20 new agreements in the Puget Trough ecoregion.

**Table 3.24.** Shipyard and terminal agreements by ecoregion and county.

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| Columbia Plateau | Benton | 1 |
| | Franklin | 1 |
| | Yakima | 1 |
| East Cascades | Chelan | 2 |
| | Kittitas | 1 |
| North Cascades | Skagit | 5 |
| Northwest Coast | Clallam | 8 |
| | Grays Harbor | 9 |
| | Jefferson | 3 |
| | Pacific | 6 |
| | Wahkiakum | 4 |
| Puget Trough | Clark | 8 |
| | Cowlitz | 4 |
| | Island | 2 |
| | King | 36 |
| | Kitsap | 3 |

| Ecoregion | County(s) | Number of Agreements |
|---|---|---|
| | Lewis | 1 |
| | Mason | 1 |
| | Pierce | 16 |
| | San Juan | 3 |
| | Snohomish | 2 |
| | Whatcom | 6 |
| | **Total Agreements** | 123 |

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# Chapter 4
# Factors Affecting Species

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# Chapter 4 — Factors Affecting Species

Chapter 4 describes the direct and indirect effects of covered activities on species and their habitats; the level of effects associated with the activities; and how the extent of the impact is calculated. The information in the following sections of Chapter 4 is from the "Potential Effects and Expected Outcomes Technical Paper" (November 2007)

**Section 4.1** describes the life history, habitat use, and distribution of covered species.

**Section 4.2** explains the analysis that was completed to arrive at the qualitative descriptions and quantitative values of potential effects presented.

**Section 4.3** explains the potential effects on habitat types of covered activity on state-owned aquatic lands.

**Section 4.4** addresses potential effects and expected outcomes specific to covered species if conservation measures are applied.

## 4.1 Covered species: life history, habitat use, and distribution

The Aquatic Lands Habitat Conservation Plan has identified a list of covered species that depend on habitats available on state-owned aquatic lands for a significant portion of their life history. Chapter 1 presented information on the species selection process and described the types of habitat they use. It also described geographic ecoregions throughout the state of Washington. These ecoregions are used throughout this section to describe distribution ranges of covered species.

# Amphibians and turtles

## Columbia spotted frog *(Rana luteiventris)*

### Life history

Columbia spotted frogs range between 5 and 10 centimeters (2–4 inches) in length and reach sexual maturity between the ages of 2 and 6 years, with females breeding every 1 to 3 years in the spring (Johnson & O'Neil, 2001; NatureServe, 2005a). The species has a maximum life span of 10 to 12 years and lives near permanent water (Bull, 2005; Johnson & O'Neil, 2001; Lannoo, 2005; NatureServe, 2005a; Nussbaum et al., 1983; Stebbins, 1966). Clutch sizes range between 150 and 2,400 eggs, with the larvae (tadpoles) emerging within 8 to 21 days. While most tadpoles metamorphose in mid- to late summer, northerly populations or those at higher elevations may metamorphose as late as October or November (Lannoo, 2005). Tadpoles feed on algae and other vegetation, organic debris, and zooplankton, while adult frogs feed on insects, mollusks, crustaceans, and spiders (Johnson & O'Neil, 2001; Nussbaum et al., 1983). This frog hibernates during the winter, after burrowing into mud at the bottom of ponds and lakes (Pilliod et al., 2002).

### Habitat use

Spawning and incubation occur in permanent waters, 10 to 20 centimeters in depth (4–8 inches), of most aquatic habitats occupied by the species, although only slow-moving reaches of riverine habitat are used for this purpose (Johnson & O'Neil, 2001; Lannoo, 2005; Nussbaum et al., 1983). Spawning is temperature-dependent and generally occurs from March through June, with egg masses deposited as free-floating clusters (Bull, 2005; Hallock & McAllister, 2005a; NatureServe, 2005a). Adults move overland between ephemeral and permanent water sources, with juveniles moving greater distances than mature adults (Funk et al., 2005; Johnson & O'Neil, 2001; Stebbins, 1966). Research indicates that females move up to 1,030 meters (0.5 miles) from breeding habitats, while males move less that 200 meters (0.1 miles) (Pilliod et al., 2002). Maximum distances recorded are equal to 5,750 meters (3.5 miles) (Funk et al., 2005).

Columbia spotted frog. Photo: Lisa Hallock

### Distribution

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, 1966). In Washington, the species occurs on the eastern side of the Cascade Mountains in the Okanogan and Columbia Plateau ecoregions. While populations in the Columbia Plateau are small and scattered, this frog is common in the northern and eastern portions of its range in Washington (Hallock & McAllister, 2005a).

## Northern leopard frog *(Rana pipiens)*

### Life history

Northern leopard frogs grow to 5 to 10 centimeters (2–4 inches) in length and have a maximum life span of 5 to 9 years, with females becoming sexually mature at 2 to 3 years of age (AmphibiaWeb, 2007a; Lannoo, 2005; McAllister et al., 1999; NatureServe, 2005b). The northern leopard frog deposits between 645 and 7,648 eggs per spawning event, with tadpoles emerging within 2 to 17 days and undergoing metamorphosis within 3 to 6 months (Lannoo, 2005). Although little is known about overland movements in Washington, these frogs migrate to and from breeding ponds and overwintering water bodies (Johnson & O'Neil, 2001; Hallock & McAllister, 2005b; McAllister et al., 1999).

Adults of this species are entirely carnivorous and regularly feed on beetles, flies, ants, damselflies, dragonflies, grasshoppers, spiders, and small vertebrates such as birds, snakes, and other frogs (Johnson & O'Neil, 2001; Nussbaum et al., 1983). While developing in shallow nearshore waters, leopard frog tadpoles graze on periphytic (attached) algae; metamorphosis is completed during the summer of the first year (Zeiner et al., 1988). After metamorphosis, young frogs may emigrate from their natal ponds to permanent waters, such as a lake or stream. Leopard frogs usually overwinter underwater among stones, sunken logs, or leaf litter at the bottom of ponds, lakes, and streams (Hallock & McAllister, 2005b; McAllister et al., 1999)

### Habitat use

While this species depends on upland vegetation as *refugia* from predators, it ranges widely across a variety of habitats, including wet meadows, grassy woodlands, and hay fields (McAllister et al., 1999; Nussbaum et al., 1983; Stebbins, 1966). Northern leopard frogs spawn from April through June in shallow water with emergent or submerged vegetation, such as cattails and sedge marshes (Johnson & O'Neil, 2001; Nussbaum et al., 1983; Zeiner et al., 1988). Northern leopard frogs lay egg masses, which they attach to emergent vegetation, in water depths of less than 65 centimeters (26 inches) and exposed to sunlight (McAllister et al., 1999; Zeiner et al., 1988).

Northern leopard frog. Photo: K. McAllister

Breeding ponds are generally greater than 1.5 meters (5 feet) in depth, with gradually sloping shorelines. They are characterized by substantial amounts of emergent and submerged vegetation for egg masses, shelter from predators, and tadpole grazing, and open waters that warm quickly and dry up periodically, thereby eliminating fish. Adult foraging habitat is generally associated with un-mowed pastures, shallow marshes, or meadows (McAllister et al., 1999).

### Distribution

In Washington, the northern leopard frog historically occurred on the eastern side of the Cascade Mountains in both the Columbia Plateau and Okanogan ecoregions. Reports of the northern leopard frog include sites near the Pend Oreille River, the Potholes Reservoir, and Alder Creek (Klickitat County), and the Columbia, Snake, Spokane, and Walla Walla rivers.

## Oregon spotted frog *(Rana pretiosa)*

### Life history

Adult Oregon spotted frogs reach lengths of 4 to 10 centimeters (1.5–4 inches) and live to approximately 5 years of age (Hallock & McAllister, 2005c; Lannoo, 2005). Males reach sexual maturity in their second year, while females mature at 2 to 3 years. Females frequently lay their eggs in communal masses of 10 to 75, with individual masses containing between 500 and more than 1,000 eggs. Larvae hatch within 18 to 30 days, and tadpoles undergo metamorphosis 3 to 4 months later (Lannoo, 2005; McAllister & Leonard, 1997).

Oregon spotted frog. Photo: W.P. Leonard

The Oregon spotted frog has two types of annual migration pattern: Wet-season migrations occur infrequently and between widely separated breeding pools. In contrast, dry-season migrations are likely a response to changing water levels, with the migrations occurring more frequently and between pools that are closer together (Watson et al., 2000).

Adults forage in and under water, primarily consuming beetles, spiders, flies, and ants, although the species has been observed eating newly metamorphosed red-legged frogs and juvenile western toads (Johnson & O'Neil, 2001; Pearl & Hayes, 2002). Tadpoles graze on algae and plant detritus. Oregon spotted frogs overwinter in waters generally free of ice, burying themselves in the sediment at the base of plants during the coldest periods (Hallock & McAllister, 2005c; Lannoo, 2005; Watson et al., 2000).

### Habitat use

The Oregon spotted frog is found in marshy edges of ponds and lakes or overflow pools associated with streams (Nussbaum et al., 1983; Stebbins, 1966). In Washington, the species occurs in large, shallow, wetland systems associated with streams and beaver impoundments. Breeding occurs from February to March in seasonally flooded margins of wetlands, with unattached egg masses laid in areas with little or no vegetative shading (Hallock & McAllister, 2005c; Johnson & O'Neil, 2001; Nussbaum et al., 1983). Adults prefer deeper waters, under open canopies, and rarely venture further than 2 meters (6.5 feet) from surface water. Tadpoles prefer warm shallow water, with dense emergent and submerged vegetation (Lannoo, 2005).

### Distribution

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 & McAllister, 2005c). In Washington, the frog is found in both the Puget Trough and East Cascade ecoregions at elevations from sea level to 610 meters (2,000 feet) (Johnson & O'Neil, 2001). Only six populations are currently known to exist in Washington: four in Thurston County in the Black River watershed and two in Klickitat County (Hallock & McAllister, 2005c) .

## Western toad *(Bufo boreas)*

### Life history

Adult western toads reach lengths of 5 to 14 centimeters (2–5.5 inches) and live to be about 10 years of age, with sexual maturity occurring at 2 to 6 years (AmphibiaWeb, 2007b; Lannoo, 2005). One toad lays an average of 5,200 eggs in double stranded strings during each spawning event. Embryos hatch within 3 to 10 days, and tadpoles undergo metamorphosis during their first summer (Lannoo, 2005; Leonard et al., 1993).

Although little is known about the migration behavior of this species, females have been observed up to 2,600 meters (1.6 miles) from breeding sites, with the documented movements of males covering shorter distances (Johnson & O'Neil, 2001). Adults of this species feed primarily on insects, but they also eat spiders, centipedes, sowbugs, crayfish, and earthworms. Tadpoles graze on algae and detritus. Hibernation typically occurs from November through April, but the length of time varies with location and temperature (Johnson & O'Neil, 2001). Observations of some toads reveal that they hibernate in terrestrial locations, although little information is available in the general literature regarding hibernation (Nussbaum et al., 1983).

### Habitat use

In Washington, spawning and incubation occur in almost any standing water from February through July (Zeiner et al., 1988). Strings of eggs are attached to submerged and emergent vegetation or laid directly on the substrate in shallow ponds, lakes, slow-moving reaches of streams, springs, reservoirs, stock ponds, canals, and roadside ditches (Hallock & McAllister, 2005d; Johnson & O'Neil, 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, 1966; Vander Haegen et al., 2001). It can also occur in low-density urban habitats with irrigated landscaping (Ferguson et al., 2001). Western toads depend on loose soils for protection from predators and to prevent dehydration; they are known to use burrows of other animals for the same purposes (Vander Haegen et al., 2001).

Western toad. Photo: Lisa Hallock

### Distribution

While the current and historic distribution of western toads includes the entire state of Washington, they appear to be absent from the south-central portion of the Columbia Plateau ecoregion (Hallock & McAllister, 2005d; Nussbaum et al., 1983; Stebbins, 1966). The species occurs from sea level to elevations as high as 2,255 meters (1.4 miles) in the mountains (Martin 2001; Stebbins 1966).

## Western pond turtle *(Actinemys marmorata)*

### Life history

Western pond turtles (also known as Pacific pond turtles) have an estimated lifespan of between 50 and 70 years, reaching reproductive maturity at over 10 years of age or at a carapace length of 135 to 140 millimeters (5.3–5.5 inches) (Hays et al., 1999). They nest from May to mid-July, with females burying between 2 and 13 eggs in soils with little or no vegetative covering (Hays et al., 1999; Johnson & O'Neil, 2001; Nussbaum et al., 1983; Stebbins, 1966). Incubation times range between three and four months. These turtles usually nest within 100 meters (328 feet) of water, but occasionally will nest up to 400 meters (1,312 feet) from water (Hays et al.,1999; Nussbaum et al., 1983). Similar to other turtles, the gender of the hatchlings depends on the temperature of the surrounding soils.

Western pond turtle. Photo: W. P. Leonard

Western pond turtles are opportunistic feeders, foraging in or under water for invertebrates (insects, earthworms, mollusks, and crayfish), vertebrates (fish, tadpoles, and amphibians), and carrion (small mammals, birds, amphibians, and turtles). Adults of the species overwinter in the muddy bottoms of lakes or ponds, or in upland habitats adjacent to water bodies (Nussbaum et al., 1983). Observation of juveniles in one study suggests they may also overwinter in the water (Hays et al., 1999).

### Habitat use

This aquatic turtle occurs in streams, ponds, lakes, and both permanent and ephemeral wetlands (Nussbaum et al., 1983; Stebbins, 1966). Pond turtles will migrate overland, and may slow their metabolism to help conserve water during hot or dry periods (Johnson & O'Neil, 2001). Because they are *ectothermic*, pond turtles utilize floating vegetation, cattail mats, logs, rocks, mud flats, and sandbanks to bask in the sun (Hays et al., 1999). In large rivers, the pond turtle is located near the banks or in adjacent backwater habitats, where the current is relatively slow and basking sites are abundant (Stebbins, 1966).

A variety of substrates are found in the habitat range used by western pond turtles, including rocks, boulders, cobbles, gravel, sand, mud, decaying vegetation, and combinations of these (Stebbins, 1966). Vegetative cover used by pond turtles includes areas with little or no emergent vegetation; areas with abundant emergent vegetation; sites with no emergent vegetation, but with 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 are unsuitable habitat for pond turtles (Hays et al., 1999).

### Distribution

Within Washington, western pond turtles historically occurred in the Puget Trough ecoregion and in the Columbia River Gorge from sea level up to elevations near 300 meters (984 feet) (Hays et al., 1999; Hallock & McAllister, 2005e). There are four populations in the Columbia River Gorge, two naturally occurring and two that have been established through reintroductions. There are two populations in Puget Sound that have been established through reintroductions.

# Birds

## Black Tern *(Chlidonias niger)*

### Life History

Black terns are migratory birds that use eastern Washington as breeding grounds and as resting areas during their migration to and from their wintering grounds in Central and South America. In Washington, terns lay eggs between May and June. A clutch generally contains two to three eggs (Dunn and Agro 1995; NatureServe 2006b). Chicks hatch from late June to late July, with both parents tending the chicks until they *fledge* at 2 to 3 weeks. Adults and young both feed on insects, spiders, small crustaceans, and fish, with the proportions of insects to fish in the diet varying with availability (Dunn & Agro, 1995; NatureServe, 2006b).

### Habitat use

Black terns are semi-colonial and generally nest in emergent vegetation (such as cattails and bulrushes) along prairie sloughs, rivers, lakes, impoundments, wet meadows, and marshes; occasionally, they nest on mats of floating vegetation or wood (NatureServe, 2006b). In northeastern Washington, the birds nest in major river valleys and other suitable habitats up to 914 meters (2,998 feet) in elevation (U.S. Fish and Wildlife Service, 1999). Black terns nest in areas with shallow water, usually within 1 to 2 meters (3.3–6.5 feet) of open water (NatureServe, 2006b). During fall and spring migrations between their 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.

Black tern. Photo: Mike Yip

### Distribution

Although this species is common in eastern Washington during migrations, nesting birds are less common (Wahl et al., 2005). Black terns 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).

## Common loon *(Gavia immer)*

### Life history

Common loons breed in the summer. Both parents tend yearly clutches of one to three eggs. The chicks hatch within 29 days (on average) and are then transferred to the parents' backs for an additional 3 weeks. Adults continue to feed and defend their young until the chicks are roughly 11 weeks old and capable of flight (NatureServe, 2006c). Adults are flightless during a few weeks in mid-winter (February) and are therefore vulnerable to environmental disturbances (McIntyre & Barr, 1997).

### Habitat use

Common loons generally nest on clear, *oligotrophic* lakes with complex rocky shorelines, numerous bays and islands, and deep inlets, but they will also use floating bogs if fish are present

(Richardson et al., 2000). Preferred nesting sites are on island or shoreline edges that are within 1.5 meters (5 feet) of water, sheltered from winds, and positioned within the vegetation to allow a view of the pairs' territory (McIntyre & Barr, 1997).

The species winters primarily in nearshore coastal marine waters—over shoals and in sheltered bays, inlets, and channels—with some individuals on freshwater lakes, reservoirs, and low-gradient river valleys. Winter distributions are variable, but are related to the abundance and stability of the forage base, protection from storms, and turbidity (Spitzer 1995). Birds in Washington are concentrated in Puget Sound and the Strait of Juan de Fuca (Richardson et al., 2000).

Common loon. Photo: U.S. Fish and Wildlife Service

Prior to their migration during April and again from late October to early December, this species aggregates on low-gradient river valleys 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 & Barr, 1997).

### Distribution

Within Washington, common loons nest on lakes and reservoirs in the Okanogan, North Cascades, East Cascades, and Puget Trough ecoregions, while non-nesting birds are found during the summer throughout the state (Richardson et al., 2000). 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).

## Harlequin duck *(Histrionicus histrionicus)*

### Life history

Harlequin ducks generally nest from mid-April through August, laying clutches of 5 to 7 eggs and incubating them for 27 to 30 days (Seattle Audubon, 2002). The chicks fledge within 5 to 6 weeks, whereupon both the young and their mother move to coastal wintering areas (Lewis & Kraege, 2004; NatureServe, 2006d; Robertson & Goudie, 1999). Males and non-breeding females are flightless during late July to mid-August, with breeding females generally flightless during September (Robertson & Goudie, 1999). Fall migration occurs from late June through mid-September.

### Habitat use

Harlequin ducks build nests on the ground adjacent to relatively undisturbed fast-flowing streams with cobble- to boulder-size substrate and vegetated banks in riparian, subalpine, or coastal habitats (Lewis & Kraege, 2004). Preferred nesting habitat includes low-acidity streams with high invertebrate density, steep banks with vegetation, braided channels with small islands, and gravel and sand bars (Robertson & Goudie 1999). Prior to their spring migration (mid-March through May), many harlequin ducks aggregate at Pacific herring 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. This species will also forage on a variety of mollusks (snails, periwinkles, limpets, chitons, and blue mussels) and fish, such as small sculpins and gunnels (Gaines & Fitzner, 1987; Vermeer, 1983).

In Washington, migratory harlequin ducks occur primarily in marine water less than 1 meter (3.3 feet) deep containing eelgrass (Zostera spp.) and kelp communities, and occasionally over sand or mudflats. Winter distributions are variable, but are related to the abundance of available intertidal and subtidal invertebrate forage species, with crustaceans, amphipods, isopods, and barnacles preferred.

### Distribution

An estimated 400 harlequin duck pairs nest beside fast-flowing mountain streams in the Olympic and Cascade Ranges and in northeastern Washington (Robertson & Goudie, 1999; Wahl et al., 2005). Although there are questions surrounding the sightings, harlequin ducks may also occur in the southeastern corner of Washington in the Blue Mountains ecoregion (Lewis & Kraege, 2004). An estimated 3,000 harlequin ducks winter along the outer coast and in northern Puget Sound, northern Hood Canal, the Strait of Juan de Fuca, and the San Juan Archipelago (Lewis & Kraege, 2004; Robertson & Goudie, 1999.

Harlequin duck. Photo: L. Barnes

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 (Lewis & Kraege, 2004; Smith & Smith, 2003).

## Marbled murrelet *(Brachyramphus marmoratus)*

### Life history

Marbled murrelets breed in the early spring. Between April and July, each female lays a single egg, which is then tended by both parents. Incubation lasts for approximately 30 days, with the chick fledging in roughly 4 weeks (Miller et al., 1997). The birds forage in saltwater within 2 to 5 kilometers (1–3 miles) of shore in protected coastal and nearshore waters and within the top 50 meters (164 feet) of the water column (Thompson, 1999).

### Habitat use

Although marbled murrelets are seabirds, they nest in old-growth coniferous forests and travel up to 80 kilometers (50 miles) to feed their young. The species feeds on small schooling fish, such as Pacific sand lance (*Ammodytes hexapterus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*i), surf smelt (*Hypomesus pretiosus*), and shiner surfperch (*Cymatogaster aggregata*), as well as rockfish (*Sebastes spp.*) and a host of marine invertebrates, including squid and shrimp (Nelson,1997). During breeding season, they may also feed on juvenile salmon (*Oncorhynchus spp.*) in freshwater lakes (Nelson, 1997). Although foraging murrelets are

generally solitary, individuals may aggregate where Pacific herring are spawning (Speich & Wahl, 1989).

### Distribution

The remaining marbled murrelet populations in Washington occur mainly in northern Puget Sound and the northern Pacific Coast (Speich & Wahl, 1995). While at-sea distributions vary temporally and spatially, there is a general shift in winter abundance eastward 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 & Wahl, 1995). Distribution and abundance during foraging may be influenced by distance from the nest—usually less than 20 kilometers (12 miles)—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). Abundance decreases with increasing distance from the shoreline, and juvenile birds tend to remain closer to shore (Speich & Wahl, 1995).

Marbled murrelet. Photo: Oregon State University

## Western snowy plover *(Charadrius nivosus nivosus)*

### Life history

Western snowy plovers have an average life span of 3 years, reaching sexual maturity at one year of age. Nesting occurs from late April to late June (Wahl et al., 2005), with females laying two to three clutches of three eggs annually (Page et al., 1995). Incubation lasts approximately one month, and the chicks fledge within 31 days (Warriner et al., 1986). Although both parents tend the eggs, females frequently abandon the chicks in search of a new mate, leaving the male to tend to the chicks until they fledge (NatureServe, 2006e; Warriner et al., 1986).

Western snowy plover. Photo: M. L. Baird

### Habitat use

Pacific Coast western snowy plovers prefer flat, sandy areas with little or no vegetative cover, such as barrier beaches, dry lake beds, and salt flats (Palacios et al., 1994; Wilson-Jacobs & Meslow, 1984). The birds generally nest above the high-tide line on coastal beaches, sand spits, dune-backed beaches, and sparsely vegetated dunes; along beaches at creek and river mouths; and on saltpans at lagoons and estuaries. They secondarily nest on bluff-backed beaches, dredge-spoil piles, salt-pond levees, dry salt ponds and river bars (Palacios et al., 1994; Powell, 2001).

### Distribution

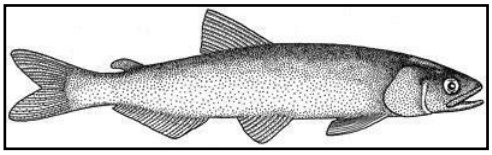
Western snowy plovers occur in several western states (Arizona, California, Colorado, Kansas, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, Washington, and Wyoming), but only members of the Pacific Coast population (California, Oregon, and Washington) are listed as threatened (Code of the Federal Regulations, 1993). Historically, there were breeding snowy plovers in at least five areas in western Washington; however, there are now only three known active breeding grounds: the Damon Point/Oyhut Wildlife Area in Grays Harbor County and Midway Beach and Ledbetter Point/Gunpowder Sands in Pacific County (Richardson, 1995. All three breeding sites are federally designated critical habitat (Code of Federal Regulations, 2005). No nesting has been documented in eastern Washington, although several individuals have been observed there since 1967 (Richardson, 1995).

# Fish

## Eulachon/Pacific smelt *(Thaleichthys pacificus)*

### Life history

Eulachon are important prey for many species of fish, marine mammals, and birds along the Pacific Coast (Sigler et al., 2004). The species is anadromous, becoming sexually mature at 2 to 5 years of age and returning to freshwater to spawn from late winter to early summer (Wydoski & Whitney, 2003). These fish are broadcast spawners: Each female deposits between 17,000 and 60,000 eggs, which hatch in approximately one month and wash out to sea (McLean et al., 1999; Wydoski & 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. Despite their widespread occurrence, very little is known about eulachon during their saltwater phase, except that they are known to prey heavily on euphausiid shrimp in shallow waters and are often bycatch in the shrimp fishery (Wydoski & Whitney, 2003).



Graphic: Alaska Fish and Game

### Habitat use

Adult eulachon are *pelagic*, found throughout the Pacific Ocean water column at depths of 80 to 200 meters (262–656 feet). Eulachon generally spawn in lower gradient reaches with coarse sediments, during strong freshets, and at night (Fisheries and Oceans Canada, 2004; McLean et al., 1999; Wydoski & Whitney, 2003).

### Distribution

Eulachon naturally occur from the Pribilof Islands in the Bering Sea south to Monterey Bay, California (Eschmeyer & Herald, 1983). In the Pacific Northwest, the species spawns in the Fraser and Nooksack rivers, with the strongest runs occurring in the Columbia River below Bonneville Dam and in the Cowlitz, Grays, Kalama, Lewis, and Sandy rivers (National Marine Fisheries Service, 2008a; Wydoski & Whitney, 2003). Listed federally as threatened in 2010, with critical

habitat designated in 2011 (50 Code of Federal Regulations 226), the southern population of the species spreads across three states (California, Oregon, and Washington).

## Pacific herring *(Clupea pallasi)*

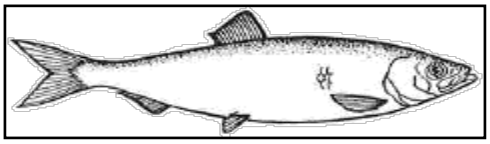
The Washington Department of Fish and Wildlife recognizes 18 distinct herring stocks in the Puget Trough ecoregion and two in the Northwest Coast ecoregion (Willapa Bay and Grays Harbor), with the populations delineated based on spawning grounds (Lemberg et al., 1997; Stick, 2005; Stout et al., 2001; Washington Department of Fish and Wildlife, 1997b).

### Life history

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 plants, fish and mammals. They reach sexual maturity at 2 to 3 years of age, spawning yearly until they die (Washington Department of Fish and Wildlife, 1997b). Total life span for this species is approximately 9 years, although some individuals have been aged at greater than 15 years (Lassuy, 1989).

### Habitat use

Adult herring are pelagic, moving to holding areas adjacent to their spawning grounds shortly before spawning occurs. Depending on the stock, spawning can begin as early as January and last until June (Table 4.1), with the eggs deposited primarily on eelgrass at depths of up to minus 12 meters (40 feet) (Penttila, 2007; Washington Department of Fish and Wildlife, 1997b). Herring eggs hatch within 2 to 3 weeks, and larvae are distributed by local currents (Lassuy, 1989). Following metamorphosis, juvenile herring use the same ecosystem and habitats as adults.



Pacific herring. Graphic: Washington Department of Fish and Wildlife

### Distribution

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, as well as the Asian coast from the Arctic Ocean to Japan (Washington Department of Fish and Wildlife, 1997b). Within Washington, the species occurs in all marine waters and uses both state- and privately owned shorelines for spawning.

**Table 4.1.** Pacific herring spawning season windows (Penttila, 2007). Shaded boxes indicate when spawning occurs.

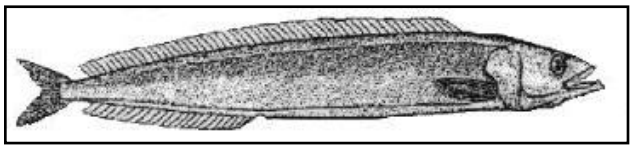
| Region | Spawning Area | January | February | March | April | May | June |
|---|---|---|---|---|---|---|---|
| Puget Trough | Squaxin Pass | | | | | | |
| | Wollochet Bay | | | | | | |
| | Quartermaster Harbor | | | | | | |
| | Port Orchard | | | | | | |
| | South Hood Canal | | | | | | |
| | Quilcene Bay | | | | | | |
| | Port Gamble | | | | | | |
| | Kilisut Harbor | | | | | | |
| | Port Susan | | | | | | |
| | Holmes Harbor | | | | | | |
| | Skagit Bay | | | | | | |
| | Fidalgo Bay | | | | | | |
| | Samish/Portage Bay | | | | | | |
| | San Juan Island | | | | | | |
| | Semiahmoo Bay | | | | | | |
| | Cherry Point | | | | | | |
| | Discovery Bay | | | | | | |
| | Dungeness/Sequim Bay | | | | | | |
| Northwest Coast | Willapa Bay | | | | | | |

## Pacific sand lance *(Ammodytes hexapterus)*

Sand lance are especially important in the diets of juvenile salmon; the sand lance comprises up to 60 percent of the diet of juvenile Chinook salmon (Washington Department of Fish and Wildlife, 1997c).

### Life history

Pacific sand lance spawn from November through February, with peak spawning occurring early in the period (Penttila, 2007). Wave action disperses eggs across the intertidal zone, and incubation lasts approximately 4 weeks (Lemberg et al., 1997). Currents disperse the larvae, which form schools when they reach approximately 22 millimeters (0.8 inches) in length (Washington Department of Fish and Wildlife, 1997c).



Pacific sand lance. Graphic: Washington Department of Fish and Wildlife

### Habitat use

Sand lance spawn on sandy intertidal beaches with freshwater seeps at tidal elevations from mean higher-high water to plus 2 meters (7 feet) (Lemberg et al., 1997). Both adults and juveniles use sandy, nearshore substrates for burrowing at night, and open water areas for foraging during daylight (Penttila, 2007; Washington Department of Fish and Wildlife, 1997c).

### Distribution

Pacific sand lance have a wide distribution and are common in Puget Sound, the Strait of Juan de Fuca, and Washington's coastal estuaries. Since 1989, the Washington Department of Fish and Wildlife has documented spawning activity along about 130 miles of Puget Sound shoreline (Lemberg et al., 1997; Washington Department of Fish and Wildlife, 1997c.

## Surf smelt *(Hypomesus pretiosus)*

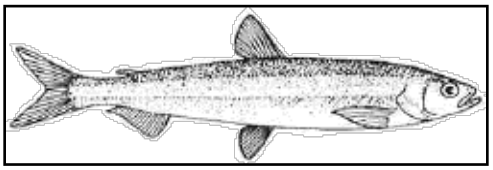
Although their movements are generally unknown, surf smelt are a common nearshore species (Penttila, 2007; Washington Department of Fish and Wildlife, 1997d).

### Life history

Surf smelt life history is largely unknown. Thought to have maximum life spans of 4 to 5 years, smelt reside in the nearshore adjacent to their natal spawning grounds throughout their lives (Penttila, 2007; Washington Department of Fish and Wildlife, 1997d). Most adults spawn in their second year, but a small portion spawn after one year (Lemberg et al., 1997; Penttila, 1978; Washington Department of Fish and Wildlife, 1997d).

### Habitat use

Surf smelt spawn throughout the year on intertidal beaches of mixed sand and gravel from about extreme high water to plus 2 meters (7 feet) in tidal elevation (Penttila, 2007). Spawning sites seem to be associated with areas containing freshwater seeps, with the eggs deposited near the waterline and hatching in one to two months (Washington Department of Fish and Wildlife, 1997d). Surf



Surf smelt. Graphic: Washington Department of Fish and Wildlife

smelt larvae are planktonic and assume their adult body type after about three months. Juveniles continue to rear and school in nearshore areas (Penttila 2007; Washington Department of Fish and Wildlife, 1997d).

### Distribution

Surf smelt range from Long Beach, California, north to Chignik, Alaska, with populations in Washington (Table 4.2) occurring throughout the nearshore ecosystem (Washington Department of Fish and Wildlife, 1997d).

**Table 4.2.** Surf smelt spawning season windows (Penttila, 2007)
Shaded boxes indicate when spawning occurs.

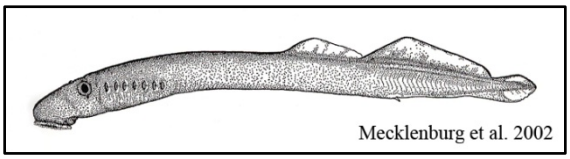
| Region | Spawning Area | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Puget Sound | Island County | | | | | | | | | | | | |
| | Birch/ Cherry Point | | | | | | | | | | | | |
| | Fidalgo Bay | | | | | | | | | | | | |
| | Dungeness Bay | | | | | | | | | | | | |
| | North Port Orchard | | | | | | | | | | | | |
| | Sinclair/ Dyes Inlet | | | | | | | | | | | | |
| | Quarter-master Harbor | | | | | | | | | | | | |
| | South Hood Canal | | | | | | | | | | | | |
| | South Puget Sound | | | | | | | | | | | | |
| | San Juan Islands | | | | | | | | | | | | |

| Region | Spawning Area | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pacific Coast | | | | | | | | | | | | |
| **Northwest Coast** | Grays Harbor | | | | | | | | | | | | |

## Pacific lamprey *(Lampetra tridentate)*

### Life history

Pacific lampreys are anadromous, and the adult form is parasitic, using its sucker-like mouthparts to remove body fluids from host organisms (marine fish and mammals). The species is the largest of the native lampreys, reaching a length of 76 centimeters (30 inches) and a weight of 450 grams (1 pound) (Wydoski & Whitney, 2003).



Pacific lamprey.

Adults spend 1 to 3 years in the ocean before returning to their natal streams to spawn. Migrations begin up to a year before spawning occurs, with the species overwintering in deep pools and reproducing in the spring (Wydoski & Whitney, 2003). Upon returning to freshwater, Pacific lamprey end parasitic feeding and rely exclusively on stored carbohydrates, proteins, and lipids until they spawn. Spawning occurs from February through July; lamprey that spawn in coastal streams do so earlier than lamprey further inland (Moser & Close, 2003).

Larvae (ammocoetes) hatch within approximately 20 days, burrowing into silty substrates and remaining within slow-moving reaches of streams, where they feed by filtering microscopic plants and animals out of the water (Moser & Close, 2003). Ammocoetes remain in freshwater for 4 to 7 years. They can reach a size of up to 17 centimeters (7 inches) before metamorphosing into their parasitic adult phase (Moser & Close, 2003). Metamorphosis occurs from July until November, and the newly metamorphosed lamprey may either move immediately to sea or remain in fresh water for up to 10 months (Wydoski & Whitney, 2003).

### Habitat use

Pacific lamprey have been found from 9 to 100 kilometers (6 to 62 miles) offshore in waters as deep as 800 meters (2,645 feet), although they are more commonly located in water depths of 70 to 250 meters (230–820 feet) (Wydoski & Whitney, 2003). Nests are generally located in riffles or the tails of pools in moderate- to high-flow streams at depths of less than 1 meter (3 feet) (Moser & Close, 2003).

### Distribution

Pacific lamprey range from Baja California to the Aleutian Islands in Alaska, and they are found along the eastern coast of Asia as far south as Japan (Wydoski & Whitney, 2003). In Washington

State, the species is found in most large rivers and streams along the coast, Strait of Juan de Fuca, and Puget Sound, and it occurs far inland in the Columbia, Snake, and Yakima rivers (Moser & Close, 2003; Wydoski & Whitney, 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 & Whitney, 2003). Pacific lamprey are also located in streams along the southern, western, and northern boundaries of the Olympic Peninsula.

# Rockfish *(Sebastes spp.)*

Rockfish are associated with rocky outcroppings and walls in both coastal and inland waters. Species frequently occupy the same location, but use different depths. This genus of fish is ovoviviparous, with females producing live young that undergo a pelagic phase before metamorphosing to juvenile life forms and beginning their gradual descent to their adult habitat. Although long-lived, the species distributions, life histories, and status are frequently not well documented or understood, and available data are generally the result of fishery trawls and recreational dives. No spatial data are available for the three species discussed here.

## Bocaccio *(Sebastes paucispinis)*

### Life history

The maximum life span for bocaccio is unknown. An estimated lifespan is up to 50 years; the fish reaches sexual maturity between 3 and 8 years of age (Love et al., 2002; National Marine Fisheries Service, 2008b). Mating generally occurs once a year: females store sperm for 4 to 6 weeks while their eggs develop (Wyllie-Echeverria, 1987). They produce between 20,000 and 2.3 million eggs per season (Phillips, 1964; Stanley et al., 2001). Bocaccio release larvae offshore during the winter months and remain in the water column for several months while transitioning to juvenile life form (Garrison & Miller, 1982;Wyllie-Echeverria, 1987).

### Habitat use

Bocaccio most commonly inhabit steep slopes with sand and rocky substrates at depths between 50 and 250 meters (164–820 feet); larger fish occupy the deeper habitats (Love et al., 1990; Love et al., 2002; National Marine Fisheries Service, 2008b; Palsson et al., 2008; Starr et al., 2002). Bocaccio larvae remain in the water column for several months while transitioning to pelagic juveniles, and the juveniles then settle in shallow vegetated rocky areas (Garrison & Miller, 1982; National Marine Fisheries Service, 2008b). As they grow, they move to deeper water habitats with crevices and rocky holes (Garrison & Miller, 1982). Juveniles have been observed occupying areas of high relief and have also been associated with anthropogenic structures, including offshore oil platforms in southern California (Love et al., 2002). Bocaccio co-occurs with several other species of semi-pelagic rockfish, including yellowtail and widow rockfish, often caught in mid-water trawls.

Bocaccio *(Sebastes paucispinis)*. Photo: M. Conlin

### Distribution

Bocaccio have been found on rocky outcroppings in the offshore waters of Washington, Central Puget Sound, Ports Gardner and Susan, and the Strait of Juan de Fuca (Love et al., 2002; Miller & Borton, 1980; Palsson et al., 2008). Canadian assessments have shown bocaccio to be abundant along the northwest coast of Vancouver Island (Committee on the Status of Endangered Wildlife in Canada, 2002). NOAA Fisheries listed Puget Sound bocaccio as endangered in 2010.

## Canary Rockfish (*Sebastes pinniger*)

### Life history

Canary rockfish can live more than 80 years (Wilkins et al., 1998). They reach sexual maturity between 7 and 8 years of age in Washington State. Mating occurs from September to March, with the peak off the Washington coast occurring in December and January (Methot & Piner, 2001). Females produce from 250,000 to over 2 million eggs per year (Love et al., 2002). The young are released into the water column from January to March (Westrheim, 1975).

Canary rockfish. Photo: Fisheries and Oceans Canada

### Habitat Use

Adult canary rockfish are benthopelagic, forming loose schools in the water column over cobble, mud, and sand habitats interspersed in rocky structures from 80 to 200 meters (262–656 feet) in depth (Love et al., 2002; National Marine Fisheries Service, 2008b). Larvae are thought to remain in the plankton for up to four months, and juveniles gradually settle into benthic habitats associated with kelp beds or other high relief nearshore areas (Love et al., 1991; Love et al., 2002; Sampson & Stewart, 1994). Similar to other rockfish, juveniles move to deeper habitats as they grow larger (Boehlert, 1980).

### Distribution

In Washington, canary rockfish were once common in Puget Sound, but now primarily inhabit the marine and the outer coast environments (Garrison & Miller, 1982). The Washington Department of Fish and Wildlife's current trawl, video, and scuba distribution data indicate that the species also inhabits the northern and central Sound and Northern Hood Canal (Palsson et al., 2008). NOAA Fisheries listed Puget Sound canary rockfish as threatened in 2010.

## Yelloweye rockfish *(Sebastes ruberrimus)*

### Life history

Yelloweye are among the largest and longest-lived of rockfish, with some individuals exceeding 100 years of age (Andrews et al., 2002). The species is slow growing and matures late, with both males and females reaching sexual maturity at about 20 years of age (Barss, 1989; Methot et al., 2002). Mating occurs once a year, generally in the winter, and females can produce between 1 and 3 million eggs per season (Garrison & Miller, 1982; Love et al., 2002). Females store sperm for 4 to 6 weeks while their eggs develop; after fertilization. The embryos develop for about 5 weeks before the young are released (Wourms, 1991) offshore between February and September, peaking at different times depending upon location in the range (Love et al., 2002).

### Habitat use

Yelloweye rockfish occupy complex rock and wall habitats and are often associated with boulder fields, broken rock, overhangs, and crevices at depths ranging from 40 to 550 meters (131–1,804 feet) (Eschmeyer & Herald, 1983; Jagielo et al., 2003; Love et al., 2002; Yoklavich et al., 2000). As adults, they are sedentary demersal fish, generally found on or just above rocky substrates, and they are thought to possess strong site fidelity because of their sedentary nature (Love et al., 2002; Methot et al., 2002; Yamanaka et al., 2000). While little information exists for the early life-history stages of this species, larvae are thought to use the upper mixed zone of the ocean, where they are believed to be dispersed by physical transport processes (Love et al., 2002; Yamanaka et al., 2000). Yelloweye juveniles settle in shallow (50 to 100 meters or 164 to 328 feet) nearshore and offshore rocky areas (Yamanaka et al., 2000).

Yelloweye rockfish. Photo: G. McIntyre

### Distribution

Yelloweye rockfish range from Unalaska Island in the Aleutian Islands of Alaska to the Baja California peninsula in northwestern Mexico; they are most abundant from central California to southeast Alaska (Hart, 1973; Love et al., 2002). In Washington, Yelloweye are found offshore along the outer coast and appear to be rare in Puget Sound (Love et al., 2002; Palsson et al., 2008). In 2010, NOAA Fisheries listed Puget Sound Yelloweye as threatened.

# Salmonids

The life histories, habitat usage, and residency time of the eight salmonid species addressed by the Aquatic Lands Habitat Conservation Plan can differ greatly between and within species. Salmonids typically exhibit one or more of the following life history strategies:

- **Anadromous:** Spawning in freshwater; juvenile rearing in fresh- and saltwater; migrating to saltwater for adult rearing.
- **Adfluvial**: Spawning and juvenile rearing in freshwater tributaries; migrating to lakes or reservoirs for adult rearing.
- **Fluvial:** Spawning and juvenile rearing in small freshwater streams; migrating to larger rivers for adult rearing
- **Resident:** Entire life history occurs in smaller streams.

Anadromous, adfluvial, and fluvial life history types also exhibit distinct strategies (such as parr, fry, or yearling migration) for each life history type, as well as distinct life phases (upstream migration, spawning, incubation, emergence, juvenile rearing, downstream migration, and estuarine/marine/freshwater rearing to adult) (Beamer et al., 2005).

In general, migrating adult salmonids return to their natal streams to spawn. Each female excavates a pocket (redd) within the gravel substrate for her eggs, and one or more males fertilizes the eggs prior to the female covering them with loose gravel. The eggs incubate within the interstitial spaces in the gravel, with the larvae (alevins) feeding on their yolk sacks between hatching and emergence from the gravel as fry. Fry leave the gravel in search of food and protective cover, imprinting on the odor of their natal stream as they grow into juveniles.

Following their freshwater rearing period, juveniles begin their downstream migration. Anadromous species migrate to saltwater and acclimate through a process called smoltification. These smolts forage, rest, and grow in estuaries and nearshore habitats before they migrate to deeper water and the open ocean. Growth and development continues in the open ocean for a few months to several years, depending on the species. When mature, adult salmon migrate back to their natal streams, where they typically spawn and die (Salo & Cundy, 1987; Spence et al., 1996; Wydoski & Whitney, 2003). While fluvial and adfluvial populations exhibit behavior similar to that of anadromous forms, they remain in freshwater throughout their lives and generally spawn more than once.

## Habitat requirements common to all salmonids

### Clean gravels

Although the gravel size used for spawning and incubation varies by species, all salmonids require clean, stable gravel with interstitial spaces and low levels of fine sediment. In addition to providing *refugia* for *alevins*, gravel also increases stream productivity by providing habitat for plankton and aquatic invertebrates—an important food source for fish and other species.

### Complex channel structure and large woody debris

Deep pools with vegetative cover and large woody debris are important as holding and resting areas for overwintering juveniles and migrating adults. Streams with more structure (logs, root wads, and undercut banks) support more fish, not only because they provide more usable habitat, but also because they provide more food and cover from predators (Scrivener & Andersen, 1982). Large woody debris also traps coarser sediment for spawning grounds and supports nutrient cycling by trapping fish carcasses and leaf litter (Meyer et al., 1988; Salo & Cundy, 1987; Spence et al., 1996).

### Cool, well-oxygenated water

The preferred temperature range for most salmon and trout is 12 to 15° C (54–59° F), with juveniles susceptible to sublethal effects when the average stream temperature is above 15° C (59° F) (Bjornn & Reiser, 1991; Hicks, 2002). Areas of cold groundwater upwelling and *hyporheic* (river-influenced groundwater) exchange have been documented to be especially important for both bull trout spawning habitat and chum salmon (Baxter & Hauer, 2000; Frissell; 1999; Lister et al., 1980). Adequate riparian cover is also important for shading and maintaining cool stream temperatures (Frissell, 1999; National Research Council, 1996). In addition, cooler water temperatures help maintain adequate dissolved oxygen concentrations for all life stages: The Washington State Department of Ecology defines the minimum dissolved oxygen requirement for salmonids as 6.5 milligrams per liter (Washington Administrative Code 173-201A-200).

### Estuarine and nearshore habitat

Beach seining surveys suggests that juvenile anadromous salmonids use estuarine/nearshore habitats year-round (Fresh, 2006; Redman et al., 2005). The abundant food supplies, wide salinity gradients, and diverse habitats associated with estuarine/nearshore areas are particularly valuable to anadromous fish for rearing, feeding, and *osmoregulatory* acclimation during the transition between freshwater and marine life stages (Healey, 1982; Macdonald et al., 1987; Simenstad, 1983). Estuarine/nearshore food webs are supported by abundant sources of detritus from submerged vegetation (such as eelgrass and kelp), salt marshes, and terrestrial vegetation, coupled with high levels of primary production in the shallow, nutrient-rich waters (Phillips, 1984). Forage fish species such as surf smelt, Pacific sand lance, and Pacific herring also depend upon beaches

and intertidal areas for spawning (Hart, 1973; Washington Department of Fish and Wildlife, 1997b; 1997c; 1997d; Washington State Department of Ecology, 2007).

### Functioning floodplains

In addition to helping dissipate floodwaters across the adjacent terrestrial landscape, functioning floodplains provide increased sediment storage capacity as well as a variety of aquatic habitats (such as sloughs, oxbow lakes, and wetlands). While some of these features have a permanent hydrologic connection to the main channel, many features exist only during seasonal connections or exposure during periods of higher flows. These slower water areas can provide seasonal spawning and rearing habitats outside of the main river channels, as well as foraging and overwintering habitat (Spence et al., 1996).

### Habitat connectivity

While habitat connectivity is an important consideration for all species, the diversity of use of salmonid habitat makes connectivity a critical issue for their survival. Connectivity gives salmonids access to natal spawning grounds, the ability to move between different rearing habitats, and escape from adverse conditions (including high water temperatures, fluctuating flows, and high turbidity), and it allows populations to recolonize areas after catastrophic events. While both natural features (such as floods and logjams) and man-made structures (such as dams and roads) can change habitat connectivity, the degree to which natural features block access generally varies seasonally. Loss of connectivity from man-made structures is generally permanent and leads to the loss of large areas of previously available habitat.

### Low turbidity

High concentrations of suspended solids reduce light penetration, leading to a reduction in algal productivity and nutrients for salmonids. Suspended particulate matter may also physically abrade fish gills, decreasing the ability of the fish to breathe (Spence et al., 1996).

### Natural stream flows

Adult migration and spawning depends on the natural and unaltered stream flow regimes. Peak flows beyond natural levels may cause increased movement of large woody debris and bed materials (such as gravel, cobble, and boulders), decreasing egg and fry survival by increasing channel scour, bank erosion, and sedimentation. Low summer flows can also affect both adult migration and juvenile rearing due to decreased dissolved oxygen concentrations, increased water temperature, reduced availability of habitat as a result of decreased water depths, and increases in predation associated with migrating fish being concentrated in available habitat.

The changes associated with both high and low flow events are important for the persistence of salmonid populations. High-flow events redistribute sediments in streams, flushing fine sediments from spawning gravels and allowing recruitment of gravels to downstream reaches. In addition, high flows are essential in the development and maintenance of healthy floodplain systems through deposition of sediments, recharge of groundwater aquifers, recruitment and transport of large woody debris, and creation of side channels. Low flows may also be important for establishing riparian vegetation on gravel bars and along stream banks, providing additional terrestrial food sources and habitat complexity (Spence et al., 1996).

### Shoreline/riparian buffers

Both fresh- and saltwater shoreline buffers are important for maintaining bank stability, shading, and organic matter, as well as for recruitment of large woody debris. In addition to contributing leaf detritus, riparian vegetation produces insects that fall into the water and supplement juvenile salmonid diets (Murphy & Meehan, 1991). Riparian buffers are especially important as the source of large woody debris and thereby directly influence several habitat attributes important to

salmonids, such as pool formation and maintenance, refugia, prey availability, and sediment storage (Forest Ecosystem Management Assessment Team, 1993; Spence et al., 1996).

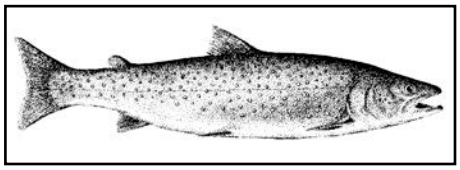
### Wetlands

Wetlands play a vital role in watershed health as a whole, benefiting humans as well as other animals and plants. In addition to playing a key role in groundwater recharge, wetlands reduce flood events by slowing and storing storm flows. They also help convert inorganic nutrients into organic forms, breakdown pollutants, and store sediments (Mitsch & Gosselink, 1999; Reinelt & Horner, 1990; Richardson, 1994). Larger, deeper wetlands may also provide foraging and overwintering habitat for both resident and anadromous salmonids (Peterson, 1982).

## Bull trout *(Salvelinus confluentus)*

### Life history

Bull trout exhibit resident, fluvial, adfluvial, and anadromous life history forms, and individuals are capable of adopting more than one strategy during the course of a lifetime, as well as alternating strategies from year to year (Goetz et al., 2004). They reach sexual maturity at approximately 5 years of age, and they may live as long as 15 years (Donald & Alger, 1993; Wydoski & Whitney, 2003). Migratory forms of this species grow to lengths of 60 centimeters (23 inches), while lengths for resident forms range between 15 and 30 centimeters (6–12 inches) (Wydoski & Whitney, 2003).



Bull trout. Graphic: D. Pruett

Unlike salmon, bull trout are capable of spawning more than once (iteroparous). Females deposit between 100 and 10,000 eggs per spawning event. Spawning migrations of fluvial, adfluvial, and anadromous bull trout may begin as early as April, with spawning occurring in late summer and fall in small headwater streams at temperatures of 5 to 9° C (41–48° F) (Meehan & Bjornn, 1991). *Fecundity* ranges between 74 and 12,000, and often correlates with size and with resident fish having the fewest number of eggs (Wydoski & Whitney, 2003). Egg development is dependent on temperature: In colder waters, 6 months can pass before the alevins emerge (Meehan & Bjornn, 1991).

Although anadromous, adfluvial and fluvial bull trout typically rear in their natal streams for 2 to 4 years; resident fish may remain in their streams for their entire lives. Fluvial and adfluvial forms 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. Anadromous bull trout migrate to saltwater. Approximately 84 percent of bull trout out-migrants captured in northern Puget Sound are 3 years old (Goetz et al., 2004).

Bull trout are opportunistic feeders, and their diet appears to vary seasonally with the availability of prey items (Goetz et al., 2004). Bull trout in lakes prey on invertebrates (such as chironomidae, ephemeroptera, trichoptera, and amphipods) and on smaller fish, such as mountain whitefish *(Prosopium williamsoni)*, lake whitefish *(Coregonus clupeaformis)*, and kokanee *(Oncorhynchus nerka)*. Exact diets depend on the availability of prey and on competitive pressures (Donald & Alger, 1993). While the resident form of this species may subsist entirely on insects, migratory forms become increasingly *piscivorous* as they increase in size.

### Habitat use

Bull trout require cold, clean water. Although they are generally absent when temperatures rise above 18° C (64° F), bull trout have been observed in lakes with temperatures up to 20° C (68° F) (Donald & Alger, 1993). Increased stream temperatures negatively affect 11 of 34 subpopulations in the coastal Puget Sound population (U.S. Fish and Wildlife Service, 2004).

All bull trout spawn in small headwater tributaries, and resident forms often remain within a few hundred meters of their natal stream throughout their lives. Fluvial forms move into larger streams for growth and maturation, while adfluvial forms migrate to lakes and anadromous bull trout migrate to the more productive nearshore marine and estuarine wetland ecosystems for growth and maturation. *Young-of-the-year* use low velocity habitats, such as side channels and the lateral margins of streams, where they feed primarily on aquatic invertebrates and fish eggs (Wydoski & Whitney, 2003).

Bull trout in the nearshore ecosystem rely upon estuarine wetlands and favor irregular shorelines with unconsolidated substrates over rocky (consolidated) types of habitat (Goetz et al., 2004). Juveniles may rear within estuarine wetlands and tidally influenced distributary channels (Goetz et al., 2004). Juvenile bull trout have been observed using tidal sloughs in the Chehalis River and tidally influenced floodplain areas of Puget Sound (U.S. Fish and Wildlife Service, 2004). The distribution of bull trout in the nearshore ecosystem depends upon the abundance and distribution of food prey items, such as sand lance, juvenile salmonids, surf smelt, and Pacific herring.

Bull trout tend to use the nearshore ecosystem during the spring and late summer months, but do not forage exclusively in the marine environment. Observations of individuals show that bull trout migrate hundreds of kilometers through the nearshore ecosystem in order to forage in different river basins (Goetz et al., 2004).

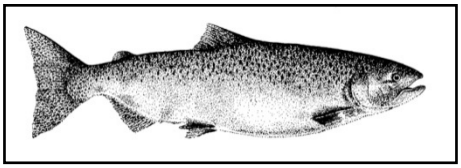
### Distribution

Bull trout occur from the headwaters of the Yukon River in Alaska to the Klamath basin in Oregon (Dunham et al., 2003). In the Pacific Northwest, populations occur in the interior regions of the Columbia River and in parts of Montana, Idaho (the Wood River), Nevada (the Jarbridge River), and Canada (Bond, 1992). Bull trout are widely distributed in the state of Washington, and their current overall range is likely similar to their historical range (Washington Department of Fish and Wildlife, 2000). This habitat conservation plan covers both the Columbia River and coastal-Puget Sound evolutionarily significant units. In 2010, the U.S. Fish and Wildlife Service finalized critical habitat designations for bull trout in all of Washington State.

## Chinook salmon *(Oncorhynchus tshawytscha)*

### Life history

While the generalized life history of Chinook salmon is typical of anadromous Pacific salmon, the variety of life history types among Chinook salmon makes their habitat requirements particularly complex. The species is generally divided into three categories based on when the adults return to freshwater: spring run (March to May), summer run (June and July), and fall run (August and September) (Wydoski & Whitney, 2003). All Chinook spawn in the fall, with the spring runs spawning first in headwater streams, followed by



Chinook salmon. Graphic: D. Pruett

summer Chinook near tributary mouths, and fall types in main stem tributaries (Wydoski & Whitney, 2003). This species also exhibits one of two life history types or races: the stream-type and the ocean-type (Good et al., 2005). Stream-type Chinook tend to spend one or more years in freshwater environments as juveniles prior to migrating to saltwater and moving quickly into subtidal and offshore habitats (Beamer et al., 2005). Juveniles of the ocean-type Chinook depend more on estuarine habitats than any other species of salmon (Healey, 1991). They exhibit one of three post-emergence life history strategies:

1. A quick migration to saltwater and minimal use of tidal deltas (fry migrant).
2. A quick migration to saltwater, followed by several weeks or months in tidal deltas (tidal delta rearing migrants).
3. Rearing in freshwater for several months, followed by migration to saltwater and minimal use of tidal deltas (parr migration) (Beamer et al., 2005).

Pocket estuaries appear to play a critical role in the survival of fry and parr migrants and serve to relieve overcrowding in tidal deltas (Beamer et al., 2003, 2005).

With an average length of approximately 1 meter (3 feet) and weights ranging from 1 to 56 kilograms (2–123 pounds), adult Chinook are the largest of the Pacific salmon. The species spends between 2 and 6 years at sea prior to returning to freshwater to spawn, but this time varies between stocks and also depends somewhat on ocean conditions (Meehan 1991; Wydoski and Whitney 2003). Chinook tend to spawn in large river systems. In Washington, the species spawns at sites with escape cover, such as logs, undercut banks, and deep pools, that are dominated by large gravel or cobble between 2.5 and 15 centimeters (1–6 inches) in diameter (Healey, 1991; Meehan, 1991). As with other salmonids in Washington, fecundity correlates with size, and females produce between 3,385 and 5,504 eggs (Wydoski & Whitney, 2003). Chinook generally spawn at depths of less than 3 meters (3.3 feet), although Chinook have been observed spawning in the tailraces along the lower Snake River at depths of up to 9 meters (10 feet) (Wydoski & Whitney, 2003). Like other salmonids, Chinook often spawn in areas used by other salmon earlier in the year (Meehan, 1991). Male salmon die shortly after spawning, while adult females may spend 4 to 25 days guarding redds before dying (Healey, 1991).

While the length of time it takes for eggs to hatch depends heavily on water temperature, Chinook eggs generally hatch between 90 and 150 days after deposition. Optimal temperatures for incubation are between 7 and 10° C (45–50° F); although eggs hatch sooner in warmer water, the alevins that emerge are generally smaller and have lower survival rates (Healey, 1991). Alevins typically remain in the gravel for 2 to 3 weeks (Wydoski & Whitney, 2003). Newly emerged fry move to shallower pools where they establish and defend feeding areas (Meehan, 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, and beetles), earthworms, and small crustaceans, such as Dungeness crab larvae and juveniles (Botsford & Lawrence, 2002; Healey, 1991). Their diets become more piscivorous with age: Adult Chinook feed primarily on larval and juvenile fish, as well as smaller species, such as Pacific herring, anchovy, and sand lance, while at sea (Healey 1991; Wydoski & Whitney, 2003).

### Habitat use

Juvenile Chinook can occupy stream reaches with bottom current velocities of approximately 0.02 to 0.04 cubic meters per second (0.8–1.4 cubic feet per second) and depths ranging between 0.2 and 0.6 meters (0.7–2 feet) (Wydoski & Whitney, 2003). Younger juveniles seek out covered

areas with lower flow near the edges of stream and river channels; they move to higher-velocity, midstream areas as they mature (Healey, 1991).

Ocean-type juveniles, which are typically the progeny of fall- and summer-run spawners, move slowly downstream after emerging from redds. Stream-type juveniles, meanwhile, overwinter in freshwater for at least 1 year and characteristically begin their downstream migration in the spring of the following year (Wydoski & Whitney, 2003). Stream-type juveniles in systems with higher percentages of large woody debris show higher overwinter survival rates (Murphy et al., 1986). Juvenile Chinook have also shown a preference for seasonally inundated floodplains in larger river systems (Sommer et al., 2001).

Ocean-type Chinook typically migrate to estuaries within 3 months of emergence, average about 50 to 70 millimeters (2–2.8 inches) in length, and make extensive use of estuarine and nearshore habitat for rearing (Healey, 1991). Stream-type (yearling) smolts, on the other hand, are much larger than ocean-type (sub-yearling) smolts and exhibit less reliance on estuaries for rearing (Beamer et al., 2005).

Because of their extended freshwater migration period, migrating 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).

### Distribution

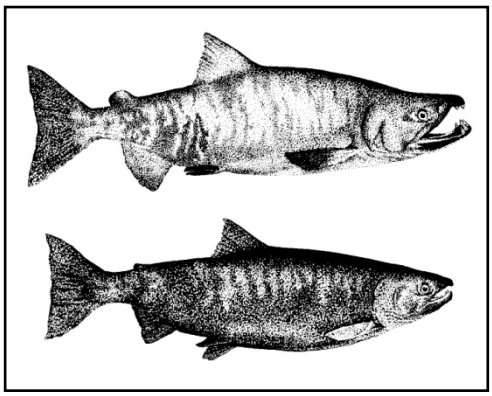
The historic range of Chinook within the state of Washington included most rivers, and fish migrated to the headwaters of the Columbia and Snake rivers (Good et al., 2005; Healey, 1991; Meehan, 1991; Wydoski & Whitney, 2003). Chinook inhabit the rivers and streams of Puget Sound (including Hood Canal and the Strait of Juan de Fuca), the Pacific coast, and the middle and lower Columbia River and its tributaries (Wydoski & Whitney, 2003). Some landlocked, resident populations occur in Lake Washington, Lake Cushman, and Lake Roosevelt (Wydoski & Whitney, 2003).

Washington stocks fall under nine federal evolutionarily significant units, with the lower Columbia River, Puget Sound, Snake River fall-run, Snake River spring/summer run, and upper Columbia River spring-run listed as threatened. In addition to those stocks, this plan also includes the middle Columbia River spring-run, Puget Sound Strait of Georgia, upper Columbia River fall-run, and Washington coast units. In 2000, NOAA Fisheries designated federal critical habitat for Puget Sound and lower and upper Columbia Chinook runs.

## Chum salmon *(Oncorhynchus keta)*

### Life history

In size and weight, chum salmon are second only to Chinook, reaching up to 1 meter (3 feet) long and about 20.8 kilograms (46 pounds). As with other Pacific salmon, chum are *anadromous* and *semelparous* (they perish after spawning). Adults return to spawn between 2 and 6 years of age, entering coastal streams from June to November (Froese & Pauly 2004; Neave et al., 1976; Wydoski & Whitney, 2003). 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. Grapic: D. Pruett

Chum females produce between 2,000 and 3,600 eggs each. Spawning females typically favor sites with current velocities of 0.02 to 0.08 cubic meters per second (0.7–2.8 cubic feet per second) and depths of approximately 0.5 meters (1.6 feet), with substrates ranging from medium gravel to bedrock strewn with boulders (Johnson et al., 1971; Quinn, 2005; Scott & Crossman, 1973). Hatching time varies from approximately 45 to 182 days, depending on water temperatures (Salo, 1991).

Alevins emerge from the gravel 30 to 50 days after hatching and quickly migrate toward estuarine rearing habitat. In Washington, the fry migrate downstream from late January through June, with migration peaking between April and June (Wydoski & Whitney, 2003). Chum fry lack an obvious hiding response to disturbances, but congregate in the shade of aquatic and riparian vegetation for refuge from predators (Salo, 1991).

Although there is little information concerning feeding behavior during their downstream migration, chum fry have been observed to feed intensely upon chironomid and mayfly larvae, as well as other aquatic insects (Salo, 1991). Juveniles generally prey on epibenthic crustaceans, while larger juveniles may prey on terrestrial insects, copepods, amphipods, and other zooplankton (Simenstad et al., 1982). Migration timing along the nearshore seems linked to prey abundance; offshore migration occurs either when nearshore prey availability becomes low or when juveniles are large enough to feed on larger offshore zooplankton (Salo, 1991; Simenstad, 1983).

## Habitat use

Chum salmon usually spawn in low elevation reaches, because they are unable to negotiate riverine blockages or falls due to a reduced ability to leap. 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 (1,553 miles) and 170 kilometers (105 miles) upstream respectively (Johnson et al., 1997).

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; Quinn, 2005; Wydoski & Whitney, 2003). Estuarine wetlands are critical to chum salmon survival, because they provide an abundance of prey, 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 occurs in productive and shallow eelgrass beds until the juveniles reach 30 to 66 millimeters (1.2–2.6 inches) in length and move offshore. Juvenile habitat usage may be due in part to possible overlap with returning adult chum salmon (Hood Canal summer-run), which may feed upon juveniles (Johnson et al., 1997). As major predators of chum juveniles in estuarine wetlands, returning chum salmon adults are joined by juvenile coho salmon *(Oncorhynchus kisutch)*, cutthroat trout *(O. clarki clarki)*, and aquatic birds. In addition to predation, causes of mortality in estuaries include cold temperatures, extreme changes in water flow, habitat degradation, disease, and *interspecific* competition from native and exotic species (Johnson et al., 1997).

Detailed studies of residence time in estuaries do not exist. Juveniles begin their seaward migrations in April, with larger fish leaving first. The young fish migrate northward through Puget Sound to the Strait of Georgia and have been observed along the coast of Washington and the west coast of Vancouver Island by mid-May. A study by Hartt and Dell in 1986 found that in their first year in the ocean, chum salmon tended to stay within 36 kilometers (22 miles) of the shore.

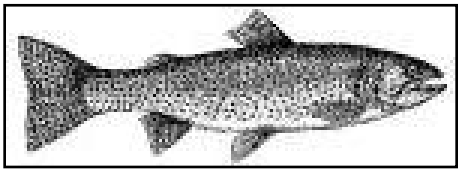
### Distribution

In Washington state, chum salmon can inhabit 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 & Whitney, 2003). The stocks are divided into four evolutionarily significant units: Puget Sound/Strait of Georgia, Hood Canal summer-run, Pacific Coast, and Columbia River (Johnson et al., 1997). Critical habitat designations were applied to the Hood Canal and Columbia River runs in 2000. Chum salmon have the most extensive distribution of all Pacific salmon. Their western reach encompasses Korea, Japan, and Russia, including the Arctic coast.

## Coastal cutthroat trout *(Oncorhynchus clarki clarki)*

### Life history

Similar to bull trout, coastal cutthroat trout are repeat spawners (iteroparous) and exhibit resident, fluvial, adfluvial, and anadromous life history forms. Although the species reaches sexual maturity between 2 and 3 years of age, many anadromous fish do not spawn upon their first return to freshwater (Wydoski & Whitney, 2003). Resident fish tend to be small as adults (15–30 centimeters or 6–12 inches in length), with anadromous individuals living to 10 years of age and attaining lengths of 43 to 48 centimeters (17–19 inches) (Pauley et al., 1989).



Coastal cutthroat trout. Graphic: D. Pruett

This species spawns from July through January in small tributaries with flows of less than 0.14 cubic meters per second (5 cubic feet per second) and total drainage areas of less than 1,300 hectares (3,212 acres) (Pauley et al., 1989). Females typically spawn upstream of salmon and steelhead spawning areas, depositing between 250 to 2,700 eggs in riffles at water depths of 15 to 45 centimeters (6–18 inches). Substrates selected for spawning typically range in size between 0.1 and 5 centimeters (0.04–2 inches) (Wydoski & Whitney, 2003).

Egg development depends on an optimal temperature of 10 to 11° C (50–52° F), with incubation lasting 6 to 7 weeks at those temperatures (Johnson et al., 1999; Pauley et al., 1989). Although cutthroat eggs and alevins tolerate fine sediment due to their relative smallness, the success rate for incubation and emergence decreases as the percentage of fine sediments in the interstitial spaces of the gravel increases.

Coastal cutthroat trout typically rear in their natal streams for up to 2 years, occupying streams with step-pool, plane-bed, pool-riffle and low gradient habitats (Connolly & Hall, 1999; Moore & Gregory, 1988a). Fluvial and adfluvial coastal cutthroat trout migrate out of their natal streams between 1 and 4 years of age (Wydoski & Whitney, 2003). Most anadromous forms migrate to saltwater during the spring at 2 to 4 years of age (Meehan & Bjornn, 1991). Resident fish may remain in their natal streams for their entire lives, while migratory fish move out to larger rivers, lakes, and estuaries.

Young fish feed primarily on aquatic invertebrates, but are opportunistic and will use other food sources, such as terrestrial invertebrates, zooplankton, and fish eggs (Pauley et al., 1989). Resident cutthroat trout may subsist entirely on insects, while their migratory counterparts become increasingly piscivorous as they increase in size.

### Habitat use

Resident coastal cutthroat generally use small headwater and mid-size streams for all of their life-stages, residing within a few hundred meters of where they hatched or moving downstream to occupy larger habitat areas (such as deeper pools) as they grow larger. Fluvial cutthroat move out of their natal streams to larger rivers, and adfluvial fish extend their migration to downstream lakes. Although young-of-the-year typically use low velocity habitats (such as side channels and stream margins) associated with shallow, fast moving streams, adults prefer deeper pools with slower velocities. Moore and Gregory (1988a; 1988b) found that fry and juvenile fish in stream reaches with an abundance of low-velocity habitats attained larger sizes than fish in reaches with less cover. 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 & Whitney, 2003).

After their downstream migrations, anadromous coastal cutthroat forage in estuarine wetlands, as well as nearshore coastal and inland waters, and typically occur in water less than 3 meters (10 feet) in depth. Available information indicates that this species will also occupy river deltas, distributary channels, and shallow shorelines, thereby demonstrating some preference for unconsolidated substrates (Johnson et al., 1999; Pauley et al., 1989). Although evidence suggests that coastal cutthroat trout rarely occur in marine waters greater than 3 meters (10 feet) deep, the species has been captured by fishing vessels in water up to 80 kilometers deep off the Oregon/Washington coast (Pauley et al., 1989; Wydoski & Whitney, 2003).

### Distribution

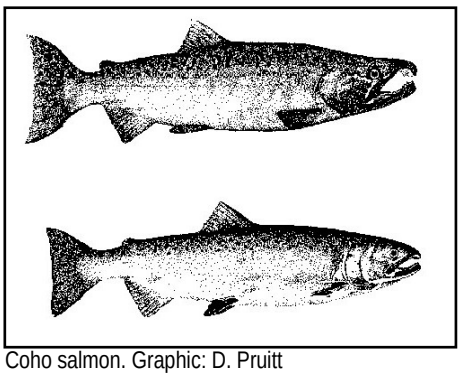
Three of the six defined evolutionarily significant units of coastal cutthroat occur in the state of Washington: Puget Sound, Olympic Peninsula, and southwestern Washington (Johnson et al., 1999). The fish are distributed in large rivers and small tributaries of the Columbia River up to the Bonneville Dam and drainage basins on the west side of the Cascade Mountains, including the Olympic Peninsula .

## Coho salmon *(Oncorhynchus kisutch)*

### Life history

While the life history of coho is typical of other Pacific salmon, this species tends to use a greater diversity of habitats than the other native anadromous species and can be found in headwater streams, small coastal creeks, and tributaries of major rivers (Meehan, 1991). 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. At maturity, coho weigh between 3 and 6 kilograms (7–13 pounds), with lengths ranging from 50 to 75 centimeters (20–30 inches) (Wydoski & Whitney, 2003).

Although the timing is often unique for each run, in Washington, coho generally return to spawn beginning in August. Spawning occurs from September through January, with the adults entering freshwater earliest and moving the farthest upstream (Groot & Margolis, 1991; Meehan, 1991; Wydoski & Whitney, 2003). Females lay an average of 3,500 eggs in gravel areas that are free of heavy sedimentation and that have adequate flow and cool, clear water. Eggs hatch within 6 to 8



Coho salmon. Graphic: D. Pruitt

weeks and alevins remain in the gravel for an additional 2 to 3 weeks (Wydoski & Whitney, 2003). Upon emergence, fry move to shallow, protected areas of the stream, usually seeking pools formed by large woody debris or boulders, where they establish and defend feeding areas (Hartman, 1965; Meehan, 1991). Juveniles migrate to saltwater in the spring when they are 1 to 2 years of age.

Coho fry feed primarily on aquatic insects, such as mayflies, caddisflies, and chironomids, but they also eat terrestrial insects and earthworms. Both juveniles and adults feed on invertebrates, but become more piscivorous as they grow larger, commonly eating sand lance and other forage fish, smaller rockfish, pollock, and flatfish (Groot & Margolis, 1991; Wydoski & Whitney, 2003).

## Habitat use

Juvenile coho exhibit a strong preference for freshwater structural components, such as undercut banks, large woody debris, root wads, and off-channel pools and channels, for protection from high winter flows (McMahon & Hartman, 1989; Nickelson et al., 1992). Bustard and Narver (1975a; 1975b) found that beaver ponds were an important overwintering area for juvenile coho, which have a survival rate roughly twice that of the entire stream system.

In their transition to ocean phase, migrating smolts depend upon estuarine and marine waters and are comparatively larger than juvenile Chinook and chum found in the same areas (Levy & Northcote, 1982; Weitkamp et al., 1995). Early out-migrating coho fry may feed and rear in productive estuarine habitats for several weeks, and they are often found in eelgrass meadows and tidal flats (Miller & Sadro, 2003). As adults, coho can be divided into two types: ocean and coastal, with ocean types occupying offshore waters and coastal types using nearshore waters (Groot & Margolis, 1991).

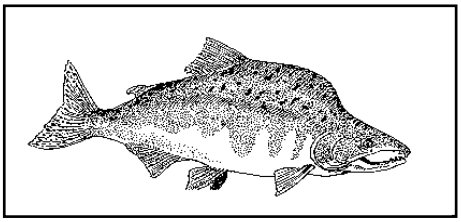
## Distribution

Coho probably inhabited most of the coastal streams in Washington, and some extinct populations once spawned in tributaries of the upper Columbia River (Groot & Margolis, 1991; Nehlsen et al., 1991; Weitkamp et al., 1995; Wydoski & Whitney, 2003). Current populations occur throughout Puget Sound, Hood Canal, the Strait of Juan de Fuca, the Olympic Peninsula, and the Columbia River Basin. Washington stocks fall under three federal evolutionarily significant units: the lower Columbia River, Olympic Peninsula, and Puget Sound /Strait of Georgia.

## Pink salmon *(Oncorhynchus gorbuscha)*

### Life history

Pink salmon are the smallest of the Pacific salmon, maturing on a two-year cycle. In Washington, pink salmon spawn only in odd years, except in the Snohomish River, which has both odd- and even-year spawners. Adults range in length from 30 to 75 centimeters (12–30 inches) and weigh on average almost 2 kilograms (5 pounds) (Wydoski & Whitney, 2003). They spend a little over a year in the open ocean before returning to spawn.



Pink salmon. Graphic: R. Savannah, U.S. Fish and Wildlife Service

Spawning migrations in Washington typically occur in August and September (Hard et al., 1996; Wydoski & Whitney, 2003); however, arrival times can vary within and between river systems, leading to both an early and a late run (Hard et al., 1996). Unlike other Pacific salmon, pink salmon rarely make extended spawning runs and generally spawn near river mouths or a short distance upstream in fast-flowing current (Wydoski & Whitney, 2003). Spawners may remain in local bays for up to a month before migrating into the river; this delay allows for full gonadal development (Heard, 1991). Although intertidal spawning occurs, it is not common in Washington (Hard et al., 1996).

Pink salmon spawning behavior is similar to that of other salmonids, with females often digging redds in riffles with small- to medium-sized gravel; documented exceptions include the tail-ends of pools (Wydoski & Whitney, 2003). This species prefers to spawn in clear, fast-flowing streams. Pink salmon also spawn in rivers with substantial amounts of silt from glacial runoff, such as the Nisqually and Nooksack (Hard et al., 1996; Wydoski & Whitney, 2003). Females lay an average of 2,800 eggs, which hatch in 3 to 5 months (Hard et al., 1996; Wydoski & Whitney, 2003). Alevins may remain in the gravel for several months; emergence peaks during March and April (Heard, 1991; Quinn, 2005).

### Habitat use

Out-migrant juvenile pink salmon move quickly to saltwater-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, although foraging usually occurs in the water column in nearshore areas along beaches or shorelines with complex structural characteristics (Heard, 1991). Juveniles form schools in nearshore habitats for several months during the summer, but move offshore by late summer or early fall (Hard et al., 1996; Wydoski & Whitney, 2003). Some Puget Sound populations spend their entire marine life in marine-nearshore habitats (Hard et al., 1996).

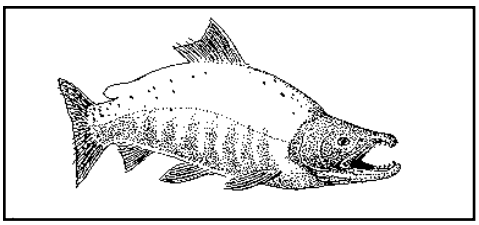
### Distribution

Pink salmon are the most abundant species of Pacific salmon and are found throughout the north Pacific, including northern Asia. 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, Dosewallips, Dungeness, and Elwha rivers (Wydoski & Whitney, 2003). Pink salmon have also been reported in other systems (for example, the Bogachiel River and Lake Washington), but these individuals are considered strays (Wydoski & Whitney, 2003).

## Sockeye salmon/kokanee *(Oncorhynchus nerka)*

### Life history

Sockeye is one of the most complex of any Pacific salmon species, both 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 (kokanee) remain in fresh water throughout their life spans (Wydoski & Whitney, 2003). Anadromous forms stay at sea for 2 to 4 years, reaching a maximum length of 83 centimeters (33 inches) and weighing between 1.5 and 3.5 kilograms (3.3–7.7 pounds) at maturity. Landlocked forms are generally smaller (lengths 20 to 40 centimeters or 8 to 16 inches) (Wydoski & Whitney, 2003).



Sockeye salmon/kokanee. Graphic: R. Savannah, U. S. Fish & Wildlife Service

Adult sockeye salmon home in and return to their natal stream or lake habitat, and stream fidelity is thought to be adaptive, ensuring that juveniles will encounter a suitable nursery lake (Hanamura, 1966; Quinn, 1984; Quinn et al., 1987). Spawning begins as early as August and may continue into February. Each female deposits up to 4,000 eggs in shallow water along lakes and rivers with gravel substrates (Wydoski & Whitney, 2003). Upon emergence, sockeye fry migrate downstream to the deep waters of nursery lakes and are particularly susceptible to predation because of their small size (25 to 32 millimeters or 1 to 1.3 inches).

Growth influences the duration of juvenile residency in nursery lakes. The growth rate is influenced by intraspecific and interspecific competition, food supply, water temperature, thermal stratification, migratory movements to avoid predation, lake turbidity, and the length of the growing season. Anadromous juveniles characteristically rear in lakes for 1 to 3 years before out-migrating (Burgner, 1991). Kokanee continue their lake residency and become sexually mature at ages 2 to 3 years (Wydoski & 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).

Juvenile forms and adult kokanee largely feed on zooplankton, while sockeye adults are generally piscivorous (Wydoski & Whitney, 2003).

### Habitat use

Compared to other Pacific salmon, sockeye exhibit substantial diversity in selecting spawning habitat, timing in entering rivers, and the duration of holding in lakes prior to spawning. Although the species typically spawns in inlet or outlet tributaries of a nursery lake, they may spawn in suitable habitat between lakes or along the shore of nursery lakes on tributary outwash fans or submerged beaches where groundwater upwelling occurs. Sockeye also spawn along beaches where the gravel or rocky substrate is free of fine sediment and the wind-driven circulation provides oxygen to the eggs, or in main-stem rivers without juvenile lake-rearing habitat (Burgner, 1991).

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).

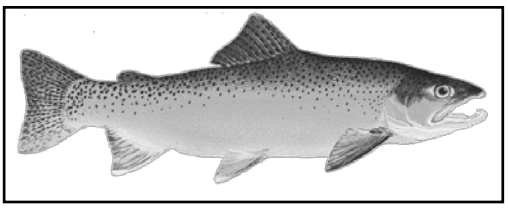
### Distribution

Populations of sockeye occur in a number of lakes and rivers throughout the state of Washington, including the Snake River, Okanogan River, Lake Wenatchee, Lake Quinault, Lake Ozette, Baker River, Lake Pleasant, Lake Washington, and Big Bear Creek drainages. River sockeye regularly spawn in the north and south forks of the Nooksack River, the lower Samish, the upper Skagit and Sauk rivers, and the north fork of the Stillaguamish River, as well as the Wallace, Green, and Dungeness rivers. Although genetics are unclear, these river spawners are likely part of a wide-ranging west coast population. The landlocked form of sockeye (kokanee) occurs in many lakes throughout Washington, and many of these populations are the result of hatchery fish stocking. Some of the larger populations are in Banks and Loon lakes in eastern Washington, and lakes Whatcom, Washington, and Sammamish in western Washington (Wydoski & Whitney, 2003). The stocks fall under eight federal evolutionarily significant units: Baker River, Okanogan River, Lake Wenatchee, Quinault Lake, Lake Pleasant, Kokanee, Ozette Lake, and the Snake River. The NOAA Fisheries designated Ozette Lake as critical habitat in 2000.

## Steelhead trout (Oncorhynchus mykiss)

### Life history

During their ocean phase of life, steelhead range from Alaska to Japan and are generally found within 16 to 40 kilometers (10–25 miles) of the shore (McKinnell et al., 1997; Wydoski & Whitney, 2003). Steelhead generally rear in freshwater for 2 years, followed by 2 years at sea, before returning to spawn (Busby et al., 1996). They attain lengths of approximately 60 centimeters (24 inches) and weights of 2.5 to 5 kilograms (5.5–11 pounds) (Wydoski & Whitney, 2003). Similar to bull trout and coastal cutthroat, steelhead are capable of spawning more than once (semelparous) and return to the ocean after spawning (Wydoski & Whitney, 2003).



Steelhead trout. Graphic: Windsor Nature Discovery

Most steelhead spawn at least twice in their lifetimes, and many return to spawn three or four times (Wydoski & 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 & Whitney, 2003). Females spawn at depths of 0.2 to 0.4 meters (0.6–1.3 feet) in mixed gravel (1 to 10 centimeters or 0.4 to 4 inches) and deposit an average of 3,434 eggs across several redds (Wydoski & Whitney, 2003).

Although time to hatching is temperature dependent, steelhead eggs generally hatch within 50 days at 10° C (50° F) (Wydoski & Whitney, 2003). Alevins typically remain in the gravel for another 4 to 6 weeks. Upon emergence, fry usually move to shallow, protected areas at the stream margins, where they establish and defend feeding areas (Wydoski & Whitney, 2003). Most juveniles move into riffles or to the head of shallow pools, although larger juveniles will move to deeper areas of pools or runs (Meehan, 1991). Out-migrating smolts typically leave their natal streams when they are between 2 and 4 years of age (Groot & Margolis, 1991).

Young-of-the-year feed primarily on aquatic insects, such as mayflies, caddisflies, and chironomids, although terrestrial invertebrates are important prey (Groot & Margolis, 1991). As

steelhead grow larger, they become mainly piscivorous feeders on juvenile rockfish, sand lance, sculpin (Cottidae), and greenlings (Hexagrammidae). They also feed on invertebrates, especially euphausiids, amphipods, copepods, and squid (Groot & Margolis, 1991).

### Habitat use

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 that are less than 0.6 meters (2 feet) deep (Meehan, 1991). Like other species of salmonids, juvenile steelhead trout generally prefer areas that include large woody debris, root wads, 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). Escape cover, such as logs, undercut banks, and deep pools are important for adult and young steelhead (Meehan, 1991).

Although steelhead trout use all types of freshwater riverine habitat for rearing, they prefer faster water (such as riffles) than do the coho and Chinook salmon rearing in the same streams (Meehan, 1991).

### Distribution

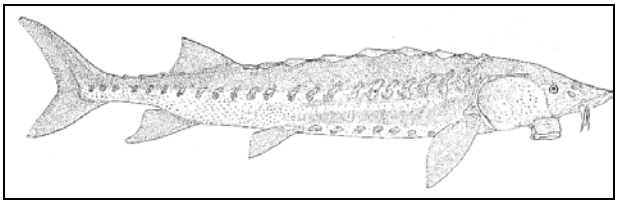
Steelhead populations in Washington are divided into five federal evolutionarily significant units: the upper Columbia River; middle Columbia River; lower Columbia River; Puget Sound, Olympic Peninsula, and southwest Washington; and the Snake River—and occur in all 10 reporting units. In 2000, NOAA Fisheries designated critical habitat for steelhead runs in the upper, middle and lower Columbia and Snake rivers.

## Green sturgeon *(Acipenser medirostris)*

Characterized by large size, sturgeon have a long life expectancy and grow slowly. They are bottom feeders, and although they rely heavily on crustaceans (shrimp, crabs, and amphipods), mollusks (clams, mussels, and snails), and worms, they are also known to consume small fish (Adams et al., 2002; Hart, 1973; Wydoski & Whitney, 2003).

### Life history

Adult green sturgeon reside in subtidal areas, moving from coastal marine waters into estuaries and rivers to feed and spawn (Emmett et al., 1991). Estimated to live up to 60 years, the green sturgeon can reach lengths of approximately 2 meters (6.5 feet) and weights of 136 kilograms (300 pounds) (Emmett et al., 1991; Hart, 1973). Reproductive maturity occurs between 15 and 17 years of age, and females produce 60,000 to 140,000 eggs every 3 to 5 years (Adams et al., 2002). There are no documented spawning locations for green sturgeon within the state of Washington; however, the species spawns in the Sacramento, Klamath, and Rogue rivers from March to July (Adams et al., 2002; Wydoski & Whitney, 2003).



Green sturgeon. Graphic: NOAA Fisheries

Optimal temperatures for incubation range from 10 to 18° C (50–65° F), with egg mortality occurring at temperatures exceeding 20° C (68° F) (Wydoski & Whitney, 2003). Larvae emerge within approximately 8 days and begin feeding about 10 days after hatching (Adams et al., 2002).

Larvae metamorphose into juveniles at approximately 45 days, remaining in the tidal freshwater areas of their natal rivers for 1 to 4 years before migrating out to nearshore marine waters (Emmett et al., 1991). Young sturgeon grow rapidly (up to 300 millimeters or 11 inches in one year) on a diet of benthic invertebrates (amphipods and mysid shrimp) (Adams et al., 2002; Wydoski & Whitney, 2003). 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).

### Habitat use

Adult sturgeon make extensive use of coastal estuaries, where benthic organisms are plentiful. Eggs are broadcast spawn on mixed substrates (coarse sand to bedrock) in deep areas with swift currents, where the eggs settle into crevices and spaces in the substrate (Adams et al., 2002; Emmett et al., 1991).

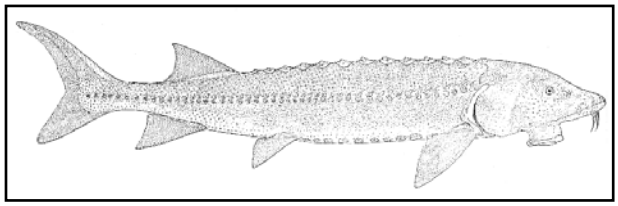
### Distribution

While there are no known spawning populations of green sturgeon in Washington, they can be locally common throughout the state's saltwater habitats (Adams et al., 2002). Fisheries data show minor catches in Puget Sound and coastal Washington, with summer concentrations of green sturgeon found in Willapa Bay and Grays Harbor and in the Columbia River below Bonneville Dam (Adams et al., 2002). Recent telemetry data suggest that both the northern and southern distinct population segments migrate up and down the Pacific coast, with fish in Washington moving between Willapa Bay and the Columbia River (Moser & Lindley, 2006).[1] The northern distinct population segment spawns in the Klamath Basin, while the southern population spawns in the rivers of California's San Pablo Bay basin. The southern population of green sturgeon was listed as threatened in 2006 and critical habitat designated in 2009.

## White sturgeon (Acipenser transmontanus)

### Life history

White sturgeon are the largest fish in North America's freshwater environments (Wydoski & Whitney, 2003). Their life spans may exceed 100 years (Emmett et al., 1991). Although this species is anadromous, it is also capable of completing its entire life cycle in freshwater, and several stocks occur in the dam impoundments along the Columbia River. The majority of white sturgeon in the lower Columbia River do not become sexually mature until 16 to 35 years of age (Wydoski & Whitney, 2003).



White sturgeon. Graphic: NOAA Fisheries

Spawning typically occurs from early spring to early summer in large river channels with swift currents (0.7 to 2.8 meters per second or 2.3 to 9 feet per second in the Columbia River) and a substrate composed of cobble or boulders (Emmett et al., 1991). These habitats are often limited to areas

[1] Distinct population segments are those species subgroups that are either physically, behaviorally, or ecologically separated from other populations; or subgroups that use habitat across political boundaries with differing regulatory and management mechanisms (Federal Register, Volume 61, 4722; http://www.fws.gov/endangered/POLICY/Pol005.html)

below rapids or dams. Like other sturgeon species, white sturgeon will spawn multiple times over the course of their lives, with 3 to 11 years separating spawning events (Emmett et al., 1991; Wydoski & Whitney, 2003). Fecundity of white sturgeon is high: mature females produce between 100,000 and 300,000 eggs, and larger individuals may produce over a million eggs. Fertilized eggs settle to the river bottom, where they attach to cobble and hatch in 4 days to 2 weeks, depending on temperature (Emmett et al., 1991). Optimal temperatures for incubation range between 10 and 18° C (50–64° F), with egg mortality occurring at temperatures exceeding 20° C (68° F) (Wydoski & Whitney, 2003).

Larvae range in length from 8 to 19 millimeters (0.31–0.75 inches) and are found throughout the water column, becoming oriented to the bottom within 5 to 6 days after developing pectoral fins. Juveniles less than one year old are found only in freshwater habitats, where they feed on algae and small invertebrates (Emmett et al., 1991).

## Habitat use

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 Columbia River, young-of-the-year white sturgeon were collected over unconsolidated sediments in water 13 to 27 meters (43–89 feet) deep, with an average velocity of 0.4 meters per second (1.3 feet per second) (Wydoski & Whitney, 2003). Sub-yearlings were also common during the summer over unconsolidated substrates in shallow freshwater areas of the San Joaquin Delta (Emmett et al., 1991). Habitat used by older juveniles (subadults) is similar to that used by adult white sturgeon.

White sturgeon are generally demersal (associated with the bottom) and use barbels (slender, whisker-like tactile organs) on their snouts to locate prey in turbid bottoms. Older juveniles and subadults in unimpounded river systems will move to estuarine habitats, where they consume a variety of benthic and epibenthic invertebrates, including tube-dwelling amphipods (Corophium sp.), bivalves, shrimp, and chironomids (Emmett et al., 1991; Wydoski & Whitney, 2003).

In the unimpeded reach of the Columbia River below Bonneville Dam, this species appears to migrate upstream into tidal freshwater habitats during the fall and downstream into marine-influenced habitats in the late winter and spring (Wydoski & 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.

## Distribution

In Washington, white sturgeon are found in all coastal and inland nearshore waters and are considered common to abundant in Willapa Bay, Grays Harbor, and the lower Columbia River (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 & Whitney, 2003). Dams along the Columbia River have changed the white sturgeon's historic range, creating a number of landlocked, isolated 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 the river above Bonneville Dam. Observations of white sturgeon concentrations include other freshwater tributaries (such as Salmon Creek in Discovery Bay) of Puget Sound and the Strait of Juan de Fuca (Washington State Department of Natural Resources, 2007b).

# Mammal

## Southern resident killer whale (Orca) *(Orcinus orca)*

### Life history

Killer whales are the largest species of dolphins currently in existence and can be found throughout the deep waters of the open ocean, as well as in shallow inland and intertidal waters planet wide (Baird, 2001; Wiles, 2004). The species is sexually dimorphic, with males reaching lengths of approximately 9 meters (30 feet) and weights of 5,600 kilograms (12,346 pounds) and females 8 meters (26 feet) and 3,500 kilograms (7,716 pounds) (Reeves et al., 2002). Killer whales are relatively long-lived: males have an average life span of 17 years (maximum age range 50 to 60 years) and females of 29 years (maximum age range 80 to 90 years) (Reeves et al., 2002; Wiles, 2004).

Orca. Photo: R. W. Baird

Males reach sexual maturity at about 15 years of age, and females typically give birth to their first calf at about 12 years of age, with an average of 5 years between calves (Reeves et al., 2002; Wiles, 2004). Mating probably occurs between May and October, but may take place year round (Wiles, 2004). Gestation lasts approximately 17 months. Southern resident populations give birth from October to March, and calves remain physically close to their mothers for at least their first year (Wiles, 2004). Although calves may nurse for 1 to 2 years, they develop teeth within their first 3 months and take solid food from their mothers (Wiles, 2004).

Resident killer whales have highly developed social frameworks, which are divided into four separate levels: matrilines, pods, clans, and communities. Matrilines are small groups related along maternal lines and are generally comprised of a female, her offspring, and the offspring of her daughters. Matrilines often contain up to 17 individuals from 3 generations. Members rarely separate for more than a few hours. Pods are larger groups related by a recent common maternal ancestor, while clans consist of pods with similar vocalizations and a more distant maternal ancestor, and communities are defined by pod and clan association patterns (Wiles, 2004). The community of southern resident killer whales are all members of the J clan, which consists of the J (4 matrilines), K (4 matrilines), and L pods (12 matrilines) (National Marine Fisheries Service, 2008c; Wiles, 2004).

Southern resident killer whale diets are likely similar to those of the northern population, with both populations preying predominately on Chinook salmon while they are in Washington's waters (National Marine Fisheries Service, 2008c). Little information is available on diets during winter and spring outside of Washington's waters (National Marine Fisheries Service, 2008c; Wiles, 2004).

### Habitat use

Killer whales in the Georgia Basin do not generally enter water less than 5 meters (16 feet) 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 populations feed in high-relief areas, such as canyons, ridges, and steep slopes that increase feeding efficiency by limiting fish movements, while Ford et al. (1998) found no such association between feeding and bottom topography.

### Distribution

Resident killer whales occur primarily in near-coastal and inland waters from central California to southeast Alaska, where they feed on salmon and other fish (Ford et al., 1998; Wiles, 2004). Southern residents 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). They use core areas for summer rearing and migrate as far south as central California during the winter and early spring (Hauser, 2006; Krahn et al., 2004; Wiles, 2004). All three southern resident pods move back into Washington's waters beginning in the spring, with the K and L pods arriving first in May or June and staying 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. Southern resident killer whale were listed as endangered in 2005, with critical habitat designated in 2006.

# 4.2 Data analysis and methods

The Aquatic Lands Habitat Conservation Plan calculates potential impacts as the amount of area, in acres, that each covered activity may have on covered species habitat. Sections 4.3 and 4.4 describe these impacts as potential effects. Expected outcomes have been calculated and expressed as a percent decrease, or reduction, in the area of potential impact and are described in Section 4.4. These findings are a result of a complex review of GIS data, database analysis, and literature. The details of the review are described in this section. The calculations used to arrive at the findings are based on physical, chemical, and biological impacts associated with existing authorized activities and the habitats in which they reside. Calculations do not factor in the effects of historic uses prior to current use, effects from new uses, effects from unauthorized or illegal activities occurring on state-owned aquatic lands, or habitat altered through restoration or mitigation. To better convey how impacts were determined, this chapter is divided into two sections:

- The methods used to analyze and quantify potential effects from activities authorized by the Washington Department of Natural Resources (DNR) on aquatic habitats and species.
- The methods used to select applicable conservation measures and quantify the expected outcomes from applying the measures.

Many of the details resulting from this data analysis are not included in this overview. The information provided in this section is meant to explain the methods and reasoning for the calculations, rather than present all computational steps and values from the database. Additional information regarding how potential effects and expected outcomes were identified is located in the Aquatic Resources Program Endangered Species Act Compliance Project, Potential Effect and Expected Outcomes Technical Paper (Washington State Department of Natural Resources, 2007b) and the Aquatic Resources Program Habitat Conservation Plan Covered Species Technical Paper (Washington State Department of Natural Resources, 2007b).

## 4.2.1 Potential effects analysis

The potential effects analysis described here comprises three major steps:

- Step 1: Database construction—Compilation of the relevant information on the distribution of species, habitats, and activities (Washington Department of Natural Resources, 2007, 2005a) and standardization of data sources (Figure 4.1).
- Step 2: Spatial and temporal screening—Identification of potential interactions between species and activities in both space and time (Figure 4.1).
- Step 3: Determination of effect—Review of the available literature characterizing each activity sub-group, identification of potential controlling factors for ecosystem function, and quantification of the impacts on species habitat (Figure 4.1).

### Covered activities, subgroups, and covered species

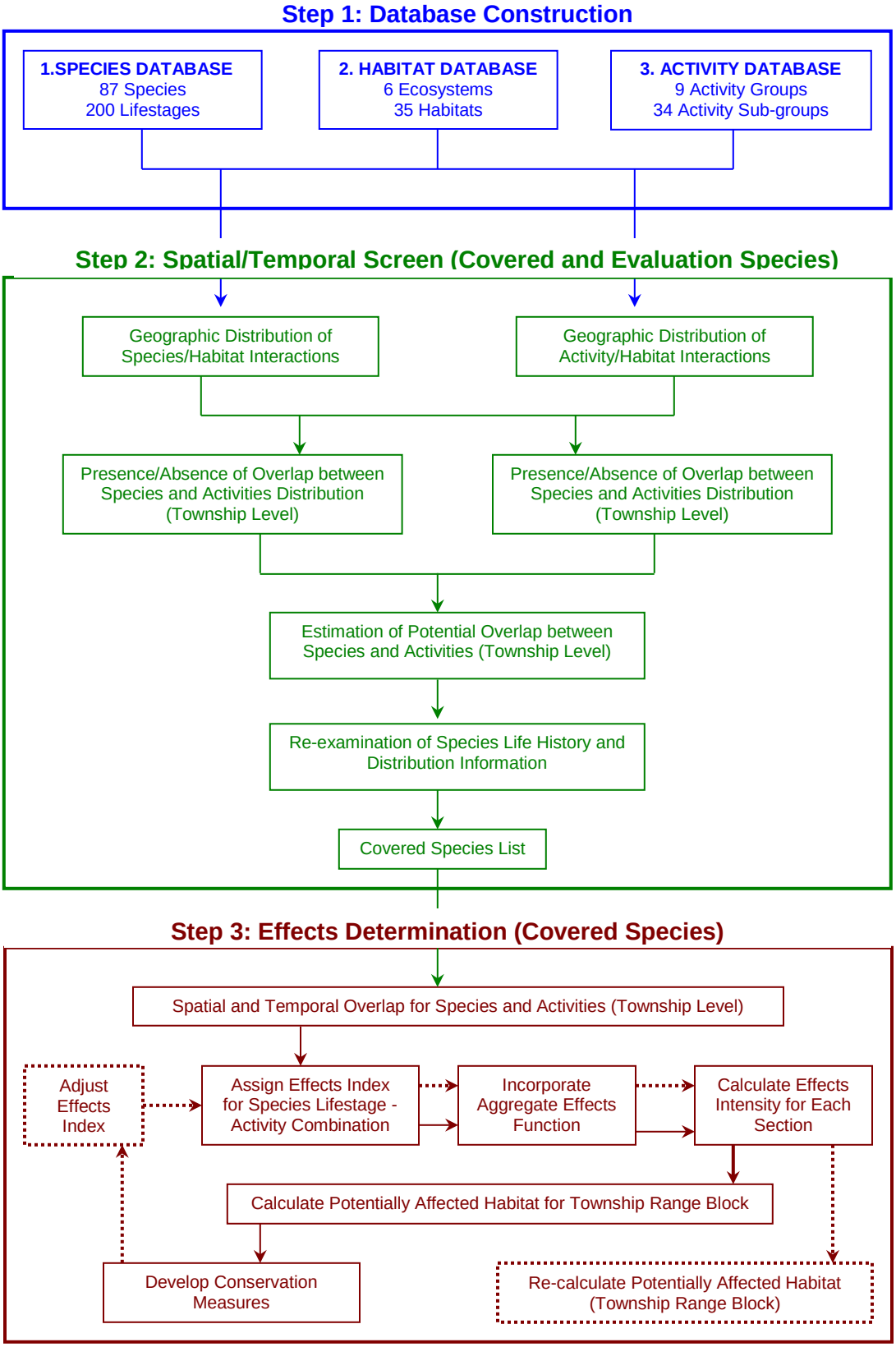
The baseline-effects analysis originally included eight activity groups and 42 species. Washington DNR is seeking Endangered Species Act coverage for only three activity groups: overwater structures, log booming, and aquaculture (Table 4.3). The selection process for these activities and

the final list of covered species is described in Chapter 1 ("Introduction") and in Chapter 3 ("Description of Activities). Sub-groups were selected for various activities to identify which of Washington DNR's authorizations can be separated into a more detailed description or use type and fit within one of the three activity types. These are described in Chapter 3. Ecosystems and habitat types used in this analysis are described in Chapter 1.

**Table 4.3** Activities covered and sub-groups identified

| Activity Group | Sub-group | Covered Activity |
|---|---|---|
| Overwater Structures (single element) | Boat ramps, launches, hoists; docks & wharves; rafts & floats; floating homes; mooring buoys; nearshore buildings | All |
| Overwater Structures (multiple elements) | Marinas; shipyards & terminals | All |
| Aquaculture | Net pens; shellfish; commercial geoduck harvest; sand shrimp | Shellfish |
| Miscellaneous Nearshore | Public access; sediment removal; log booming & storage | Log booming and storage |

**Figure 4.1.** Potential effects analysis, steps 1–3.
Dashed lines indicate feedback loop for implementation of conservation measures.



# 4.2.2 Step 1: database construction

Three key data types were used in constructing the database:

- **Species data:** Information regarding the spatial and temporal distribution of species.
- **Habitat data:** Spatial distribution of ecosystems and associated habitats.
- **Activities data:** Information about the spatial and temporal distribution of authorized activities on state-owned aquatic lands.

Each data type and its associated databases are discussed in the following pages. Figure 4.2 provides a conceptual illustration of the organization, content, and initial output.

## 1. Species data: database construction

The species database was developed as part of the literature review conducted for the 87 species and 200 lifestages addressed in the Covered Species Technical Paper (Washington Department of Natural Resources, 2007). The reviews and worksheets that document the timing and habitat usage of each life-stage occurrence for each species were compiled and incorporated into the species database (Figure 4.2). These data were not available for all stages or for all species. For example, very little is known about the juvenile habitat use of certain rockfish (*Sebastes spp.*). As a result, the three covered rockfish lack potential effects and expected outcomes outlined in Section 4.4.

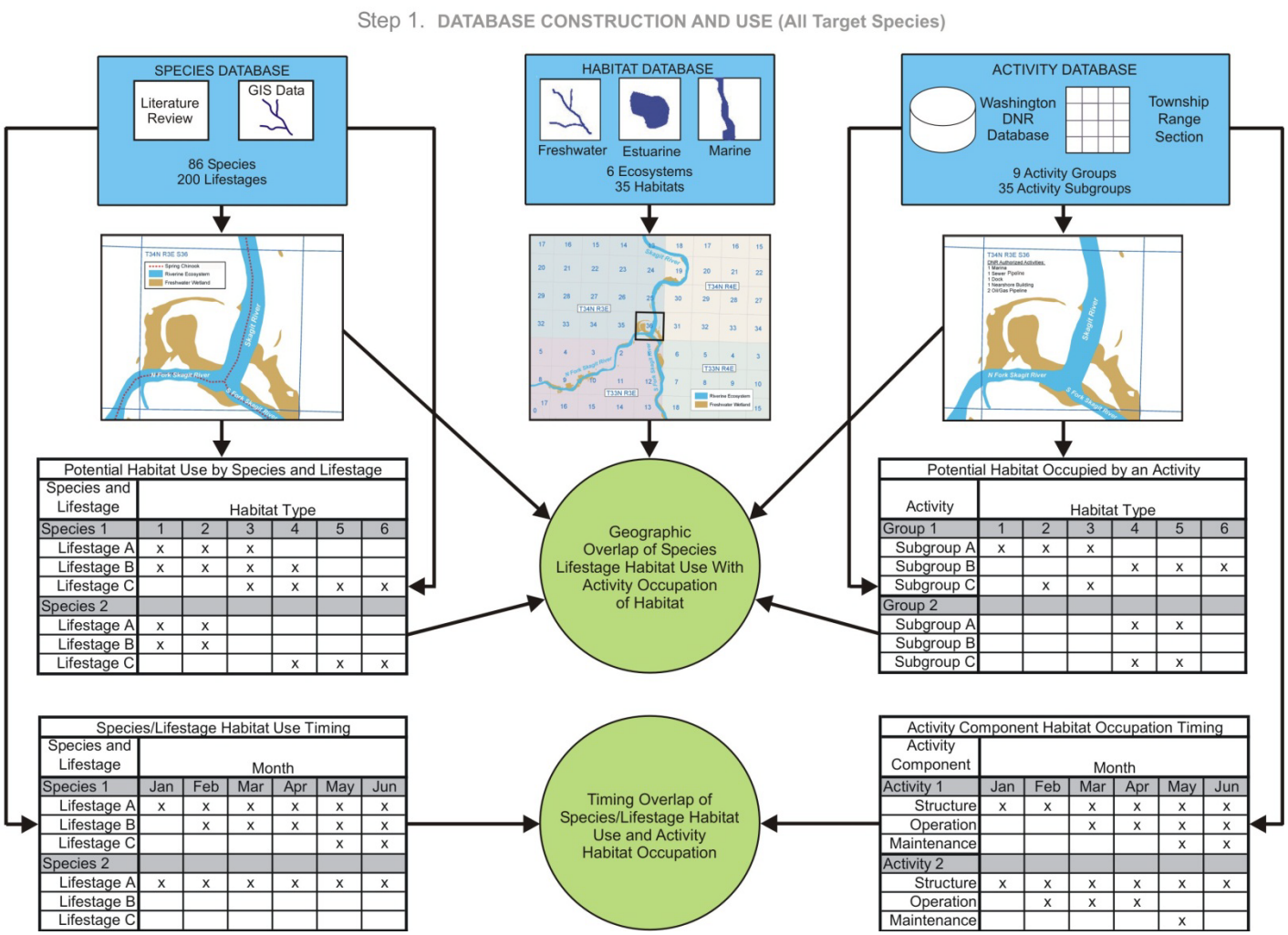
The spatial distribution of species was obtained in a geographic information system (GIS) shapefile or coverage format compatible with Environmental Systems Research Institute (ESRI) ArcGIS® mapping software. Because of the broad scope of this project, focus was placed on using widely available, standardized information. Data sources included the Washington Gap Analysis Project, Washington Department of Fish and Wildlife, Washington DNR, the Washington Nature Mapping Program, and the Interior Columbia Basin Ecosystem Management Project. For a number of the species reviewed, it was not possible to obtain data that adequately portrayed the species distribution for the entire life history (for example, salmonid use of saltwater environments). For all species, potentially suitable habitats identified in the literature reviews were selected from the GIS habitat classification datasets to spatially represent the areas where the species may occur. Any additional modifying information (such as a species only occurs in eastern Washington) was also incorporated into the potential habitat selection.

For many of the species reviewed, distribution information is portrayed as discrete point data that reflect actual field observations and likely underestimate the true range and movement of the species. To overcome this limitation in our input data sets, life history information was used for three covered species to create estimates around observation points of species' distribution range area (Table 4.4). For species that lacked sufficient information to estimate the species' distribution, no distribution map was created and no screening or potential effects determination was performed as these species were listed under ESA and added to the habitat conservation plan after the potential effects document was developed. The habitat protections provided in this plan for these species will provide substantial benefits for the habitat within the areas of assumed habitat overlap with the aquatic lands covered.

**Table 4.4.** Range area estimates: Applicable covered species

| Species | Species Group | Data Source | Distance |
|---|---|---|---|
| Common loon | Bird | • Species predicted distribution: Washington Gap Analysis Program<br>• Species observations: Washington Department of Fish and Wildlife, Puget Sound Ambient Monitoring Program | 100 km (62 mi) |
| Harlequin duck | Bird | • Species observations: Washington Department of Fish and Wildlife, Wildlife Heritage | 2 km (1.25 mi) |
| Marbled murrelet | Bird | • Species observations: Washington Department of Fish and Wildlife, Puget Sound Ambient Monitoring Program, Wildlife Heritage | 5 km (3 mi) |

**Figure 4.2.** Step 1: Database organization (squares), content, and initial output (circles).



# 2. Habitat data: database construction

Washington DNR used an ecosystem-based approach to organizing information, leading to a habitat-based perspective for addressing the conservation needs of species. This analysis calculates the take for each species as potentially affected habitat and is measured in hectares, but reported in acres. By relating species and lifestages to habitat-type, existing spatial and temporal aspects of habitat use can more directly relate to activities authorized by Washington DNR. The *Covered Habitat Technical Paper* (Washington Department of Natural Resources, 2005a) provides definitions of ecosystems and associated habitats used in the Washington DNR Endangered Species Act compliance process.

Although the definitions were founded on scientifically based and commonly used classification systems, they were simplified to address the broad geographic scope of state-owned aquatic lands (2.6 million acres); the large number and variability of both species and activities; and the differences in the resolution of available data. The *Covered Habitat Technical Paper* also provides a perspective on how Washington DNR's simplified use of the terms *ecosystem* and *habitat* within the Endangered Species Act compliance process compares to current use in ecology and systematic biology. This information is summarized in Chapter 1 of the Aquatic Lands Habitat Conservation Plan.

Six ecosystems (saltwater-offshore, saltwater-nearshore, tidal wetland, riverine, lakes, and freshwater wetlands) and 35 associated habitats were ultimately identified, with five basic criteria used in their selection:

1. Habitat types must have biological relevance to a broad array of species, including amphibians, aquatic invertebrates, birds, fish, and turtles.

2. Habitat types must be based on physical processes.

3. Habitat types must be based on a widely accepted classification system.

4. Habitat types must be categorized from existing data that are easily obtainable.

5. The spatial resolution of the habitat types must be consistent and compatible with other data sources used in the analysis (such as Washington DNR authorized activities), as well as adaptable to future refinements.

More information about habitats and associated habitats are in Chapter 1.

To assess the accuracy of the classifications, the GIS dataset was compared to field habitat observations (ground-truthing), and a report was generated (Washington Department of Natural Resources, 2005c). While the number of observations was small when compared to the overall dataset, there was a high degree of agreement with those projected in the GIS database.

# 3. Activities

Activities data used in the potential effects analysis were derived from the Washington DNR Revenue, Timber and Assets systems database. The *Potential Covered Activities Technical Paper* (Washington DNR 2005b) provides detailed descriptions of activities authorized by Washington DNR, the Revenue, Timber and Assets systems and the activities database developed from it, and the assumptions used to develop the information required for the potential effects analysis. Covered activity information used in this portion of database construction can be found in Chapter 3. The activities database used in this analysis consists of two main datasets:

- **Spatial data:** Spatially explicit representations of the locations of authorized activities on state-owned aquatic lands.
- **Descriptive data:** Descriptive information about temporal and spatial components of the activities.

## Spatial data

The spatial data for the activities database is GIS based. Washington DNR currently uses the Public Land Survey System of geographic section-, township-, and range-blocks to track activities, rather than the exact location (that is, the GPS coordinate or equivalent) of the authorized activities. This means that the activity can occur anywhere within a particular geographic 1-square-mile (640-acres or about 260-hectares) section. Most sections end along the shoreline of navigable waterways and do not extend into the water. Sections indicated in the dataset are typically a waterward extension of the section nearest to the activity occurring on state-owned aquatic lands. Some activities extend across section lines and, by extrapolation, may also cross township and range blocks. The resulting level of geographic accuracy in the activities database created limitations for the analysis of effects from activities on the environment. While we assume that all species, habitats, and activities occurring in the same section co-occur or overlap in their distribution, overlaps that were identified as unlikely (such as fill or bank armoring in deep water) were eliminated.

## Descriptive data

The original data contained in the Revenue, Timber and Assets systems are also limited by the lack of a standardized approach to how Washington DNR characterizes individual use authorizations. Consequently, two individual use authorizations that are similar in nature may have markedly different size or use characteristics, with some entries lacking size descriptors or any description beyond a billing code (Washington Department of Natural Resources, 2005b).

Addressing the lack of reliable spatial and temporal characteristics for over 4,000 individual use authorizations is beyond both the scope and the ability of Washington DNR's Endangered Species Act Compliance Project. As a result, a *typical activity* was defined for each of the 35 activity sub-groups that incorporates the average characteristics of a broad spectrum of use authorizations, thereby facilitating the development of descriptive statistics at the sub-group level. Typical activity assumptions are described in greater detail in Section 4.3 and in Chapter 3, with the descriptive data placed in one of two categories:

- **Size descriptors:** Data related to the size of the activity sub-groups.
- **Temporal descriptors:** Data characterizing the temporal aspect of the sub-groups.

## Size descriptors

Two elements of an activity influence the spatial extent of effects on a species or habitat:

- The activity's footprint.
- The area of alteration that results from the activity's broader area of influence. To simplify the estimated area of alteration, it was assumed that habitat structure is correlated with ecological function. This allows spatial impacts to habitats to be extrapolated to impacts on ecological functions.

For each typical activity, the area of alteration was estimated by means of review of the literature, professional opinion, and field examination (Washington Department of Natural Resources, 2005c). To characterize the area of alteration, the footprint of the activity was first estimated based on a description of a typical structure. The structure's characteristics were drawn from a review of current leases in the Revenue, Timber and Assets systems and supplemented by input from land managers at Washington DNR and scientists with the Endangered Species Act Compliance Project who are familiar with the activities. Following an examination of the sources and controlling factors (mechanisms) for potential effects, the extent of habitat alteration (structure or process) was defined using one or more of the factors identified in Table 4.5 and estimated based on the area of the typical activity's footprint. Controlling factors listed in Table 4.5 are explained in greater detail in Section 4.3 (see the discussion of covered activity potential effects). The definitions and descriptions of covered activities in Chapter 3 and the covered activity footprint, or assumed area of alteration, in Section 4.3, were used to evaluate and determine controlling factors.

**Table 4.5.** Controlling factors potentially affecting ecosystem function.

| Controlling Factors (Mechanisms)* | |
|---|---|
| • Loss of natural shade | • Wave energy |
| • Increased artificial shade | • Sediment supply |
| • Pollution (toxins, nutrients, thermal) | • Substrate type |
| • Physical disturbance (recurring human activity) | • Depth/slope |
| • Hydrology | • |

* Adapted from Thom *et al.*, 2005.

### Temporal descriptors

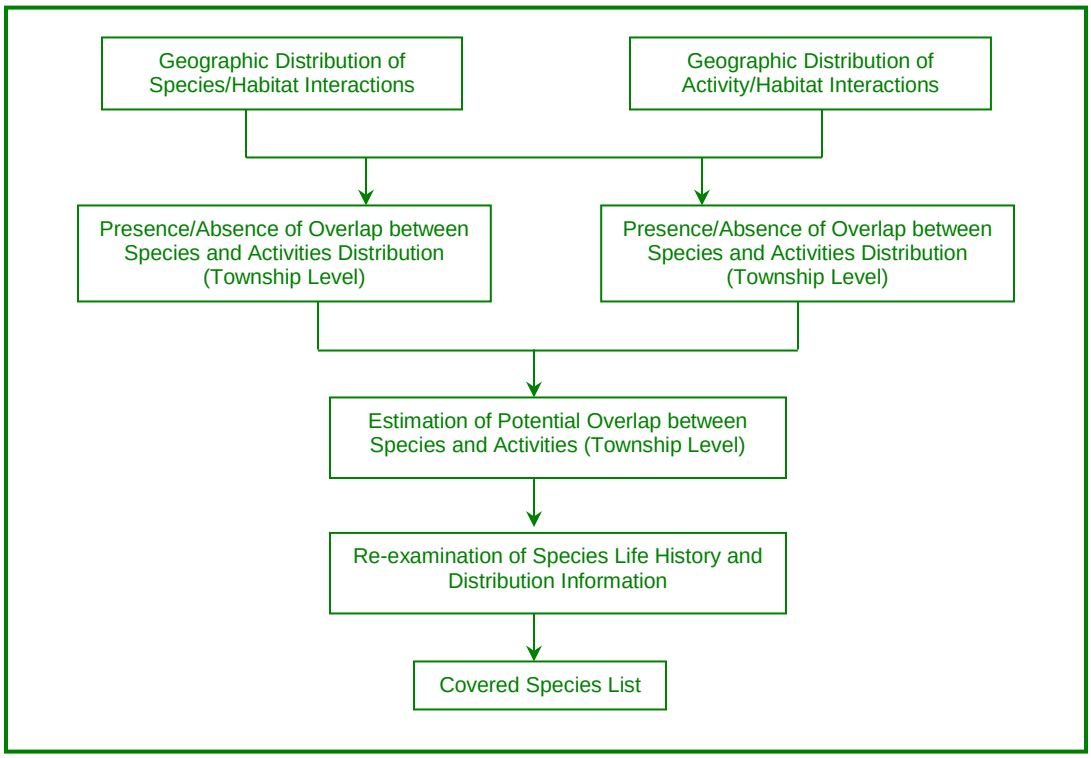
Temporal descriptors for typical activity sub-groups are presented in Chapter 3 and include the following information:

- **Structure:** The type of structures present in aquatic habitats (for example, log rafts, creosote pilings, and rip-rap).
- **Operation:** A description of the operational conditions associated with the activity.
- **Maintenance:** The period of time in which the maintenance activities occur.
- **Temporal:** The time period during which the structure or activity occurs.

## 4.2.3 Step 2: screening analysis

The second step in the potential effects analysis was the screening analysis used to identify intersections between species, habitats, and activities authorized by Washington DNR (Figure 4.3). To complete this analysis, it was necessary to divide the landscape into analysis units and determine which species, activities, and habitats occur within each analysis unit. As Washington DNR currently characterizes authorized activities by the Public Land Survey System section, township, and range, this dataset was used as the analysis unit and intersected with species distribution data, habitat distribution data, and activity data to identify overlaps.

**Figure 4.3.** Step 2: Potential effects analysis (spatial/temporal screen)




Information generated in the screen was used to confirm or deny any assumptions regarding overlap among species, life stages, and activities, and provides the basic information required for the calculation of potentially affected habitat provided in Sections 4.3 and 4.4. What follows is a description of the role of the screen in determining the likelihood of potential interaction between species/lifestages and Washington DNR activities. This screen is also how the covered species list from 2005 was confirmed. The species selection process is discussed in Chapter 1 in greater detail.

## Spatial overlap analysis

The objective of the screen was to determine the degree to which the distributions of authorized uses potentially interact with covered species. This was accomplished using two techniques: First, a metric was developed that describes the number of activities authorized by Washington DNR that co-occur with each species' distribution. The number of activities overlapping with a species' distribution was then converted into a rank score of low (1), medium (2), or high (3), as described in Table 4.6. Second, the screen data were used to examine the spatial extent of the species distribution relative to the spatial extent of all authorized uses of state-owned aquatic lands. The calculated percentage of each species distribution coinciding with activities authorized by Washington DNR is referred to as *coincident habitat* and is used as an indicator of the likelihood of interaction. This is described in acres for each species in Section 4.4. Table 4.6 illustrates the ranking criteria and metrics used for the species/lifestage and activity overlap and coincident habitat metrics. This part of the process was used to confirm overlap of the covered species. Detailed tables of the data are available in the *Aquatic Resources Program Endangered Species Act Compliance Project, Potential Effect and Expected Outcomes Technical Paper* (Washington Department of Natural Resources, 2007b).

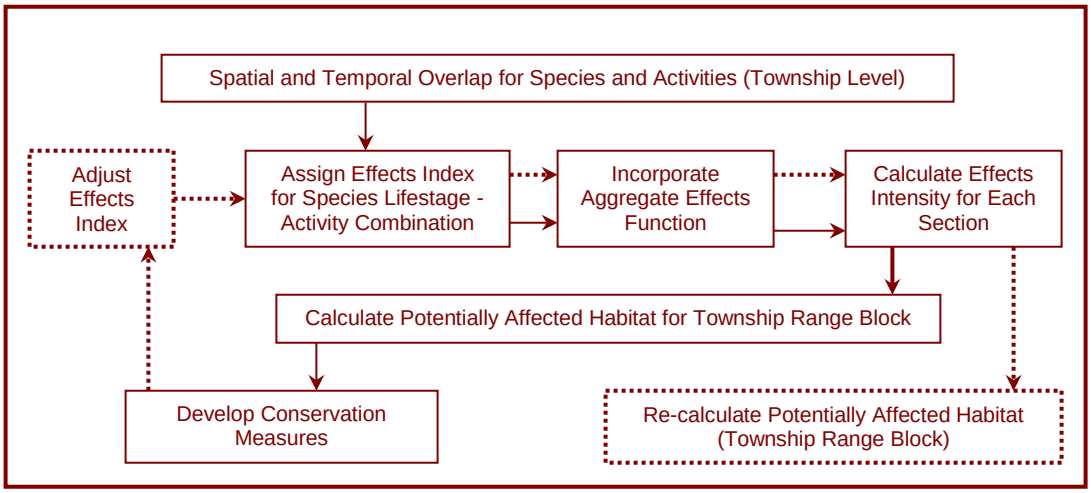
**Table 4.6.** Activity overlap ranking

| Species/lifestage and Activity Overlap | | Coincident Habitat | |
|---|---|---|---|
| **Count** | **Rank** | **Percent of Townships** | **Rank** |
| 0–22 | Low (1) | 0–34 | Low (1) |
| 23–30 | Medium (2) | 35–66 | Medium (2) |
| 31–34 | High (3) | 67–100 | High (3) |

# 4.2.4 Step 3: Potential effects determination

The potential effects determination is the final step in the potential effects analysis (Figure 4.4) and was used to estimate the extent, magnitude, and intensity of effects from activities authorized by Washington DNR on habitats occupied by covered species and lifestages.

**Figure 4.4**. Step 3: Potential effects analysis (effects determination)



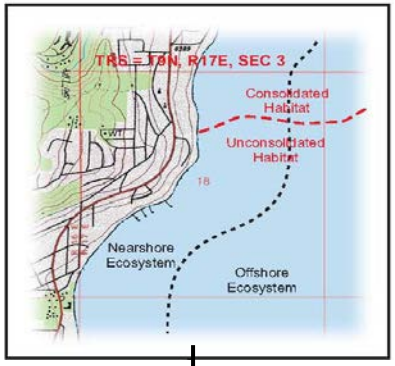
The determination of effects consists of four basic components:

- **Magnitude of Effect** (ME): A qualitative ranking of the magnitude of direct and indirect effects resulting from the physical presence, operation, and maintenance of each activity sub-group on covered species and lifestages.
- **Intensity of Effect** (IE): The adjustment of the magnitude of effect to reflect any additional impacts that may occur as a result of the density of authorized uses within a given area.
- **Potentially Affected Habitat** (PAH): The total habitat area affected by authorized uses. Potentially affected habitat is a function of the extent of alteration as well as the magnitude and intensity of the effect.
- **Intensity of Effect Distribution** (IED): A spatially explicit representation of the intensity of effect for all species, lifestages, and activity sub-groups within each section.

Detailed discussions of the components of the potential effects model are presented in the following sub-sections; Figure 4.5 on the following page illustrates the process used.

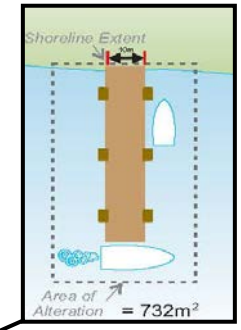
**Figure 4.5.** Process for determining potential effects

**Determine geographic overlap of habitat for species lifestage and activity$_x$**




(Area of Alteration)
x
(Number of Activities in Section)

**Determine footprint, shoreline extent, and extent of alteration for typical activity$_x$**




**Assign magnitude of effects for each species lifestage & activity combination**

| Species X<br>Lifestage Y | Activity 1 Effects Index | Activity 2 Effects Index | Activity 3 Effects Index |
|---|---|---|---|
| **Direct Effect** | | | |
| *Species level* | | | |
| Increased activity | x | x | x |
| Impair behavior/timing patterns | x | x | x |
| Physical harm or harassment | x | x | -- |
| Assigned Effect Index Value | 0.75 | 0.75 | 0.5 |
| *Habitat level* | | | |
| Air quality impairment (acute levels) | -- | -- | -- |
| Water impairment (acute levels) | -- | -- | -- |
| Sediment quality impairment (acute levels) | -- | -- | -- |
| Permanent habitat destruction/displacement | x | x | x |
| Permanently inaccessible habitat | x | x | x |
| Assigned Effect Index Value | 0.75 | 0.75 | 0.75 |
| **Indirect Effect** | | | |
| *Habitat loss* | | | |
| Temporary destruction/displacement | x | x | x |
| Temporarily inaccessible | x | x | x |
| Assigned Effect Index Value | 0.75 | 0.75 | 0.75 |
| *Habitat degradation* | | | |
| Energy resource reduction | x | x | x |
| Air quality impairment (chronic levels) | -- | -- | -- |
| Water quality impairment (chronic levels) | x | -- | x |
| Sediment quality impairment (chronic levels) | x | -- | x |
| Reduction of structural habitat quality metrics | x | x | -- |
| Assigned Effect Index Value | 0.75 | 0.75 | 0.75 |
| Average Direct Effects | 0.75 | 0.75 | 0.63 |
| Average Effects Index | 0.75 | 0.75 | 0.69 |
| **Magnitude of Effects** | 0.75 | 0.75 | 0.69 |

* Scale: 1= total loss; 0.75 = high effect; 0.5 = moderate effect; 0.25 = low effect; 0 = trace effect

** Scale: 1= No effectiveness; 0.75 = low effectiveness; 0.5 = moderate effectiveness; 0.25 = high effectiveness; 0 = Total effectiveness

x = Sources of effect

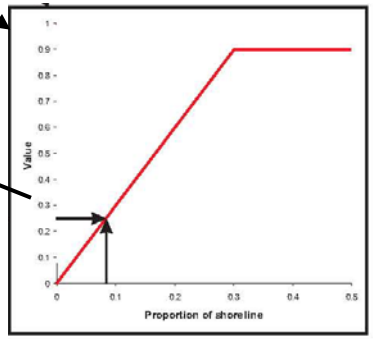
-- = Absence of effect

NA = Absence of interaction

**Calculate intensity of effect for each activity by section**

Intensity of Effects = $\frac{\text{Magnitude of Effects}_x}{1 - f_x}$

**Integrate aggregate effects function (*f*)**




**Calculation of Potentially Affected Habitat$_{\text{Activity X}}$**

1ST Potentially Affected Area$_{\text{Activity X}}$ = Intensity of Effects x Area of Alteration

2ND Σ Potentially Affected Area$_{\text{Activity x}}$ for all Sections in Township Range

3RD Using habitat types associated with activity, assign habitat area to potentially affected area proportional to habitat found in township range

4TH Σ for Habitat

5TH Σ for Ecosystem

Intensity of Effects Illustration (map): Sum of the intensity of effects for <u>all</u> activities in a section for a specific species lifestage

## Magnitude of effect (ME)

The magnitude of effect is a qualitative ranking of the direct and indirect effects resulting from an authorized activity, including the physical presence of any structures, operation of facilities and infrastructure, and maintenance.

### Regulatory basis for determining magnitude of effect

To meet the requirements of a Section 10 permit, the effects from the covered activities must meet the standards of both Section 10 (the effects do not appreciably reduce the likelihood of survival and recovery of the species in the wild) and Section 7 (the effects are not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat). The effects of covered activities are typically described as direct or indirect, with direct effects including the immediate impacts of an activity on the species or its habitat (such as entrainment in surface water diversions), as well as the destruction of habitat (such as elimination due to the placement of a structure). Indirect effects are those ". . . that are caused by, or will result from, the proposed action and are later in time, but still are reasonably certain to occur. . ." (50 Code of Federal Regulations 402.02) and include chronic exposure to contaminants and reductions in prey.

### Process for determining magnitude of effect

Effect indices were prepared for each unique species, lifestage, and activity sub-group combination, and composite scores characterizing the magnitude of effect were derived from individual rankings of direct and indirect effects. Fifteen mechanisms for potential effects were identified, with the mechanisms assigned to two categories for both direct effects (species and habitat level) and indirect effects (habitat loss and habitat degradation) (Table 4.7). For each mechanism, an "X" was used to indicate an overlap between the effect category, the species/lifestage being considered, and the particular activity. Justifications for the assumed overlap and the interpretation of the magnitude of the effect were based on a review of the literature and supplemented by professional judgment (Section 4.3: Assumed area of alteration).

Magnitude was determined by first having experts follow an ordinal ranking system ranging from 0 (no or trace effect) to 1.0 (total loss) for ranking direct and indirect effects, and then calculating the magnitude as the greater of either the average of individually ranked direct and indirect effects or the direct effect rank. Rankings for effects were created using effect indices for each of the covered species and lifestages for each activity sub-group (such as docks and wharves), with the indices providing a standardized method across species and activities to estimate the relative severity of effects associated with activity structure, operation, and maintenance.

**Table 4.7.** Effect index example (Assigned effects values are averages.)

| **Species X** | | | |
|---|---|---|---|
| **Lifestage Y** | **Activity 1** | **Activity 2** | **Activity 3** |
| **Direct Effect** | | | |
| *Species level* | | | |
| Increased activity | x | x | x |
| Impair behavior/timing patterns | x | x | x |
| Physical harm or harassment | x | x | -- |
| Assigned Effects Index Value | 0.5 | 0.5 | 0.25 |
| *Habitat level* | | | |
| Air quality impairment (acute levels) | -- | -- | -- |
| Water impairment (acute levels) | x | x | x |
| Sediment quality impairment (acute levels) | x | x | x |
| Permanent habitat destruction/displacement | x | x | -- |
| Permanently inaccessible habitat | -- | -- | -- |
| Assigned Effects Index Value | 0.25 | 0.25 | 0.5 |
| **Indirect Effect** | | | |
| *Habitat loss* | | | |
| Temporary destruction/displacement | x | x | x |
| Temporarily inaccessible | x | x | -- |
| Assigned Effects Index Value | 0.5 | 0.5 | 0.25 |
| *Habitat degradation* | | | |
| Energy resource reduction | x | x | x |
| Air quality impairment (chronic levels) | -- | -- | -- |
| Water quality impairment (chronic levels) | x | x | x |
| Sediment quality impairment (chronic levels) | x | x | x |
| Reduction of structural habitat quality metrics | x | x | x |
| Assigned Effects Index Value | 0.5 | 0.5 | 0.25 |
| **Average Direct Effects Index** | **0.38** | **0.38** | **0.38** |
| **Average Effects Index** | **0.44** | **0.44** | **0.31** |
| **Magnitude of Effects** | **0.44** | **0.44** | **0.38** |
| | | | |
| Scale: 1= total loss; 0.75 = high effect; 0.5 = moderate effect; | | | |
| 0.25 = low effect; 0 = trace effect | | | |
| x = Sources of effect | | | |
| -- = Absence of effect | | | |
| NA = Absence of interaction | | | |
| [1] Use direct effect value if greater | | | |

Once it was determined that a category had a nexus and the potential magnitude of effect was identified, the potential effect value (score) for each of the four types of effect (direct—species and habitat level; indirect—habitat loss and habitat degradation) was estimated. Effects were evaluated in relation to the area of alteration and the severity of the potential impact and were assigned scores of 0 (trace effect), 0.25 (low effect), 0.5 (moderate effect), 0.75 (high effect), and 1 (total loss). Since the total area affected by a given activity is the product of the area of alteration and the magnitude of effect, activities with very large areas of alteration may have relatively low magnitude of effects values because the impacts are spread over a large total area. For example, if the entire area of alteration was considered a complete loss due to the specified mechanism, it was rated a 1 for that effects component. If half of the entire area of alteration was considered a complete loss with regard to a mechanism, it was scored a 0.5. Similarly, if it was determined that the entire area of alteration was moderately affected by the mechanism, then the assigned effect index (EI) value would equal 0.5.

The magnitude of effect is a composite score derived from the assigned effect index values for direct and indirect effects. The magnitude of effect for each activity sub-group and species lifestage is the greater of either the average of the two direct effect category scores or the average of the scores for all four (direct and indirect) categories. For example, the magnitude of effect for Activities 1 and 2 in Table 4.7 is equal to 0.44— the average of all four categories—whereas the magnitude of effect for Activity 3 is 0.38, which is the direct effect value.

### Intensity of effect (IE)

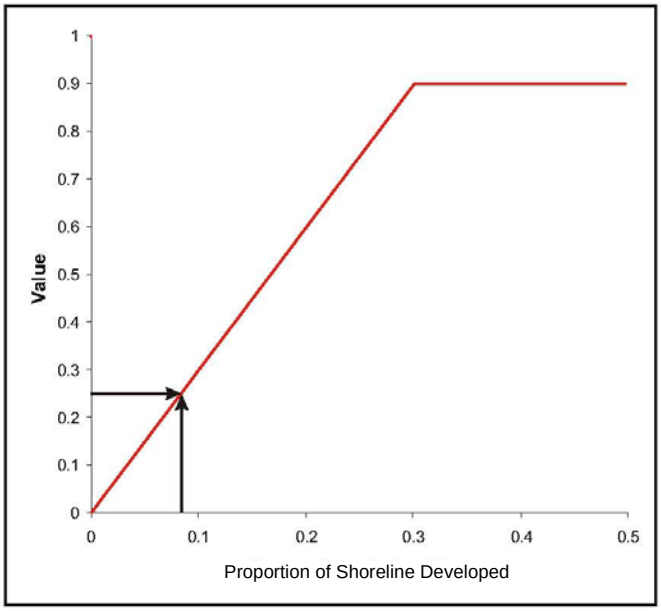
The intensity-of-effect (IE) metric is calculated as the ratio of the magnitude of effect over an aggregate effects function, described below.

## Incorporation of aggregate effects (AE)

In estimating potentially affected habitat, it is important to incorporate an aggregate-effects factor to account for an increase in the magnitude of impacts in areas where activities authorized by Washington DNR are concentrated. For example, a single dock authorization may not significantly impact nearshore sediment supply and transport processes, but in all likelihood the combined presence of many docks along a shoreline will.

The role of aggregate effects in aquatic ecosystems is not well studied; however, research in upland watersheds indicates that a combination of factors influences the ecological integrity (physical, chemical, and biological measures) of aquatic resources. A science panel convened to evaluate ecological conditions in Puget Sound and the Georgia Basin concluded that ecosystem value declines rapidly with the percentage of developed shoreline (Puget Sound Action Team, 2005). The aggregate effects function used in this analysis (Figure 4.6) is based on the conclusions of the panel regarding nearshore ecosystem function and on a weight-of-evidence approach (Thom *et al.*, 2005). This function suggests that ecosystem value declines rapidly as the percentage of shoreline development increases until a threshold is reached (≈30 percent). At this limit, no additional density effect is observed, and activities achieve their maximum impacts.

**Figure 4.6.** Aggregate effects function



### Process for incorporation of aggregate effects

Aggregate effects were incorporated into the analysis by calculating the ratio of the length of shoreline encumbered by uses authorized by Washington DNR to the total length of shoreline. This calculation was performed for each activity sub-group and was based on the assumed dimensions of each typical activity. The function consists of a line associated with the proportion of shoreline affected on the X-axis and an aggregate effect value of between 0 and 1 on the Y-axis (Figure 4.6). The line rises at a 45-degree angle from 0 for both axes until 30 percent of the shoreline was estimated to be affected and an aggregate effect of 0.9 was reached. The lack of further increases in the function is designed to reflect observations that substantial and increasing degradation of ecosystem function occurs when 0 to 30 percent of a shoreline is developed, after which ecosystem function changes very little.

The aggregate effects function was used to arrive at the intensity of effect, with the intensity of effect (IE) equal to the ratio of the magnitude of effect (ME) and the aggregate effects function (AE) (Equation 1). The ratio is used in determining the potentially affected area (PAA) for each activity (Equation 2), with AA being the assumed area of alteration for that activity.

**Equation 1**

$$IE = \frac{ME}{(1 - AE)}$$

**Equation 2**

$$PAA = (AA) \times \left( \frac{ME}{(1 - AE)} \right)$$

The value derived from the aggregate effects function increases with the percentage of shoreline development, decreasing the value of the denominator in the effects intensity ratio and resulting in a higher intensity of effect. When shoreline development is small, the intensity of effect is roughly equal to the magnitude of effect.

For example, assuming that approximately 5 percent of the shoreline in section X is disturbed, the aggregate effects (AE) function is equal to 0.1. If the area of alteration (AA) from activity Y is 100 meters$^2$ and the activity has a moderate (0.5) magnitude of effect (ME) on species B, the potentially affected area (PAA) is:

$$PAA = \left(100 meters^2\right) \times \left( \frac{0.5}{(1 - 0.1)} \right) = 55 meters^2$$

In contrast, if 25 percent of the shoreline is disturbed, the aggregate effects function is equal to 0.75 and the potentially affected area would quadruple:

$$PAA = \left(100 meters^2\right) \times \left( \frac{0.5}{(1 - 0.75)} \right) = 200 meters^2$$

## Potentially affected habitat

As described in Section 4.2.1 (Database construction), the ecosystem and habitat data were referenced to the township and range block, while activities were referenced to a section, with the exact location of the activity within the section unknown. Therefore, the estimation of potentially affected habitat was calculated on the township/range scale. This was done by calculating the potentially affected area for a specific activity by section, adding all of the areas in a township and

range block, and simply proportioning the habitat by the percentage of that habitat type found in the township and range (Figure 4.7). As described above in the screening analysis, only those habitats potentially associated with a particular activity are included in the habitat area calculation.

This also enables an estimation of the percentage of an ecosystem or habitat that is potentially affected by Washington DNR activities in relation to all that is available in the region/state. The data summaries assist in determining:

- What activities are having the greatest impacts on habitats and the species/lifestages they support.
- What ecosystems and habitats affected by Washington DNR authorized activities are contributing to, or limiting recovery of, a species on a regional scale.
- What conservation measures should be emphasized for an activity, ecosystem, habitat, and species/lifestage to encourage recovery.

**Figure 4.7.** Calculation of potentially affected habitat

**Calculation of Potentially Affected Habitat$_{\text{Axtivity X}}$**

1$^{ST}$ Potentially Affected Area$_{\text{Activity X}}$ = Intensity of Effects X Area of Alteration

2$^{ND}$ $\Sigma$ Potentially Affected Area$_{\text{Activity x}}$ for all Sections in Township Range

3$^{RD}$ Using habitat types associated with each activity, assign habitat area to potentially affected area proportional to habitat found in township range

4$^{TH}$ $\Sigma$ for Habitat

5$^{TH}$ $\Sigma$ for Ecosystem

## Intensity of effects distribution

As described above, potentially affected habitat was summarized by activity, activity sub-group, ecosystem, habitat, and species/lifestage. Although the coarseness of the locational datasets for habitats and activities prohibited defining the precise geographic distribution of affected habitat, the summaries provide an understanding of where potentially affected habitat occurs and where activities are concentrated, as well as a basis for developing and applying appropriate conservation measures.

The summary was accomplished by examining the intensity of effect (IE) values for all species-lifestage-activity combinations on a regional basis. Using the intensity of effect equation (Equation 1), the theoretical maximum intensity of effect value for an individual species-lifestage-activity combination (SLAC) in a section equals 10 and would occur only when both the

magnitude of effect (ME) was very high (i.e., 1.0 = total loss) and the density of activities authorized by Washington DNR comprised at least 30 percent of the shoreline (AE = 0.9).

**Equation 3**

$$IED_{SectionX} = \sum_{SLAC=1}^{n} IE_{SLAC}$$

As part of the potential effect analysis, 51 species-lifestage combinations and 354 activity sub-groups were examined; thus, the theoretical maximum intensity of effect value for all species-

$$IE_{Maximum} = \frac{ME}{(1-AE)} = \frac{1}{1-0.9} = 10$$

lifestage and activity sub-groups in a given section is 17,340 and the minimum is zero. The analysis of the distribution of the intensity of effects was based on the combined influence of activities authorized by Washington DNR within a given section on all species present. The intensity of effects distribution (IED) was calculated by adding the intensity of effect (IE) values for each species-lifestage-activity combination (SLAC) within a section (Equation 3).

Examination of the intensity of effect distribution values for individual sections is a useful and convenient method to identify specific locations within the state where numerous species-lifestages and activities interact. To illustrate the relative effect intensity distribution on a map, the range of scores observed was divided into three equally sized groups and assigned a symbol corresponding to low, medium, or high. As part of the examination of regional differences, the state of Washington was divided into a grid that consisted of 28 equal-area blocks (blocks) that were each 1 degree by 1 degree in length. Basic statistics were generated to examine the number of sections in which effect intensity scores were observed as well as the range of scores observed within blocks.

# 4.2.5 Expected outcomes, applying conservation measures

A critical component of habitat conservation planning is the implementation of a conservation program or strategy that ". . . ensures that the effects of the authorized incidental take will be adequately minimized and mitigated to the maximum extent practicable" (U.S. Fish and Wildlife Service & National Marine Fisheries Service, 1996). To accomplish this purpose, Chapter 5 lays out Washington DNR's operating conservation program, through the application of conservation measures, to avoid, minimize, and compensate for impacts to the covered species from authorized activities, and to protect and conserve habitats that support these species on state-owned aquatic land.

Conservation measures vary considerably in terms of their specificity for addressing threats to covered species, their potential for use as mitigation measures, and their potential to benefit species and reduce potential impacts to state-owned aquatic lands. The analysis of the measures and their expected outcomes focused on identifying and evaluating actions that would avoid and

minimize potential effects to covered species in a cost-effective manner. Only avoidance-and-minimization conservation measures were included in the analysis, because it is assumed that mitigation would be more effective if based on a species-specific "likelihood of survival and recovery" approach, rather than an approach that involves mitigation by activity.

The conservation measures selected for each activity group/sub-group can generally be described as conditions or best management practices that will likely be required as part of current permitting processes for new facilities. Ranking criteria in the spatial analysis description were employed to ensure that each of the measures was:

- Effective in avoiding or minimizing potential effects on covered species and lifestages (reducing threats).
- Applicable across a wide range of Washington DNR authorized activities.
- Addressed operation and maintenance aspects of Washington DNR authorized activities (scope of the potential effects analyses).

This approach made it possible to characterize the reduction in potential effects to covered species that results from the application of a common environmental protection standard to all the authorizations within an activity group. It also provides a basis for examining how different activities can contribute to "a reasonable possibility of not jeopardizing the continued existence of a species" and assist in the recovery of that species with the application of standard best management practices.

# 4.2.6 Selection of conservation measures

A three-step filtering process was used to select the conservation measures:

- Identification and ranking of the initial pool of potentially applicable conservation measures for each of the nine activity groups defined in the *Potential Covered Activities Technical Paper* (Washington DNR, 2005b).
- Categorization and screening of the pool of identified conservation measures to determine whether measures could be classified as those that avoid, minimize, or mitigate potential effects. Avoidance and minimization measures were retained for possible inclusion in the expected outcomes analysis. Those measures identified as mitigation were separated out as potential programmatic measures to be negotiated with NOAA Fisheries and the U.S. Fish and Wildlife Service.
- Evaluation of the identified avoidance and minimization measures to determine if they would reduce identified direct or indirect effects to covered species.

## Step 1: Identification and ranking

An array of possibly applicable conservation measures were identified by Washington DNR scientists using relevant literature and professional judgment (B.C. Ministry of Agriculture and Lands, 2005; Environmental Protection Agency, 2000; G3 Consulting Ltd., 2003; Hanson *et al.*, 2003; Pacific Coast Shellfish Growers Association, 2001; Pentec Environmental, 2000; Washington Administrative Code Title 220; Washington Department of Fish and Wildlife, 1999; Washington Department of Transportation, 2004, 2005; U.S. Fish and Wildlife Service, 2003; United States Army Corps of Engineers, 1989). Conservation measures were retained for further analysis if they focused on the operations and maintenance of activity groups authorized by

Washington DNR, with measures designed for specific projects modified to remove site-specific constraints and make them more generally applicable to the covered activities (for example, aquaculture and overwater structures).

The biological effectiveness of each conservation measure was ranked by scientists at the Washington Department of Fish and Wildlife. Using their professional judgment, they assigned each measure an ordinal score of high (3), medium (2), or low (1), based upon the measures' ability to avoid, minimize, or mitigate direct or indirect effects to covered species. To reduce the subjectivity of ordinal scores, each conservation measure was reviewed and ranked by multiple biologists. The biological effectiveness rank (BER) for each conservation measure was then calculated by first summing the scores in each category (that is, avoid, minimize) for each activity sub-group, and then dividing by the number of Washington Department of Fish and Wildlife scientists who ranked the effectiveness of the measure. Scientists at Washington DNR chose not to further analyze conservation measures with biological effectiveness ranks of less than 1.5 due to their limited potential to provide biological benefit. Conservation measures that were limited to monitoring practices were also removed from the analysis at this point.

## Step 2: Categorization and screening

In Step 2, the consulting team screened the conservation measures to ensure that they:

- Were general enough for standard application across the range of groups or sub-groups developed for the potential effects analysis.
- Could be applied to the operation and maintenance of existing structures and facilities authorized by Washington DNR on state-owned aquatic lands.
- Addressed avoidance and minimization of effects rather than compensatory mitigation.

Standard best management practices were desirable, as they provided a mechanism to examine—across activity groups—the changes in effects that result from the application of a common environmental protection standard. If conservation measures were considered too specific or oriented toward compensatory mitigation rather than avoidance or minimization, they were identified as *applicable to mitigation only*.

So that conservation measures could be used more effectively in the analysis, some were slightly reworded to make them more broadly applicable, or they were changed to include operation or maintenance activities (rather than construction). To assist in organization and consistency, conservation measures that were similar in content were combined to create a single measure. If a measure was applicable only as mitigation, then it was neither carried forward in the pool of possibly applicable conservation measures, nor included in the calculation of potentially affected habitat for the expected outcomes analysis.

## Step 3: Evaluation of the potential to reduce threats

In step 3, the remaining conservation measures were evaluated to determine whether the threats and potential direct or indirect effects identified could be reduced for each covered activity and covered species. As with the potential effects analysis, this analysis focused on species threats as indicated by the magnitude of direct and indirect effects (ME) and ultimately the intensity of effects (IE).

These *risk pathway* evaluations were based on literature reviews, the *potential effects* portion of this data analysis, and the professional opinion and experience of the consulting team that completed the analysis. The codes in Table 4.8 were used to simplify the process of linking the conservation measures to the mechanisms for direct and indirect effects identified in the potential effects determination. The conservation measure ranks that were calculated in Step 1 were used as decision points in the final selection of conservation measures.

**Table 4.8.** Direct and indirect effects analyzed by activity group and sub-group.

| Mechanism | Assigned Code |
|---|---|
| **Direct Effects** | |
| *Species Level* | |
| Increased activity | DE1 |
| Impaired behavior/timing patterns | DE2 |
| Physical harm or harassment | DE3 |
| *Habitat Level* | |
| Air quality impairment (acute) | DE4 |
| Water impairment (acute) | DE5 |
| Sediment quality impairment (acute) | DE6 |
| Habitat destroyed or displaced permanently | DE7 |
| Habitat inaccessible permanently | DE8 |
| **Indirect Effects** | |
| *Habitat loss* | |
| Habitat destroyed or displaced temporarily | IE1 |
| Habitat inaccessible temporarily | IE2 |
| *Habitat degradation* | |
| Energy resource reduction | IE3 |
| Air quality impairment (chronic) | IE4 |
| Water quality impairment (chronic) | IE5 |
| Sediment quality impairment (chronic) | IE6 |
| Reduction of structural habitat quality metrics | IE7 |

The total affected habitat and the percent of total habitat affected by each activity group for each covered species were reviewed using the potential effects analysis before conservation measures were selected. If there was no indication of a significant overlap between an activity and a covered species lifestage, then the species was eliminated from further consideration in the expected outcomes analysis for that activity.

# 4.2.7 Characterizing expected outcomes

To characterize the expected outcomes of implementing the applicable conservation measures, the amount of potentially affected habitat for each covered species was recalculated to account for the expected benefits of the conservation measures. The matrices used for determining the magnitude of effect were expanded to include an estimate of the effectiveness of the chosen conservation measures using a net conservation measures index (NCMI) for all the applicable conservation measures that would be applied to each activity sub-group. The net conservation measure index was determined using a weight-of-evidence approach based on relevant literature and the analysts' professional judgment as to whether the measure(s) could legitimately reduce the risks of direct and indirect effects. Like the assigned effects-index values, the NCMI was ranked on a 0-to-1 ordinal scale in 0.25 increments; however, the scale was reversed, with:

- 0 equal to the measure being completely effective at eliminating all threats associated with a particular type of effect (such as habitat loss)
- 0.25 equal to a high level of effectiveness
- 0.50 indicating moderate effectiveness
- 0.75 low effectiveness
- 1 no effectiveness

The adjusted effects index (AEI) was then calculated by multiplying the assigned effects index for each activity group and applicable covered species' life stage by the NCMI for the same activity and species (Equation 4).

**Equation 4**:

$$AEI = (EffectsIndex)x(NCMI)$$

Lower values for net conservation measures lead to a greater reduction in the magnitude of effects. Using the direct effect value for Sub-group A in Table 4.9 as an example, if, prior to applying conservation measures, the effects index was 0.25 (low effect) and NCM was estimated as 0.75 (low effectiveness in eliminating effects), the adjusted effects index becomes 0.19:

$$AEI = (0.25)x(0.75) = 0.19$$

The resulting adjusted effects index was then used to recalculate the magnitude of effect for each species-lifestage-activity combination; this adjusted magnitude of effect (ME) was used in Equation 2 to recalculate the potentially affected area (PAA) .

**Table 4.9.** Example effect index and net conservation measures index

| Species X | Sub-group A | | | Sub-group B | | |
|---|---|---|---|---|---|---|
| Lifestage Y | Effects Index | Net Conservation Measure Index | Adjusted Effects Index | Effects Index | Net Conservation Measure Index | Adjusted Effects Index |
| **Direct Effect** | | | | | | |
| *Species level* | | | | | | |
| Increased activity | x | | | x | | |
| Impair behavior/timing patterns | x | | | x | | |
| Physical harm or harassment | x | | | -- | | |
| Assigned Effects Index Value | 0.25 | 0.75 | 0.19 | 0.25 | 0.75 | 0.19 |
| *Habitat level* | | | | | | |
| Air quality impairment (acute levels) | -- | | | -- | | |
| Water impairment (acute levels) | -- | | | -- | | |
| Sediment quality impairment (acute levels) | -- | | | -- | | |
| Permanent habitat destruction/displacement | x | | | -- | | |
| Permanently inaccessible habitat | x | | | -- | | |
| Assigned Effect Index Value | 0.25 | 0.75 | 0.19 | 0 | 0.75 | 0.00 |
| **Indirect Effect** | | | | | | |
| *Habitat loss* | | | | | | |
| Temporary destruction/displacement | x | | | x | | |
| Temporarily inaccessible | x | | | x | | |
| Assigned Effect Index Value | 0.25 | 1 | 0.25 | 0.25 | 1 | 0.25 |
| *Habitat degradation* | | | | | | |
| Energy resource reduction | x | | | -- | | |
| Air quality impairment (chronic levels) | -- | | | -- | | |
| Water quality impairment (chronic levels) | -- | | | -- | | |
| Sediment quality impairment (chronic levels) | -- | | | -- | | |
| Reduction of structural habitat quality metrics | x | | | -- | | |
| Assigned Effect Index Value | 0.25 | 0.75 | 0.19 | 0 | 0.75 | 0.00 |
| **Average Direct Effects Index** | **0.25** | | **0.19** | **0.13** | | **0.09** |
| **Average Effects Index** | **0.25** | | **0.20** | **0.13** | | **0.11** |
| **Magnitude of Effects** | **0.25** | | **0.20** | **0.13** | | **0.11** |
| | | | | | | |
| **Effects Index Scale** | | **Conservation Measures Effectiveness Scale** | | | | |
| Scale: 1= total loss; 0.75 = high effect; 0.5 = moderate effect; | | 1 = Trace or no Effectiveness | | | | |
| 0.25 = low effect; 0 = trace effect | | 0.75 = Low Effectiveness | | | | |
| x = Sources of effect | | 0.5 = Medium Effectiveness | | | | |
| -- = Absence of effect | | 0.25 = High Effectiveness | | | | |
| NA = Absence of interaction | | 0 = Elimination of Effect | | | | |
| [1] Use direct effect value if greater | | | | | | |

# 4.2.8 Database improvements, assumptions, and uncertainties

## Improvements

While the potential effects model was created using typical activity descriptions and size estimates (Section 4.2.2, Descriptive data), it was also designed to use explicit spatial data as more became available and to allow the inclusion of additional authorizations.

To improve the precision of the potentially-affected-area estimates used in Washington DNR's Endangered Species Act decision-making process, several refinements were made to the original 2005 spatial data. The following specific improvements were made to the original database:

- All use authorization data were updated and are current as of June 2007.
- Only covered species were included in the analysis.

- Ecosystem and water body names were added for all use authorizations.
- Wherever possible, typical activity size estimates were replaced by explicit size information for all covered activities.

The resulting information for the data analysis and methods described is the basis of the affected habitat estimates and potential decreases presented in Sections 4.3 and 4.4. Additional information regarding how potential effects and expected outcomes were identified, including all database results, are located in the *Aquatic Resources Program Endangered Species Act Compliance Project, Potential Effects and Expected Outcomes Technical Paper* (Washington DNR, 2007b) and the *Aquatic Resources Program Habitat Conservation Plan Covered Species Technical Paper* (Washington Department of Natural Resources, 2007).

## Assumptions and uncertainties

The following list describes various assumptions and uncertainties within the data analysis that allow for potential unquantifiable errors.

**Lease code limitations**: Lease codes used to determine use authorization types can change over time. Historically, lease codes have been limiting, because one code could apply to multiple use authorization types. This can lead to assumptions that certain activities occur on state-owned aquatic lands that are not a representation of what is actually present. The agency is currently working on improving this by expanding the lease codes used for new use authorizations and going through existing leases to reassess the codes applied.

**Unauthorized uses**: There are unauthorized uses on state-owned aquatic lands that were not included in the database analysis. These unauthorized uses could change the values presented for potential effects and expected outcomes.

**Ownership uncertainties:** State-owned aquatic lands have been identified in various water bodies throughout the state of Washington. State ownership is still unknown in a number of areas. These ownership issues could change the values presented for potential effects and expected outcomes.

**Conservation measures change:** Certain conservation measures were selected and used in the database analysis to determine potential effects and expected outcomes. Current conservation measures may be different than those used in the initial analysis. Conservation measures can be adjusted over time as more information becomes available that supports a change, such as biological, ecological, and legal information, or considerations of practicality. Alterations in conservation measures could change the values presented for potential effects and expected outcomes.

# 4.3 Covered activities: potential effects

Aquaculture, log booming and storage, and overwater structures have been identified as the three covered activities in the Aquatic lands Habitat Conservation Plan (Chapter 3). The following section discusses how the covered activities can impact habitat essential to covered species in one or more of their life stages. To determine the potential effects discussed in this chapter, habitat descriptions from Chapter 1 and definitions of covered activities from Chapter 3 were used. Section 4.2 describes the data analysis used to identify the impacts of an activity. Section 4.4 addresses activity-specific effects to covered. Additional information regarding how potential effects were identified is located in the *Aquatic Resources Program Endangered Species Act Compliance Project, Potential Effect and Expected Outcomes Technical Paper* (Washington Department of Natural Resources, 2007b).

## Aquaculture: potential effects

When determining the potential effects that shellfish aquaculture has on the habitats that covered species use on state-owned aquatic land, aquaculture descriptions and definitions from Chapter 3 were used. The potential effects attributed to aquaculture are estimated in Chapter 4 by applying assumptions of the typical structure, operation, temporal dynamics, and maintenance required. An area of alteration for aquaculture was determined by totaling the number of leases and multiplying by average width and length measurements (Table 4.10).

### Assumed area of alteration: aquaculture

The area of alteration includes the area under cultivation and adjacent areas where support activities or other direct effects occur.

The total footprint for mussel, clam, and oyster aquaculture activities is estimated to be 85,248 meters$^2$.

Areas outside of cultured areas experience direct effects only from associated shoreline structures and disturbance of wildlife by human activities. A relatively small area of alteration is assumed due to the highly localized nature of the activity sub-group, with the total area of alteration equal to 102,300 meters$^2$.

**Table 4.10.** Assumed area of alteration: Aquaculture

| Activity Group | Activity Sub-group | Number of Leases | Max. Width (meters) | Max. Length (meters) | Assumed Width (meters) | Assumed Length (meters) | Estimated Footprint (meters$^2$) | Area of Alteration (meters$^2$) |
|---|---|---|---|---|---|---|---|---|
| Aquaculture | Shellfish | 134 | 183 | 915 | 1,332 | 64 | 85,248 | 102,300 |

### Sources, controlling factors, potential effects

Table 4.11 concisely summarizes the potential effects of aquaculture by identifying the source of the effects from the activity, alterations that can become a controlling factor, and the potential effect the controlling factor may have on the biological and ecological community (species or habitat). The data analysis and methods used to identify activity impacts is described in Section 4.2. A literature review was included in those methods and used to develop the table provided and

the subsequent narrative. Activity-specific effects to covered species and habitat are identified later (Section 4.4).

**Table 4.11.** Potential effects: Aquaculture.

| Source | Controlling Factors | Potential Biological Effect |
|---|---|---|
| Tilling, raking and digging to harvest shellfish | Disturbance and long-term modification of sediment substrates and submerged aquatic vegetation in nearshore unconsolidated habitats, displacement of natural biota and replacement with cultured species | Long-term habitat disturbance during active culture |
| Placement of structures for growing shellfish, stakes, tubes, lines, dikes, mussel rafts | Placement of aquaculture structures preventing access to habitats and shading of substrate | Long-term inaccessible habitat and habitat impairment, reduction in photosynthetically active radiation |
| Harvesting activities, pest control, interaction with aquaculture structures | Human and machinery presence, harvesting operations, physical disturbance of substrate | Temporarily inaccessible habitat, physical trauma to organisms, harassment of organisms due to increased turbidity |
| Mechanical harvesting using hydraulic methods | Increased turbidity; surface/ subsurface substrate and above substrate disturbance (*e.g.* physical structure or vegetation), disturbance of natural substrate with temporary and localized increases in turbidity | Temporary habitat destruction and inaccessibility, reduction in photosynthetically active radiation, water quality impairment |
| Pest (burrowing shrimp) control using chemical (carbaryl) methods | Contamination of water and substrates with chemical; food web effects | Short-term impairment of water and sediment quality, loss of biomass, incidental mortalities of salmonids |

| Source | Controlling Factors | Potential Biological Effect |
|---|---|---|
| Mussel culture using rafts | Deposition of shells and feces and release of sediment when harvesting | Long-term alteration of sediments, temporary impairment of water quality |

# Aquaculture impacts to habitat

## Direct effects — habitat

Shellfish culture operations use a variety of methods to grow and maintain their crop. As a result, the type and degree of affects to covered species or their habitat varies with the shellfish species being cultivated, cultivation and harvest methods, and the frequency of the disturbance. Preparation, maintenance, and harvest of mussels, clams, and oysters are both by hand and by mechanical means, while access to the culture sites occurs by boat and from adjacent terrestrial lands. Intertidal shellfish harvest is by hand and therefore depends on tidal stage, with harvest operations occurring during day- or nighttime low tidal cycles. Subtidal harvest does not depend on tidal stage and generally occurs during the day.

Destruction of habitat from shellfish culture is generally temporary and limited to harvest cycles of 1 to 5 years, with the cycle varying with the species being cultured. The magnitude of direct effects to habitat vary with the species being cultured, methods used, and harvest cycles. Effects may include, but are not limited to:

- Changes in substrate size/quality.
- Loss or alteration of vegetative communities during seeding, growth, and harvest operations due to dredging, digging, tilling, or raking of sediments, and change/conversion of substrate.
- Altered substrate composition from the deposition of growing mediums, such as shell fragments (cultch) and coarse gravel.
- Alteration of habitat complexity as a result of bed preparation, the installation of structures such as stakes, protective tubes or nets, and anchors.
- Changes in vegetative and invertebrate communities.

Suspended shellfish culture methods (such as longlines and rafts) can alter substrate composition and quality with the alteration of wave and current energies and the deposition of shells, feces, and solids, such as excess food. This can cause changes in sediment oxygen and nutrient flux (Callier *et al.*, 2006; Giles *et al.*, 2006; Hargrave *et al.*, 2008). The three dimensional structure of shellfish aquaculture can cause hydraulic dynamics that may lead to localized changes in substrate composition. The type of equipment and harvest methods that are used also can cause localized changes in substrate. Local bathymetry and drift cell dynamics, as well as the species cultivated and cultivation method, shape these effects. For example, mechanical harvest reduces the quantity of fine grains at a site through resuspension, with longlines potentially increasing sedimentation through decreases in water circulation (Wisehart *et al.*, 2007). Structures such as bags, racks, and longlines can also interrupt the action of waves and currents, resulting in deposition of fine sediments in the immediate vicinity of the structure.

Culture methods that involve the use of elevated or overwater structures (such as longlines and raft culture) artificially shade benthic habitats and may eliminate or reduce aquatic vegetation within

the shade footprint. Because of the reduction in vegetation, organic detritus inputs may be decreased locally, limiting food sources for organisms that feed on these inputs (for example, polychaetes and amphipods) and for the species that prey upon them. One study, however reports that the diversity and productivity of oyster culture and eelgrass habitat in Willapa Bay were equivalent (Ferraro and Cole 2007).

Intertidal and shallow subtidal (+1 to -8 feet mean lower low water) shellfish culture occurs in habitats similar to those favored by eelgrass (*Zostera marina*) and other aquatic vegetation—moderately stable fine- to medium-grained sediments, minimal bioturbation, and moderate surface roughness. Shellfish culture can directly affect the distribution of submerged aquatic vegetation through a decrease in the surface area available for colonization; or through direct physical disturbance during seeding and harvest operations and the removal of plants and rhizomes during mechanical harvest or bed harrowing (Carvalho *et al.*, 2006; Simenstad & Fresh, 1995; Tallis *et al.*, 2009). Sites that have been dredge harvested show higher rates of eelgrass growth and flowering than those harvested by other methods (Wisehart *et al.*, 2007).

Ropes used in longline culture can potentially entwine vegetation, increasing desiccation and decreasing plant densities (Wisehart *et al.*, 2007). While the magnitude of the impacts varies with the location and methods used for culturing and harvesting, effects from mechanical harvesting are generally the greatest, while hand harvesting causes the least impact (Wisehart *et al.*, 2007). Narrowly spaced longlines (1.5–2.5 feet) decreased the eelgrass density and percent cover; widely spaced longlines (5–10 feet), on the other hand, had eelgrass cover and density similar to control sites (Rumrill & Poulton, 2004). There is very little information regarding vegetation and rack and bag culture; however, Ward *et al.* (2003) found no spatial loss of eelgrass associated with oyster rack culture.

Shellfish are filter feeders and remove phytoplankton from the water column. As a result, there may be localized decreases in turbidity and an associated increase in the penetration of photosynthetically active radiation (PAR) (Newell, 2004). Shellfish feces and pseudofeces (pellets of indigestible sediment and plankton) may also provide localized increases in sediment nutrients, thereby stimulating shellfish growth (Peterson & Heck, 2001; Reusch & Williams, 1998). Wisehart *et al.* (2007) found that oyster beds that were mechanically harvested every three years had higher seedling abundance and production of seed compared to either an adjacent control or longline areas, although this is not considered a long-term benefit.

## Indirect effects — habitat

Shellfish culture has the potential to alter water quality through increased filtration. It can also alter prey/food resource availability for covered species in the habitat conservation plan; and it can reduce the quality of structural habitat for covered species. Bivalve shellfish are filter feeders, removing plankton and suspended sediments from the water column (Cole, 2002; Heffernan, 1999; Stenton-Dozey *et al.*, 2001). In large quantities, they may both degrade and benefit habitat. Biofiltration by shellfish may locally decrease phytoplankton abundance, thereby reducing turbidity and increasing light penetration for submerged vegetation (Grant *et al.*, 2007; Newell, 2004). In areas where shellfish culture dominates, it may also limit nutrient availability for marine vegetation and non-cultured species (Gibbs, 2004). Dumbauld *et al.* (2009) found that although Totten Inlet, near Olympia, has the highest density of shellfish culture of any embayment in Puget Sound, as well as high anthropogenic nutrient inputs, only localized nutrient depletion occurred.

Changes in benthic infaunal and epifaunal communities associated with shellfish culture may alter the forage base for covered species. Several studies document that while species richness,

numbers, and biomass associated with aquaculture gear can be equal to or higher than that of eelgrass, diversity varied significantly (Dealteris *et al.*, 2004; Dumbauld *et al.*, 2000, 2009; Feldman *et al.*, 2000; Meyer & Townsend, 2000; O'Beirn *et al.*, 2004; Pinnix *et al.*, 2005; Powers *et al.*, 2007).

Accumulations of feces, pseudofeces, and shell fragments may affect sediment quality in areas that are not well flushed. The substrate may become finer, enriched with nutrients, and, in some cases, anoxic (Heffernan, 1999). Benthic enrichment of the substrate can also change the composition, diversity, and structure of benthic communities, increasing the abundance of pollution-tolerant species and locally altering food-web dynamics (Bendell-Young, 2006; Carvalho *et al.*, 2006). In some cases, recovery of pre-culture community structure and nutrient balance can occur once cultivation stops; however, the process may take several years and depends on a number of environmental parameters that can be challenging to qualify and quantify (Heffernan, 1999; Stenton-Dozey, 2001).

# Log booming and storage: potential effects

Chapter 3 provides the descriptions and definitions of log booming and storage that were applied when determining the potential effects of log booming and storage on the habitats used by covered species on state-owned aquatic land. The potential effects attributed to log booming and storage are estimated in this chapter by applying assumptions about the typical structure, operation, temporal dynamics, and maintenance required. An area of alteration for log booming and storage was determined by totaling the number of leases and multiplying the result by average width and length measurements (Table 4.12).

## Area of alteration

The area of alteration is based on the extent of bark and debris deposition that occurs in areas beneath and adjacent to log storage areas. The total footprint of log booming and storage areas is estimated to be 79,994 meters$^2$. Bark deposition may occur on the substrate as far as 60 meters from the edge of the log boom and encompasses approximately 100,000 meters$^2$ outside the activity footprint (Pease, 1974). Consequently, the total assumed area of alteration is approximately 180,000 meters$^2$.

**Table 4.12.** Assumed area of alteration: Log booming and storage activity group.

| **Number of Leases** | **Max. Width** (meters) | **Max. Length** (meters) | **Assumed Width** (meters) | **Assumed Length** (meters) | **Estimated Footprint** (meters$^2$) | **Area of Alteration** (meters$^2$) |
|---|---|---|---|---|---|---|
| 61 | 610 | 762 | 622 | 127 | 79,994 | 180,000 |

## Sources, controlling factors, potential effects

The Table 4.13 below concisely summarizes the potential effects of log booming and storage by identifying:

- The source of the effects from the activity.
- Alterations that can become a controlling factor.

- The potential effect the controlling factor may have on the biological and ecological community (species or habitat).

The data analysis and methods used to identify activity impacts is described in Section 4.2. A literature review was included in those methods and was used to develop the table and the subsequent narrative. Activity-specific effects on covered species and habitat are identified later in Section 4.4.

**Table 4.13.** Log booming and storage potential effects

| Source | Controlling Factors | Potential Effect |
|---|---|---|
| Waste accumulation on benthos | Altered substrate composition, soil compaction<br>Degraded water quality, increased biological and chemical oxygen demand, increased turbidity<br>Depth and slope alteration | Shifts in biological communities from changes in substrate composition or elevation changes<br>Reduced habitat connectivity<br>Reduced prey abundance<br>Behavioral avoidance of degraded water and sediment quality<br>Decline or loss of aquatic vegetation |
| Boomed logs | Increased artificial shade<br>Reduced wave energy<br>Source of bark deposition<br>Degraded water quality—temperature dissolved oxygen<br>Altered hydrology—reduced circulation<br>Altered structural characteristics of habitat<br>Physical trauma from log movement | Shifts in biological communities due to reduced water circulation in sheltered area and degraded water quality<br>Reduced wave energy alters processes that maintain nearshore beaches<br>Reduced growth of aquatic plants and macroalgae due to increased shading<br>Potential increases in pinniped staging areas increases predation on fish |
| Operation | Periodic dredging to maintain boat access to log storage areas<br>Offloading logs (dumping) compacting sediment or altering depth and slope characteristics<br>Wave energy from boat traffic increases shoreline erosion<br>Recurrent episodic and unpredictable human activities | Shifts in biological communities due to changes in elevation ranges from dredging and altered substrate<br>Physical trauma to habitat and species from dumping or vessels<br>Reduction of aquatic macroinvertebrate production<br>Reduced habitat connectivity due to physical barriers (*e.g.*, wood debris)<br>Behavioral avoidance from species' ability to use habitat |

# Log booming and storage impacts to habitat

## Direct effects — habitat

Booming or dumping of logs occurs year-round and can be sporadic or constant. The most widely researched effects from log booming and storage are those that relate to alteration of the sediment structure. Dumping logs may result in the scouring and compacting of substrates beneath the logs and within the storage areas, with severe compaction altering benthic prey communities (Pease 1974; Sedell *et al.*, 1991). Thick accumulations of bark, whole logs, and other miscellaneous trash, such as metal bands and cables, may be common on the substrate beneath both dumping and rafting sites (Jackson, 1986; Kirkpatrick *et al.*, 1998; Pease, 1974). Bark deposits may extend outward from the site for up to 60 meters (197 feet); may be greater than 0.5 meters (1.6 feet) thick;, and have been observed to persist at abandoned sites for at least 30 years (Jackson, 1986; Pease, 1974; Sedell *et al.*, 1991). While debris may persist for decades or centuries in freshwater systems, the persistence of woody debris in saltwater systems is considerably shorter because it is broken down by wood-boring organisms such as teredos (*Teredos* spp.) or shipworms (*Bankia setacea*) (Bilby *et al.*, 1999; Naiman *et al.*, 2002; Pease, 1974).

Effects on submerged vegetation are possible through smothering by woody debris, increases in hydrogen sulfide associated with decomposition of the debris, or shading caused by log rafts (Elliott *et al.*, 2006). While there is little research regarding shading from log booming and storage in either fresh- or saltwater, potential effects are considered to be similar to those from overwater structures, marinas, and shipyards and terminals, with the extent of the shade dependent on the orientation of the boom relative to the position of the sun. Permanent habitat effects are also possible, because of changes in water and sediment quality associated with decomposition of the debris, which results in associated decreases in dissolved oxygen, stratification of water temperatures, and wood leachate from either logs or pilings.

## Indirect effects — habitat

The effects of log booming and storage on prey resources and the structural quality of habitat are generally the result of the physical and chemical changes associated with accumulations of debris (such as bark, logs, and cables), loss of submerged aquatic vegetation in shaded areas beneath dumping and rafting sites, and sediment compaction and scour associated with log dumping and propeller wash. While these changes are likely most significant beneath the log rafts, the area of alteration associated with bark deposits may extend outward from the site for up to 60 meters (197 feet) (Pease, 1974). Bark and debris can be displaced down slope from the originating area into adjacent, deeper areas, with the deposits persisting for at least 30 years (Kirkpatrick *et al.*, 1998; Sedell *et al.*, 1991).

Although species richness is generally reduced in habitats dominated by bark deposits, epibenthic organisms such as harpacticoid copepods, amphipods (such as *Anisogammarus confervicolus*), and isopods (such as *Exoshpaeroma oregonensis*) may occur in greater abundance beneath and adjacent to log rafts because of the structural habitat provided by the logs and debris (Kirkpatrick *et al.*, 1998; Sedell *et al.*, 1991). In contrast, benthic infauna were less abundant in areas covered with bark and had lower biomass when compared to reference sites, regardless of depth (Jackson, 1986). Suspension feeders are more affected by bark deposits than organisms that feed on deposited material. Sediment compaction may also prevent substrate use by larger suspension feeders, such as clams, and may shift benthic assemblages such that infaunal detritus feeders become the dominant species (Sedell *et al.*, 1991).

Chronic impacts to water and sediment quality affects prey resources, as the decomposition of woody debris and leachate (tannins and lignins) from the logs depletes the dissolved oxygen concentrations surrounding the rafts (Pease, 1974; Power & Northcote, 1991). The anaerobic decomposition of woody debris and associated release of hydrogen sulfide impacts habitat quality, vegetation, and prey resources (Elliott *et al.*, 2006). Additional water and sediment quality impacts associated with the use of treated wood for raft pilings, stormwater runoff from onshore log handling facilities, and vessel traffic are discussed below (overwater structures).

## Overwater structures: potential effects

When determining the potential effects that overwater structures have on the habitats used by covered species on state-owned aquatic lands, descriptions and definitions of all eight types of overwater structure were used (see Chapter 3). The potential effects attributed to overwater structures are estimated in Chapter 4 by applying assumptions of typical structure, operation, temporal dynamics, and maintenance required. An area of alteration for overwater structures was determined by totaling the number of leases and multiplying the result by average width and length measurements (Table 4.14).

**Table 4.14.** Assumed area of alteration: Overwater structures activity group.

| Activity Sub-group | Number of Leases | Max. Width (meters) | Max. Length (meters) | Assumed Width (meters) | Assumed Length (meters) | Est. Footprint (meters$^2$) | Area of Alteration (meters$^2$) |
|---|---|---|---|---|---|---|---|
| Boat Ramps, Launches, Hoists | 56 | 16 | 46 | 8 | 31 | 248 | 275 |
| Docks, Wharves | 309 | 10 | 122 | 2 | 61 | 122 | 750 |
| Floating Homes | 68 | 56 | 23 | 45 | 18 | 810 | 900 |
| Mooring Buoys | 274 | 10 | 10 | 7 | 7 | 49 | 100 |
| Nearshore Buildings | 98 | 244 | 246 | 61 | 63 | 3,838 | 11,500 |
| Rafts, Floats | 8 | 11 | 16 | 8 | 8 | 64 | 128 |
| Marinas | 394 | 2,000 | 400 | 1,000 | 200 | 200,000 | 650,000 |
| Shipyards & Terminals | 59 | 500 | 4,000 | 200 | 2,000 | 400,000 | 1,115,000 |

## Area of alteration: docks and wharves

The area of alteration includes the footprint of the structure, the area of changed hydrodynamics, sediment dynamics, shoreline modification, vessel propeller scour, shading, storm water, and chemicals leaching from treated timber.

The estimated footprint of docks and wharves is approximately 122 meters$^2$.

The area of alteration associated with docks and wharves is relatively large due to shading and estimated area of hydrodynamic alteration. For the purposes of this analysis, it is estimated to encompass 750 meters$^2$.

## Area of alteration: boat ramps/launches/hoists

The area of alteration for ramps includes the footprint of the structure, along with the surrounding area altered by propeller scour, shoreline modification, and changes in sediment transport.

The estimated footprint of boat ramps is approximately 248 meters$^2$.

A relatively small area of alteration results from the physical structure and placement of boat ramps. Due to their low profile, which is usually level with or only slightly above existing grade, ramps cause relatively little effect on sediment transport, shading, and benthic biota. For the purposes of this analysis, the area of alteration encompasses approximately 275 meters$^2$.

## Area of alteration: nearshore buildings

The area of alteration for nearshore buildings includes the estimated footprint of the structure and adjacent aquatic lands that could be affected by the building through shading, shoreline modification, and associated vessel activity.

The estimated footprint of nearshore buildings is approximately 3,838 meters$^2$.

Nearshore buildings have a relatively large area of alteration due to associated modifications of the shoreline and adjacent aquatic land through shading, structures, and vessel activity. For the purposes of this analysis, the area of alteration encompasses approximately 11,500 meters$^2$.

## Area of alteration: mooring buoys

The area of alteration for mooring buoys includes the footprint of the anchoring system and float, the area potentially altered as a result of anchor/chain drag, and shading by the buoy and vessel. The estimated footprint of mooring buoys is approximately 49 meters$^2$.

For the purposes of this analysis, the area of alteration encompasses approximately 100 meters$^2$. This area includes the area directly impacted by the chain or unbuoyed cable and shading from the attached vessel and the anchor.

## Area of alteration: floats and rafts

The area of alteration for floats and rafts includes the footprint of the structure and the area potentially altered as a result of impacts associated with anchor and chain/cable drag and shading. The estimated footprint of rafts and floats is approximately 64 meters$^2$.

Due to the similarity of structures and effects (for example, anchoring system, cable or chain drag, and shading), the area of alteration relative to the footprint is assumed to be similar to that for mooring buoys and equals 128 met meters$^2$.

## Area of alteration: floating homes

The area of alteration for floating homes includes the footprint of the floating home plus the area potentially altered by impacts from moorage systems and shading. The estimated footprint of floating homes is approximately 810 meters$^2$.

A relatively small area of alteration is assumed due to the typically low energy and highly impacted environment in which floating homes are located. For the purposes of this analysis, the area of alteration encompasses approximately 900 meters$^2$.

## Area of alteration: marinas

The area of alteration for marinas includes the area of the overwater structure(s) associated with the marina, shading, propeller scour, stormwater pollution, disturbance of aquatic species as a result of boat traffic, and shoreline erosion caused by waves produced by the boat. The adjacent area includes that affected by the discharge of water carrying pollutants from impermeable surfaces or from facilities and by light or noise pollution. In-water alterations are related to impacts extending beyond the footprint of boat traffic that result in scour from propeller wash, paint releases, waste releases, vessel moorage and loading (for example, shading or spillage and accidental discharges of toxins or waste), fueling, vessel repair and associated pollutants, and transfer of materials. The operation of boats can create changes in the physical environment beyond the facility through changes in currents, light, water, and sediment composition. The net effect is that marinas exert a wider influence on the bottom than that contained within the estimated footprint (Washington Department of Natural Resources, 2005c). However, the area of alteration may be restricted due to enclosure by breakwaters, which limits the impact of many controlling factors, such as storm water pollutants, scour, noise, and wave energy.

The estimated footprint of a typical marina is 200 meters by 1,000 meters, totaling approximately 200,000 meters$^2$ (Table 4.14).

Based on the length of 150 meters for each of four sides of the estimated footprint of a typical marina, the estimated dimensions of the area of potential disturbance of aquatic species as a result of the operation of boats and personal watercraft is 500 meters by 1,300 meters, totaling approximately 650,000 meters$^2$.

## Area of alteration: shipyards and terminals

The area of alteration includes the area of the overwater structure(s) associated with the terminal or shipyard; shading; propeller scour; storm water pollution; disturbance of aquatic species as a result of vessel, vehicle, and loading equipment traffic; and shoreline erosion caused by waves produced from shipping vessels. Adjacent area includes that affected by the discharge of water carrying pollutants from impermeable surfaces or from facilities and by light or noise pollution. In-water alterations are related to impacts extending beyond the footprint of vessel traffic that result in scour from propeller wash, paint releases, waste releases, vessel moorage and loading (for example, shading or spillage and accidental discharges of toxins or waste), fueling, vessel repair and associated pollutants, and transfer of materials. Terminals are associated with storage and

warehousing, which require industrial strength grating and the use of heavy equipment and rail or pipelines that move cargo—all of which can contribute toxic discharges, reduction in photosynthetically active radiation, and noise and light pollution.

The estimated footprint of shipyards and terminals is 200 meters by 2,000 meters, totaling approximately 400,000 meters$^2$.

Based on the length of 150 meters for each of four sides of the estimated footprint of a typical marina, the estimated dimensions of the area of potential disturbance of aquatic species as a result of the operation of boats and personal watercraft is 500 meters by 2,300 meters, totaling approximately 1,115,000 meters$^2$.

## Sources, controlling factors, potential effects

Table 4.15 concisely summarizes the potential effects of overwater structures by identifying:

- The source of the effects that result from the activity.
- What can result from that source and become a controlling factor.
- The potential effect that the controlling factor has on the biological and ecological community (species or habitat).

The data analysis and methods used to identify activity impacts are described in Section 4.2. A literature review was included in those methods and was used to develop the table and the subsequent narrative. Activity-specific effects on covered species and habitat are identified later in this chapter (see Section 4.4).

**Table 4.15**. Overwater structure potential effects

| Source | Controlling Factors | Potential Effect |
|---|---|---|
| Dredging | Depth and slope alteration | Altered biological communities as a result of depth increases and greater saltwater intrusion into freshwater ecosystems |
| | Degraded water quality | Loss of spawning habitat for some fish species |
| | Change in substrate composition | Reduced presence of submerged aquatic vegetation and associated biological communities |
| | Physical disturbance of substrate | Physical trauma or mortality from dredging (e.g., entrainment, crushing) from fish and benthics. |
| | Recurrent human activity | Reduced prey abundance |
| | Loss of natural shade | Behavioral avoidance due to degraded water quality or noise |
| | | Reduced fitness or increased mortality due to suspension of persistent bioaccumulative toxins |
| Fishing | Recurrent disturbance | Mortality |

| Source | Controlling Factors | Potential Effect |
|---|---|---|
| | Physical trauma to fish | Reduced fitness |
| Vehicular, boat, and foot traffic | Altered substrate composition, soil compaction, trash accumulation | Altered biological communities due to changes in substrate, depth and slope |
| | Degraded water quality, increased biological and chemical oxygen demand, increased turbidity | Reduced habitat connectivity |
| | Change in substrate composition | Reduced prey abundance |
| | Depth and slope alteration | Behavioral avoidance of degraded water quality |
| | Noise | Mortality of eggs, juveniles, and adults<br>Flushing<br>Behavioral avoidance |
| | Collision or entrainment | Mortality of eggs, juveniles, and adults |
| Operational activity | Altered depth/slope profile | Behavioral avoidance |
| | Altered hydrology | Physical disturbance and stress-related trauma |
| | Physical disturbance | Degradation of habitat |
| | Reflected wave energy | Alteration of substrate composition |
| | Structural habitat alteration (e.g., depth/slope profile) | Nesting failure of birds |
| | | Increased predation |
| | | Reduced habitat connectivity (increased fragmentation) |
| | | Reduced prey abundance |
| | | Reduction of aquatic macroinvertebrate production |
| | | Physical barriers to migration or movement |
| | Vessel traffic and accompanying human activity | Noise and other human activity can disturb activities such as feeding, nesting, and resting |
| | | Propeller wash can create turbidity, change sediment regime, disturb communities, and injure species |
| | Water and sediment quality degradation | Direct mortality |

| Source | Controlling Factors | Potential Effect |
|---|---|---|
| Physical structure | Change in habitat structure (pilings) | Aggregation of predatory finfish species (e.g., bass) and birds in fresh and marine ecosystems |
| | | Increased predation on juvenile salmonids in fresh and marine ecosystems |
| | Displacement of habitat—pilings, boat ramps, and other structures, such as bank hardening and breakwaters | Replaces habitats used for foraging, reproducing, and migrating with a completely different structure and ecological community. |
| | Shading—behavioral changes | Modified juvenile salmonid behavior (increased schooling, avoidance) in saltwater, estuarine, and freshwater ecosystems |
| | | Increased use of deep water by juvenile salmonids in saltwater ecosystems |
| | Shading—community changes | Reduction of emergent or submerged aquatic vegetation in saltwater, estuarine, and freshwater ecosystems |
| | | Reduction of benthic infauna in wetland ecosystems |
| | | Modification of benthic infauna community structure (reduction of diversity, increase in abundance of tolerant species) in saltwater ecosystems |
| | | Increased population density of mobile benthic predators and scavengers (e.g., crabs, sea stars, sculpins) |
| Placement of nearshore stabilization materials (*e.g.*, breakwalls) | Pollution | Reduced water circulation in sheltered area and water quality degradation results in physiological stress and acute or chronic toxicity for some organisms |
| | Altered hydrology | Reduced water circulation in sheltered area and water quality degradation results in physiological stress and acute or chronic toxicity for some organisms |

| Source | Controlling Factors | Potential Effect |
|---|---|---|
| Placement of shoreline erosion control structures (*e.g.*, rip-rap) | Reduced sediment supply | Changes in community composition and population numbers due to altered habitat |
| | Reflected wave energy | Increased depth and slope in nearshore ecosystem reduces area within elevation ranges suitable for some organisms |
| | Change in substrate composition | Loss of large organic debris as cover element |
| | Depth and slope alteration | Loss of channel complexity |
| | Structural habitat simplification | Reduced habitat connectivity |
| | Water quality degradation | Reduced prey abundance |
| | | Behavioral avoidance |
| Presence of outfall structure on aquatic lands | Artificial hard substrate in habitats | Artificial reef effect: Benthic habitat modification through accumulation of species and biomass not typical to habitat; may include predators (e.g., rockfish, sculpins) of covered species (e.g., salmonids) |
| | Physical changes in sedimentary processes (scouring, sediment transport, deposition, sediment composition) | Disturbance and change of existing habitat structure and function from unconsolidated to consolidated |
| | Physical changes in hydrodynamics | Inaccessible habitat because of presence of structure and effluent plume |
| Storm water or wastewater discharge | Increased nutrient loads | Decreased reproductive success |
| | | Increased productivity and an accompanying decrease in dissolved oxygen |
| | | Increase in algal blooms |
| | | Localized alteration of benthic communities<br>Decline or loss of aquatic vegetation from increased water turbidity and changes in sediment |
| | Accumulation of toxins (e.g., metals, pesticides, herbicides, hydrocarbons) and other harmful chemicals (e.g., endocrine disrupters) in sediment | Bioaccumulation of toxins |
| | Degradation of water and sediment quality | Can have indirect effects on health of species. |

| Source | Controlling Factors | Potential Effect |
|---|---|---|
| | | Modification of benthic infauna community structure (reduction of diversity, increase in abundance of tolerant species) in saltwater ecosystems |
| | Discharge of toxins (e.g., metals, pesticides, herbicides, hydrocarbons) and other harmful chemicals (e.g., endocrine disrupters) into the water column | Altered food web dynamics |
| | Introduction of human and pet pathogens | Increases in disease or lesions |
| Treated wood in pilings, other structural components, and debris | Impairment of water quality | Little documented effect. |
| | Impairment of sediment quality | Modification of benthic infauna (decrease in diversity and abundance) in saltwater, estuarine, and freshwater ecosystems. |
| Waste and chemical contamination | Degraded water quality, increased biological and chemical oxygen demand, increased turbidity | Decreased oxygen levels resulting in impaired respiration |
| | | Introduction of diseases or pathogens |

# Overwater structures impacts to habitat

## Direct effects — habitat

Disturbance from overwater structures can be sporadic or constant, occurring year-round. Use of recreational structures (single-family docks, mooring buoys, boat ramps/launches, and rafts) tends to be greater in April to October, thereby concentrating effects on the breeding and rearing periods of many of the species addressed in Section 4.4. Most of the activities in this group have structural features in common with docks and wharves, while their configuration, materials, and effects on submerged habitats vary. The structures affect predation, behavior, and habitat function by altering physical processes (such as ambient light and sediment transport), which in turn alters the quality and quantity of habitat available for reproduction, rearing, and refuge (Carrasquero, 2001; Nightingale & Simenstad, 2001).

In-water structures, such as pilings, breakwaters, bulkheads, and fill, alter wave and current energies, modifying the longshore transport of sediments and changing nearshore sediment composition and beach/shore nourishment patterns adjacent to the structures. These effects can also permanently alter bathymetry by replacing shallow unconsolidated habitats with deeper, steeper consolidated substrates (Toft *et al.*, 2004). Fill, bulkheads, and jetties associated with shipyards and terminals influence adjacent habitat in similar ways. Marinas, however, that are nearly enclosed with protective breakwaters designed to buffer wave and current energy have a

similar, but more pronounced level of effect on these physical habitat parameters and water quality impacts. Construction of in-water structures may also remove or reduce riparian vegetation, leading to a loss of natural shading and increases in nearshore/littoral water and beach temperatures, and reduction of litterfall and organic debris (Beschta, 1997; Jennings *et al.*, 1999; Rice, 2006). Permanent changes in bathymetry and sediment composition may also occur as a result of vessel scour, dredging, and modification of bottom water currents adjacent to storm water or process water outfalls (Diener *et al.*, 1997; King County, 2003; Washington Department of Natural Resources, 2007b).

The combined effects of several types of overwater structures may alter sediment input and transport processes over large areas, disconnecting aquatic ecosystems from important sediment sources, woody debris recruitment, nutrient loading, and affecting infaunal communities. In saltwater ecosystems, stabilization structures can trap sediment from feeder bluffs or structures may prevent tidal or storm inundation and erosion of sediment stored high on beaches (Macdonald *et al.*, 1994). While bank armoring and breakwaters in lakes have similar effects, armoring in low gradient riverine ecosystems does not substantially affect sediment supply and channel patterns (Bolton & Shellberg, 2001; Montgomery & Buffington, 2001; Reid & Holland, 1997). Bank armoring may also increase the transport of sediment near the structure, as reflected wave energy narrows beaches and coarsens substrate, lowering beach elevation as sediment is transported away and large organic debris is eliminated (Macdonald *et al.*, 1994; Williams & Thom, 2001). Similar impacts may be observed in riverine and lake ecosystems, with fine sediments—entrained by reflected waves—transported and deposited elsewhere. In rivers, channel incision, coarsening of bed substrates, and shifting of bank erosion to unarmored sections of the channel is common (Biedenharn *et al.*, 1997).

In addition to site-specific impacts, an area of alteration surrounds the structures, approximately 2 to 10 times larger than the structure footprint. The area of alteration is a result of shading and changes in ambient light levels, changes in shore zone habitat structure, and the disruption of water flow pattern and energy (Carrasquero, 2001; Simenstad *et al.*, 1999; Washington Department of Natural Resources, 2005d). This is particularly true of large structures, such as marinas, shipyards, and terminals, which modify both physical and chemical habitat characteristics, such as light, temperature, salinity, nutrient levels, and wave action (Simenstad et *al.*, 1999).

Shading from overwater structures in both salt- and freshwater ecosystems can eliminate submerged aquatic vegetation—such as eelgrass (*Zostera marina)*, kelp (Laminariales), hornworts (Ceratophyllaceae), and water-starworts (Callitrichaceae)—from a much larger area than just the surface area of the structure (Nightingale & Simenstad, 2001; Simenstad *et al.*, 1999; Washington Department of Natural Resources, 2005d). A study conducted by Washington DNR (2005d) found that while the area shaded by a structure varies with season, water depth, dimensions of the structure, and the presence of vessels, the shadow-to-deck-area is approximately a 4:1 ratio. Mooring buoys may have additional impacts due to the potential for the anchor line to drag on the bottom and remove vegetation within the scope of the system (Betcher & Williams, 1996).

Over- and in-water structures may also lead to acute water and sediment quality impacts. Reduced water circulation behind breakwaters can lead to significant, potentially lethal decreases in dissolved oxygen as a result of increased water temperatures and increases in nutrient concentrations from gray water, storm water, or process water discharges. Storm water may also contain PAHs, as well as high levels of nitrates and phosphates, pesticides, and sediments, as well as bacteria and pathogens from domesticated animals (Ackerman & Weisberg, 2003; Ahn *et al.*, 2005; Cubbage, 1995; Kerwin, 2001; King County, 2004; Olivieri *et al.*, 1977).

## Indirect effects — habitat

Overwater structures degrade habitat by changing physical and chemical habitat characteristics, such as light, temperature, nutrient levels, and wave energy (Simenstad *et al.*, 1999). While the changes are attributable to the presence of the structures, the effects are frequently interrelated and intensified by concentrations of structures, operational activities (such as vessels and noise), and associated structures (such as storm water outfalls, bulkheads, and breakwaters).

The presence of aquatic vegetation is likely one of the most important influences on the type, diversity, and density of prey available (Haas *et al.*, 2002). Prey resources may also be impacted by increases in turbidity caused by vessel traffic, changes in current energy, degradation of the quality of water and sediment as a result of operational activities (for example, fuel spills and increased turbidity), and changes to the substrate and sediment transport processes associated with the presence of the structures. The extent of the change in available prey depends on the size of the structure and the magnitude of the disturbance(s). Reductions in prey associated with large overwater structures, such as marinas, shipyards, and terminals, result from a combination of direct disturbance (such as propeller wash), reduced benthic vegetation from shading, and chemical, biological, and physical habitat alterations. While these facilities may be thought of as single, distinct entities, they are in fact a conglomeration of components (for example, docks, nearshore buildings, breakwaters, storm water outfalls, and shoreline armoring), and each component has its own impact. In addition, because marinas, shipyards, and terminals are frequently located in nearshore/littoral and estuarine environments, their effects on prey resources are concentrated in productive environments. Concentrations of smaller structures (recreational docks, buoys, rafts) may also affect prey resources across a large area due to their locations in shallower, productive, nearshore/littoral waters.

Overwater structures may also result in chronic water and sediment quality impacts. Structures may be a source of heavy metals (found in marine paints), fuels, and other polycyclic aromatic hydrocarbons (PAHs); as well as leachate from treated wood (Carrasquero, 2001). Washington State currently allows three types of treated wood: creosote, ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate type C (CCA). Species are exposed to wood preservatives through contaminants leaching into the water column and sediments and through direct contact with the wood (for example, eggs deposited directly on a treated piling). Existing research suggests that the measurable extent of influence for treatment chemicals is limited to 10 meters (33 feet) from the structure (Brooks, 2000; Poston, 2001; Vines *et al.*, 2000; Weis *et al.*, 1998). The potential for cumulative impacts associated with large quantities of treated wood in a given water body or embayment is largely unaddressed in the literature.

Both point and non-point storm water discharges contain accumulations of toxics (such as metals, pesticides, herbicides, and hydrocarbons), pathogens from human and pet waste, and nutrients, such as nitrogen and phosphorous. While the discharges may lead to localized impacts on prey availability, they may also lead to chronic effects on both high risk species and species of concern through bioaccumulation, increases in disease or lesions, decreased reproductive success, and decreases in dissolved oxygen because of increased algal decay (King County, 2003).

Sediments, especially those with high organic content, often accumulate contaminants and have much higher pollutant concentrations than the overlying water column (EVS Environmental Consultants, 2003). Resuspension, because of in-water construction and propeller turbulence from vessel traffic, can lead to short-term increases in contaminant concentrations, with metals and other toxins entering the food web through consumption by filter feeders. Contaminants from

water and sediment may also bioaccumulate in the fatty tissues of higher-level predators (EVS Environmental Consultants, 2003).

Water quality may also be degraded by breakwaters and maintenance dredging. Decreases in flows behind breakwaters may result in increases in pollutants (such as nutrients), as well as increases in sediment deposition. Navigational dredging may increase the extent of saltwater intrusion in otherwise freshwater ecosystems (U.S. Army Corps of Engineers, 1989).

The net result of these changes is a reduction in habitat complexity, as well as in ecosystem function. For example, reflected wave energy from stabilization structures may result in the complete destruction of spawning habitat for forage fish species such as surf smelt and sand lance, while scouring may also decrease the amount of substrate suitable for submerged plants (Thom *et al.*, 1994; Williams & Thom, 2001). Reduction in habitat complexity may also result in the loss of important cover elements, such as large woody debris.

# 4.4 Covered species, potential effects, and expected outcomes

Section 4.1 describes covered species life history, habitat use, and distribution. Section 4.3 describes potential effects that covered activities have on habitat used by the covered species. This section links the previous two by delineating activity-specific effects on covered species and describing expected outcomes if conservation measures are applied. Conservation measures for each activity are outlined in Chapter 5. The findings provided in this chapter are a result of a complex review of GIS data, database analysis, and relevant literature. Section 4.2 provides details on how numeric values were determined and threats identified, and it defines key terms used. Additional information regarding how potential effects and expected outcomes were identified can be found in the *Aquatic Resources Program Endangered Species Act Compliance Project, Potential Effects and Expected Outcomes Technical Paper* (Washington Department of Natural Resources, 2007b) and the *Aquatic Resources Program Habitat Conservation Plan Covered Species Technical Paper* (Washington Department of Natural Resources, 2007).

## Columbia spotted frog (*Rana luteiventris*)

### Threats warranting coverage in the habitat conservation plan

The covered activity identified as having potential effects on the Columbia spotted frog is overwater structures. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the Columbia spotted frog in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the Columbia spotted frog occurs, 34 percent overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Changes in habitat structure (such as channel morphology)
2. Increase in predation
3. Water and sediment quality degradation
4. Physical harm or harassment

Log Booming and Storage

- None

Aquaculture

- None

### Potential effects of covered activities

**Overwater Structures:** For the Columbia spotted frog, the relative average area of potentially affected habitat as a result of overwater structures is 186 acres. The types of overwater structures identified as having potential effects on Columbia spotted frog habitat include boat ramps and launches, docks and wharves, and marinas. Estimates of habitat affected for the three life stages

are as follows: 220 acres for the adult life stage, 222 acres for the egg stage, and 117 acres for the tadpole stage.

**Log Booming and Storage:** Potentially affected habitat from log booming and storage is 0 acres, because there is currently no spatial overlap.

**Aquaculture:** Potentially affected habitat from aquaculture is 0 acres, because there is currently no spatial overlap

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 12 percent decrease in potentially affected area. For the egg stage, there is an estimated 14 percent decrease in potentially affected area. For the tadpole stage, there is an estimated 25 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 17 percent.

## Northern leopard frog (*Rana pipiens*)

### Threats warranting coverage in the habitat conservation plan

The covered activities identified as having potential effects on the northern leopard frog are **overwater structures** and log booming and storage (there is potential for spatial overlap through future authorizations). The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the northern leopard frog in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the northern leopard frog occurs, 53 percent overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Changes in habitat structure (such as channel morphology)
2. Increase in predation
3. Water and sediment quality degradation
4. Physical harm or harassment

Log Booming and Storage

- None

Aquaculture

- None

### Potential effects of covered activities

**Overwater Structures:** For the northern leopard frog, the relative average area of potentially affected habitat as a result of overwater structures is 108 acres. The types of overwater structures identified as having potential effects on northern leopard frog habitat include boat ramps and launches, docks and wharves, and marinas. Estimates of habitat affected for the three life stages

are as follows: 108 acres for the adult life stage, 0 acres for the egg stage, and 0 acres for the tadpole stage.

**Log Booming and Storage:** Presently, potentially affected habitat from log booming and storage is 0 acres, because there is currently no spatial overlap.

**Aquaculture:** Potentially affected habitat from aquaculture is 0 acres, because there is currently no spatial overlap.

#### Expected outcomes with application of conservation measures: northern leopard frog

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 12 percent decrease in potentially affected area. For the egg stage, there is an estimated 0 percent decrease in potentially affected area. For the tadpole stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 12 percent.

## Oregon spotted frog (*Rana pretiosa*)

### Threats warranting coverage in the habitat conservation plan

There are no covered activities identified as having potential effects on the Oregon spotted frog. Of the current geographic townships in which where the Oregon spotted frog occurs, 0 percent% of them overlap with an authorized activity. The Oregon spotted frog warrants coverage in the Aquatic Lands Habitat Conservation Plan due to the species' highly aquatic nature (occurring in a variety of freshwater habitats), the difficulty of determining species presence, and the possibility of missed spatial overlap of authorized covered activities and species occurrence. The following list identifies potential threats, either to the species or to the habitat it uses, from current use authorizations on state-owned aquatic lands.

Overwater Structures

- None

Log Booming and Storage

- None

Aquaculture

- None

### Potential effects of covered activities

**Overwater structures:** Potentially affected habitat from overwater structures is 0 acres, because there is currently no spatial overlap.

**Log booming and storage:** Potentially affected habitat from log booming and storage is 0 acres, because there is currently no spatial overlap.

**Aquaculture:** Potentially affected habitat from aquaculture is 0 acres, because there is currently no spatial overlap.

### Expected Outcomes with Application of Conservation Measures

- None

## Western toad (*Bufo boreas*)

### Threats warranting coverage in the habitat conservation plan

The covered activities identified as having potential effects on the western toad are overwater structures and log booming and storage. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the western toad in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the western toad occurs, 43 percent overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use authorizations on state owned aquatic lands.

Overwater Structures

1. Changes in habitat structure (such as channel morphology)
2. Increase in predation
3. Water and sediment quality degradation
4. Physical harm or harassment

Log Booming and Storage

1. Mortality from traffic
2. Physical harm or harassment
3. Habitat degradation

Aquaculture

- None

### Potential effects of covered activities

**Overwater structures:** For the western toad, the relative average area of potentially affected habitat as a result of overwater structures is 833 acres. The types of overwater structures identified as having potential effects on western toad habitat include boat ramps and launches, docks and wharves, floating homes, nearshore buildings, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 1,356 acres for the adult life stage, 395 acres for the egg stage, and 747 acres for the tadpole stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 48 acres. Estimates of habitat affected for the three life stages are as follows: 75 acres for the adult life stage, 35 acres for the egg stage, and 35 acres for the tadpole stage.

**Aquaculture:** Potentially affected habitat from aquaculture is 0 acres, because there is currently no spatial overlap.

### Expected outcomes with application of conservation measures

**Overwater Structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 15 percent decrease in potentially affected area. For the egg stage, there is an estimated 14 percent decrease in potentially affected area. For the tadpole stage, there is an estimated 27 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 19 percent.

**Log Booming and Storage:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for log booming and storage has been evaluated and averaged by life stages. For the adult stage, there is an estimated 0 percent decrease in potentially affected area. For the egg stage, there is an estimated 50 percent decrease in potentially affected area. For the tadpole stage, there is an estimated 50 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 33 percent.

## Western pond turtle (*Actinemys marmorata*)

### Threats warranting coverage in the habitat conservation plan

The covered activities identified as having potential effects on the western pond turtle are **overwater structures** and **log booming and storage**. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the western pond turtle in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the Western pond turtle occurs, 65 percent of the foraging occurrences and 41percent of the overwintering occurrences overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Permanent destruction and fragmentation of wetland, side channel, and backwater habitats
2. Changes in habitat structure (such as channel morphology)
3. Increase in predation
4. Water and sediment quality degradation
5. Physical harm or harassment

Log Booming and Storage

1. Mortality from traffic
2. Physical harm or harassment
3. Habitat degradation

Aquaculture

- None

### Potential effects of covered activities

**Overwater structures:** For the western pond turtle, the relative average area of potentially affected habitat western pond turtle as a result of overwater structures is 48 acres. The types of overwater structures identified as having potential effects on western pond turtle habitat include docks and wharves, floating homes, nearshore buildings, marinas, and shipyards and terminals. Estimates of habitat affected for the two life stages are as follows: 73 acres for the non-wintering life stage and 24 acres for the overwintering stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 8 acres. Estimates of habitat affected for the two life stages are as follows: 8 acres for the non-wintering life stage and 0 acres for the overwintering stage.

**Aquaculture:** Potentially affected habitat from aquaculture is 0 acres, because there is currently no spatial overlap.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the non-wintering stage, there is an estimated 17 percent decrease in potentially affected area. For the wintering stage, there is an estimated 17 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 17 percent.

**Log booming and storage:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for log booming and storage has been evaluated and averaged by life stages. For the non-wintering stage, there is an estimated 31 percent decrease in potentially affected area. For the wintering stage, there is an estimated 0 percent decrease in potentially affected area.

## Black tern *(Chlidonias niger)*

### Threats warranting coverage in the habitat conservation plan

The covered activity identified as having potential effects on the black tern is **overwater structures**. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the black tern in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the black tern occurs, 32 percent overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Habitat destruction, conversion. and degradation
2. Impaired behavior
3. Changes in habitat structural matrices
4. Water and sediment quality degradation
5. Human disturbance
6. Related prey abundance and reductions in energy resources

Log Booming and Storage

- None

Aquaculture

- None

### Potential effects of covered activities

**Overwater Structures:** For the black tern, the relative average area of potentially affected habitat as a result of overwater structures is 193 acres. The types of overwater structures that have been identified as having potential effects on black tern habitat include boat ramps and launches, docks and wharves, mooring buoys, marinas, and shipyards and terminals. Estimates of habitat affected for the two life stages are as follows: 168 acres for the migration life stage and 219 acres for the nesting stage.

**Log Booming and Storage:** Potentially affected habitat from log booming and storage is 0 acres, because there is currently no spatial overlap.

**Aquaculture:** Potentially affected habitat from aquaculture is 0 acres, because there is currently no spatial overlap.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the migration stage, there is an estimated 19 percent decrease in potentially affected area. For the nesting stage, there is an estimated 16 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 17 percent.

## Common loon (*Gavia immer*)

### Threats warranting coverage in the habitat conservation plan: common loon

The covered activities identified as having potential effects on the common loon are overwater structures, aquaculture, and log booming and storage. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the common loon in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the common loon occurs, 40 percent of the non-breeding occurrences and 14 percent of the nesting occurrences overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Habitat destruction, conversion, and degradation
2. Impaired behavior
3. Changes in habitat structural matrices
4. Water and sediment quality degradation
5. Human disturbance
6. Related prey abundance and reductions in energy resources

Log Booming and Storage

1. Habitat destruction
2. Human disturbance
3. Changes in structural habitat

Aquaculture

1. Permanent habitat destruction/displacement
2. Energy resource reduction
3. Water and sediment quality degradation
4. Increased human activity, impaired behavior, and physical harassment

### Potential effects of covered activities

**Overwater structures:** For the common loon, the relative average area of potentially affected habitat as a result of overwater structures is 8,127 acres. The types of overwater structures that have been identified as having potential effects on common loon habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the two life stages are as follows: 5,372 acres for the nesting life stage and 10,881 acres for the non-nesting stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 1429 acres. Estimates of habitat affected for the two life stages are as follows: 1,379 acres for the nesting life stage and 1,479 acres for the non-nesting stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 37 acres. Estimates of habitat affected for the two life stages are as follows: 0 acres for the nesting life stage and 37 acres for the non-nesting stage.

### Expected outcomes with application of conservation measures: common loon

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the nesting stage, there is an estimated 14 percent decrease in potentially affected area. For the non-nesting stage, there is an estimated 14 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 14 percent.

**Log booming and storage:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for log booming and storage has been evaluated and averaged by life stages. For the nesting stage, there is an estimated 50 percent decrease in potentially affected area. For the non-nesting stage, there is an estimated 26 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 38 percent.

**Aquaculture:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for aquaculture has been evaluated and averaged by life stages. For the nesting stage, there is an estimated 0 percent decrease in potentially affected area. For the non-nesting stage, there is an estimated 20 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 20 percent.

## Harlequin duck *(Histrionicus histrionicus)*

### Threats warranting coverage in the habitat conservation plan

The covered activity identified as having potential effects on the harlequin duck is overwater structures. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the harlequin duck in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the harlequin duck occurs, 65 percent of the non-breeding occurrences and 36 percent of the nesting occurrences overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Habitat destruction, conversion, and degradation
2. Impaired behavior
3. Changes in habitat structural matrices
4. Water and sediment quality degradation
5. Human disturbance
6. Related prey abundance and reductions in energy resources

Log Booming and Storage

- None

Aquaculture

- None

### Potential effects of covered activities

**Overwater structures:** For the harlequin duck, the relative average area of potentially affected habitat as a result of overwater structures is 2,132 acres. The types of overwater structures that have been identified as having potential effects on harlequin duck habitat include nearshore buildings and marinas. Estimates of habitat affected for the two life stages are as follows: 3,644 acres for the nesting life stage and 640 acres for the non-nesting stage.

**Log booming and storage:** Potentially affected habitat from log booming and storage is 0 acres, because there is currently no spatial overlap.

**Aquaculture:** Potentially affected habitat from aquaculture is 0 acres, because there is currently no spatial overlap.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the nesting stage, there is an estimated 17 percent decrease in potentially affected area. For the non-nesting stage, there is an estimated 15 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 15 percent.

## Marbled murrelet *(Brachyramphus marmoratus)*

### Threats warranting in the habitat conservation plan

The covered activities identified as having potential effects on the marbled murrelet are **overwater structures, log booming and storage**, and **aquaculture.** The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the marbled murrelet in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the marbled murrelet occurs, 41 percent overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use authorizations on state-owned aquatic lands.

Overwater Structures

1. Habitat destruction, conversion, and degradation
2. Impaired behavior
3. Changes in habitat structural matrices
4. Water and sediment quality degradation
5. Human disturbance
6. Related prey abundance and reductions in energy resources

Log Booming and Storage

1. Habitat destruction
2. Human disturbance
3. Changes in structural habitat

Aquaculture

1. Permanent habitat destruction/displacement
2. Energy resource reduction
3. Water and sediment quality degradation
4. Increased human activity, impaired behavior, and physical harassment

### Potential effects of covered activities

**Overwater structures:** For the marbled murrelet, the relative average area of potentially affected habitat as a result of overwater structures is 10,099 acres. The types of overwater structures identified as having potential effects on marbled murrelet habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the two life stages are as follows: 9,201 acres for the nesting life stage and 10,996 acres for the non-nesting stage.

**Log booming and storage:** The relative average area of potentially effected habitat from log booming and storage is 1,906 acres. Estimates of habitat affected for the two life stages are as follows: 1,282 acres for the nesting life stage and 2,531 acres for the non-nesting stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 2,406 acres. Estimates of habitat affected for the two life stages are as follows: 2,406 acres for the nesting life stage and 2,406 acres for the non-nesting stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the nesting stage, there is an estimated 16 percent decrease in potentially affected area. For the non-nesting stage, there is an estimated 17 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 16 percent.

**Log booming and storage:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for log booming and storage has been evaluated and averaged by life stages. For the nesting stage, there is an estimated 26 percent decrease in potentially affected area. For the non-nesting stage, there is an estimated 49 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 38 percent.

**Aquaculture:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for aquaculture has been evaluated and averaged by life stages. For the nesting stage, there is an estimated 20 percent decrease in potentially affected area. For the non-nesting stage, there is an estimated 20 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 20 percent.

## Western snowy plover *(Charadrius nivosus nivosus)*

### Threats warranting coverage in the habitat conservation plan

The covered activity identified as having potential effects on the snowy plover is aquaculture. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the western snowy plover in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the snowy plover occurs, 92 percent overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

- None

Log Booming and Storage

- None

Aquaculture

1. Permanent habitat destruction/displacement
2. Energy resource reduction
3. Water and sediment quality degradation
4. Increased human activity, impaired behavior, and physical harassment

### Potential effects of covered activities

**Overwater Structures:** Potentially affected habitat from overwater structures is 0 acres.

**Log Booming:** Potentially affected habitat from log booming and storage is 0 acres.

**Aquaculture:** For the snowy plover, the relative average area of potentially affected habitat as a result of aquaculture is 3,681 acres. Estimates of habitat affected for the two life stages are as follows: 4,098 acres for the nesting life stage and 3,264 acres for the wintering stage.

### Expected outcomes with application of conservation measures

**Aquaculture:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for aquaculture has been evaluated and averaged by life stages. For the nesting stage, there is an estimated 25 percent decrease in potentially affected area. For the wintering stage, there is an estimated 18 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 22 percent.

## Fish Species: Introduction

For certain fish species there was insufficient data to identify any threats warranting coverage in the habitat conservation plan, the potential effects of covered activities, or the expected outcomes with the application of conservation measures. The following are included in the Aquatic Lands Habitat Conservation Plan because of their listing status and assumed habitat overlap on state-owned aquatic lands. These species were listed under ESA and added to the HCP after the potential effects document was developed. The habitat protections provided in the HCP for these species will provide substantial benefits for the habitat within the areas of assumed habitat overlap with the aquatic lands covered in this HCP.

**Lamprey:** Pacific lamprey *Lampetra tridentata*)

**Rock fish:** Bocaccio (*Sebastes paucispinis*), canary rockfish (*Sebastes pinniger*), and yelloweye rockfish (*Sebastes ruberrimus*)

Four forage fish species are covered in the Aquatic Lands Habitat Conservation Plan; however, they were added after the data analysis was completed. There is no quantitative data from the data analysis for the following species.

**Forage Fish:** Eulachon/Pacific smelt (*Thaleichthys pacificus*), Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*)

# Fish complex: introduction

The following eight species of fish were evaluated separately and then grouped and treated as a *fish complex* in the analysis because they exhibit similar habitat uses or life histories:

- Bull trout
- Chinook salmon
- Chum salmon
- Coastal cutthroat trout
- Coho salmon
- Pink salmon
- Sockeye salmon
- Steelhead trout

The covered activities identified as having potential effects on the fish complex species are **overwater structures, log booming and storage**, and **aquaculture**. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the fish complex in the Aquatic Lands Habitat Conservation Plan. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Habitat conversion and degradation
2. Physical trauma, harm, and harassment
3. Reduced structural habitat quality
4. Energy resource reduction

Log Booming and Storage

1. Water and sediment quality degradation
2. Human disturbance
3. Habitat degradation

Aquaculture

1. Permanent habitat destruction/displacement
2. Temporary habitat degradation
3. Energy resource reduction resulting from decreased prey abundance
4. Water and sediment quality degradation
5. Increased human activity, impaired behavior, and physical harassment

## Potential effects of covered activities

Species-specific effects are described in the pages following.

## Expected outcomes with application of conservation measures: fish complex

**Overwater structures:** Species-specific effects are described in the pages following.

**Log booming and storage:** For all species within the fish complex, with the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for log booming and storage has been evaluated and averaged by life stages. For the

adult stage, there is an estimated 24 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 25 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 16 percent.

**Aquaculture:** For all species within the fish complex, with the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for aquaculture has been evaluated and averaged by life stages. For the adult stage, there is an estimated 12 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 12 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 6 percent.

## Bull trout *(Salvelinus confluentus)*

### Threats warranting coverage in the habitat conservation plan

The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the bull trout in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the bull trout occurs, 54 percent of the adult occurrences, 54 percent of the juvenile occurrences, and 15 percent of the incubation/emergence occurrences overlap with an authorized activity. See the fish complex list, which identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

### Potential effects of covered activities

**Overwater structures:** For the bull trout, the relative average area of potentially affected habitat as a result of overwater structures is 8,465 acres. The types of overwater structures identified as having potential effects on bull trout habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 10,151 acres for the adult stage, 15,241 acres for the juvenile stage, and 1 acre for the incubation/emergence stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 1,199 acres. Estimates of habitat affected for the three life stages are as follows: 869 acres for the adult stage, 1,529 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 1,203 acres. Estimates of habitat affected for the three life stages are as follows: 2,406 acres for the adult stage, 2,406 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 17 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 23 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 11percent.

**Log booming and storage:** See fish complex expected outcomes with application of conservation measures, log booming and storage.

**Aquaculture:** See fish complex expected outcomes with application of conservation measures, aquaculture.

## Chinook salmon *(Oncorhynchus tshawytscha)*

### Threats warranting coverage in the habitat conservation plan

The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the Chinook salmon in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the Chinook salmon occurs, 59 percent of the adult occurrences, 59 percent of the juvenile occurrences, and 30 percent of the incubation/emergence occurrences overlap with an authorized activity. See the fish complex list, which identifies potential threats, either to the species or to the habitat it uses, from current use authorizations on state-owned aquatic lands.

### Potential effects of covered activities

**Overwater structures:** For Chinook salmon, the relative average area of potentially affected habitat as a result of overwater structures is 10,067 acres. The types of overwater structures identified as having potential effects on Chinook habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 12,084 acres for the adult stage, 18,062 acres for the juvenile stage, and 54 acres for the incubation/emergence stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 1,020 acres. Estimates of habitat affected for the three life stages are as follows: 973 acres for the adult stage, 1,701 acres for the juvenile stage, and 388 acres for the incubation/emergence stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 1,203 acres. Estimates of habitat affected for the three life stages are as follows: 2,406 acres for the adult stage, 2,406 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

### Expected outcomes with application of conservation measures

**Overwater Structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 17 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 23 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 11 percent.

**Log booming and storage:** See fish complex expected outcomes with application of conservation measures, log booming and storage.

**Aquaculture:** See fish complex expected outcomes with application of conservation measures, aquaculture.

## Chum salmon *(Oncorhynchus keta)*

### Threats warranting coverage in the habitat conservation plan

The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the chum salmon in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the chum salmon occurs, 65 percent of the adult occurrences, 65 percent of the juvenile occurrences, and 23 percent of the incubation/emergence occurrences overlap with an authorized activity (F-2). See the fish complex list, which identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

### Potential effects of covered activities

**Overwater structures:** For chum salmon, the relative average area of potentially affected habitat as a result of overwater structures is 5,902 acres. The types of overwater structures identified as having potential effects on chum habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 7,005 acres for the adult stage, 10,647 acres for the juvenile stage, and 54 acres for the incubation/emergence stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 861 acres. Estimates of habitat affected for the three life stages are as follows: 628 acres for the adult stage, 1,093 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 1,203 acres. Estimates of habitat affected for the three life stages are as follows: 2,406 acres for the adult stage, 2,406 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 16 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 22 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 12 percent.

**Log booming and storage:** See fish complex expected outcomes with application of conservation measures, log booming and storage.

**Aquaculture:** See fish complex expected outcomes with application of conservation measures, aquaculture.

## Coastal cutthroat trout *(Oncorhynchus clarki clarki)*

### Threats warranting coverage in the habitat conservation plan

The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the coastal cutthroat trout in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the coastal cutthroat trout occurs, 62 percent of the adult occurrences, 62 percent of the juvenile occurrences, and 30 percent of the incubation/emergence occurrences overlap with an authorized activity (F-2). See the fish complex list, which identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

### Potential effects of covered activities

**Overwater structures:** For the coastal cutthroat trout, the relative average area of potentially affected habitat as a result of overwater structures is 8,977 acres. The types of overwater structures identified as having potential effects on coastal cutthroat trout habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 10,851 acres for the adult stage, 16,038 acres for the juvenile stage, and 43 acres for the incubation/emergence stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 1,020 acres. Estimates of habitat affected for the three life stages are as follows: 973 acres for the adult stage, 1,701 acres for the juvenile stage, and 388 acres for the incubation/emergence stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 1,203 acres. Estimates of habitat affected for the three life stages are as follows; 2,406 acres for the adult stage, 2,406 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 16 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 22 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease of potentially affected area of 12 percent.

**Log booming and storage:** See fish complex expected outcomes with application of conservation measures, log booming and storage.

**Aquaculture:** See fish complex expected outcomes with application of conservation measures, aquaculture.

## Coho salmon *(Oncorhynchus kisutch)*

### Threats warranting coverage in the habitat conservation plan

The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the coho salmon in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the coho salmon occurs, 62 percent of the adult occurrences, 62 percent of the juvenile occurrences, and 20 percent of the incubation/emergence occurrences overlap with an authorized activity. See the fish complex list, which identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

### Potential effects of covered activities

**Overwater structures:** For coho salmon, the relative average area of potentially affected habitat as a result of overwater structures is 8,981 acres. The types of overwater structures identified as having potential effects on coho habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 10,862 acres for the adult stage, 16,051 acres for the juvenile stage, and 29 acres for the incubation/emergence stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 1,337 acres. Estimates of habitat affected for the three life stages are as follows: 973 acres for the adult stage, 1,701 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 1,203 acres. Estimates of habitat affected for the three life stages are as follows: 2,406 acres for the adult stage, 2,406 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 16 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 22 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 12 percent.

**Log booming and storage:** See fish complex expected outcomes with application of conservation measures, log booming and storage.

**Aquaculture:** See fish complex expected outcomes with application of conservation measures, aquaculture.

## Pink salmon *(Oncorhynchus gorbuscha)*

### Threats warranting coverage in the habitat conservation plan

The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the pink salmon in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the pink salmon occurs, 52 percent of the adult occurrences and 52 percent of the juvenile occurrences overlap with an authorized activity. See the fish complex list, which identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

### Potential effects of covered activities

**Overwater structures:** For pink salmon, the relative average area of potentially affected habitat as a result of overwater structures is 4,830 acres. The types of overwater structures identified as having potential effects on pink salmon habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 5,673 acres for the adult stage, 8,806 acres for the juvenile stage, and 12 acres for the incubation/emergence stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 488 acres. Estimates of habitat affected for the three life stages are as follows: 527 acres for the adult stage, 917 acres for the juvenile stage, and 19 acres for the incubation/emergence stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 1,203 acres. Estimates of habitat affected for the three life stages are as follows: 2,406 acres for the adult stage, 2,406 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 16 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 22 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 12 percent.

**Log booming and storage:** See fish complex expected outcomes with application of conservation measures, log booming and storage.

**Aquaculture:** See fish complex expected outcomes with application of conservation measures, aquaculture.

## Sockeye salmon (Oncorhynchus nerka)

### Threats warranting coverage in the habitat conservation plan

The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the sockeye salmon in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the sockeye salmon occurs, 66 percent of the adult occurrences, 66 percent of the juvenile occurrences, and 16 percent of the incubation/emergence occurrences overlap with an authorized activity. See the fish complex list, which identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

### Potential effects of covered activities

**Overwater structures:** For sockeye salmon, the relative average area of potentially affected habitat as a result of overwater structures is 10,186 acres. The types of overwater structures identified as having potential effects on sockeye habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 12,052 acres for the adult stage, 18,027 acres for the juvenile stage, and 480 acres for the incubation/emergence stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 1,301 acres. Estimates of habitat affected for the three life stages are as follows: 940 acres for the adult stage, 1,642 acres for the juvenile stage, and 1,322 acres for the incubation/emergence stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 1,203 acres. Estimates of habitat affected for the three life stages are as follows: 2,406 acres for the adult stage, 2,406 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 16 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 22 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 12 percent.

**Log booming and storage:** See fish complex expected outcomes with application of conservation measures, log booming and storage.

**Aquaculture:** See fish complex expected outcomes with application of conservation measures, aquaculture.

## Steelhead trout (*Oncorhynchus mykiss*)

### Threats warranting coverage in the habitat conservation plan

The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the steelhead trout in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the steelhead trout occurs, 57 percent of the adult occurrences, 57 percent of the juvenile occurrences, and 39 percent of the incubation/emergence occurrences overlap with an authorized activity. See the fish complex list, which identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

### Potential effects of covered activities

**Overwater structures:** For the steelhead trout, the relative average area of potentially affected habitat as a result of overwater structures is 10,067 acres. The types of overwater structures identified as having potential effects on steelhead habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 12,084 acres for the adult stage, 18,062 acres for the juvenile stage, and 54 acres for the incubation/emergence stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 1,020 acres. Estimates of habitat affected for the three life stages are as follows: 973 acres for the adult stage, 1,701 acres for the juvenile stage, and 388 acres for the incubation/emergence stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 1,203 acres. Estimates of habitat affected for the three life stages are as follows: 2,406 acres for the adult stage, 2,406 acres for the juvenile stage, and 0 acres for the incubation/emergence stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for overwater structures has been evaluated and averaged by life stages. For the adult stage, there is an estimated 16 percent decrease in potentially affected area. For the juvenile stage, there is an estimated 22 percent decrease in potentially affected area. For the incubation/emergence stage, there is an estimated 0 percent decrease in potentially affected area. For all life stages, there is an average decrease in potentially affected area of 12 percent.

**Log booming and storage:** See fish complex expected outcomes with application of conservation measures, log booming and storage.

**Aquaculture:** See fish complex expected outcomes with application of conservation measures, aquaculture.

## Green sturgeon *(Acipenser medirostris)*

### Threats warranting coverage in the habitat conservation plan

The covered activities identified as having potential effects on the green sturgeon are **overwater structures, log booming and storage**, and **aquaculture.** Of the current geographic townships in which the green sturgeon occurs, the percent overlap with an authorized activity is undetermined. The green sturgeon warrants coverage in the Aquatic Lands Habitat Conservation Plan due to the species' highly aquatic nature, the difficulty of determining species presence, and the possibility of missed spatial overlap of authorized covered activities and species occurrence. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Habitat conversion and degradation.
2. Physical trauma, harm and harassment.
3. Reduced structural habitat quality.
4. Energy resource reduction.

Log Booming and Storage

1. Water and sediment quality degradation
2. Human disturbance.
3. Habitat degradation.

Aquaculture

1. Permanent habitat destruction/displacement.
2. Temporary habitat degradation.
3. Energy resource reduction resulting from decreased prey abundance.
4. Water and sediment quality degradation.
5. Increased human activity, impaired behavior, and physical harassment.

### Potential effects of covered activities

**Overwater structures:** For the adult life stage of the green sturgeon, potentially affected habitat as a result of overwater structures is 3,239 acres. The types of overwater structures identified as having potential effects on green sturgeon habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals.

**Log booming and storage:** For the adult life stage, potentially affected habitat from log booming and storage is 484 acres.

**Aquaculture:** For the adult life stage, potentially affected habitat from aquaculture is 3,927acres.

### Expected outcomes with application of conservation measures

**Overwaters:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area for adult and juvenile habitat was 67 percent for mooring buoys, rafts and floats, 24 percent for marinas, nearshore buildings, shipyards, and terminals, and 12 percent for floating homes.

**Log booming and storage:** For log booming and storage, there is an estimated 26 percent decrease in potentially affected area.

**Aquaculture:** For aquaculture, there is an estimated 32 percent decrease in potentially affected area.

## White sturgeon *(Acipenser transmontanus)*

### Threats warranting coverage in the habitat conservation plan

The covered activities identified as having potential effects on the white sturgeon are **overwater structures, log booming and storage**, and **aquaculture**. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the white sturgeon in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the white sturgeon occurs, 65 percent of the adult/spawning occurrences, 35 percent of the juvenile occurrences, and 10 percent of the egg/larvae occurrences overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Habitat conversion and degradation
2. Physical trauma, harm and harassment
3. Reduced structural habitat quality
4. Energy resource reduction

Log Booming and Storage

1. Water and sediment quality degradation
2. Human disturbance
3. Habitat degradation

Aquaculture

1. Permanent habitat destruction/displacement
2. Temporary habitat degradation
3. Energy resource reduction resulting from decreased prey abundance
4. Water and sediment quality degradation
5. Increased human activity, impaired behavior, and physical harassment

### Potential effects of covered activities

**Overwater structures:** For the white sturgeon, the relative average area of potentially affected habitat as a result of overwater structures is 5,946 acres. The types of overwater structures identified as having potential effects on white sturgeon habitat include boat ramps and launches, docks and wharves, floating homes, mooring buoys, nearshore buildings, rafts and floats, marinas, and shipyards and terminals. Estimates of habitat affected for the three life stages are as follows: 13,941 acres for the juvenile/adult stage, 1,956 acres for the larvae stage, and 1,941 acres for the egg stage.

**Log booming and storage:** The relative average area of potentially affected habitat from log booming and storage is 543 acres. Estimates of habitat affected for the three life stages are as

follows: 954 acres for the juvenile/adult stage, 367 acres for the larvae stage, and 309 acres for the egg stage.

**Aquaculture:** The relative average area of potentially affected habitat from aquaculture is 518 acres. Estimates of habitat affected for the three life stages are as follows: 4,234 acres for the juvenile/adult stage, 1,037 acres for the larvae stage, and 0 acres for the egg stage.

### Expected outcomes with application of conservation measures

**Overwater structures:** With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area of habitat for adult and juvenile white sturgeon was 67 percent for mooring buoys, rafts and floats, 24 percent for marinas, nearshore buildings, shipyards and terminals, and 12 percent for floating homes.

**Log booming and storage:** For log booming and storage, there is an estimated 18 percent decrease in potentially affected area.

**Aquaculture:** For aquaculture, there is an estimated 32 percent decrease in potentially affected area.

## Southern resident killer whale (Orca) (*Orcinus orca*)

### Threats warranting coverage in the habitat conservation plan

The covered activities identified as having potential effects on the southern resident killer whale are overwater structures, log booming and storage, and aquaculture. The identified threats and spatial overlap of authorized covered activities and species occurrence warrant coverage of the southern resident killer whale in the Aquatic Lands Habitat Conservation Plan. Of the current geographic townships in which the southern resident killer whale occurs, 73 percent overlap with an authorized activity. The following list identifies potential threats, either to the species or to the habitat it uses, from current use-authorizations on state-owned aquatic lands.

Overwater Structures

1. Human disturbance
2. Energy resource reduction
3. Water quality impairment
4. Altered behavior, physical harm

Log Booming and Storage

- None

Aquaculture

1. Permanent habitat destruction/displacement
2. Temporary habitat degradation
3. Energy resource reduction resulting from decreased prey abundance
4. Water and sediment quality degradation
5. Increased human activity, impaired behavior, and physical harassment

### Potential effects of covered activities

**Overwater structures:** For the resident life stage of the killer whale, potentially affected habitat as a result of overwater structures is 5,130 acres. The types of overwater structures identified as having potential effects on killer whale habitat include docks and wharves, floating homes, marinas, and shipyards and terminals.

**Log booming and storage:** For the resident life stage, potentially affected habitat from log booming and storage is 252 acres.

**Aquaculture:** For the resident life stage, potentially affected habitat from aquaculture is 0 acres.

### Expected outcomes with application of conservation measures

With the application of conservation measures to state-owned aquatic lands, the estimated percent decrease in potentially affected area has been estimated for the resident life stage.

**Overwater structures:** For overwater structures, there is an estimated 0 percent decrease in potentially affected area.

**Log booming and storage:** For log booming and storage, there is an estimated 0 percent decrease in potentially affected area.

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# Chapter 5
# The Operating Conservation Program

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# Chapter 5. The Operating Conservation Program

Chapter 1 of this plan describes the context, rationale, and need for the Washington State Department of Natural Resources' (Washington DNR) Aquatic Lands Habitat Conservation Plan. A critical component of habitat conservation planning is the implementation of a conservation program or strategy that ". . . ensures that the effects of the authorized incidental take will be adequately minimized and mitigated to the maximum extent practicable" (U.S. Fish and Wildlife Service & National Marine Fisheries Service, 1996).

In this chapter, Washington DNR lays out the agency's operating conservation program, the aim of which is to avoid, minimize, and compensate for impacts on covered species that result from authorized activities, and to protect and conserve habitats that support these species on state-owned aquatic lands. The intent of this planning effort is to contribute—on broad geographic scales—to the persistence and recovery of 29 covered species and to improve overall health and function of aquatic ecosystems.

This chapter describes:

- The conservation goals and objectives of the Aquatic Lands Habitat Conservation Plan (Section 5.1).
- The activity-specific conservation measures, standards for use of state-owned aquatic lands, programmatic measures, and management practices of Washington DNR (Section 5.2).
- Funding and administration of the habitat conservation plan (Section 5.3).
- Effectiveness and compliance monitoring programs and the adaptive management process (with research recommendations) that was developed as part of this habitat conservation plan (Section 5.4).
- How Washington DNR will enforce requirements for authorized uses on state-owned aquatic lands (Section 5.5).

Section 79.105.030 of the Revised Code of Washington (RCW) defines Washington DNR's mission for managing state-owned aquatic lands and focuses on ensuring the sustainability of the resources managed, while balancing economic and ecological benefits. That mission drives the conservation goals of this habitat conservation plan. The objectives that were derived from these goals guide the conservation strategies of the operating conservation program and provide a basis for measuring success. Figure 1 illustrates the relationship between these elements of the conservation plan.

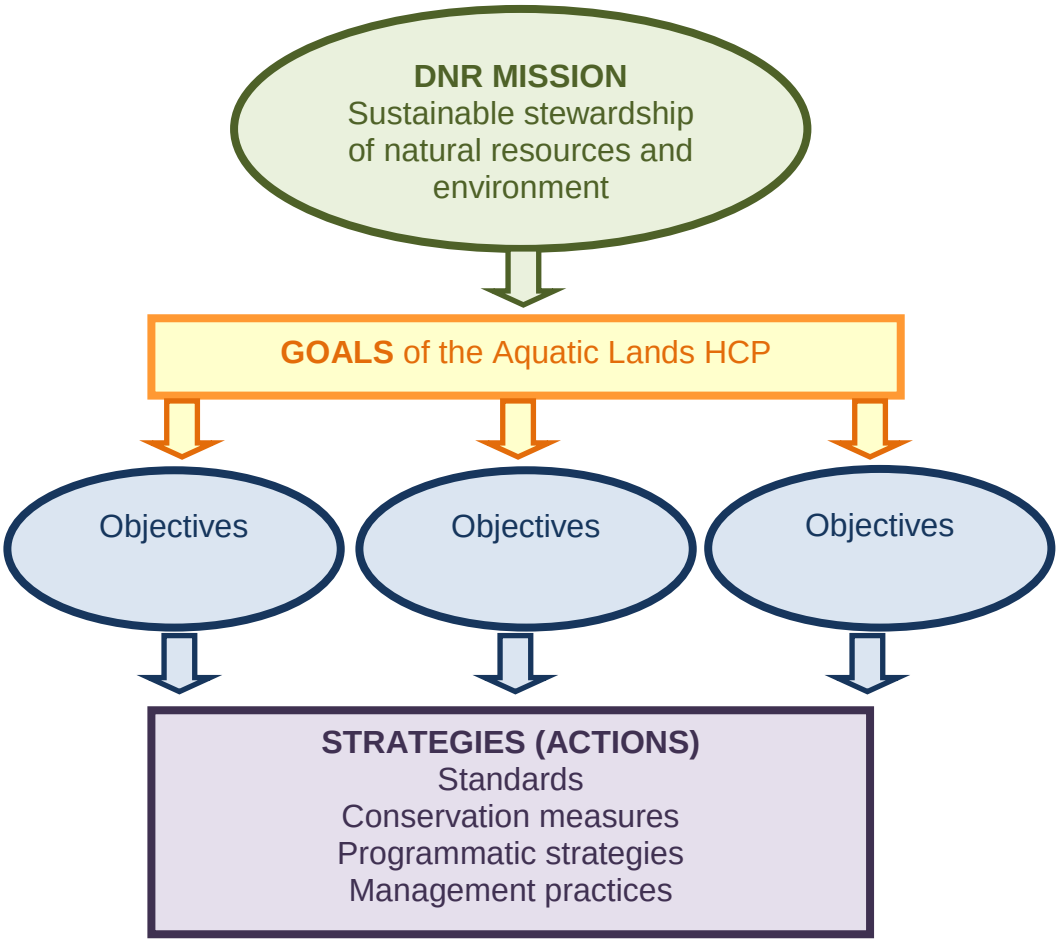
# 5.1 Program goals and objectives

The conservation goals of Washington DNR's operating conservation program are to:

- Avoid or, if unable to avoid, minimize adverse effects on the species and habitats covered under the habitat conservation plan.
- Identify and protect important habitat areas on state-owned aquatic lands.
- Compensate for unavoidable impacts by improving and restoring habitat.

These three goals and their objectives are described in the following pages.

**Figure 5.1.** Elements of the habitat conservation plan.



# 5.1.1 Goal 1: Avoid or minimize effects on covered species and their habitats

Authorized activities on state-owned lands have the potential to affect species covered under the habitat conservation plan, species habitat, and ecosystem processes (such as sediment transport and light transmission). For all activities, Washington DNR will avoid these impacts by implementing siting standards (including native aquatic vegetation buffers) and limiting activities in areas identified as important habitats. For activities covered under the habitat conservation plan**, protective standards** and **best management practices**—collectively called ***conservation measures***—will further minimize impacts. These measures will be required and implemented as part of any new or re-authorization agreement.

The objectives derived from this goal address potential effects and sources of the effects that may result from authorized activities. Chapter 4, Section 3 describes these effects in detail.

## Objectives

- Avoid or minimize impacts to water and sediment quality.
- Avoid or minimize alteration of natural habitat-forming processes, such as wave and current energy and sediment transport.
- Avoid or minimize alterations to, and loss of, physical habitat features (such as connectivity and substrate composition) and biological communities (such as native submerged aquatic vegetation and prey resources) that support the covered species.
- Avoid or minimize disturbance and displacement of, or harm to, species covered under the habitat conservation plan.
- Avoid or minimize permanent and temporary loss of habitat.

# 5.1.2 Goal 2: Identify and protect habitats that are important to covered species

Washington DNR will identify and protect habitats that directly or indirectly support species that are covered under the habitat conservation plan. Such habitats include, but are not limited to, foraging, spawning, migration, nesting, rearing, and aggregating areas, as well as areas that support ecological processes (such as production of prey species) that are vital to the species covered under this habitat conservation plan.

## Objectives

- Identify state-owned aquatic lands that are important to species covered under the habitat conservation plan and prioritize them for protection, restoration, or habitat creation.
- Avoid future impacts from uses authorized by Washington DNR that affect the value and function of the habitat of covered species whose populations in Washington state are either extremely vulnerable or limited to small home ranges.

### 5.1.3 Goal 3: Improve and restore habitat quality to compensate for unavoidable effects of covered activities

Beyond avoiding and minimizing direct and indirect effects from authorized activities, Washington DNR will compensate for unavoidable impacts from DNR-authorized activities by restoring and improving the overall quality of habitat that supports covered species on state-owned aquatic lands. This is further described as *programmatic measures* in Chapter 5, Section 2.3.

#### Objectives

- Restore or improve habitat in areas where natural habitat functions and habitat-forming processes have been altered.
- Identify and reduce or eliminate sources of habitat degradation.

## 5.2 The operating conservation program of the habitat conservation plan

The operating conservation program of the Aquatic Lands Habitat Conservation Plan defines how Washington DNR will implement the mitigation sequence of avoidance and minimization of and compensation for unavoidable impacts of activities authorized by Washington DNR (Figure 5.2). The program applies to all uses of state-owned aquatic lands, except in areas managed under port management agreements (Chapter 2, Section 3.2) and transportation projects managed by the Washington Department of Transportation. Because of the broad diversity of ecosystems and associated habitats covered by this habitat conservation plan, measures required to meet the conservation goals and objectives will be site-specific, tailored to specific conditions of the location, activity, and water body. All new and reauthorized uses will include explicit conservation requirements, conditions and timelines for implementation.

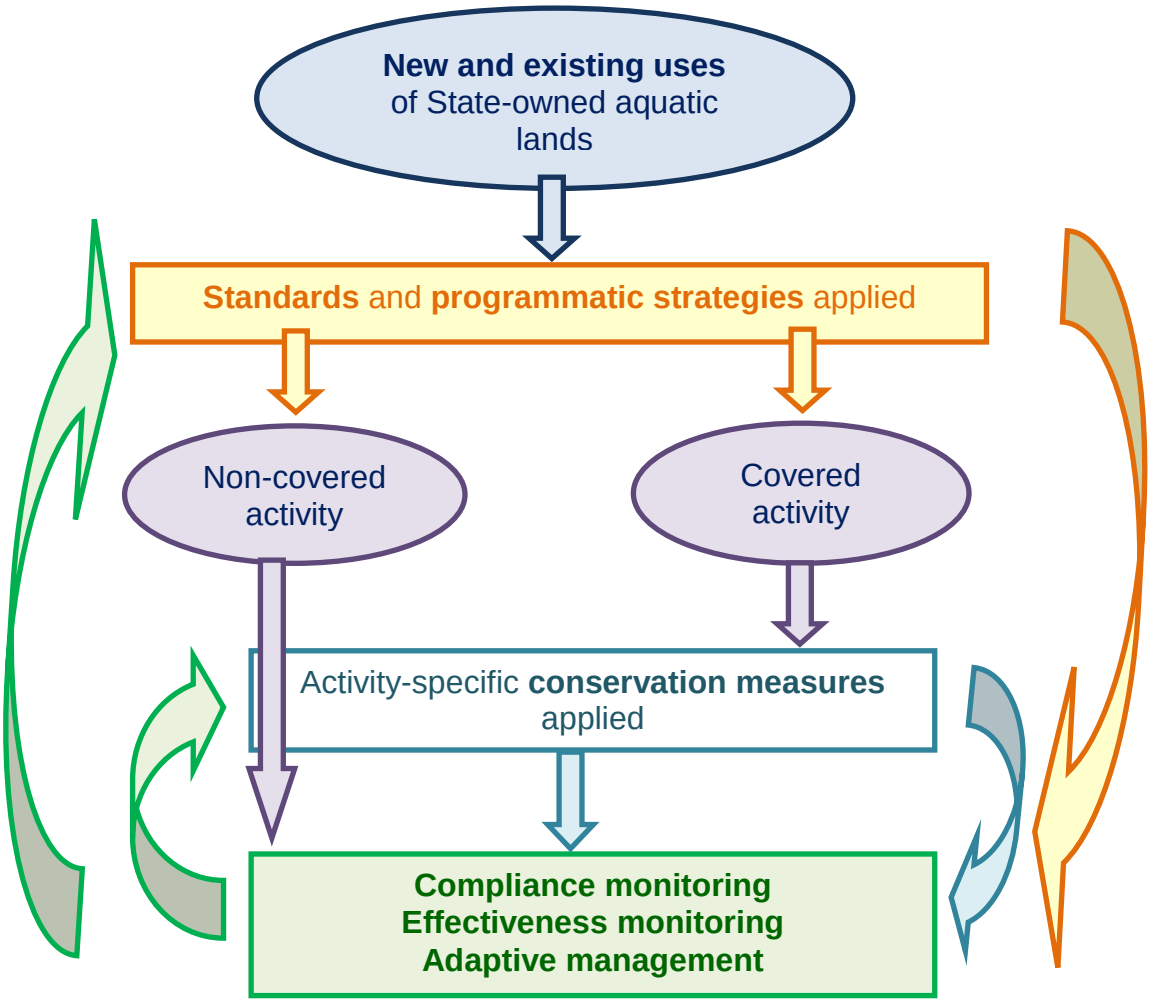
The operating conservation program of this habitat conservation plan has four components:

- **Conservation Measures** (Section 1)—Activity-specific conservation measures and practices to avoid and minimize direct and indirect effects on the species and habitats covered under the habitat conservation plan.
- **Standards** (Section 2)—Standards, which apply to all uses of state-owned aquatic lands, to compensate for unavoidable impacts from authorized uses.
- **Programmatic Measures** (Section 3)—Agency programs that are designed to restore or protect aquatic habitat, independent of activity-specific land-use authorizations, and intended to compensate for unavoidable impacts from authorized uses.
- **Management Practices** (Section 4)—Agency business management practices that contribute to meeting the goals and objectives of the habitat conservation plan and maximize interagency cooperation to compensate for unavoidable impacts from authorized uses.

The elements of the operating conservation program required under this habitat conservation plan will apply in all instances for which they are deemed by Washington DNR to be the most protective measure and the best option for achieving the plan's goals and. In cases where a more protective measure applies, as prescribed by another regulatory entity, Washington DNR will defer to that measure. Where engineering or structural requirements, public safety, or federal, state, or local laws or authorities require exceptions to these strategies, Washington DNR will require that project proponents provide compensatory mitigation[1] for unavoidable impacts. The exact nature of such compensatory mitigation will be determined individually for each authorization.

This operating conservation program is not intended to interfere with or restrict any tribal harvest rights in the state of Washington.

**Figure 5.2.** Conceptual illustration of the application of the operating conservation program.




[1] Compensating for the impact by replacement or providing substitute resources or environments.

# Monitoring and adaptive management

The measures and standards presented in this chapter are based on best available science and are assumed to be capable of improving habitat and habitat conditions for covered species. However, aquatic ecosystem processes are often not directly observable. In addition, there is often significant uncertainty associated with the response of habitat and species to the proposed measures. This uncertainty is further complicated by a lack of fine-scale distribution data for species and habitat, spatially accurate leasing data, and data related to the cumulative effects that uses of state-owned aquatic lands may have on habitat and species.

To reduce uncertainty and ensure that Washington DNR is meeting the conservation goals and objectives specified in Section 1 of this chapter, two plans will facilitate compliance and effectiveness: The Effectiveness and Compliance Monitoring Plan (Sections 5.4.2 and 5.4.3) verifies implementation of the measures specified in the conservation program. The Adaptive Management and Monitoring Plan (Section 5.4.1) assesses how effectively specified measures reduce impacts. The plan defines the procedures for collecting baseline data to document the condition of submerged lands and habitats, defines the experimental methods to test the effectiveness of conservation strategies, and describes the process that Washington DNR will follow to facilitate changes in management to achieve the goals and objectives of the habitat conservation plan.

# Application of the operating conservation program to use authorizations of state-owned aquatic lands: the process

Washington DNR will implement the conservation measures of the habitat conservation plan as part of the authorization process for shellfish aquaculture, log booming and storage, and overwater structures. Standards (Section 5.2.2) and programmatic measures (Section 5.2.3) for state-owned aquatic lands will be applied to use authorizations for all activities, including those not covered by the habitat conservation plan. Washington DNR staff will define site-specific, use-authorization requirements after a review of the supporting documentation (for example, surveys, biological evaluations, and joint aquatic resources permit applications) and, when appropriate, field analysis of the site. Washington DNR will review and approve all recommendations and requirements to ensure consistency with the habitat conservation plan. Documentation defining the requirements for the site and written justification of the inclusion or omission of measures will be stored in a habitat conservation plan database.

Washington DNR will not authorize a use of state-owned aquatic lands unless the operating conservation program requirements are included within the applicant's authorizing document. Each document authorizing use must comply with the terms of the incidental take permits issued to Washington DNR.

## New proposed uses

Biologists at Washington DNR will review materials submitted for proposed uses of state-owned aquatic land to identify potential impacts on the species and habitats covered under the habitat

conservation plan. Site visits will occur where appropriate. The biologists will provide a report for each use authorization detailing the following:

- Applicable conservation measures for activities covered under the habitat conservation plan.
- Standard requirements for use of state-owned aquatic lands.
- Any areas for which the data are insufficient.
- Biological survey requirements, if warranted.
- Timeframe requirements for improvements or renovations.
- Any concerns about the use.

Land management agency staff will then incorporate the biologists' report into the use-authorization documents. Agency management staff will provide the final review, recommend specific conservation measures, standards, and programmatic measures, and approve or deny the applicant's proposal.

New proposals that fail to meet the commitments made in this habitat conservation plan and in the incidental take permit will not be authorized.

All use-authorization requirements will be included in the use-authorization documents.

## Existing uses

Habitat stewardship specialists at Washington DNR will review materials submitted for proposed uses of state-owned aquatic land to identify potential impacts on the species and habitats covered by the habitat conservation plan. Site visits will occur where appropriate. The habitat stewardship specialist will provide a report for each use authorization. This report will include:

- Applicable conservation measures for activities covered under the habitat conservation plan.
- Standard requirements for use of state-owned aquatic lands.
- If warranted, timeframe requirements for improvements or renovations.
- Any concerns about the use.

Land management agency staff will then incorporate the habitat stewardship specialists' report into the use authorization documents. Agency management staff will provide the final review and approval or denial of the proposal.

To set the timeframes for completing required improvements to the facilities, Washington DNR will use industry expectations for the materials used and an assessment of the current condition. Any and all redesign or renovation conducted during the term of the agreement must meet the commitments of this habitat conservation plan.

DNR will assess each use authorization for consistency with the commitments of the habitat conservation plan. For existing uses on state-owned aquatic lands, district land managers will review each use authorization prior to its expiration date. Reauthorizations that fail to meet the commitments made in this habitat conservation plan will not be authorized. All use-authorization requirements will be included in the use-authorization documents.

Table 5.1 displays the number of existing authorizations that will expire in a given year as well as those that expired or were in holdover status as of the end of 2012. Holdovers are authorizations that have expired, but the previously authorized person continues to occupy the site (with Washington DNR's permission) while Washington DNR develops a new authorization. When the activity is reauthorized, it will be brought into compliance with the new terms and conditions specified in the habitat conservation plan. The timeframe for compliance will be defined in the authorizing document (Section 5.2: Implementation Schedule for Requirements).

**Table 5.1.** Anticipated future renewals of Washington DNR use authorizations (2012).

| | Activity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Overwater Structures | | | | | | | | | |
| **Year of Expiration** | **Shellfish Aquaculture** | **Log Booming and Storage** | **Boat Ramps and Launches** | **Boat Repair** | **Docks and Wharves** | **Floating Homes** | **Marinas** | **Mooring Buoys** | **Nearshore Buildings** | **Rafts and Floats** | **Shipyards and Terminals** | **Total** |
| Expired | | | 1 | 1 | 2 | | 1 | 2 | 1 | | 3 | 11 |
| Extended or in Holdover | 21 | 15 | 7 | 7 | 46 | 6 | 70 | 9 | 3 | 1 | 19 | 204 |
| 2012 | 1 | 1 | | | 3 | | | 21 | | | 1 | 27 |
| 2013 | 20 | | 4 | | 9 | 1 | 11 | 57 | 2 | | 4 | 108 |
| 2014 | 13 | 3 | 3 | | 7 | | 15 | 46 | | | 6 | 93 |
| 2015 | 16 | | 3 | | 5 | | 21 | 87 | | | 8 | 140 |
| 2016 | 6 | 2 | 1 | | 9 | 3 | 27 | 67 | 6 | 2 | 6 | 129 |
| 2017 | 15 | 1 | 4 | 1 | 9 | 1 | 32 | 54 | 2 | | 2 | 121 |
| 2018 to 2022 | 12 | 0 | 10 | 1 | 45 | 25 | 70 | 197 | 10 | 1 | 15 | 386 |
| 2023 to 2027 | 2 | 4 | 4 | 1 | 12 | 13 | 24 | 8 | 5 | 1 | 3 | 77 |
| 2028 to 2032 | | | | 1 | 1 | 6 | 13 | 4 | 3 | | 10 | 38 |
| 2033 to 2037 | 2 | | 2 | 2 | 4 | 6 | 42 | 83 | 7 | 2 | 20 | 170 |
| 2038 to 2042 | | | 7 | | 11 | | 15 | 378 | 7 | | 21 | 439 |
| **Total Scheduled Only (2012–2042)** | **87** | **11** | **38** | **6** | **115** | **55** | **270** | **1,002** | **42** | **6** | **96** | **1,728** |
| **Total Expired; Extended or in Holdover; and Scheduled (2012–2042)** | **108** | **26** | **46** | **14** | **163** | **61** | **341** | **1,013** | **46** | **7** | **118** | **1,943** |

## Implementation schedule for structural requirements for existing uses

Washington DNR establishes a reasonable timeframe within which contractual users of state-owned aquatic lands must bring their facilities into compliance with the terms of the incidental take permit. The length of this timeframe is based on:

- The age of the facility and life expectancy of the existing structure and materials.
- The priority of replacement based on an assessment of current environmental impacts (that is, items with high negative impact on the environment must be replaced as soon as possible, while replacement of items with minor impact may wait until later in the lease term.)
- The length of the lease term. (Required implementation of all conservation measures identified in the agreement by the end of the term or by the end of year 20 in the case of a lessee who seeks a term of 20 years or more).
- Impacts on covered species.

## Implementation schedule for nonstructural requirements

DNR will require a lessee who enters into a new term with existing facilities to implement best management practices in the operation of that facility immediately.

## Use authorization compliance

Once an activity has been authorized, Washington DNR staff will, in accordance with the Compliance Monitoring Plan (Appendix H), periodically visit the site. The purpose of these site inspections is to ensure compliance with the requirements identified in the authorization documents and the habitat conservation plan. Staff will prioritize compliance visits based on the activity's potential for impacts to covered species and habitats.

If authorization compliance is not achieved, Washington DNR will notify the responsible tenant, grantee, or permittee of the default(s) and require that the default(s) be remedied as specified in the use authorization. If the default is not corrected, Washington DNR will pursue appropriate legal remedies. These management actions, which are necessary to bring an authorization into compliance, will be integrated with the compliance and effectiveness monitoring actions of the habitat conservation plan (as described in Section 5.4).

## Counterproposals

Counterproposals to the measures, standards, and programmatic strategies defined in the operating conservation program may be presented for uses of state-owned aquatic lands. Such proposals will be considered by Washington DNR and reviewed for consistency with the goals and objectives of the operating conservation program and the commitments of the incidental take permit. The counterproposal' measures must be equivalent to or better than the measures in the operating conservation program. Washington DNR must find that the counterproposal meets or exceeds the goals and objectives of the habitat conservation plan in order to be acceptable. NOAA Fisheries

and the U.S. Fish and Wildlife Service will review and concur with the counterproposals prior to their implementation and the issuance of a lease or license.

# 5.2.1 Conservation measures for activities covered under the habitat conservation plan

Chapter 3 of this habitat conservation plan provides a detailed explanation of the activities that Washington DNR has determined are contributing to the harm and harassment—or take—of the species identified in Chapter 4. This section defines the activity-specific conservation measures that may be applied to use authorizations for overwater structures, shellfish aquaculture, and log booming and storage facilities, based on the site-specific conditions of the facility. These conservation measures have been established to fulfill the commitments of the incidental take permit to avoid and minimize impacts on species covered under the habitat conservation plan. Each measure is linked to a specific goal and objective of the operating conservation program of Washington DNR's habitat conservation plan (Appendix I, "Meeting the Goals of the Habitat Conservation Plan").

The avoidance and minimization measures (conservation measures) defined here are specific to each of the three categories of covered activities: shellfish aquaculture, log booming and log storage, and overwater structures. Overwater structures include boat ramps and launches, docks and wharves, watercraft lifts, floating homes, rafts, marinas, mooring buoys, nearshore buildings, shipyards, and terminals. Detailed descriptions of each activity's structural and operational components are provided in Chapter 3 (Description of Activities), and effects of the activities on covered species and their habitat are described in Section 4.3 (Covered Activities: Potential Effects).

Most of the units used in this chapter were derived from metric unit measurements. Conversions into U.S. standard units were added to provide clarity for readers unfamiliar with the metric system. When a decimal occurred in the conversion, the value was rounded to the nearest whole number.

## Overwater structures

**All overwater structures will be required to implement the following conservation measures for all authorizations:**

1. Floating structures and boats must not rest on the substrate.
    a. New overwater structures must be located in water that is sufficiently deep to prevent the structure from grounding at the lowest low water. Alternatively, stoppers must be installed to prevent grounding, keeping the bottom of the structure at least 0.5 meters (1.5 feet) above the level of the substrate.
    b. Boat moorage systems must be deployed in a manner that prevents dragging of the vessel or line. Midline floats or other technologies which prevent the line from dragging and scouring must be used on anchor lines.
2. Grounding of boats, prop scour, and the need for dredging must be avoided through the use of naturally deep water.

3. At the time of application or reauthorization, applicants and lessees shall assess water drainage and runoff patterns and shall develop and implement a plan to alter or treat them, as necessary, to reduce direct inputs of contaminants and nutrients into state waters.
4. Unless the aquatic vegetation present at a site can be accurately delineated using existing information, proponents of new activities will be required to conduct a vegetation survey to determine the location and species of aquatic vegetation on a proposed leasehold.

## Complex and multiple element structures

**All marinas, shipyards, and terminals will be required to implement the following conservation measures for all authorizations:**

1. For structures associated with motorized watercraft: To avoid dredging and scour caused by propellers on motorized watercraft, the buffer distance between the outside of the vessel and the vegetation is 8 meters (25 feet) whenever there is a vertical distance of 2 meters (7 feet) of water above the substrate at the lowest low water.

   Alternatively, the buffer may be established through prop-wash modeling to identify appropriate buffers that will avoid scouring of the substrate and impacts to aquatic vegetation (if it occurs on or adjacent to the site). The modeling must be conducted and certified by an engineer experienced in assessing these impacts. The results of the modeling should provide Washington DNR with recommended siting buffers and depths and other proposed actions to avoid impacts from the types of motorized watercraft that will be using the facility.
2. Grounding of boats and the need for dredging must be avoided through the use of naturally deep water. Methods for achieving this include the following:
   a. Locate slips for deeper draft boats in deeper water or moor deeper draft boats offshore.
   b. Orient new construction or expansions of complex facilities so that entrances align with natural channels.
   c. Provide onshore storage facilities.
3. Multiple element structures must maximize water flow to reduce effects on water quality. Measures to achieve this include, but are not limited to:
   a. Locating facility openings in a manner that promotes flushing (for example, at opposite ends) to prevent water stagnation and to prevent or reduce the need for dredging.
   b. Orienting docks with currents or prevailing winds to prevent trapping surface debris and oily residue.
   c. Maintaining dredged basins in a manner that prevents internal deeper pockets that can act as unflushed holding basins. Generally, depth should increase with distance from the shore.
4. The portions of piers and elevated docks that are above the nearshore or littoral area must have unobstructed grating over 100 percent of their surface area. Floats must have unobstructed grating over at least 50 percent of their surface. Floats less than 1.5 meters (5 feet) in width may reduce the amount of unobstructed grating to a minimum of 30 percent of the surface area if it is a structural requirement specified by engineering design. All grating material must have at least 60 percent functional open space. Grating requirements can also be met if the combination of grated surface area and grating open space are equal to or better than the above standards.
5. Post and enforce no-wake advisories to minimize effects on sediments and important habitats and to prevent stranding of juvenile fish.

6. Work on overwater structures and associated vessels that could introduce toxins into the water is prohibited unless the following protective measures are enacted to prevent discharge to the water:
   a. In-water repair and refinishing of boats is limited to decks and superstructures.
   b. In-water hull scraping, or any process that removes paint from the boat hull underwater, is prohibited.
   c. Refinishing work from boats and temporary floats is prohibited unless permitted by an industrial National Pollutant Discharge Elimination System (NPDES permit).
   d. Dust, drip, and sand spill control measures, such as tarps placed to contain spills, are mandatory to ensure that there is no discharge to waterways.
7. The surface area of gangways must be entirely composed of grating. The grating materials must have at least 60 percent functional open space unless other site-specific measures that will maximize light are defined in stewardship review.
8. Marinas, shipyards, and terminals must incorporate and post best management practices to prevent the release of chemical contaminants, wastewater (grey and black water), garbage, and other pollutants, as specified in the *Resource Manual for Pollution Prevention in Marinas* (Washington State Department of Ecology, 1998). As those guidelines are updated or new regulatory standards are established by the Washington State Department of Ecology or any future agency charged with water quality regulation, the most current guidance or standard will apply.
9. Docks and marinas with moorage for more than 10 boats must have a written plan that identifies sewage management, including options for disposing of wastewater from vessel holding tanks and portable toilets and availability of upland restroom facilities. Docks and marinas that have moorage for 5 to 10 boats and that lack a pumpout must clearly post the location of the nearest sewage pumpout facility and upland restroom.
10. Skirting is prohibited. When existing structures undergo maintenance or repair or when the structure is reauthorized (whichever comes first), the replaced portions must meet these standards.

## Floating homes

1. Floating homes are considered water-oriented uses. Washington DNR will only authorize new, expanded, or additional nonwater-dependent uses or water-oriented uses in the exceptional circumstances defined under Chapter 332-30-137 of the Washington Administrative Code and when compatible with water-dependent uses existing in or planned for the area.
2. Washington DNR may authorize the maintenance, repair, replacement, remodeling, and reauthorization of existing floating homes, so long as there is no net increase in the exterior dimensions (footprint). A minor increase in the net footprint may be allowed when necessary to comply with federal, state, or local building, health, and safety codes. Washington DNR will not authorize new or additional floating homes in new locations.
3. Floats 1.5 meters (5 feet) or greater in width must have unobstructed grating over at least 50 percent of the surface. Floats less than 1.5 meters (5 feet) in width must have unobstructed grating over at least 30 percent of the surface. All grating material must have at least 60 percent functional open space. Grating requirements can also be met if the combination of grated surface area and grating open space are equal to or better than the above standards.
4. Piers and elevated docks that are over the nearshore or littoral area and gangways must have 100 percent grating with 60 percent functional open space.

## Boat ramps, launches, hoists, lifts, and rails

1. Floating or suspended watercraft lifts must be located greater than 2.7 meters (9 feet) waterward from ordinary high water or a sufficient distance that they do not ground at any time. For covered watercraft lifts, the lowest edge of the canopy must be at least 2.5 meters (8 feet) above the ordinary high water elevation, with the canopy oriented in a north-south direction to the maximum extent practicable. While joint-use watercraft lifts are encouraged, only one canopy will be authorized for each lift.
2. Existing authorized watercraft lifts that ground must be removed or re-located by the end of the current use authorization.
3. New or renovated ramps and launches in marine waters must have an elevated design or be level with the beach slope within the nearshore area. For an elevated design, the height above the substrate within the nearshore area must be sufficient to minimize the obstruction of currents, minimize the alteration of sediment transport, and eliminate the accumulation of drift logs and debris under the ramps. In instances where the substrate is suitable for forage fish spawning, the structure must also span the spawning area with a gangway or other design feature that avoids placing any portion of the structure in the spawning area.

## Docks, piers, and wharves

**These conditions apply to all private (including recreational), public, and commercial docks, piers, and wharves.**

1. For structures associated with motorized watercraft: To avoid dredging and scour caused by propellers on motorized watercraft, the buffer distance between the outside of the vessel and the vegetation is 8 meters (25 feet) whenever there is a vertical distance of 2 meters (7 feet) of water above the substrate at the lowest low water. Alternatively, the buffer may be established through prop-wash modeling, which must be conducted and certified by an engineer experienced in assessing these impacts, to identify appropriate buffers that will avoid scouring of the substrate and impacts on aquatic vegetation (if it occurs on or adjacent to the site). The results of the modeling should provide Washington DNR with recommended siting buffers and depths and other proposed actions to avoid impacts from the types of motorized watercraft that will be using the facility.
2. Grounding of boats and the need for dredging must be avoided by extending piers and docks into naturally deep water.
3. Floats 1.5 meters (5 feet) or greater in width must have unobstructed grating over at least 50 percent of their surface. Floats less than 1.5 meters (5 feet) in width must have unobstructed grating over at least 30 percent of their surface if it is determined to be required by engineering design. All grating material must have at least 60 percent functional open space. Grating requirements can also be met if the combination of grated surface area and grating open space are equal to or better than the above standards.
4. Post and enforce no-wake advisories to minimize effects on sediments and important habitats and to prevent stranding of juvenile fish.
5. Piers and elevated docks that are located over nearshore or littoral areas and gangways must have 100 percent grating with 60 percent functional open space.
6. Docks and marinas with moorage for more than 10 boats must have a written plan that identifies sewage management, including options for disposing of wastewater from vessel holding tanks and portable toilets, and availability of upland restroom facilities.

7. Docks and marinas that have moorage for 5 to 10 boats and that lack a pumpout must clearly post the location of the nearest sewage pumpout facility and upland restroom.
8. Skirting is prohibited. When existing structures undergo maintenance or repair or when the structure is reauthorized (whichever comes first) the replaced portions must meet these standards.
9. Private recreational docks must meet the standards of the habitat conservation program. In cases in which a more protective restriction applies from a regulatory entity, Washington DNR will defer to that standard.

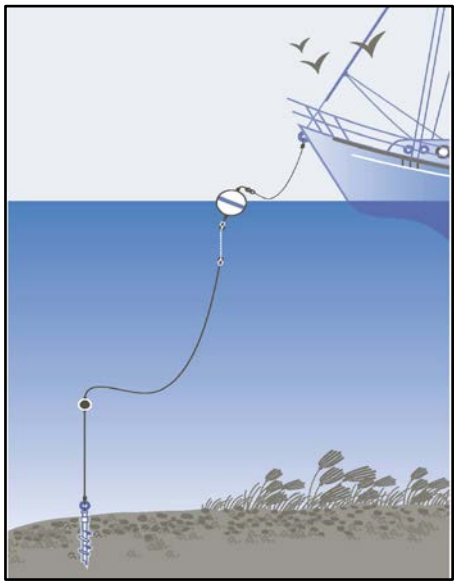
## Mooring buoys

To prevent prop scour, areas for new mooring buoys must be located either where the water will be deeper than 2 meters (7 feet) at the lowest low water, or where it can be shown that prop scour will not adversely impact aquatic vegetation or increase suspended sediment loads.

Grounding of boats and the need for dredging must be avoided through the use of naturally deep water. Situate mooring buoys in water deep enough that vessels do not ground at lowest low water.

Unless prohibited by substrate or other specific site conditions, mooring buoys must use embedded anchors and midline floats to prevent dragging of anchors or lines (Figure 5.3). Any alternative to using an embedded anchor must be approved by Washington DNR. Existing buoy systems that are not in compliance with this standard must be removed and replaced during scheduled maintenance, repair, or replacement or before the end of the term of the next renewed authorization.

**Figure 5.3.** Embedded anchor system using a midline float. Graphic: Luis Prado



## Nearshore buildings

**All nearshore buildings located on pilings or filled state-owned aquatic lands and managed by DNR will be required to implement the following conservation measures for all authorizations:**

1. New construction or expansions proposed for nearshore buildings must be at least a specified buffer distance from existing native aquatic vegetation attached to or rooted in substrate. The buffer between the building and aquatic vegetation must be equal to or greater than the longest shadow cast by the structure into the water body.
2. To avoid leaching harmful materials into receiving waters, building exteriors should not include the use of zinc or copper unless the stormwater is filtered through a pre-treatment facility before it leaves the site.

### Rafts and floats

- To prevent prop scour, boat mooring areas for new rafts and floats must be located either where the water will be deeper than 2 meters (7 feet) at the lowest low water, or where it can be shown that prop scour will not adversely impact aquatic vegetation or increase suspended sediment loads.
- Unless prohibited by substrate or other specific site conditions, floats and rafts must use embedded anchors and midline floats to prevent dragging of anchors or lines (Figure 5.3). Any alternative to using an embedded anchor must be approved by Washington DNR. Existing floats and rafts that are not in compliance with this standard must be removed and replaced during scheduled maintenance, repair, or replacement or before the end of the term of the next renewed authorization.

### Covered moorage, covered watercraft lifts, and boathouses

1. New covered moorage and boat houses will not be allowed on state-owned aquatic lands. Where Washington DNR determines that existing covered moorage, covered watercraft lifts, and boathouses are impacting or occur within predicted habitats for covered species and their prey, the structures must be moved from the nearshore and littoral area to deeper water or removed without replacement, either when the structure is in need of repair or replacement (if consistent with the lease), or when the authorization expires, whichever occurs first.

   In areas not identified as predicted habitat for covered species or their prey, the structures must be replaced or renovated with structures that maximize light transmission within a period defined in the authorizing agreement. Where covered moorage and boathouses are allowed to continue, the replacement structures must include translucent or transparent roofing materials over at least 50 percent of the roof surface and 100 percent of horizontal surfaces that are rated by the manufacturer as having 85 percent or better light transmittance. No side walls or barrier curtains are allowed.
2. All authorizations for both new and existing structures will include this conservation measure where applicable. For existing structures, the authorizing document will define a schedule for removal or renovation to maximize light transmission, as well as the appropriate construction materials and transmission levels.

## Shellfish aquaculture

**All shellfish aquaculture activities will be required to implement the following conservation measures for all authorizations:**

1. Predator exclusion devices, such as nets or PVC pipe, must be installed securely so that they do not break free and litter surrounding areas. The lessee will be required to monitor the farmed lands on a weekly basis to comply with this requirement and document surveys in a record that is available for review upon request by Washington DNR. Additionally, any fish or wildlife entangled or caught in these devices, if dead, will be collected, frozen, and submitted to Washington DNR for identification. If wildlife and fish are still alive, photographs of the animals should be taken for identification purposes; the animals should then be released and Washington DNR notified immediately. Photographs of the organisms shall be provided to Washington DNR within 10 calendar days.
2. Intertidal areas must not be used for long-term storage of materials such as bags, marker stakes, rebar, or nets. Materials stored in the intertidal zone must be secured and located

outside of vegetated areas. Materials to be stored for longer than seven days shall be stored above the high-tide line. The site will be kept clean of litter. All excess or unsecured materials and trash must be removed from state-owned aquatic lands prior to the next incoming tide.

3. Gravel used for amending the substrate must first be washed in an upland location where wash water is not discharged to surface waters.
4. If mechanical and hydraulic harvest, grading, cleaning, tilling, harrowing, or other bed preparation activities are proposed within a mapped tidal reference area and outside the specified work windows for Pacific herring, Washington DNR will require the work area to be surveyed for the presence of herring spawn. Vegetation, substrate, and aquaculture materials shall be inspected by trained and certified personnel. If Pacific herring spawn is present, these activities are prohibited in the areas where spawning has occurred until such time as the eggs have hatched and herring spawn is no longer present. Surveys must be documented in a record that is available for review upon request by Washington DNR.
5. Operators of vehicles or machinery must reduce contamination from vehicles and equipment used on state-owned aquatic lands. This should be achieved by the following means:
    a. All pump intakes (for geoduck harvest, washing down gear, etc.) that use seawater should be screened in accordance with criteria established by NOAA Fisheries and the Washington Department of Fish and Wildlife. (Note: This does not apply to work-boat motor intakes, i.e. jet pumps.)
    b. Wash water from all-terrain vehicles (ATVs) must be treated to remove contaminants before it is discharged.
6. Vehicles shall be stored, fueled, and maintained in a vehicle staging area placed 150 feet or more from any stream, water body, or wetland. Where this is not possible, documentation that explains the circumstances must be provided to Washington DNR, written approval from Washington DNR must be obtained, and the operators must have a spill prevention plan and maintain a spill prevention kit, which shall be readily available. To detect fuel leaks, operators shall inspect daily all vehicles operated within 150 feet of any stream, water body, or wetland before the vehicle is allowed to leave the vehicle staging area. Any leaks detected should be repaired in the vehicle staging area before the vehicle resumes operation. Operators must document inspections in a record that is available for review upon request by Washington DNR.
7. Activities that disturb the substrate of documented surf smelt and sand lance spawning areas—above 1.5 to 1.8 meters or 5 to 6 feet mean lower low water (MLLW), as defined by local tidal datums—may not occur during the no-work window of the species that use the site. Alternatively, Washington DNR may authorize shellfish growers to work within the no-work window, provided that the growers monitor for surf smelt or sand lance spawn to evaluate if the area is spawning habitat and whether spawning is occurring. If the results indicate forage fish or spawn are present, work will be halted for 14 days to allow eggs to hatch. Work may be resumed once a subsequent survey shows no viable eggs are present. All monitoring work shall be conducted in accordance with Washington Department of Fish and Wildlife protocols using workers certified by the Washington Department of Fish and Wildlife to conduct this work. Operators must document surveys in a record that is available for review upon request by Washington DNR.
8. Activities that disturb the substrate of potential and documented surf smelt and sand lance spawning areas—above 1.5 to 1.8 meters or 5 to 6 feet mean lower low water (MLLW), as defined by local tidal datums—must not alter the substrate such that it is no longer suitable for spawning. Placement of materials within potential or documented spawning habitat will require pre- and post-disturbance surveys of the substrate to demonstrate that there has been

no change in suitability. Documentation must be presented in a record that is available for review upon request by Washington DNR.

9. To minimize impacts to sensitive aquatic resources, such as forage fish spawning areas and aquatic vegetation, beach access routes to shellfish aquaculture leaseholds will be established for vehicles, equipment, or personnel on foot. Specific access methods will be defined by the lessee in conjunction with Washington DNR and will be designated in the lease.
10. Fuels and other toxic materials must be stored in a location and in a manner that ensures that they do not pose a risk of contaminating intertidal or nearshore areas. This can be achieved by:
    a. Maintaining pumps, boat motors, and other equipment in good condition, without leaks.
    b. Storing equipment free of fuel or in secure containment areas where any accidental leaks will be contained.
    c. Containing and cleaning up spills of fuels or other fluids without delay. Absorbent materials must be available on site for this purpose.
    d. Removing broken-down vehicles promptly from beaches and intertidal areas.
    e. Periodically washing vehicles in an appropriate upland location to ensure that they are free of oil and other toxic fluids.

## Floating raft aquaculture activities

1. To avoid shading or deposition of materials from the operation, new, expanded, or re-located floating shellfish rafts shall not be located above existing aquatic vegetation (native eelgrass or kelp).
2. Pre- and post-benthic surveys will be conducted to ensure that the bottom-dwelling organisms are not adversely affected in a way that causes harm to species covered under the habitat conservation plan. Operators should document surveys in a record that is available for review upon request by Washington DNR.
3. Predator exclusion devices, such as nets, must be installed securely so that they do not break free and litter surrounding areas. Operators should document compliance in a record that is available for review upon request by Washington DNR. Additionally, any fish or wildlife entangled or caught dead in these devices must be collected, frozen, and submitted to Washington DNR for identification. If wildlife and fish are still alive, photographs of the animals should be taken for identification purposes; the animals should then be released and Washington DNR notified immediately. Photographs of the organisms shall be provided to the U.S. Fish and Wildlife Service or the National Marine Fisheries Service and Washington DNR within 10 calendar days.

## Native aquatic vegetation conservation measures for shellfish aquaculture activities

Impacts to aquatic vegetation from all shellfish aquaculture activities must be avoided through implementation of the following conservation measures. In situations where vegetation grows within, or encroaches on, a shellfish growing area that was originally situated so that an appropriate buffer separated it from the native aquatic vegetation, harvest and replanting of shellfish will be allowed. The lessee must provide documentation to Washington DNR regarding the pre-existing condition of the site to demonstrate that this situation existed prior to disturbance of vegetation within the area.

1. For existing leases containing *native aquatic vegetation* (as defined in the habitat conservation plan),[2] the following applies:
   a. Buffers and adaptive management for native aquatic vegetation shall only apply to expanded footprints of existing leases or lease renewals that have new footprints.
   b. In the case of new areas of existing leases or new leases with native aquatic vegetation,[3] longlines or other similar culture systems that are suspended, but attached to the bottom culture of oysters, may be allowed. The lines may be attached to or rooted in substrate if a distance of 5 feet is maintained between each line. Alternatively, groups of two to four lines may be spaced 1 to 2.5 feet apart, provided that an open space of 10 feet is left between each group.
2. For new leases with native aquatic vegetation: In the case of new or expanded leases (outside of an existing leased area) in which leased areas contain native aquatic vegetation, the culture of species or use of methods other than suspension above and attachment to the bottom culture of oysters must comply with one of the following conservation measures:
   a. *Setback option:* Uncontained bottom culture of oysters (single or clusters), higher concentrations of culture systems, shade creating systems, alternative species, higher density bottom culture, and mechanical harvest methods of cultivation must not be placed within 8 meters (25 feet) of existing native aquatic vegetation attached to or rooted in substrate. Washington DNR will consider buffers of less than 8 meters on a case-by-case basis through the adaptive management option, provided that monitoring is included.
   b. *Adaptive management option:* Uncontained bottom culture of oysters (single or clusters), higher concentrations of culture systems, shade creating systems, alternative species, higher density bottom culture, and mechanical harvest methods of cultivation in areas with native aquatic vegetation will be evaluated through adaptive management. Such adaptive management evaluation shall monitor adverse impacts on species covered under the habitat conservation plan. Results will inform revisions to conservation measures based on observed impacts on species covered under the habitat conservation plan.
3. Water access to shellfish aquaculture leaseholds will be established to the extent practicable to minimize impacts to sensitive aquatic resources, such as forage fish spawning areas and aquatic vegetation. Specific access methods will be defined by the lessee in conjunction with Washington DNR and will address the following items as is practical:
   a. Minimize the grounding of work boats and barges in native aquatic vegetation (defined in Section 5.2.3 of this chapter) that is attached to or rooted in substrate.
   b. Prevent anchors, chains, and ropes from dragging on the bottom in native aquatic vegetation (defined in Section 5.2.3 of this chapter) that is attached to or rooted in substrate.
   c. Arrange moorage and operation of boats and barges to minimize impacts from propeller scour or anchoring on native aquatic vegetation (defined in Section 5.2.3 of this chapter) that is attached to or rooted in substrate.

[2] For this measure, native aquatic vegetation exists prior to placement of aquaculture. If native aquatic vegetation migrates to the site after aquaculture has begun, these conservation measures do not apply.

[3] New leases, as used in these conservation measures, include only leases of new areas that have not been previously subject to shellfish aquaculture.

# Log booming and storage conservation measures

1. At the time of reauthorization, existing log booming and storage facilities must be moved or reconfigured as necessary to reduce impacts to nearshore/littoral areas. Where navigational and harbor line designations allow, facilities must be moved beyond the nearshore or littoral area and out of areas that are important habitat of covered species.
2. Operators must monitor log handling facilities to ensure that logs are not grounding. If grounding is occurring, either the facility must be moved to deeper water, or the leasehold must be reconfigured.
3. Where the infrastructure exists, lessees shall be required to debark logs prior to placing them in the water.
4. If debarking infrastructure is not available, the following measures are required:
   a. Bundle logs prior to water transport and storage and store only bundled logs in water.
   b. Assemble bundles, sort individual logs, or break apart bundles in upland areas away from water.
   c. Maintain a containment boom to collect floating debris and retain all wood debris for disposal at an appropriate upland location.
   d. Use a crane to move logs into the water from barges, rather than roll the logs off of barges, which loosens the bark.
   e. Retain all loose bark and wood debris that accumulates on transport vessels and dispose of it at an upland location.
5. Operators must implement measures to prevent chains and ropes on anchorage, mooring, and containment boom systems from dragging on the bottom. Measures include, but are not limited to, the use of embedded anchors and midline floats.
6. Log handling facilities must control and properly dispose of wood waste at all log handling sites, including upland operations. Control methods include limiting accumulations around transfer sites, constructing bark trash boxes at log dump racks, and installing trash containment screens.
7. Lessees shall complete underwater surveys for wood debris to determine rates of accumulation. This must be done at the beginning of the authorization term, at predefined intervals during the term, and at the termination of the agreement. The surveys must include the leasehold and areas outside the leasehold boundary that may have been impacted by the use, and they must be performed according to standardized protocols defined by Washington DNR.

   Based on the rate of accumulation, interim cleanup may be required during the authorization term, which will reduce the scale and cost of cleanup required at the close out of the authorization. Interim cleanup would be required based on weight of evidence from the required surveys, including total accumulation and percent coverage. When the agreement is terminated, weight of evidence will also be used to determine the extent to which material must be removed.
8. New and expanded log transfer sites and in-water storage facilities will not be established in areas that do not meet state or federal water or sediment quality standards.
9. Proponents of new and expanded log booming and storage authorizations shall conduct underwater surveys to establish baseline benthic conditions prior to approval for the facility. Surveys shall be performed according to Washington DNR-approved sampling plans sufficient to characterize the chemical and physical properties of the surface and subsurface sediment.

10. To avoid impacts to new and expanded areas, new log booming and storage facilities will not be allowed unless located where the activity has historically occurred.
11. New and expanded log booming and storage facilities will be located beyond the nearshore or littoral area to avoid nearshore and shoreline areas.
12. New and expanded log booming and storage activities must be kept at least 60 meters (200 feet) from existing native aquatic vegetation attached to or rooted in substrate.

# 5.2.2 Standards

This section defines the standards that Washington DNR will apply to all uses of state-owned aquatic lands, including not only the activities that are covered under the habitat conservation plan, but also activities that are not. These standards have been established to fulfill the commitments of the incidental take permit to compensate for the unavoidable impacts that activities authorized by Washington DNR have on species covered in this plan. Each standard is linked to a specific goal and objective of the operating conservation program (Appendix I, "Meeting the Goals of the Habitat Conservation Plan").

Implementation of these standards under the habitat conservation plan is site-specific, based on the individual conditions of each site. The standards and a timeline for implementation are specified in all new and renewed authorizations. Section 5.2.2 describes the specific application of these standards for the activities covered under this habitat conservation plan. Where engineering or structural requirements, public safety, or federal, state, or local laws or authorities require exceptions to these standards, compensatory mitigation for unavoidable impacts will be required.

## Artificial lighting

### Standard

Artificial night lighting on and from overwater structures must be minimized by focusing the light on the dock's surface and by using shades that minimize illumination of the surrounding environment and reduce glare on the surface of the water.

### Intent and effects addressed

Artificial lighting can have direct and indirect effects on covered amphibians, birds, fish, and their prey by disrupting reproductive, migratory, and foraging behavior and by increasing exposure to predators. This standard is designed to minimize disturbance, displacement, and harm to covered species and their prey.

### Implementation

Night lighting requirements that address orientation, light shields or covers, and the use of light emitting diodes (LEDs) will be included in authorizing documents. Implementation of this standard does not supersede the requirements of the U.S. Coast Guard (Code of Federal Regulations, Title 33, Navigation and Navigable Waters, Chapter 1, Coast Guard, Department of Homeland Security, Part 67) or the Occupational Health and Safety Administration (OSHA).

# Bank armoring

## Standard

New bulkheads or hard bank armoring are not allowed on state-owned aquatic lands except under extraordinary circumstances associated with public safety, such as the protection of bridges, roads, and utility corridors, or in instances of sanctioned habitat creation or restoration. New structures proposed in nearshore and littoral areas must be designed and located in a manner that eliminates the need for bank armoring. Proposed new activities that include new bulkhead or bank armoring will require a certified engineer's report that clearly defines the need for armoring before the activity can be authorized. Compensatory mitigation will be required for all new armoring.

Existing bank armoring on state-owned lands must be removed or, if the need for continued protection is documented in an engineering report, replaced with softer (less intrusive) shoreline protection systems. Where engineering or infrastructure protection issues make replacement of bulkheads and hard bank armoring with softer shoreline armoring systems unduly onerous, Washington DNR may allow the lessee to use hard materials, provided that the new bulkhead or armoring occupies the same or smaller footprint. Authorizations for replacement of existing bank armoring will require a licensed professional engineer's report that clearly defines the continuing need for armoring. All engineering reports will be reviewed for validity by Washington DNR's structural engineer. Compensatory mitigation will be required if continued use is authorized.

## Intent and effects addressed

Example of shoreline armoring using rock. Photo: DNR Staff

Bank armoring can have profound effects on the habitats of covered species. In addition to altering fundamental processes that shape natural habitats, such as wave and current energy and sediment transport, armoring also alters important habitat features, such as the slope of the beach or shoreline and the presence and composition of aquatic vegetative and biological communities. This standard is designed to avoid and minimize alterations to natural habitat-forming processes, habitat features, and biological communities that support the covered species.

## Implementation

All authorizations for new construction will include this prohibition. Authorizations for existing structures will define an explicit timeline for replacement and the least damaging shoreline protection method, with associated replacement materials. Exceptions for public safety will also be documented in the authorization agreement, with the exceptions based on specific conditions.

# Breakwaters

## Standard

New, fixed breakwaters will not be authorized on state-owned aquatic lands. If breakwaters are critical to the safety or protection of a facility, floating breakwaters or wave boards may be authorized, provided that they are designed in a manner that does not block the predominant long-shore current or fish passage and that they are modeled in conjunction with engineering design. As for existing solid breakwaters, a timeframe for retrofitting must be scheduled at the time of re-authorization. Such retrofitting is to incorporate gaps, either through or under the structure, that will allow long-shore transport of sediments, fish passage, and water circulation.

Rubblemound breakwater structure horizontal to marina facility Photo: DNR staff.

## Intent and effects addressed

Breakwaters alter fundamental processes that shape natural habitats, especially wave energy, current energy, and sediment transport, and can result in alterations to important habitat features, such substrate composition, aquatic vegetation, and the composition of biological communities. Breakwaters also contribute to water quality degradation and can block movements of fish in nearshore areas, preventing access to habitat. This standard addresses avoidance and minimization of alterations to natural habitat-forming processes, habitat features, and biological communities that support the covered species.

## Implementation

Authorizations for new structures will either include the prohibition against new fixed breakwaters, or they will document exceptions needed to protect infrastructure, identify acceptable materials, and authorize only floating breakwaters or wave-boards that do not block long-shore current or fish passage.

# Derelict structures and abandoned equipment

## Standard

Use authorizations shall require the removal of lessee- or grantee-owned structures, such as treated wood pilings, vessels, and equipment, when these are no longer being used as part of the permitted use or at the termination of the authorization. Washington DNR is responsible for removal of unused state-owned improvements. Where appropriate, Washington DNR will contract for removal of unused and abandoned structures, pilings, vessels, and equipment for which a responsible party cannot be located or compelled to conduct removal.

## Intent and effects addressed

Shading from overwater structures adversely impacts aquatic vegetation, benthic organisms, and juvenile salmonids. Abandoned structures, vessels, and other equipment may have other harmful effects as well, including contamination of water and substrate, alteration of wave and current energy, and alteration of sediment transport. This standard focuses on avoiding and minimizing loss of habitat, impacts to water and sediment quality, and alteration of natural habitat features and habitat-forming processes.

Example of a derelict structure on state-owned aquatic lands
Photo: DNR staff.

## Implementation

All authorizations for both new and existing structures will include this standard and will define a schedule for implementation and appropriate removal methods. For existing abandoned structures for which no current lessee or grantee is responsible, Washington DNR will pursue all available legal remedies to ensure removal of the structures or will remove the structures and seek cost recovery from responsible parties. Under some circumstances, Washington DNR may completely remove all the structures from the leasehold at agency expense or through other viable funding sources.

# Dredging and sediment removal

## Standard

Dredging, including sand and gravel mining, will not be allowed on state-owned aquatic lands except where Washington DNR determines that it is required for navigation, trade and commerce, flood control, maintenance of water intakes, or other public health and safety purposes.

## Intent and effects addressed

Under Washington Administrative Code (WAC), Washington DNR is required to "allow suitable state aquatic lands to be used for mineral and material production." The same code also requires Washington DNR to "ensure environmental protection" (WAC 332-30-100).

Navigational channel dredging using a clam shell dredge Photo: DNR Staff

Removing sediment from submerged habitats changes slope and depth profiles and alters substrate composition, resulting in loss of habitats of covered species and their prey. It also changes the supply and distribution of sediment, possibly causing alterations in habitat structure in other locations. Because of these significant effects, dredging and gravel mining are not suitable uses of state-owned aquatic lands. This standard is designed to avoid and minimize alteration of habitat features and loss of habitat.

## Implementation

The only aquatic lands that are suitable for production of sand and gravel are those that must be dredged for specified public health and safety purposes. Therefore, sand and gravel mining will not be allowed, but material removed in the course of other authorized actions may be sold, as allowed under Chapter 79.140 of the Revised Code of Washington.

Washington DNR will require that all proposals for dredging be accompanied by the federal, state, and local permits required for the project. All flood control proposals must also be accompanied by a report from a licensed hydrologist that clearly describes the link between dredging and flood control and justifies the need for dredging as compared to other flood control alternatives. All dredge proposals, including permits and hydrological reports, will be reviewed by Washington DNR and will not be authorized except for the reasons specified in the standard.

This habitat conservation plan does not apply to historic river channels or other lands having the characteristics of uplands that are classified as state-owned aquatic lands, but are no longer part of a navigable water body. Sand and gravel removal may be permitted on such lands, as allowed under Section 79.140.150 of the Revised Code of Washington.

# Fill

## Standard

New fill, or additional placement of fill, will not be allowed on state-owned aquatic lands except in the case of those activities listed under the "Implementation" section.

Shell or washed gravel is not considered fill under this standard and may be applied as a substrate amendment for authorized shellfish aquaculture activities on a site-by-site basis when the authorizing agreement defines the bathymetric, seasonal, and quantitative limits of the application. Gravel or shell may not be placed on existing or suitable forage fish spawning habitat or native aquatic vegetation protected by this habitat conservation plan.

Filled aquatic lands. Photo: US Army Corps of Engineers.

## Intent and effects addressed

Fill alters important habitat features, such as slope and depth profile, modifies current and wave patterns and energies, and eliminates benthic infauna and epifauna. This standard avoids and minimizes loss of habitat and alteration of natural habitat features and habitat-forming processes.

## Implementation

All authorizations for both new and existing structures will contain the prohibition against new fill, as well as any exceptions authorized for sediment remediation, habitat creation, or restoration projects. If needed, exceptions to this standard may be allowed on state-owned aquatic lands when authorized by the U.S. Army Corps of Engineers and Washington Department of Fish and Wildlife and when an exception is necessary to support:

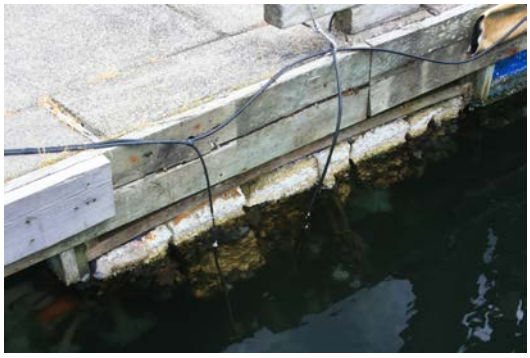
- **Aquaculture**—Shell or washed gravel may be applied as a substrate amendment for authorized shellfish aquaculture activities where known and suitable forage fish spawning habitat or native aquatic vegetation will be avoided.
- **Remediation of contaminated sediments**—The remedy must be directed or accepted by the Washington Department of Ecology or U.S. Environmental Protection Agency or be part of an interagency environmental cleanup plan.
- **Public safety**—Flood risk reduction and other projects that directly avoid effects to public safety may be authorized when consistent with the Washington DNR Shoreline Stabilization and Breakwater Projects guidance. Fill shall not be allowed where shore stabilization projects would be required to hold materials in place to create filled tidelands or shorelands.
- **Disposal of dredged material**—This may be authorized when considered suitable under, and conducted in accordance with, Washington State's Dredged Material Management Program.

- **Expansion or alteration of transportation facilities of statewide significance currently located on the shoreline**—Fill will only be authorized upon demonstration that alternatives are not feasible and when this has been documented in an engineer's report.
- **Environmental restoration, beach nourishment, or enhancement projects**—Fill may be used for these activities provided that the primary purpose of the action is clearly restoration of the natural character and ecological processes and functions of the shoreline, and when evaluated by Washington DNR's science staff and a marine engineer's report.
- **Public Access**—Washington DNR makes state-owned aquatic lands available for public use and access for example boat launches, recreational shellfish, beach access.

# Foam material

## Standard

All foam material, whether used for floatation or for any other purpose, is prohibited unless it is encapsulated within a shell that prevents breakup or loss of the foam material into the water and provided that it is not readily subject to damage by ultraviolet radiation or abrasion. During maintenance, existing un-encapsulated foam material must be removed or replaced.



Exposed foam on dock used for floatation Photo: DNR staff

### Intent and effects addressed

Debris from disintegrated foam material breaks down and contaminates water and sediment. Visible particles floating in the water may be ingested by species covered under the habitat conservation plan and by other wildlife. This standard is designed to avoid and minimize impacts on water and sediment quality, as well as to avoid direct harm of covered species and their prey.

### Implementation

All authorizations for new construction will include this standard. For existing structures, the authorizing document will define a schedule for replacement of any un-encapsulated foam material and will specify encapsulated replacement materials.

# Pesticide application

## Standard

Washington DNR will allow pesticide[4] to be used on state-owned aquatic lands if all of the following criteria are met:

[4] Pesticides are substances regulated as pesticides under (1) federal law: the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S. Code §§ 136-136, as amended, and 40 Code of Federal Regulations parts, 150 to 189, as amended; and (2) state law: Washington Pesticide Control Act, Chapter 15.58 of the Revised Code of Washington and Chapter 16-228 the Washington Administrative Code, *et seq*.

- The Environmental Protection Agency has conducted an ecological risk assessment and registered the pesticide.
- The U.S. Fish and Wildlife Service or NOAA Fisheries (or both) have evaluated use of the pesticide, and either 1. they have concluded that there is neither jeopardy to species listed under the habitat conservation plan, nor adverse modification of federally designated critical habitat, or 2. they have issued an incidental take statement pursuant to the Endangered Species Act Section 7(b)(4) upon completion of a formal consultation (16 U.S.Code 1536(b)(4)).
- The use of pesticides on aquatic lands is in compliance with the laws of Washington State.
- If the use of pesticide is subject to an incidental take statement, the terms and conditions of the incidental take statement will be a condition of Washington DNR's agreement to allow use of the pesticide on state-owned aquatic lands.

Washington DNR will use the preceding information to assess whether there is potential for harm to covered species, their habitats, and their prey. If there is indication of the potential for harm, Washington DNR will not allow use of the pesticide on state-owned aquatic lands. Washington DNR may, in some circumstances, make an exception for state agencies using pesticides to control invasive species. In addition to the above criteria, all new use authorizations must avoid applying pesticides whenever forage fish or eggs are present.

### Intent and effects addressed

While the application of pesticides is frequently intended to target a specific species, the use of chemicals may have wider impacts on non-targeted species through both direct and indirect effects. This standard supports avoidance and minimization of impacts on water and sediment quality, as well as avoidance of direct harm of covered species and their prey.

### Implementation

Permission to use pesticides on state-owned aquatic lands will not be granted unless the these criteria have been met and support a conclusion that such use will not harm covered species or their prey.

## Pressure washing

### Standard

Power-assisted pressure washing or cleaning of equipment, machinery, and floating or fixed structures must be conducted in a manner that avoids scouring of the substrate. Equipment that contains or is covered with petroleum based products may not be pressure washed in or over the water, and wash water must be contained and taken to an approved treatment facility.

Structures and equipment must first be cleaned using dry methods and equipment. Debris accumulations on the structure must be collected or swept up and properly disposed of prior to fresh-water flushing. To prevent detergents or other cleaning agents from entering waters of the state, flushing must involve the use of clean water only.

Pressure washing of structures must be done using appropriate filter fabric to control and contain paint particles generated by the activity.

Pressure washing of concrete structures must be held to the minimum necessary to maintain the structure's integrity. (Pressure washing of concrete structures can result in an increased pH discharge, with a potential to violate Washington state water quality criteria.)

Wash water and debris resulting from pressure washing (including, but not restricted to, dirt and old paint chips) shall be filtered through a filter structure capable of collecting all such debris.

### Intent and effects addressed

This standard is intended to prevent contamination of the substrate and water column by contaminants present on machinery and to prevent disturbance and alteration of the substrate. Shallow-water habitats are a primary concern, because pressure washing is more likely to cause direct harm to substrates in shallow water and because contaminants are slower to disperse.

### Implementation

All over- and in-water authorizations will include this prohibition as part of the authorizing document.

## Tires

### Standard

Tires are prohibited as part of above- and below-water structures or where they could potentially come into contact with the water (for example, when used for floatation, fenders, or hinges) except in the rare circumstance when no commercially and physically practicable alternative is available. Existing tires used for floatation must be replaced with inert or encapsulated materials, such as plastic or enclosed foam, either during maintenance or repair of the structure, or at the time of reauthorization, whichever is sooner. Removal of tires used as nonstructural support elements of the structure (such as bumpers and fenders) will be required prior to the renovation life of the facility defined in the reauthorization.

### Intent and effects addressed

Foam filled tires used for floatation on a dock Photo: DNR staff

Tire leachate from whole tires, shredded tires, and tire-wear particles in the aquatic environment contains hydrocarbons and metals and degrades water and sediment quality. Tire leachate has been shown to cause decreases in hatching success, to slow rates of metamorphosis, and to accumulate in tissue of species covered in this habitat conservation plan, including amphibians and forage fish and their prey organisms (Camponelli et al., 2009; Collins et al., 2002; Smolders & Degryse, 2002; Wik & Dave, 2009). These effects may result in population losses, which will flow up the food web. This standard is designed to avoid and minimize impacts on water quality, covered species, and their habitats (Section 2.3 of this chapter).

### Implementation

All authorizations for new construction will prohibit the use of tires on or in conjunction with authorized structures. For existing structures, the authorizing document will define a schedule for replacing existing tires, as well as types of acceptable materials, and the requirement to dispose of the tires at a state authorized disposal facility. Washington DNR does not have jurisdiction over private vessels, and this measure is not intended to apply to tugboats or similar vessels.

## Treated wood

### Standard

No exposed treated wood may be used as part of the decking, pilings, or other components of any in-water structures, such as floats, docks, wharves, piers, marinas, rafts, shipyards, and terminals. Treated wood may only be used for above-water structural framing and may not be used as decking or pilings or for any other uses.

During maintenance that involves replacing treated wood, the existing treated wood must be replaced with alternative materials, such as untreated wood, steel, concrete, or recycled plastic. Alternatively, the treated wood must be encased in a manner that prevents metals, hydrocarbons, and other toxins from leaching out.

Treated wood can be used for a new structure or retained at an existing structure if an encasement method approved by Washington DNR is determined to fully preclude exposure to water and sediments and potential leaching into the aquatic environment.

### Intent and effects addressed

Treated wood leaches harmful chemicals into the aquatic environment, degrading water and sediment quality. Chemicals in treated wood can be absorbed or ingested by covered species and may cause biological dysfunction. Many of these chemicals can bioaccumulate in higher trophic levels through food web dynamics, impacting health and reproduction. This standard is designed to avoid and minimize impacts on water and sediment quality and on covered species and their habitats.

### Implementation

All authorizations for new construction will include the prohibitions on treated wood as discussed in this section. For existing structures, the authorizing document will define a schedule for replacing treated wood and will specify acceptable replacement materials, such as untreated wood, steel, concrete, or recycled plastic, or encasement in a manner that prevents environmental contamination. Disposal of treated wood at a state authorized disposal facility—such that reuse of this material is precluded— will be required.

## Covered species work windows and buffer distances

### Standard

Species work windows will be used both for the timing of any in-water construction and operational activities, and to protect covered species during sensitive life history phases (such as reproduction and migration). Work windows will be established by Washington DNR based on the recommendations of state and federal wildlife management agencies and in consultation with species experts.

### Intent and effects addressed

Work timing windows and buffers are common tools used to avoid impacts to species from mechanisms such as noise, artificial night lighting, or increases in turbidity. These windows will be used to avoid impacts during sensitive life history phases, such as reproduction, rearing, and migration. This standard supports avoidance and minimization of disturbance and displacement of covered species.

### Implementation

All authorizations will specify established work windows for species predicted or observed to occur at the site, with implementation of the windows considered part of the design criteria and operational plan. The work windows are established based on requirements of state and federal wildlife management agencies. They are therefore based on best available science concerning the life history of each covered species. These windows will be modified as new information is developed by the U.S. Fish and Wildlife Service, NOAA Fisheries, and the Washington Department of Fish and Wildlife throughout the term of this habitat conservation plan.

## Salmon early life stages

### Standard

In-water activities that potentially disturb or block migration and disrupt or preclude foraging will be assessed on a site-by-site basis, and appropriate avoidance measures and timing for these measures will be established for the respective species and tidal reference area. The recommendations of salmon recovery plans will also be factored into the planning and authorization recommendations.

### Intent and effects addressed

The purpose of this standard is to protect particularly sensitive early life stages of juvenile Chinook, chum, and pink salmonids in the shallow nearshore environment.

### Implementation

All authorizations will specify established work windows for species predicted or observed to occur at the site, with implementation of the windows considered part of the design criteria and operational plan. The work windows are established based on requirements of state and federal wildlife management agencies and are therefore based on best available science concerning the life history of each covered species. These windows will be modified as new information is developed by the U.S. Fish and Wildlife Service, NOAA Fisheries, and the Washington Department of Fish and Wildlife throughout the term of this habitat conservation plan.

# 5.2.3 Programmatic measures

Washington DNR's programmatic measures are actions the agency will take, through the agency's existing and new programs, to protect and improve the habitat of covered species.

This section defines the programmatic measures that Washington DNR will apply to all uses of state-owned aquatic lands, including not only the activities that are covered under the habitat conservation plan, but also activities that are not. These standards have been established to fulfill the commitments of the incidental take permit to compensate for the unavoidable impacts that activities authorized by Washington DNR have on species covered under the habitat conservation plan. Each programmatic measure is linked to a specific goal and objective of the operating conservation program (Appendix I, "Meeting the Goals of the Habitat Conservation Plan").

Implementation of these programmatic measures under the habitat conservation plan will based on the specific conditions of each site. The measures and a timeline for implementation will be specified in all new and renewed authorizations. Section 5.2.3 of this chapter describes the specific application of these measures for the activities covered under this Aquatic Lands Habitat Conservation Plan. Where engineering or structural requirements, public safety, or federal, state, or local laws or authorities require exceptions to these standards, compensatory mitigation for unavoidable impacts will be required.

# Protection of native aquatic vegetation

An important component of this conservation strategy is the protection of aquatic vegetation—native photosynthetic plants or algae attached to or rooted in substrate that is submerged for the whole or the majority of each day (in the case of saltwater) or the majority of the growing season (in the case of freshwater).

Four groups of native aquatic vegetation are included for protection:

1. Saltwater plants (seagrasses and saltmarsh plants that have their roots inundated for the majority of an average day)
2. Kelps (macroalgae in the order Laminariales)
3. Complex freshwater algae (stoneworts and brittleworts)
4. Rooted freshwater plants (submerged, floating, and emergent)

Similar to terrestrial vegetation, submerged, floating, and emergent vegetation provides habitats with three-dimensional structure, slows erosion and wave energy, and converts carbon dioxide ($CO_2$) into oxygen and plant biomass. Oxygenation of the water column and sediments supports respiration of fish and other animals, with some oxygen released into the atmosphere. For the species addressed in this plan, the vegetative biomass produced serves as a major source of food in two ways: directly, through consumption of the vegetation by common loon, amphibian tadpoles, and the western pond turtle; and indirectly, either through consumption of the species that seek shelter in (zooplankton, larval/juvenile fish) and on (periphyton) the vegetation, or through consumption of prey animals that use aquatic vegetation as a primary food source. Covered species, such as rockfish, salmonids, amphibians, and waterfowl, may also use vegetation for egg attachment, nursery/rearing areas, or refuge from predation.

# Intent and effects addressed

By avoiding direct and indirect impacts on aquatic vegetation, this strategy addresses a wide range of effect mechanisms that lead to habitat degradation. Additional measures to maximize the amount of light that is transmitted through overwater structures address the specific mechanism of shading, which can directly diminish the growth and survival of vegetation.

The primary objectives of the habitat conservation plan that are supported by the aquatic vegetation protection strategy include the following:

1. Avoid and minimize alterations to, and loss of, the physical habitat features (such as connectivity and substrate composition) and biological communities (such as native submerged aquatic vegetation and prey resources) that support the covered species.

2. Alteration of existing activities in order to avoid vegetation or maximize light transmission could result in an improvement of habitat quality where existing vegetation has been impacted. These actions support the following objectives related to habitat improvement:
3. Restore or improve habitat in areas where natural habitat functions and habitat-forming processes have been altered.
4. Improve existing habitat conditions by identifying and reducing or eliminating sources of habitat degradation.

# Implementation

**All activities will be required to implement these programmatic measures for all authorizations:**

All new covered and non-covered activities and structures must avoid shading, removing, and impacting existing native aquatic vegetation attached to or rooted in the substrate.

Only the four groups of native aquatic vegetation fitting the previous descriptions are protected under this habitat conservation plan. A list of aquatic vegetation to be protected is provided as guidance in Appendix C. This list may be amended as more information becomes available. This strategy does not include riparian vegetation, unless it is found within the generalized extent of state ownership of aquatic lands (below ordinary high water).

## Native aquatic vegetation buffers

The measures described in this aquatic vegetation protection strategy address impacts on aquatic vegetation in two ways:

1. Avoiding impacts, by restricting activities in or near areas with aquatic vegetation.
2. Minimizing impacts from shading by maximizing light transmission in overwater structures.

## Vegetative buffers for docks, wharves, piers, marinas, rafts, shipyards, and terminals

New and expanded docks, wharves, piers, marinas, rafts, shipyards, and terminals must be at least a specified buffer distance from existing native aquatic vegetation attached to or rooted in substrate.

For structures not associated with watercraft, the buffer distance between the edge of the structure and the vegetation is either 8 meters (25 feet) or the maximum distance shade will be cast by the structure into the water, whichever is larger.

## Vegetative buffers for activities not covered under the habitat conservation plan

### Finfish aquaculture

New and expanded finfish aquaculture net pens must be located at least 150 meters (492 feet) from existing native aquatic vegetation that is attached to or rooted in substrate.[5]

### Outfalls

New and reconfigured outfalls and piping must be located to avoid impacts on existing native aquatic vegetation that is attached to or rooted in substrate. The diffuser or discharge point(s) for new or expanded outfalls must be located at a buffer distance from native aquatic vegetation to avoid impacts on those areas. This buffer distance shall be calculated as the extent of the mixing zone (including both the acute and chronic mixing zones) as defined in the current National Pollutant Discharge Elimination System (NPDES) permit for the use authorization. Operators should avoid placement of an outfall that cuts directly through any native aquatic vegetation.

For outfall authorizations without a current NPDES permit, Washington DNR will require a mixing-zone analysis for the outfall from a qualified party. The analysis must follow protocols established by the Washington State Department of Ecology. The outfall pipe must be installed below the substrate within the nearshore and areas of attached and rooted native vegetation.

## Native aquatic vegetation survey programmatic measures

### Marine vegetation surveys

All aquatic vegetation surveys will be required to use the most current survey protocols and methods for defining a bed and must be reviewed and approved by Washington DNR. The surveys should be of high enough spatial resolution that the edge of bed can be delineated and distance between bed edge and proposed activity can be measured.

### Freshwater vegetation surveys—Sampling

Washington DNR will use the Washington State Department of Ecology's fresh-water vegetation sampling protocols (Washington State Department of Ecology, 2001). Both of the sampling methods described in the protocols—the surface/diver survey and the point intercept method—are acceptable. In addition, a towed video camera or video camera capturing quadrats for percentage cover can be supplemented. The protocol does not directly describe numbers of samples, but it does describe the maximum grid size, so sample numbers can be calculated from the size of the Washington DNR lease area.

## Vegetation management and control

Many lakes, reservoirs, and other water holding bodies are managed by different consortiums and groups (public utility districts, irrigation districts, U.S. Army Corps of Engineers, U.S. Department

[5] Elevated organic carbon levels in the sediment have been reported 50 to 200 meters (164–656 feet) from net pens (Carroll *et al.*, 2003; Ye *et al.*, 1991), and sediment hydrogen sulfide levels greater than the toxic level for aquatic vegetation (400 micro-moles/liter) have been reported 60 to 150 meters (197–492 feet) from net pens (Brooks & Mahnken, 2003).

of the Interior's Bureau of Reclamation and Bureau of Land Management, counties, cities, and tribes) with different mandates and authorities for vegetation control for these waters. Before requiring or conducting vegetation surveys, Washington DNR will identify and consult existing vegetation management plans for a water body. This step will ensure that management actions identified in the habitat conservation plan are not in conflict with existing known vegetation control efforts.

Washington DNR is involved in planning for vegetation control when it occurs on state-owned aquatic lands (either providing financial or in-kind support or being a signatory to a plan or agreement) and will ensure that management actions identified in the habitat conservation plan are not in conflict with Washington DNR's own vegetation management plans or that Washington DNR is attempting to monitor aquatic vegetation in areas where active vegetation control is occurring. The following steps will be taken in order to document if an aquatic vegetation survey is warranted:

1. Check Washington DNR's herbicide treatment database for vegetation control near the site of proposed survey area.
2. Check with the Washington Department of Fish and Wildlife to determine if a hydraulic project approval (HPA) has been issued for mechanical vegetation control in the proposed survey area.
3. Check with the local jurisdiction (for county, irrigation district, public utility district, U.S. Army Corps of Engineers, or Bureau of Reclamation) for vegetation maintenance activities.
4. Check with the Washington State Department of Ecology for known aquatic vegetation control permits issued for aquatic plant control.

There may be instances of conflicts between vegetation control activities and protection of species and habitat covered under the habitat conservation plan. Where feasible, Washington DNR will consider alternative management strategies for protecting aquatic habitat on state-owned aquatic lands and will manage aquatic weed control practices in a manner that maintains and restores habitat conditions.

## Defining eelgrass bed boundaries

There is little information concerning the number of plants or shoots that comprise an established population of aquatic vegetation or how many are required to support a patch's ecological functions, and the number may be different for different species. In addition, even sparse vegetation may provide significant benefit to species by providing a connection between more densely vegetated areas. As a result, Washington DNR has adopted a precautionary approach that both allows for growth of low-density vegetation patches and protects existing vegetation. This approach is described in Appendix J, "Technical Memorandum: Operational Definition of an Eelgrass (*Zostera marina*) Bed."

### Intent and effects addressed

Protection of native aquatic vegetation through activity-specific and programmatic application of conservation measures achieves the overall goals of Washington DNR to:

1. Avoid and minimize effects on covered species and their habitats.
2. Identify and protect habitats important to covered species.
3. Improve and restore habitat quality to compensate for unavoidable effects of covered activities.

# Removal of derelict vessels from state-owned aquatic lands

Washington DNR administers a derelict vessel removal program, which operates in accordance with Chapter 79.100 (*Derelict Vessels*) of the Revised Code of Washington. This law gives certain Washington public entities the authority to take custody of derelict and abandoned vessels in the state's waterways and establish a funding account for the program. Since the program's inception in 2003, more than495 vessels have been removed (as of August 2013) by either government entities or vessel owners, thereby preventing further degradation of water and sediment quality and removing navigational hazards.

Derelict vessels may contain large quantities of oil or other toxic substances, which pose a contamination risk to aquatic lands, nearby shorelines, and water quality. Vessels that settle on the bottom can disrupt the aquatic environment by crushing submerged aquatic vegetation and benthic infauna, compacting sediments, and interrupting currents so that scour results. Moored derelict vessels may damage vegetation through shading impacts; and the anchor chains of such vessels may affect both vegetation and the substrate by causing scour and dragging. Derelict vessels are also sources of marine debris. Removing derelict vessels from aquatic lands eliminates these impacts.

This program is funded through a $3 surcharge on the annual recreational vessel registration fee and a $5 surcharge on the cost of obtaining a foreign vessel identification document. This generates approximately $750,000 annually. Expenditures from the Derelict Vessel Removal Account may be used to reimburse authorized public entities for up to 90 percent of the costs associated with removing and disposing of abandoned or derelict vessels, when the owner of the vessel is unknown or unable to pay. When Washington DNR is the lead agency on vessel removal, the agency is required to pay 10 percent of the project costs from agency funds. Washington state law stipulates that funding priority must be given to vessels in danger of sinking, breaking up, or blocking navigation channels, or to those which present environmental risks. This applies equally to vessels on state-owned aquatic lands and to other vessels regardless of their location.

Washington DNR has developed internal Derelict Vessel Removal Program Guidelines (Washington DNR, 2007d), which describe roles and responsibilities, vessel identification and reporting, criteria for reimbursement from the Derelict Vessel Removal Account, and onsite removal procedures.

Additional details concerning how vessels in each category are prioritized can be found in the Derelict Vessel Removal Program Guidelines (Washington DNR, 2007d).

## Intent and effects addressed

The intent of including this program in the habitat conservation plan is to reduce pollutants and hazards posed by derelict vessels (RCW 79.100.005), to avoid and minimize effects on covered species and their habitats, and to compensate for vessels that have released toxic substances and pollutants into the water and displaced or damaged habitat of the covered species.

The removal of derelict vessels supports all of the conservation goals of the habitat conservation plan (Section 5.1), through:

- Avoidance and minimization of impacts on water and sediment quality and of alteration or loss of physical habitat.

- Restoration and improvement of the condition of existing habitat.
- Prioritization of derelict vessel removal to ensure that areas that are important to covered species are either not affected or minimally affected by dangers posed by these vessels.

Each of the covered species may benefit from this programmatic strategy because of the broad impacts that a derelict vessel's presence may have within an ecosystem and local area, which could include, but would not be limited to, water and sediment quality degradation, substrate compaction, shading effects, release and accumulation of waste, garbage, or contaminants, and migration impediment.

## Implementation

Floating derelict vessels are prioritized with the objective of removing them before they sink. Sunken or beached vessels are removed in accordance with Washington DNR's programmatic hydraulic project approval (HPA) (Appendix D). If a non-emergency removal does not fall within the scope of the programmatic HPA, then Washington DNR applies for additional permits to ensure environmental protection, completing a biological assessment and conducting an environmental review in accordance with both the National Environmental Policy Act (NEPA) and the State Environmental Policy Act (SEPA). The review that NOAA Fisheries and the U.S. Fish and Wildlife Service conduct of the removal frequently involves implementation of a variety of measures, including working within fish windows and use of a silt curtains and oil booms.

In most cases, removing the sunken or beached abandoned vessels prevents degradation of the habitat and allows it to recover naturally. If not removed, the vessel may continue to damage the habitat with every tidal shift and storm event. Requiring habitat restoration for the hazard-abatement environmental damages caused by vessel removal is not compatible with the operating conservation program in the habitat conservation plan, because such a requirement would decrease the number of vessels removed, thereby increasing the habitat destroyed by abandoned boats. The state's shoreline act specifically exempts hazard abatement from local permitting for this reason.

On a federal level, vessel removals are conducted under Nationwide Permit 22.

Derelict vessel removal will incorporate the habitat conservation plan's landscape prioritization process (Section 5.2.3) as an added criterion.. The landscape prioritization process identifies and ranks areas of state-owned aquatic land based on species use and condition of the habitat. From these determinations, the derelict vessel removal program will be able to prioritize derelict vessel removal more effectively for the benefit of covered species and habitat protection.

Currently vessels are given a priority ranking of 1 to 5, based on the hazards they present—with a priority ranking of 1 indicating the most immediate threat to human health and safety. Information will be added to the priority scheme of the program to rank vessels higher within each priority category if they would impact a conservation or restoration priority area of the habitat conservation plan. Washington DNR will continue to operate this program under the guidance of Section 79.100 (Derelict Vessels) of the Revised Code of Washington and will request appropriation of at least $100,000 on a biennial basis to meet the 10-percent match requirement and contribute to the funding of one full-time position.

# Protection of forage fish spawning habitat

Forage fish are a direct food source for the common loon, marbled murrelet, and salmonids, and are therefore an important link in the food web. In turn, larger fish, such as salmonids, form the basis of the diet for a number of marine mammals, including the southern resident killer whale (orca). Important forage fish species in Washington waters include Pacific herring, surf smelt, Pacific sand lance, and eulachon or Pacific smelt.

Pacific herring, surf smelt, and Pacific sand lance spawn in shallow nearshore or littoral habitats and, as a result, are particularly susceptible to alteration of sediments and vegetation associated with covered activities. Pacific herring spawn on eelgrass and marine algae in intertidal and shallow subtidal waters at depths to minus 3 meters (10 feet) MLLW; surf smelt and sand lance, meanwhile, spawn on marine beaches with a sand-gravel mix in the upper third of the tidal range: from plus 2 meters (7 feet) up to extreme high water (Penttila, 2007). Eulachon are anadromous and spawn during freshets in the side channels of low gradient rivers with coarse sand and small gravel (McLean et al., 1999; Wydoski & Whitney, 2003). All of these forage fish species are broadcast spawners, whose eggs adhere to the substrate. Incubation times for each species' eggs are: eulachon – 2 to 3 weeks; sand lance – up to one month; surf smelt – 2 to 8 weeks; and Pacific herring – 10 to 14 days (Bargmann, 1998; McLean et al., 1999; Penttila, 2007).

Because of the importance of forage fish and their vulnerability to nearshore development, Washington's Hydraulic Code lists herring, surf smelt, and sand lance spawning habitat areas as "marine habitats of special concern," requiring a "no-net-loss" management approach (WAC 220-110). The Washington Department of Fish and Wildlife defines the protection of these species as a priority for the state, and the habitat that these species use for breeding and concentrating is consequently considered a priority for protection (Washington Department of Fish and Wildlife, 2008). Guidance for the Washington Growth Management Act includes protection of herring and surf smelt spawning areas as examples of important fish and wildlife habitat to be protected as "critical areas" (Washington Department of Community Trade and Economic Development, 2003). Protection of forage fish and their habitat is also a priority of the Puget Sound Nearshore Partnership (Penttila, 2007). The Forage Fish Spawning Habitat Protection Program of this habitat conservation plan supports the goals and recommendations of these other agencies by requiring protection of forage fish spawning habitat areas on state-owned aquatic lands.

## Standards for protecting forage fish spawning habitat

**These eight standards apply to all authorized uses of state-owned aquatic lands, not just those specifically covered in this habitat conservation plan:**

1. New or reconfigured structures must be sited to avoid impacts on documented forage fish habitat on state-owned aquatic lands and must be designed to cross from the uplands to state-owned aquatic lands so as to avoid known or potentially suitable spawning habitat of eulachon *(Thaleichthys pacificus),* Pacific herring *(Clupea pallasi),* Pacific sand lance *(Ammodytes hexapterus),* and surf smelt *(Hypomesus pretiosis).* In addition, construction and operational activities associated with the authorization must be conducted in a manner that does not affect spawning behavior, disturb spawning substrate or sediment sources that support spawning, or reduce the amount or availability of aquatic vegetation used for spawning. Washington DNR does not have management authority over marine riparian areas, but will, by means of use authorizations, promote practices that maintain and establish nearshore riparian shading in upper intertidal spawning areas (when this is practical).

2. In areas of documented or potential eulachon, surf smelt, and sand lance spawning beds, new piers must have spans of at least 12 meters (40 feet) from the shoreline (extreme high water to ordinary high water) waterward to the placement of the first piling to avoid placing piling in forage fish spawning areas. The distance of 12 meters (40 feet) is based on current engineering limitations.
3. In areas that are not documented as spawning sites, but have characteristics that would support forage fish spawning, existing lessees and grantees applying for a reauthorization and proponents of new uses will be required to conduct surveys to determine if the site is used for spawning. Surveys must be conducted by consultants or agency staff trained and certified in forage fish spawning survey protocols, and these individuals must be approved by Washington DNR's science staff. Surveys will be conducted over a two-year period throughout the assumed local spawning season. Washington DNR will not require implementation of forage fish protections if no spawning is detected in two consecutive survey years. In the absence of such a survey, the project must be designed and operated under the presumption that forage fish spawning does occur at the site.
4. New authorizations for existing uses that are located in or adjacent to documented forage fish spawning areas or spawning areas determined by protocol survey will require development and implementation of a plan to minimize impacts resulting from the use and structure. The specifics of the plan and the timeframe for implementation will be determined and documented in the agreement authorizing use of the site by Washington DNR based on site-specific factors. All plans must include the following:
    a. Work windows for all in-water construction or operational work, excluding vessel movement. Lessees, grantees, and proponents shall have the option of conducting forage fish spawning surveys to establish site-specific work windows within the generalized windows. For work to proceed, the survey must result in no occurrence of viable forage fish eggs. Surveys must be conducted daily during the proposed work period and before work can proceed. Surveys must be conducted by consultants or agency staff trained and certified in survey protocols for forage fish spawning, and these individuals must be approved by Washington DNR's science staff. If the tenant is unwilling to bear the time and expense of such a survey, then all in-water work must occur within the generalized work windows.
    b. Detailed descriptions of the anticipated effects on forage fish habitat and how each effect will be minimized and mitigated.
5. In-water activities that disturb the spawning substrate or result in increased turbidity of documented spawning areas of surf smelt and sand lance may not occur during the no-work window of the species that use the site unless there is either a 0.6 meters (2 feet) vertical separation from the tidal elevation of the spawning bed, or a buffer of 55 meters (180 feet) horizontal distance from the lower edge of the surf smelt or sand lance spawning habitat zone. In-water work may occur during an outgoing tide when the water line is below the lower edge of a surf smelt or sand lance spawning habitat zone: 1.5 to 1.8 meters (5–6 feet) MLLW.
6. No pesticides may be used in documented or potentially suitable forage fish spawning areas when fish or eggs are present, regardless of whether the pesticide complies with the pesticide application standard of this habitat conservation plan. Washington DNR will use studies and opinions to assess whether there is potential for harm to covered species, their habitats, and their prey. If there is indication of the potential for harm, Washington DNR will not allow use of the pesticide on state-owned aquatic lands. All new use authorizations must avoid applying pesticides whenever forage fish or eggs are present. Exceptions may be made for state and federally sanctioned invasive species control.

7. Gravel or shell may not be placed on existing or suitable forage fish spawning habitat or native aquatic vegetation protected by this habitat conservation plan.
8. Other actions that provide protection for forage fish and their habitat include work windows for the timing of activities, prohibitions against dredging and bank armoring (Section 5.2.2), programmatic efforts to protect aquatic vegetation (Section 5. 2.3), and activity-specific avoidance and minimization measures that address disturbance of substrates or vegetation (Section 5.2.1).

## Intent and effects addressed

The intent of this strategy is to protect food web dynamics of covered species by avoiding and minimizing effects on forage fish spawning populations and their habitats. This strategy supports all of the conservation goals of this habitat conservation plan (Section 5.1) through:

- Implementation of siting standards that avoid impacts to potential forage fish substrate that is similar to substrate (sand, macroalgae) where forage fish have been known to spawn or where spawning has been documented to occur. *(For all new structures.)*
- Implementation of activity-specific avoidance and minimization measures (Section 5.2.1). *(For existing structures.)*
- Identification of forage fish spawning habitat.
- Improvement of existing forage fish spawning areas and areas that have characteristics that would support forage fish spawning.

In addition to addressing indirect effects associated with reductions in prey resources for covered species, this strategy protects existing forage fish habitat on and adjacent to state-owned aquatic lands.

## Implementation

Washington DNR will identify the overlap between state-owned aquatic lands and areas currently documented as forage fish spawning habitat by the Washington Department of Fish and Wildlife as part of the core geographic information system (GIS) work associated with this plan. Additional data regarding spawning and suitable spawning substrates will be incorporated into the overlay throughout the term of this habitat conservation plan. From this data layer, Washington DNR will identify locations where existing authorized activities will be required to implement forage fish avoidance and minimization strategies, if the use is to continue after the current authorization expires.

If the substrate of a given area appears to be capable of supporting spawning, then surveys of the area may be required even where spawning has not previously been documented. If a use is determined to be compatible with forage fish spawning, Washington DNR will require new applicants and authorized users who are reapplying for use to identify the necessary protective measures, incorporate forage fish habitat protection requirements into all use authorizations where spawning occurs, and, on a site-by-site basis, determine whether to limit activities in forage fish habitat.

Washington DNR will look for opportunities to restore historical or potential forage fish spawning habitats on a site-by-site basis. Washington DNR will also consider establishing aquatic reserves, conservation leases, conservation licenses, or lease withdrawals on state-owned aquatic lands that contain documented forage fish spawning habitat. In addition, the agency will look for

opportunities to join with other Washington DNR programs to promote conservation practices on Washington DNR managed uplands that are adjacent to forage fish spawning habitat, such as maintaining nearshore riparian buffers and marine sediment sources.

## Washington DNR programs for protection and restoration of habitat

As the manager of state-owned aquatic lands, Washington DNR generally has discretion both to delineate areas appropriate for specific uses and to limit uses in other areas, in order to ensure the protection of the aquatic lands and the species that depend on them. Only a small percentage of aquatic lands, such as harbor areas and waterways, are constitutionally or statutorily limited to specific uses. While not proposed as a covered activity, the protection and restoration of species habitat is an essential component of the programmatic strategies applied to all state-owned aquatic lands.

Washington DNR has four established mechanisms for identifying, protecting, and restoring important habitats:

1. The Aquatic Reserves program
2. The Conservation Leasing program
3. The commissioner's orders
4. The Aquatic Restoration program

In some areas of significance for covered species and their habitats, Washington DNR has combined environmental protection through multiple programs and worked with adjacent upland landowners to protect both uplands and adjacent tidelands. This approach ensures that human impacts on ecosystems are avoided or minimized. Examples of this combined-program approach include the Cypress Island Natural Resources Conservation Area and Aquatic Reserve and the Kennedy Creek Natural Area Preserve, in which Washington DNR withdrew the adjacent tidelands and bedlands from leasing. This type of conservation occurs as the opportunity arises and is not a defined program or strategy of this habitat conservation plan.

The following section describes each of the four components of Washington DNR's habitat protection and restoration strategy, how the elements will be used to compensate for unavoidable or irreversible impacts on covered species and their habitats, and how each element will be implemented as part of this habitat conservation plan.

## Creating and managing aquatic reserves

Established in 2002, the Aquatic Reserves Program was formalized through the adoption of a programmatic environmental impact statement (EIS), followed by rule-making to codify the process (WAC 332-30-151). The program focuses on conserving high-quality native aquatic ecosystems in both freshwater and marine environments, and it emphasizes management on a reach- or embayment-scale to ensure protection of entire communities of important and unique organisms, along with their associated habitat. To date, Washington DNR has established seven aquatic reserves, including more than 90,000 acres of aquatic lands in the Puget Sound.

The overall goal of the Aquatic Reserves Program is to ensure environmental protection and preserve and enhance state-owned aquatic lands in order to provide direct and indirect benefits to aquatic resources in Washington State. Because Washington DNR, tribes, and local, state, and federal regulatory agencies share management authority over the state's aquatic resources, achieving this goal requires partnerships among natural resource managers and landowners. The program defines three classes of reserves: environmental reserves, scientific reserves, and education reserves (Bloch & Palazzi, 2005).

To designate a site as an aquatic reserve, proponents need to demonstrate, through a public application process, that the area meets the criteria set forth in the Aquatic Reserve Program Implementation Guidance (Appendix E). Permissible activities within a reserve must support the purpose of the reserve and will often be conservation activities. Aquatic reserve status is designated for a 90-year term.

The process of evaluating a site for aquatic reserve status includes the submittal of an initial proposal by the proponent, review by Washington DNR, extensive public outreach, development of a management plan, review under the State Environmental Policy Act (SEPA), and final approval for designation by the commissioner of public lands (Bloch & Palazzi, 2005). Each aquatic reserve proposal is evaluated on a case-by-case basis during a 2-½-year (approximate) cycle. While sites are evaluated on an individual basis, the intent of this program is to develop an ecologically sound network of reserves that function to achieve the statewide program goals and objectives.

### Intent and effects addressed

Aquatic reserves are established for 90 years, which ensures long-term protection of the area. Site-specific management plans define the type and number of authorized activities that may occur, desired biological and physical conditions within the reserve, and timeframes for achieving the reserve's defined goals. Any of the covered species that occur within the reserve could potentially benefit from the establishment of an aquatic reserve. The Aquatic Reserves Program is an ecosystem-based approach to land protection. Habitat for covered species within an aquatic reserve will receive long-term protection, and it may be enhanced through restoration activities associated with the program and used as a reference site for research. This program is included in this habitat conservation plan to provide another option that Washington DNR may use for habitat protection and conservation

Incorporation of this program supports all three conservation goals (Section 5.1) by:

1. Avoiding and minimizing impacts on water and sediment quality, alterations of habitat-forming processes, and alteration or loss of physical habitat processes (Goal 1).
2. Limiting activities and restoring aquatic habitats within reserves (Goal 2).
3. Identifying and protecting important habitats as reserves (Goal 3).

The effects addressed by the Aquatic Reserves Program may include changes in wave and current energy; alteration of sediment transport; alteration of the composition of substrate; alteration of the depth and slope profile; shading; release of waste, garbage, contaminates, and nutrients; noise; artificial lighting; and habitat degradation and loss. The Aquatic Reserves Program would address effects on a site-specific basis through the establishment of site-specific management plans.

### Implementation

Implementation guidance for the Aquatic Reserves Program is based on the environmental impact statement for the program and was formalized in 2005. Washington DNR manages each reserve in a manner consistent with goals, objectives, and management strategies developed in a site-specific management plan (Bloch & Palazzi, 2005).

Washington DNR must retain the ability to accept proposals for aquatic reserves that may consider habitat values other than those that are associated with species covered in the habitat conservation plan. Therefore, while the Aquatic Reserves Program may serve as one tool to implement this portion of the plan, the habitat conservation plan will not be the only consideration when assessing potential reserve areas.

The goals, objectives, standards, and conservation measures of the habitat conservation plan will serve to provide the Aquatic Reserves Program with benchmarks for operation and long-term management. The use of these HCP elements will allow the Aquatic Reserves Program both to prioritize proposals more effectively based on their benefit to the species and habitats covered under the habitat conservation plan, and incorporate the goals of the habitat conservation plan (Section 5.1) into existing criteria for considering locations for aquatic reserves.

Washington DNR currently funds 2.75 staff positions to manage the reserves program. As the number of reserve areas increases, more staff time will be necessary to implement the management plans of each site effectively. To reduce costs, Washington DNR actively seeks partners to implement the strategies of the management plans, such as beach cleanup and surveys.

## Conservation leasing on state-owned aquatic land

Under its general management authority, Washington DNR can enter into leases and proprietary license agreements with persons or organizations voluntarily seeking to restore, enhance, create, and preserve aquatic habitat on state-owned aquatic lands. The goal of the Conservation Leasing Program is to protect and improve the biota, ecological services, and natural functions of aquatic environments.

Lessees or licensees must take an active role in conserving the land through actions such as implementation of a restoration plan or active management of a specific component of the site, and they must monitor the success of the actions. The program is not applicable to non-voluntary efforts, such as compensatory mitigation projects arising from regulatory action. Compensatory mitigation is covered under general leasing programs.

To initiate a conservation lease or license, the project proponent must apply for the use of state-owned aquatic lands, clearly identifying the aspect of that site that will be conserved, how the site will be managed, the desired outcome of the action, and how the site will be monitored. Washington DNR staff adheres to the Washington DNR Conservation Leasing Program Guidance when deciding whether to issue the conservation lease or license agreement. As of 2012, Washington DNR has issued one conservation lease. It encumbers 10 acres of state-owned aquatic lands in Woodard Bay near Olympia, Washington.

Washington DNR has adopted the following criteria for conservation leases of state-owned aquatic lands

- Lease actions must apply continuously on a site (15 or more days per month).
- Leases must encumber a site for a minimum of one year.
- Leases must be exclusive in nature (for example, the lessee has the expectation that the habitat improvements made to the site will not be disturbed by other Washington DNR use authorizations).

Under a conservation lease, lease terms are limited in duration by the land classification of the site and never exceed 55 years. The lessee has some level of exclusive use of the site and maintains primary responsibility for site management and protection. Conservation lessees must develop a conservation plan for their leasehold. The conservation plan must contain detailed information about the proposed activities, the expected results over defined time periods, and the method by which the site will be monitored and maintained. The plan should employ principles of adaptive management to address unexpected results or changes without altering the purpose of the intended conservation action.

Washington DNR sets rental rates for leases in accordance with statutory mandate. Generally, the rental rate is based on adjacent upland property value or fair market rent. The statutory rental formulas usually result in rental rates that tend to discourage non-profit organizations otherwise interested in conservation leasing.

### Intent and effects addressed

Washington DNR will improve the function and condition of state-owned aquatic lands through habitat preservation, restoration, enhancement, and creation activities (such as conservation activities) that are not related to mitigation needs. Conservation leasing is included in the habitat conservation plan as a tool that Washington DNR can use for land preservation. Further incorporation of the conservation leasing program supports the goal of improving and restoring habitat (Section 5.1.3) and achieves the objective of restoring or improving habitat in areas where natural habitat functions and habitat-forming processes have been altered.

Due to the broad scope of activities that could be included within a conservation lease, the range of effects addressed could be minimal to extensive depending on the size of the lease and the scope of conservation activities.

Any of the covered species that occur on the leasehold could potentially benefit from the establishment of a conservation lease. Habitat of covered species within a conservation lease will receive protection and may be enhanced through restoration activities associated with the program throughout the life of the lease. This programmatic strategy provides compensation for unavoidable impacts on covered species by providing protection and enhancement of important habitats.

### Implementation

Washington DNR will provide outreach to and interagency collaboration with entities that may have the potential to manage a long-term conservation lease during the 50-year life of the habitat conservation plan. These entities would include tribes, colleges and universities, non-profit organizations, and local governments.

Washington DNR will not limit conservation leasing to those areas that Washington DNR has identified as conservation priorities in the habitat conservation plan; however, Washington DNR will encourage conservation leasing that directly or indirectly supports conservation priority areas.

Washington DNR will continue to accept proposals for conservation leases in accordance with the guidance of Washington DNR's policies and procedures.

Washington DNR will incorporate important habitat identified in the DNR Aquatics Division data base to assist in ranking conservation lease proposals. Conservation lease requests in areas that have a high habitat value for covered species will be given greater consideration for approval.

No later than one year after the signing of the implementation agreement, Washington DNR will examine state statutes that control lease rates. Following this examination, Washington DNR may propose to the state legislature changes in the rate schedule: Such changes would be specific to conservation leasing and intended to provide an incentive to potential conservation lessees. During this same time period, the agency will also develop a process with guidance materials for entities interested in conservation partnering on state-owned aquatic lands. Washington DNR will evaluate other forms of agreements to allow private individuals and organizations to conduct conservation activities on state-owned aquatic lands.

## Commissioner's orders

The commissioner of public lands has the authority to withdraw lands from consideration for leasing at her or his discretion (RCW 79.10.210, 79.105.210(3)). Usually, commissioner's orders are for a specific term of years. Washington DNR has typically withdrawn lands for conservation purposes or in support of programs of other state agencies. For example, state agencies may request a withdrawal in support of state parks or areas of biological interest. Washington DNR may also withdraw lands from leasing in cooperation with federal agencies, such as the U.S. Army Corps of Engineers and their local sponsors, for habitat recovery projects. Unlike other protection efforts described in this section, withdrawn areas are not necessarily linked to conservation activities and are not evaluated based on established criteria or required to have a management plan. In addition, the commissioner has the discretion to revoke a previously issued withdrawal order. Depending on the circumstances, issuance or revocation of a particular withdrawal order may be subject to other legal requirements, such as review under the State Environmental Policy Act.

As part of this process for withdrawing state-owned aquatic lands, Washington DNR completes a land survey. Following the establishment of boundaries for the area, a draft withdrawal order is written by department staff in conjunction with the attorney general's office. The commissioner's order for withdrawal of lands for leasing is then signed by the commissioner of public lands and is recorded with the county and Washington DNR's title and record office.

### Intent and effects addressed

Within the context of the habitat conservation plan, withdrawing areas from leasing is an option that the commissioner of public lands may use to halt activity or impacts in identified areas for the purpose of habitat recovery or preservation. Under Section 79.105.210(3) of the Revised Code of Washington, Washington DNR may withhold lands from leasing which it finds have significant value as wildlife habitat, natural area preserve, representative ecosystem, or spawning area. Under Section 79.10.210, Washington DNR may withdraw lands for the purpose of providing increased continuity and facilitating long-range planning, if the withdrawn areas are maintained for the benefit of the public.

Withdrawing aquatic areas from leasing supports the habitat conservation plan's conservation goals ( Section 5.1) of identifying and protecting important habitats (Goal 2) and improving and restoring habitat quality (Goal 3) by limiting activities in withdrawn areas.

Withdrawing areas from leasing is potentially a very strong tool for managing habitats used by covered species, because it narrows impacts from human activity. Withdrawing habitat from incompatible uses is important for the species' continued existence. Formally withdrawing an area can help to assure that only compatible uses will be located in important habitats of covered species.

Due to the varied numbers of species and habitat features that could be included within a withdrawn area, the effects addressed depend on the species' diversity and habitat characteristics and the level of disturbance in the area. Effects addressed may include habitat disturbances from human activities (such as development, noise, and artificial lighting) and water and sediment quality.

### Implementation

Once the implementation agreement is signed, Washington DNR's policy will be that a withdrawal order issued on state-owned aquatic lands for conservation purposes during the period of the incidental take permit will have a term at least as long as the incidental take permit.

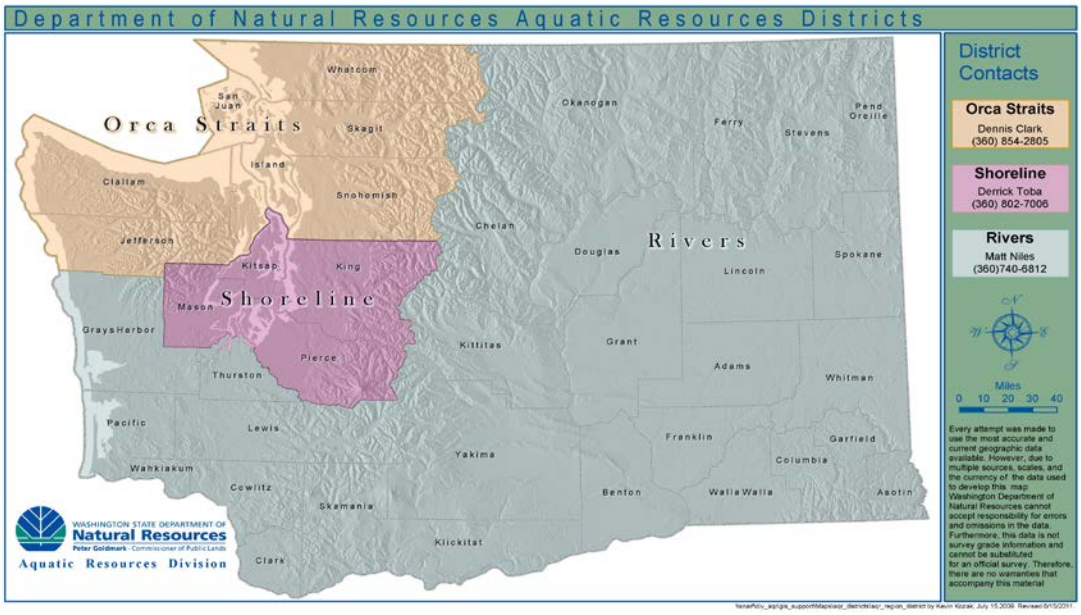
## Aquatic Restoration Program

Established in 2004, the Aquatic Restoration Program works to restore, enhance, create, and protect healthy ecological conditions in freshwater, saltwater, and estuarine aquatic systems by means of partnerships with agencies and organizations. This program is designed to actively seek out restoration opportunities and to partner with other entities when those opportunities arise.

Under the existing restoration program, Washington DNR may take the lead in providing support to the design, planning, permitting, implementation, and funding of restoration projects. In addition, the program seeks out partnerships with the restoration community to provide matching funds towards restoration projects on or adjacent to state-owned aquatic lands. Restoration work includes, but is not limited to, beach debris cleanup, removal of derelict creosote-treated structures, shoreline restoration, re-vegetation with native plants, and enhancement of salmon habitat. The agency presently receives $300,000 bi-annually (2012) from the Washington State Legislature as seed money to promote these restoration projects. The money is divided equally between each of the three Washington DNR aquatic districts (Figure 5.4). District staff may seek additional funding sources, such as grants from federal, state, and other restoration programs.

Each aquatic district works in accordance with the goals of the Aquatic Restoration Program; however, each district has defined restoration priorities based on the unique situations of the district.

**Figure 5.4.** Washington DNR Aquatic Districts.




## Intent and effects addressed

The intent of the projects undertaken is to restore, enhance, create, or protect favorable biological and ecological conditions of freshwater, saltwater, and estuarine aquatic systems.

The Aquatic Restoration Program supports the goal of improving and restoring habitat quality to compensate for unavoidable effects of covered activities (Section 5.1.3). Restoration actions will compensate for degradation and loss of habitat of covered species.

Specific effects addressed will vary depending on local conditions and the specific restoration projects proposed for a site

## Implementation

Washington DNR maintains ultimate management responsibility for these projects and will administer them based on Washington DNR's policies and procedures. Each district will administer at least one restoration project per biennium. Restoration sites are memorialized in DNR's ownership records through the establishment of easements and rights of entry.

Washington DNR will use the DNR Aquatics Division data base to identify areas of potential importance for restoration statewide. These locations, along with locations recommended by other federal, state, and local efforts, will be used by Washington DNR's district land managers to prioritize restoration projects within their respective regions.

Washington DNR currently employs three full-time restoration land managers (2012) and plans to retain these positions as part of the Aquatic Resources Division in the future. Habitat conservation program staff will use the DNR Aquatics Division data base to provide recommendations to district staff and other engaged entities as to where restoration would be the most beneficial to covered species and their habitats.

## Aquatic landscape prioritization

Aquatic landscape prioritization focuses on identifying the most important habitats statewide for species covered under the habitat conservation plan and prioritizes them for habitat management and protection.

The program contains two main elements:

1. Identification of important remnant habitats of the most vulnerable covered species found on state-owned aquatic lands to determine which areas need protection.
2. A commitment to develop aquatic landscape plans, providing a means to ensure ecologically based decisions about appropriate uses of aquatic lands in areas identified as priorities for habitat conservation.

### Identifying and protecting remnant habitats

Under the Aquatic Lands Habitat Conservation Plan, Washington DNR proposes to protect the core remaining habitat of covered, at-risk species on state-owned aquatic lands. One or more of the following circumstances apply to these species:

- They have limited breeding habitat statewide.
- Their current populations are small and vulnerable due to extirpation.
- Their state populations are rapidly declining.

Washington DNR defines "core remaining habitat" as locations that are known to be habitat of species covered under the habitat conservation plan and that meet ALL of the following criteria:

1. Washington DNR management authority can be confirmed either on or immediately adjacent to habitat.
2. Species warrant protection by virtue of their listing status or rank as follows:
   a. Species is federally listed as endangered or threatened; OR
   b. Species is state-listed as endangered, threatened; OR
   c. Species has a state rank of S1 or S2, as defined by the Washington Natural Heritage Program. (Rankings are defined in Chapter 4, "Factors Affecting Species").
3. Species either has a relatively small geographic range, or discrete, documented habitat locations are known to fulfill critical life history requirements of the species.

Appendix G ("Protecting Core Habitat Sites") identifies the two species, western pond turtle (*Actinemys marmorata*) and Oregon spotted frog (*Rana pretiosa*), that presently meet these three criteria. Appendix G also provides a detailed habitat assessment and specific management recommendations for the remnant habitat of each species.

# Aquatic landscape planning

While the DNR Aquatics Division data base identifies for Washington DNR the general areas that are priorities for aquatic conservation statewide, a more detailed and site-specific analysis is needed to determine appropriate use and protections based on local conditions. Thus, Washington DNR will create an aquatic landscape planning process, developed in cooperation with local aquatic land management entities, to define ecologically and socially appropriate uses of state-owned aquatic lands for specific locations statewide.

Aquatic landscape plans will provide the broad ecologically based planning needed to guide Washington DNR's management decisions by water body, embayment, reach or drift cell, and so on.

Aquatic landscape boundaries will be defined using the DNR Aquatics Division data base, with additional recommendations from other regional and local ecologically based natural resource planning efforts (such as county-based assessments, Puget Sound Nearshore Restoration Project datasets, Washington State Department of Ecology's Watershed Characterization, and The Nature Conservancy's Ecoregional Assessments). Washington DNR has created an initial statewide map of ecologically based regional planning areas using either a combination of water resource inventory area (WRIA) boundaries or Puget Sound Nearshore Restoration Project sub-basins. Where appropriate, these regional planning area boundaries can help assess ecosystem functions and other characteristics at broader scales for multiple landscapes within a given area. These areas may also prove helpful in delineating aquatic landscape boundaries.

Once aquatic landscape boundaries are delineated, they will provide focus and scope for each landscape plan. Washington DNR has just begun developing the Aquatic Landscape Planning program. As the program develops, Washington DNR will seek input from tribes, local entities, and interested parties by means of a public process.

### Intent and effects addressed

Washington DNR will identify important habitat areas so as to protect the best first and avoid degradation of those areas. Washington DNR will also identify lands of relatively lower value to species covered under the habitat conservation plan; such lands may be suitable for other water-dependent uses.

- Areas identified are used to guide Washington DNR's aquatic land-use decisions.
- Washington DNR will identify and protect remnant habitat for the most highly vulnerable species in Washington.
- Washington DNR will also integrate planning results with other regional landscape and management planning efforts throughout the state to create a broad-based landscape planning dataset, which will be used to define Washington DNR's long-term management strategies for state-owned aquatic lands.

Implementation of the landscape prioritization process will address effects on covered species and their habitats by avoiding and minimizing:

1. Permanent loss of habitat in areas where habitat is determined to be intact and identified as significant.
2. Loss of physical habitat features and biological communities that support the covered species.
3. Disturbance of, displacement of, or harm to covered species.
4. Alteration of natural habitat-forming processes.
5. Increases in cumulative effects (or reductions in the rate of impacts) on state-owned aquatic lands in the most important habitat areas.

### Implementation

Washington DNR will take the following actions:

- Washington DNR will not allow any new activities that negatively alter the value and function of natural habitat in priority conservation areas. Priority conservation areas are defined in the Aquatic Lands Habitat data base and in consideration of other local and regional habitat-based assessments and plans. Activities intended to rehabilitate, enhance, or restore habitat function may, following review, be authorized in these areas.
- Provide site-specific habitat analyses—based on local input and conditions—to determine appropriate management strategies and protections for the locations within the aquatic landscape.
- Assess and delineate the remnant habitat and prescribe specific management actions for five highly vulnerable species that occur on state-owned aquatic lands .

Washington DNR will manage priority conservation areas identified through the Aquatic Landscape Prioritization Program to support natural habitat value and function.

Project proponents will be required to document avoidance of new impacts, elements to be monitored throughout the term of the agreement, and contingency plans for minimizing and compensating for unanticipated impacts on the value and function of habitat as a result of the use. Proposals will be reviewed by scientists at Washington DNR and by other regional or species experts to determine if the project is acceptable. If deemed unacceptable, Washington DNR will either condition the use in a manner that makes it acceptable, or refuse to authorize the activity.

# 5.2.4 Management practices

In addition to the standards, programmatic strategies, and avoidance and minimization measures specified above, Washington DNR identified additional actions that will allow the agency to more effectively carry out its managerial obligations in relation to state-owned aquatic lands. These include the creation of new tools to better map the exact location of encumbrances on state lands, collaboration between agencies to optimize efficiency where conservation goals overlap, improved management of wood debris at log handling sites, and the tracking and management of private recreational docks.

## Interagency collaboration

Collaboration with other agencies is essential to the administration of the Aquatic Lands Habitat Conservation Plan. The overall effectiveness of the habitat conservation plan will be partly contingent on how effectively other agencies recognize Washington DNR’s management role in their internal processes of administration, permitting, and regulation. Collaboration with other agencies provides opportunities to optimize efficiencies in the implementation of the habitat conservation plan. Washington DNR has adopted as its land use application the Joint Aquatic Resources Permit Application (JARPA) used by multiple regulatory authorities in Washington in order to foster consistency among these agencies.

Outreach and communication with federal, tribal, other state agencies and local planning entities began in 2005 and will continue into the future. Entities include the U.S. Army Corps of Engineers, Washington Department of Fish and Wildlife, Washington State Parks, Washington

State Department of Ecology, the Puget Sound Partnership, the Office of Regulatory Assistance, tribal fisheries commissions, tribal governments, and local shoreline planners. Guidance from federal, tribal, and state agencies has been incorporated into the conservation actions of the habitat conservation plan.

Further planning and communication will occur as the habitat conservation plan is adopted and implementation begins. Washington DNR will meet with federal, tribal, and state agencies that have existing regulatory, monitoring, and enforcement programs. The goals of the meetings will include the following:

- Identify those areas of special concern to other agencies that overlap with important habitats of species covered under the habitat conservation plan, such as priority habitats identified by the Washington Department of Fish and Wildlife and critical or sensitive areas identified by county management plans.
- Identify recovery, monitoring, and enforcement efforts in joint areas of concern.
- Provide agencies with the expectations of Washington DNR regarding permitting of activities on state-owned aquatic lands and develop systems to include Washington DNR in permitting processes.
- Collaborate on sharing of resources, including staff, equipment, vessels, vehicles, and data.

Following these interagency collaborative meetings, additional meetings will be held for similar purposes with other organizations, including, but not limited to, salmon recovery organizations, tribal fisheries consortiums, non-profit organizations, other community action groups, and industry stakeholders. Within one year of the signing of the implementation agreement, habitat conservation plan staff will recommend to the commissioner of public lands a strategy for collaboration with other entities and combined fiscal resource management for environmental and species recovery efforts, monitoring, enforcement, and other areas of overlapping concerns and activities.

# Private recreational docks

Recreational docks are defined in Washington state law as those docks that:

- Are owned by an abutting residential owner and used exclusively for private recreational purposes (RCW 79.105.430).
- Meet the requirements of the recreational dock rule (WAC 332-30-144).

In some locations, a proliferation of private recreational docks has led to significant impacts associated with shading, loss of aquatic vegetation, and alteration of the habitat structure and prey communities of covered species (Section 4.3). Under state law, permission to install and maintain recreational docks may be revoked by Washington DNR if the agency makes a finding of public necessity to protect waterward access, ingress rights of other landowners, public health or safety, or public resources (RCW 79.105.430(3)). However, because the law precludes Washington DNR from charging rent for these docks, the agency has not actively managed recreational docks on state-owned aquatic lands, relying instead on regulatory agencies, such as the counties, Washington Department of Fish and Wildlife, and U.S. Army Corps of Engineers, to regulate dock construction and maintenance. As a result, an unknown number of these structures currently exist on state-owned aquatic lands. Washington DNR estimates that the number of private recreational docks on state-owned aquatic lands over which Washington DNR asserts (or likely

asserts) ownership ranges from 9,000 to more than 19,000, depending upon the criteria used.[6] Washington DNR does not review applications or issue use authorizations for recreational docks. The agency currently has a limited managerial relationship with residential dock owners and, subsequently, limited control over the condition of the docks or potential environmental impacts of docks.

The agency is committed, under this habitat conservation plan, to use its authority under Section 79.105.430 of the Revised Code of Washington to manage the construction and maintenance of private recreational docks to ensure that the conservation standards and measures described in the habitat conservation plan's operating conservation program (Section 5.2) are incorporated into new docks at the time of construction and existing docks as they are maintained or re-built.

Local, state, and federal agencies apply design standards to docks and marinas, and these standards are intended to minimize impacts to the aquatic species and habitats listed under the Endangered Species Act. These agencies, including the U.S. Army Corps of Engineers (regional general permits) and Washington Department of Fish and Wildlife (hydraulic permits), and county and city shoreline master plans may require standards for increasing light transmission under docks and minimizing the dock footprint (Jones & Stokes et al., 2006). However, these regulatory efforts only apply to docks as they are permitted for construction or repair, and they do not require retroactive changes to existing structures. In 2007, several state agencies collaborated to develop environmental standards for docks as guidance for county shoreline master programs (EnviroVision et al., 2007).

As each aquatic landscape plan is developed, recreational docks on state-owned aquatic lands within each landscape will be assessed, ensuring that all docks will comply with habitat conservation plan standards (Section 5.2.2) for maintenance and repair of the structure.

## Implementation

Washington DNR will conduct the following actions to manage private recreational docks on state-owned aquatic lands, with the goal of bringing 65 percent of all private recreational docks that are determined to be on state-owned aquatic lands into compliance with Washington DNR's operating conservation program standards (Section 5.2.2) by the end of the term of the incidental take permit:

1. Maintain Washington DNR's overwater structures database. Update the database at least every 10 years. Identify private recreational docks in the database that are in compliance and non-compliance with operating conservation program standards; include the reason for non-compliance.
2. Use the landscape prioritization effort and overwater structures database to define areas of highest diversity and low development where additional overwater structures could impact priority habitat.
3. As each aquatic landscape plan is developed, recreational docks on state-owned aquatic lands within each landscape will be assessed for compliance with operating conservation program standards. Washington DNR will work with property owners whose docks are not meeting the

[6] Variable criteria include assumptions about locations of navigable waterway boundaries and associated ownership boundaries of state-owned aquatic lands, particularly on larger lakes with many recreational docks.

operating conservation program standards, and a schedule will be established for the necessary changes to the structure.

4. Review applications for Washington Department of Fish and Wildlife hydraulic permits, State Environmental Policy Act (SEPA) documents, and local shoreline permits to promote consistent application of Washington DNR's operating conservation programs. Washington DNR will provide a letter of approval (including conditions) or denial for all proposed new and replacement private recreational docks. Maintain a record of Washington DNR's correspondence in the overwater structures database (Action 1).
5. Washington DNR, in consultation with the Washington Department of Fish and Wildlife, Washington State Department of Ecology, Washington State Recreation and Conservation Office, and Washington State Parks will publish design guidance on construction, repair, and rebuilding of overwater structures to increase light (Puget Sound Partnership Action Agenda B 2.4.3; 2013).
6. In collaboration with other groups and agencies that promote healthy shorelines, provide general public outreach and presentations on Washington DNR's authority and standards for managing recreational docks. Examples of such groups include the Puget Sound Partnership, the King County Green Shorelines Group, and various salmon enhancement groups. Washington DNR will provide a message that is based on sound science and that details how dock owners can be good stewards of the waters for the benefit of endangered species.
7. Consult with county, state, and federal regulatory agencies to find out what actions, if any, are being taken to upgrade private docks to current environmental standards, provide updates on Washington DNR's actions, and share information concerning the inventorying and permitting of private recreational docks.

### Long-term leasing

Some government agencies are authorized to use or manage state-owned aquatic lands under statutory authority or agreements that may not expire until after the 50-year term of the incidental take permit. There are 42 potential authorizations in this circumstance: 10 boat ramps or launches, 12 docks or wharves, 2 marinas, and 18 mooring buoys. This habitat conservation plan will not cover any long-term authorization that does not expire during the term of the incidental take permit. Washington DNR will, however, notify these tenants of the required provisions of the habitat conservation plan that are applicable to their use, if the tenant initiates repairs or maintenance. Although Washington DNR has no authority to unilaterally require changes in the authorizations, Washington DNR will ask that the tenants voluntarily agree to use the standards necessary to upgrade their facilities in a manner that is consistent with the habitat conservation plan when undertaking repair or renovation.

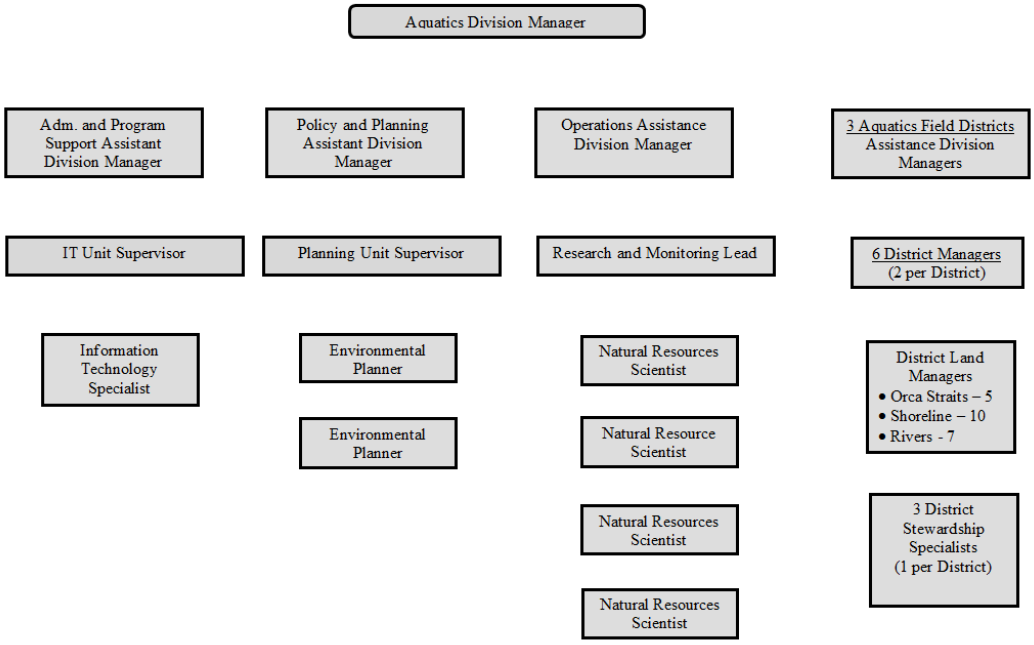
# 5.3 Administration and funding

## 5.3.1 Administration

The Aquatic Resources Division of Washington DNR administers the habitat conservation plan and is responsible for carrying out the operating conservation program and retaining all programmatic records, data, and publications related to the habitat conservation plan. Washington DNR's present staffing levels (2012) will allow for initial implementation of the habitat

conservation plan. The organizational staffing structure that was established to directly support implementation of the habitat conservation plan is shown in Figure 5.5. The staffing structure will change over time to meet the changing needs of the program as future staffing needs are identified and funded. Some research and monitoring may be funded through one-time allotments in the agency budget, grants, and cooperative agreements.

**Figure 5.5.** Structure of support staffing of the habitat conservation plan.




# 5.3.2 Funding the habitat conservation plan

Washington DNR's capacity to fund implementation of the habitat conservation plan depends on legislative appropriation.

Implementation of the habitat conservation plan will be supported through a combination of new and existing funds. The Aquatic Resources Program will also propose coordinating implementation strategies with other Washington DNR programs and, when appropriate, will look for opportunities to coordinate with other state and local regulatory agencies.

## Funding sources

Washington DNR's Aquatic Resources Program generates revenue on state-owned aquatic lands from the management of the commercial wildstock geoduck fishery, authorization of water dependent and nonwater-dependent uses, aquaculture, easements, and valuable material sales. The vast majority of the revenue from these six sources is deposited into two accounts: the aquatic Resource Management Cost Account (RMCA) and the Aquatic Lands Enhancement Account (ALEA). Washington DNR cannot withdraw funds directly from these accounts; instead, the agency must instead make a budget request to the legislature, which will then, at its discretion, appropriate funds from the RMCA, ALEA, and other state accounts for Washington DNR's use.

Generally, RMCA funds are used to cover most of the Aquatic Resources Division's operating costs associated with managing state-owned aquatic lands. The legislature typically distributes ALEA funds to seven major Washington state agencies, with only a small portion allocated to Washington DNR's Aquatic Resources Division. The cost of implementing the Aquatic Lands Habitat Conservation Plan will be met by a combination of the available funds appropriated from the ALEA and RMCA, as determined by the legislature. Washington DNR will pursue other funding sources, such as grants and research partnerships, to supplement implementation of the adaptive management and monitoring elements of the habitat conservation plan.

Washington DNR shall submit to the Washington State Legislature, on at least a biennial basis, an agency operating and capital budget that includes the funding to implement and enforce the Aquatic Lands Habitat Conservation Plan and fulfill Washington DNR's obligations under the incidental take permit and the implementation agreement. Washington DNR recognizes that failure to maintain adequate funding shall be grounds for suspension or partial suspension of the incidental take permit.

# 5.4 Adaptive management, effectiveness, and compliance monitoring

Long-term, consistent monitoring is a key element in determining if natural resource objectives and business objectives are being achieved. Monitoring also allows resource managers to track trends across time and landscapes and is used to inform and guide adaptive management strategies. Monitoring and adaptive management are also required elements of all habitat conservation plans, with NOAA Fisheries and the U.S. Fish and Wildlife Service specifying that the monitoring measures should ". . . be as specific as possible and commensurate with the project's scope and the severity of the effects" (U.S. Fish and Wildlife Service & National Marine Fisheries Service, 1996).

Because the persistence of individual species, species groups, and their habitats is the result of complex interactions between biotic and abiotic factors, Washington DNR's monitoring program uses an ecosystem-based approach to ensure that essential habitats and populations of covered species are protected within the boundaries of the habitat conservation plan.

Washington DNR's Aquatic Lands Habitat Conservation Plan, Adaptive Management and Monitoring Program (Appendix F) includes all the activities covered by this plan and will therefore occur in both fresh- and saltwater systems and all reporting units.[7] The monitoring program includes compliance, baseline, and effectiveness monitoring and is designed to be an efficient and effective means to ensure the implementation of the habitat conservation plan, increase regional knowledge of aquatic ecosystems, monitor threats associated with covered activities, and adapt to changes in the condition of habitat over time. Table 5.2 illustrates the relationship between the defined goals and elements of the program.

[7] Habitat conservation plan reporting units are defined as the nine Natural Heritage Program Ecoregions: Blue Mountains, Canadian Rockies, Columbia Plateau, East Cascades, West Cascades, North Cascades, Northwest Coast, Puget Trough, and Okanogan.

**Table 5.2.** Relationship between monitoring program goals and elements

| Goal | Program Element |
|---|---|
| Determine whether the conservation strategies defined in the habitat conservation plan are being implemented as written. | Compliance monitoring |
| Document whether the implemented strategies result in the anticipated habitat improvements. | Baseline and effectiveness monitoring |
| Increase Washington DNR's knowledge regarding the spatial and temporal components of covered activities. | Compliance, baseline, and effectiveness monitoring |
| Increase quantity and improve quality of covered species habitat on state-owned aquatic lands. | Effectiveness monitoring, adaptive management |
| Decrease quantity of known pressures on state-owned aquatic lands. | Effectiveness monitoring, adaptive management |
| Increase effectiveness of management measures applied to state-owned aquatic lands. | Effectiveness monitoring, adaptive management |

# 5.4.1 Adaptive Management and Monitoring Plan

Washington DNR's Adaptive Management and Monitoring Plan is based on the following principals:

- Inclusion of, and reliance on, interagency collaboration and stakeholder participation.
- Addressing uncertainty through scale-appropriate, science-based monitoring.
- Application of a flexible and iterative design process that is responsive to emerging issues.
- Resolution of conflicts through negotiation.
- Acknowledgement of realistic costs and feasibility in experimental design.

The Adaptive Management and Monitoring Plan consists of two phases: 1. a planning phase, during which stakeholders collectively refine the objectives and design of the plan, and 2. a process phase, during which the plan is implemented. Stakeholder groups will consist of representatives from user groups (such as marina operators and shellfish growers), tribal representatives, and regional planning entities (such as the Puget Sound Nearshore Restoration Project and the Salmon Recovery Fund). Appendix F describes the complete Adaptive Management and Monitoring Plan.

# 5.4.2 Baseline and effectiveness monitoring

Populations of covered species may change or fluctuate over time for many reasons, whether naturally or due to human influence. Washington DNR has proprietary control over habitat conditions on state-owned aquatic lands; therefore, Washington DNR will monitor habitat conditions over time, focusing on surveying and assessing changes to the quantity and quality of the habitat of covered species to determine whether conservation measures and programmatic strategies are effective. Habitat quantity and quality will be measured by indicator metrics that have precedence and support in the scientific literature, such as total area of nearshore aquatic vegetation, change in bank slope bathymetry, or loss of native benthic diversity. Monitoring will occur at several scales to address different questions.

# 5.4.3 Compliance monitoring

Compliance monitoring is intended to verify and document that Washington DNR is implementing the commitments made in the incidental take permit, habitat conservation plan, and implementation agreement. This monitoring not only determines where and when identified conservation strategies are being implemented, it also allows an assessment of how well Washington DNR is moving toward incorporating the standards, programmatic strategies, and activity-specific measures of the habitat conservation plan and if they are being implemented in a timely manner.

Washington DNR's compliance monitoring plan takes the form of an environmental audit and focuses on ensuring, first, that the authorizing instruments for covered activities (such as leases and licenses) stipulate the appropriate measures needed to avoid and minimize impacts on covered species and their habitats; and, second, that the operating conservation program described in Chapter 5, Section 2 is being carried out as specified in the habitat conservation plan. Appendix H ("Compliance Monitoring Plan") provides a complete description of the plan's components and reporting.

The process of monitoring the implementation of conservation measures and the timing for reporting will be based on the agreement set forth in the incidental take permit.

## Reporting

Each year in March, Washington DNR will report to NOAA Fisheries and the U.S. Fish and Wildlife Service the results of both the paper and field audits from the previous year. The reports shall include the number of actions (for example, leases and licenses) and the percentage of compliance with key measures and strategies according to activity and ecoregion. The first annual compliance monitoring report will be completed in March of the first full year after the incidental take permit is signed and will include only the results of the paper audit. Reports for the next five years will also be completed in March, but will describe:

- The population and sampling sizes used.
- Changes in the sampling or statistical protocol.
- The total percentage of agreements in compliance.

- The percentage of agreements in compliance by key measures and strategies, activity, and ecoregion.
- Which conservation measures were found to be out of compliance.
- Progress and accomplishments in implementing stewardship measures.
- Any suggested improvements in the protocol for the following year.

After six years of reports, the cycle and content of the reports will be re-evaluated by NOAA Fisheries, the U.S. Fish and Wildlife Service, and Washington DNR. This re-evaluation may result in modifications to the due dates and content of the reports.

# 5.5 Enforcement

When an authorized user does not comply with the terms, conditions, and actions specified in the authorizing agreement, Washington DNR will issue to the responsible party a notice of breach or default in accordance with the agreement. The notice will identify the area of non-compliance, provide reference to the applicable provisions in the authorization document, identify what is necessary to correct the non-compliance, and specify the period within which the correction must be completed. Usually the correction period is 30 or 60 days, but Washington DNR will allow a longer correction period if correction is impossible in 30 or 60 days.

After the correction period expires, agency staff will conduct another site inspection and verify that the authorized user has resolved the area of non-compliance . These actions will be documented by Washington DNR as they occur. This information is provided as part of the annual reporting to NOAA Fisheries and the U.S. Fish and Wildlife Service.

If the authorized user does not correct the compliance issues, Washington DNR will pursue all rights and remedies available in law to achieve compliance. Depending on the circumstances, Washington DNR may exercise one or more of the following options:

- Exercise its right of re-entry under the agreement to restore natural resources or the state-owned aquatic lands without terminating the agreement.
- Terminate the agreement and evict the responsible party in accordance with the terms of the agreement and state law. The evicted party would be liable for removal of all improvements and for restoration of the property to its pre-agreement condition.
- Sue for damages under additional contract or tort claims, if appropriate in the circumstances.
- In some circumstances, ask local law enforcement to bring misdemeanor charges against the responsible party (RCW 79.02.330).

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# Chapter 6
# Alternatives to the Habitat Conservation Plan

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# Chapter 6. Alternatives to the Habitat Conservation Plan

As part of the analysis of actions that might avoid take of sensitive species and their habitat, Washington State Department of Natural Resources (Washington DNR) considered three alternatives:

**Alternative 1:** No Action

**Alternative 2:** Implementation of an Aquatic Lands Habitat Conservation Plan for all state-owned aquatic lands (the proposed action)

**Alternative 3**: Implementation of an Aquatic Lands Habitat Conservation Plan for the saltwater-nearshore and saltwater-offshore ecosystems of the Puget Trough and Northwest Coast

What follows is a summary of these three alternatives; the complete discussion is presented in the environmental impact statement that accompanies this habitat conservation plan. The three alternatives are compared in Table 6.7 at the end of this chapter.

## 6.1 Alternative 1: No action

Under alternative 1, Washington DNR would not develop a habitat conservation plan and would continue to manage state-owned aquatic lands based solely on current agency practices, policies, laws, and rules (Table 6.1). The department would continue to require compliance with all local, state, and federal permitting for both construction and operation of activities on state-owned aquatic lands (Table 6.2).

**Table 6.1** Summary of statutory authority specific to state-owned aquatic lands.

| Chapter | Title | Content |
|---|---|---|
| 79.105 RCW | Aquatic Lands in General | Sets basic definitions and authorities for managing state-owned aquatic lands. Gives Washington DNR authority to sell, lease, and exchange certain aquatic lands, as well as authority to sell valuable materials (e.g. sediment and geoducks) from those aquatic lands. |
| 79.110 RCW | Aquatic Lands — Easements and Rights of Way | Sets Washington DNR's authority to grant easements and rights-of-way for specific activities on and over the state's aquatic lands |

| Chapter | Title | Content |
|---|---|---|
| 79.115 RCW | Aquatic Lands — Harbor Areas | Stipulates that harbor areas are to be established by the Board. Harbor areas are to be reserved for navigation and commerce and for facilities that promote navigation and commerce (i.e. docks and wharves). |
| 79.120 RCW | Aquatic Lands — Waterways and Streets | Stipulates that Washington DNR must plat waterways at the same time it establishes harbor areas. Waterways are generally reserved from sale or lease so they can remain free as public highways for watercraft. |
| 79.125 RCW | Aquatic Lands — Tidelands and Shorelands | Defines tidelands and shorelands and sets Washington DNR's authority to lease these lands for a variety of uses. Also stipulates that Washington DNR may exchange these lands if such an exchange is in the public interest and of benefit to the state. |
| 79.130 RCW | Aquatic Lands — Beds of Navigable Waters | Sets Washington DNR's authority to lease (for up to 55 years) beds of navigable waters that lie waterward of the extreme low tide mark. Washington DNR may not, however, lease or grant authority for anyone to use aquatic lands that lie waterward of outer harbor lines. |
| 79.135 RCW | Aquatic Lands — Oysters, Geoducks, Shellfish, and Other Aquaculture Uses | In coordination with the Washington Department of Fish and Wildlife and Washington Department of Health, sets Washington DNR's authority to lease lands for shellfish harvesting and aquaculture. The Washington Department of Fish and Wildlife regulates commercial shellfish growers and their harvesting, while the Washington Department of Health monitors beaches and shellfish tracts for pollution and other issues that affect human health. Also confirms Washington DNR's authority to sell geoducks as valuable materials and enter into agreements with the purchasers on the terms and conditions deemed necessary. |
| 79.100 RCW | Derelict Vessels | Gives Washington DNR and other public authorities certain powers to abate hazards posed by derelict vessels. |
| 332-30 WAC | Aquatic Land Management | Defines rules for Washington DNR's land management |

Note: RCW = *Revised Code of Washington*; WAC = *Washington Administrative Code*

**Table 6.2** Regulatory authority for state-owned aquatic lands.

| Entity | Permit/Approval |
|---|---|
| Federal Energy Regulatory Commission (FERC) | Licensing for interstate transmission of electricity, natural gas, and oil; construction and operation of hydroelectric projects |
| Local city or county planning office | Shoreline substantial development permit, shoreline conditional use permit, shoreline variance permit |
| | Floodplain development permit |
| Local diking districts | Dike construction |
| NOAA Fisheries | Section 7 (Endangered Species Act) and the Marine Mammal Protection Act |
| US Coast Guard | Oil Pollution Act (OPA) |
| | Federal navigational servitude |
| U.S. Army Corps of Engineers | Construction in navigable waters (Section 404 of the Clean Water Act, Section 10 of the Rivers and Harbors Act) |
| U.S. Army Corps of Engineers (continued) | Federal navigational servitude |
| U.S. Environmental Protection Agency (EPA) | Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Consent Decree |
| | Ocean Dumping Act |
| U.S. Fish and Wildlife Service | Section 7 (Endangered Species Act) |
| U.S. Food and Drug Administration | Federal Food, Drug, and Cosmetic Act (seafood and fish feeds) |
| Washington State Department of Ecology | Water Pollution Act and National Pollutant Discharge Elimination System (NPDES) |
| | Coastal Zone Management Act (CZMA) Consistency Determination |
| | Water Quality Certification (Section 401 of the Clean Water Act) |

| Entity | Permit/Approval |
|---|---|
| | Oil and Hazardous Substance Spill and Prevention and Response |
| | Pre-assessment Screening and Oil Spill Compensations Schedule Regulations |
| | Washington State Oil Spill Response Plan |
| | Sediment Management Standards |
| | Model Toxics Control Act (MTCA) Policy Advisory Committee |
| Washington Department of Fish and Wildlife | Hydraulic Project Approval (HPA) |
| | Commercial shellfish licenses |
| | Aquatic farm registrations |
| Washington Department of Health | Shellfish Closure Zone establishment |

Under alternative 1 (no action) no conservation program would be implemented to ensure that either current or future authorized activities comply with the Endangered Species Act (ESA). There would be no statewide, long-term consistency in the application of conservation measures for species or habitat, nor would timeframes, objectives, strategies, or goals be developed for species or habitat conservation.

Washington DNR would manage requests for uses of state-owned aquatic lands on a site-by-site basis. Some conservation measures might be implemented in a use authorization when the authorization is negotiated, but this would be at the discretion of land managers and district staff.

Under this alternative, use authorizations for all authorized activities occurring on state-owned aquatic lands would be based on Washington DNR's current management practices. Washington DNR would:

- Determine whether the general public will be excluded from the area by physical encumbrances, use encumbrances, or changes in aquatic land management.
- Determine who has preference rights to lease the land.
- Determine if the proposal is statutorily allowable, environmentally acceptable, and in the best interests of the state.
- Determine whether all pertinent regulatory permits have been obtained.

Under alternative 1 (no action), when deciding whether or not leasing a site is in the public interest, Washington DNR would not consider landscape-scale factors, such as species distribution, habitat distribution, the use of the area by forage fish to spawn, the cumulative

impacts of locating multiple authorizations in an area or ecosystem, or the effects of the use on sediment transport or aquatic vegetation. As funding allows, Washington DNR would continue to implement existing programs, such as identifying and managing aquatic reserves, taking part in various restoration projects, and removing derelict vessels.

Under alternative 1 (no action), Washington DNR would generally rely on regulatory requirements and intermittent review by scientific stewardship staff to provide environmental protection. If the proponent has obtained the required regulatory permits, Washington DNR would generally rely on these permits when deciding whether a proposed use should be sited in a particular location if consistent with Washington DNR's existing rules and policies. Under alternative 1 (no action), however, there could be circumstances in which Washington DNR would decide leasing is not appropriate for reasons besides those spelled out in regulation. In addition, under alternative 1, Washington DNR might not consistently incorporate prescribed best management practices into lease agreements.

Under alternative 1 (no action), inspection of any individual leasehold by Washington DNR would likely be linked either to a lease renewal (approximately once every 12 to 30 years), or to a revaluation of rental rates (approximately once every 4 years). Aside from these revenue-related visits, Washington DNR would visit individual leaseholds sporadically, as staff time allows. Washington DNR would verify the general condition of improvements (structures) on site, but would not necessarily inspect those improvements for the purpose of assessing their potential effects on species or habitats. Under alternative 1 (no action), Washington DNR would not conduct comprehensive monitoring of compliance or effectiveness or practice adaptive management. Changes to existing structures or operations would be driven by regulatory requirements, if any, or by business decisions on the part of the leaseholder.

## 6.2 Alternative 2: Statewide habitat conservation plan for all state-owned aquatic lands

Under alternative 2, Washington DNR would develop and implement a habitat conservation plan and obtain an incidental take permit that encompasses all state-owned aquatic lands in each of the defined ecoregions and ecosystems (Table 6.3). Alternative 2 is the preferred alternative of Washington DNR.

As with alternative 1 (no action), under this second alternative, Washington DNR would continue to manage state-owned aquatic lands based on current agency practices, policies, laws, and rules (Table 6.1), as well as require compliance with all local, state, and federal permits for both construction and operation prior to authorizing activities on state-owned aquatic lands (Table 6.2).

Under alternative 2, however, a specific conservation program would be implemented through the habitat conservation plan, which would ensure compliance with the Endangered Species Act. Washington DNR would conduct an evaluation of the effects that activities covered under the habitat conservation plan have on covered species and their habitats. Washington DNR would also consider direct and indirect effects of the covered activities when making all future leasing decisions. To address adverse effects (Chapter 5, Section 4), Washington DNR would adopt specific avoidance and minimization measures, standards, and best management practices, as well as compensation actions (to which NOAA Fisheries and the U.S. Fish and Wildlife Service have

agreed in the habitat conservation plan). This agreement would remain in effect for a term of 50 years, providing consistency in the management of impacts from covered activities throughout this term.

## 6.2.1 Area covered by the habitat conservation plan

Implementation of alternative 2 would include the entirety of the lands managed by Washington DNR (Chapter 1, Section 1.4, Land and Habitat Covered). Table 6.3 summarizes the distribution of the land covered by ecoregion and ecosystem.

**Table 6.3** Approximate distribution of state-owned aquatic lands by Natural Heritage Program ecoregion and defined ecosystem.

| Ecoregion | Ecosystem | Acres | Portion of Total State-owned Land |
|---|---|---|---|
| Blue Mountains | Lacustrine | 356 | < 1% |
| | Riverine | 1,333 | < 1% |
| | Sub-total | 1,689 | < 1% |
| Canadian Rockies | Lacustrine | 18,801 | < 1% |
| | Riverine | 0 | 0% |
| | Sub-total | 18,801 | < 1% |
| Columbia Plateau | Lacustrine | 99,772 | 4% |
| | Riverine | 4,832 | < 1% |
| | Sub-total | 104,604 | 4% |
| East Cascades | Lacustrine | 55,240 | 2% |
| | Riverine | 2,045 | < 1% |
| | Sub-total | 57,285 | 2% |
| North Cascades | Lacustrine | 5,894 | < 1% |
| | Riverine | 5,040 | < 1% |
| | Sub-total | 10,934 | < 1% |
| Northwest Coast | Lacustrine | 20,088 | < 1% |
| | Saltwater nearshore | 504,393 | 19% |
| | Saltwater offshore | 256,928 | 10% |
| | Riverine | 14,403 | < 1% |
| | Sub-total | 795,812 | 30% |
| Okanogan | Lacustrine | 40,228 | 2% |
| | Riverine | 4,554 | < 1% |
| | Sub-total | 44,781 | 2% |
| Puget Trough | Lacustrine | 49,766 | 2% |

| Ecoregion | Ecosystem | Acres | Portion of Total State-owned Land |
|---|---|---|---|
| | Saltwater nearshore | 869,700 | 33% |
| | Saltwater offshore | 672,460 | 25% |
| | Riverine | 25,713 | 1% |
| | Sub-total | 1,617,638 | 61% |
| West Cascades | Lacustrine | 10,027 | < 1% |
| | Riverine | 4,601 | < 1% |
| | Sub-total | 14,628 | < 1% |
| **Total** | | **2,666,171** | |

# 6.2.2 Covered species

The 29 species of animals included as covered species under alternative 2 are summarized in Table 6.4. Detailed descriptions of species' life histories and habitats, along with potential effects on species as a result of the covered activities, are in Chapter 4: Factors Affecting Covered Species.

**Table 6.4** Covered species for alternative 2.

| Species | Listing Status | Natural Heritage Rank[1] |
|---|---|---|
| **Amphibians and Turtles** | | |
| Columbia spotted frog (*Rana luteiventris)* | State candidate | G4, S4 |
| Northern leopard frog (*Rana pipiens)* | Federal concern; state endangered | G5, S1 |
| Oregon spotted frog (*Rana pretiosa)* | Federal candidate; state endangered | G2, S1 |
| Western toad (*Bufo boreas*) | Federal concern; state candidate | G4, S3 |
| Western pond turtle (*Actinemys marmorata)* | Federal concern; state endangered | G3G4, S1 |

[1] *Key to Natural Heritage program ranks:*

G = Global
S = State
B = Breeding populations
N = Non-breeding populations

1 = Critically imperiled
2 = Imperiled
3 = Rare locally or with a restricted range
4 = Apparently secure
5 = Demonstrably secure.

GNR = not ranked globally
SNR = not state ranked.

| Species | Listing Status | Natural Heritage Rank[1] |
|---|---|---|
| **Birds** | | |
| *Black tern (Chlidonias niger)* | State monitored | G4, S4B |
| Common loon (*Gavia immer)* | State sensitive | G5, S2B, S4N |
| Harlequin duck *(Histrionicus histrionicus)* | Not listed | G4, S2B, S3N |
| Marbled murrelet *(Brachyramphus marmoratus)* | Federal threatened; state threatened | G3G4, S2 |
| Western snowy plover *(Charadrius alexandrinus nivosus)* | Federal threatened; state endangered | G3, S1 |
| **Fish – Forage Fish** | | |
| Eulachon/ Pacific smelt (*Thaleichthys pacificus)* | Federal threatened; state candidate | G5, S4 |
| Pacific herring (*Clupea pallasi)* | Federal concern; state candidate | GNR, SNR |
| Pacific sand lance (*Ammodytes hexapterus*) | Not listed | None |
| Surf smelt *(Hypomesus pretiosus)* | Not listed | G5, SNR |
| **Fish - Rockfish** | | |
| Bocaccio *(Sebastes paucispinis)* | Federal endangered; state candidate | G4, SNR |
| Canary rockfish (*Sebastes pinniger*) | Federal threatened; state candidate | GNR, SNR |
| Yelloweye rockfish (*Sebastes ruberrimus)* | Federal threatened; state candidate | GNR, SNR |
| **Salmonids** | | |
| Bull trout *(Salvelinus confluentus)* | Federal threatened (Columbia River, coastal Puget Sound); state candidate | G4, S3 |
| Chinook salmon *(Oncorhynchus tshawytscha)* | Federal endangered (Upper Columbia spring run); federal threatened (Lower Columbia River, Puget Sound, Snake River fall run, Snake River spring/summer runs); state candidate | G5, S3S4 |
| Chum salmon *(Oncorhynchus keta)* | Federal threatened (Lower Columbia River, Hood | G5, S3 |

| Species | Listing Status | Natural Heritage Rank[1] |
|---|---|---|
| | Canal); state candidate | |
| Coastal cutthroat trout (*Oncorhynchus clarki clarki*) | Federal species of concern | G4, SNR |
| Coho salmon *(Oncorhynchus kisutch)* | Federal threatened (Lower Columbia River); federal species of concern (Puget Sound) | G4, S3 |
| Pink salmon *(Oncorhynchus gorbuscha)* | Not listed | G5, S3 |
| Sockeye/kokanee salmon (*Oncorhynchus nerka)* | Federal threatened (Lake Ozette); federal endangered (Snake River); state candidate (sockeye); not listed (kokanee) | G5, S2S3 |
| Steelhead trout *(Oncorhynchus mykiss)* | Federal threatened (Snake River basin; Upper Columbia, Middle Columbia, and Lower Columbia River runs; Puget Sound); state candidate | G5, S5 |
| **Sturgeon** | | |
| Green sturgeon *(Acipenser medirostris)* | Federal threatened (southern distinct population segment (DPS)) | G3, S2N |
| White sturgeon *(Acipenser transmontanus)* | Not listed | G4, S3B, S4N |
| **Lamprey** | | |
| Pacific lamprey (*Lampetra tridentate*) | Federal species of concern; state monitor | G4, S1 |
| **Marine Mammal** | | |
| Southern resident killer whale (orca) (*Orcinus orca)* | Federal endangered; state endangered | G4G5, SNR |

# 6.2.3 Covered activities

Three activity groups—log booming and storage, aquaculture, and overwater structures (boat ramps, launches, hoists, docks and wharves, floating homes, rafts and floats, marinas, mooring

buoys, nearshore buildings, shipyards, and terminals)—will be covered under alternative 2. These activities are described in detail in Chapter 3: Description of Activities.

## 6.2.4 Conservation strategies

Under alternative 2, Washington DNR would implement the standards, programmatic strategies, and activity-specific conservation measures described in Chapter 5, Section 2 ("Operating Conservation Program").

Site-specific implementation of the conservation program would be determined based on the type of authorized activity, the species predicted to be present, and the presence of important habitats (for example, submerged aquatic vegetation and forage fish spawning areas). Both new and existing covered activities would be required to implement conservation program measures under the terms and conditions of the lease or grant issued.

## 6.2.5 Monitoring

The monitoring plan developed under alternative 2 would include all covered activities and occur in ecosystems. The plan would be composed of two specific components:

1. Monitoring for compliance with the terms and conditions of the habitat conservation plan and incidental take permit (*compliance monitoring*).
2. Monitoring the effectiveness of the applied conservation measures for improving habitat conditions (*effectiveness monitoring*).

A more detailed discussion of both elements may be found in Chapter 5, Section 4 (Monitoring).

## 6.2.6 Adaptive management

Alternative 2 would include an adaptive management component, providing a process whereby the conservation actions implemented under the habitat conservation plan would be evaluated for effectiveness and alternative strategies adopted as needed to meet the goals of the habitat conservation plan. Information gathered in the course of effectiveness monitoring would be used to guide the adaptive management process. This program would be a collaborative process involving regional, divisional, and habitat conservation plan staff; external scientific oversight and review; and input from other natural resource management agencies.

# 6.3 Alternative 3: Habitat conservation plan for saltwater-nearshore and saltwater-offshore ecosystems of the Puget Trough and Northwest Coast

Under alternative 3, Washington DNR would develop and implement a habitat conservation plan and obtain an incidental take permit that consider only those state-owned aquatic lands that are associated with the saltwater ecosystems of the Puget Trough and Northwest Coast ecoregions.

As with the preceding alternatives, under alternative 3, Washington DNR would continue to manage state-owned aquatic lands based on current agency practices, policies, laws, and rules (Table 6.1), as well as require compliance with all local, state, and federal permits for both construction and operation prior to authorizing activities on state-owned aquatic lands (Table 6.2).

Similar to alternative 2, the operating conservation program described in Chapter 5, Section 2 of this document would be implemented through the habitat conservation plan to ensure compliance with the Endangered Species Act. Washington DNR would conduct an evaluation of the effects that activities covered under the habitat conservation plan have on covered species and their habitats and consider direct and indirect effects when making all future leasing decisions for the covered activities. Specific avoidance and minimization measures, standards, and best management practices, as well as compensation actions (to which NOAA Fisheries and the U.S. Fish and Wildlife Service have agreed in the habitat conservation plan), would be adopted by Washington DNR to address adverse effects (see Chapter 5, Section 4). This agreement would remain in effect for a term of 50 years, providing consistency in the management of impacts from covered activities throughout this term.

## 6.3.1 Area covered

Alternative 3 would include only the saltwater habitat managed by Washington DNR. Table 6.5 summarizes the distribution (by ecoregion and ecosystem) of the land covered.

**Table 6.5** Approximate distribution of state-owned aquatic lands for alternative 3 by Natural Heritage Program ecoregion and defined ecosystem.

| Ecoregion | Functional Ecosystem | State-owned Aquatic Lands | Percent of State Ownership |
|---|---|---|---|
| Northwest Coast | Saltwater nearshore | 504,393 | 19% |
| | Saltwater offshore | 256,928 | 10% |
| | *Total* | *761,321* | *29%* |
| Puget Trough | Saltwater nearshore | 869,700 | 33% |
| | Saltwater offshore | 672,460 | 25% |
| | *Total* | *1,542,159* | *58%* |
| **Total** | | **2,303,480** | **86%** |

# 6.3.2 Covered species

Under alternative 3, 23 species would be included in the habitat conservation plan (Table 6.6). Only those effects on species and habitats that occur in nearshore and offshore saltwater ecosystems would be considered. Detailed descriptions of the species, their habitats, and potential effects from the covered activities can be found in Chapter 4 (Factors Affecting Covered Species) of this document.

**Table 6.6** Covered species for alternative 3.

| Species | Listing Status | Natural Heritage Rank[2] |
|---|---|---|
| **Birds** | | |
| Common loon (*Gavia immer)* | State sensitive | G5, S2B, S4N |
| Harlequin duck *(Histrionicus histrionicus)* | Not listed | G4, S2B, S3N |
| Marbled murrelet *(Brachyramphus marmoratus)* | Federal threatened; state threatened | G3G4, S2 |
| Western snowy plover *(Charadrius alexandrinus nivosus)* | Federal threatened; state endangered | G3, S1 |
| **Fish – Forage Fish** | | |
| Eulachon/ Pacific smelt (*Thaleichthys pacificus)* | Federal threatened; state candidate | G5, S4 |
| Pacific herring (*Clupea pallasi)* | Federal concern; state candidate | GNR, SNR |
| Pacific sand lance (*Ammodytes hexapterus*) | Not listed | None |
| Surf smelt *(Hypomesus pretiosus)* | Not listed | G5, SNR |
| **Fish - Rockfish** | | |
| Bocaccio *(Sebastes paucispinis)* | Federal endangered; state candidate | G4, SNR |

[2] *Key to Natural Heritage program ranks:*

G = Global
S = State
B = Breeding populations
N = Non-breeding populations

1 = Critically imperiled
2 = Imperiled
3 = Rare locally or with a restricted range
4 = Apparently secure
5 = Demonstrably secure.

GNR = not ranked globally
SNR = not state ranked.

| Species | Listing Status | Natural Heritage Rank[2] |
|---|---|---|
| Canary rockfish (*Sebastes pinniger*) | Federal threatened; state candidate | GNR, SNR |
| Yelloweye rockfish (*Sebastes ruberrimus)* | Federal threatened; state candidate | GNR, SNR |
| **Salmonids** | | |
| Bull trout *(Salvelinus confluentus)* | Federal threatened (Columbia River, coastal Puget Sound); state candidate | G4, S3 |
| Chinook salmon *(Oncorhynchus tshawytscha)* | Federal endangered (Upper Columbia spring run); federal threatened (Lower Columbia River, Puget Sound, Snake River fall run, Snake River spring/summer runs); state candidate | G5, S3S4 |
| Chum salmon *(Oncorhynchus keta)* | Federal threatened (Lower Columbia River, Hood Canal); state candidate | G5, S3 |
| Coastal cutthroat trout (*Oncorhynchus clarki clarki*) | Federal species of concern | G4, SNR |
| Coho salmon *(Oncorhynchus kisutch)* | Federal threatened (Lower Columbia River); federal species of concern (Puget Sound) | G4, S3 |
| Pink salmon *(Oncorhynchus gorbuscha)* | Not listed | G5, S3 |
| Sockeye/kokanee salmon (*Oncorhynchus nerka)* | Federal threatened (Lake Ozette); federal endangered (Snake River); state candidate (sockeye); not listed (kokanee) | G5, S2S3 |
| Steelhead trout *(Oncorhynchus mykiss)* | Federal threatened (Snake River basin; Upper Columbia, Middle Columbia, and Lower Columbia River runs; Puget Sound); state candidate | G5, S5 |
| **Sturgeon** | | |

| Species | Listing Status | Natural Heritage Rank[2] |
|---|---|---|
| Green sturgeon *(Acipenser medirostris)* | Federal threatened (southern distinct population segment (DPS)) | G3, S2N |
| White sturgeon *(Acipenser transmontanus)* | Not listed | G4, S3B, S4N |
| **Lamprey** | | |
| Pacific lamprey (*Lampetra tridentate*) | Federal species of concern; state monitor | G4, S1 |
| **Marine Mammal** | | |
| Southern resident killer whale (orca) (*Orcinus orca)* | Federal endangered; state endangered | G4G5, SNR |

# 6.3.3 Covered activities

Three activity groups would be covered under alternative 3: log booming and storage, aquaculture, and overwater structures (boat ramps, launches, hoists, docks and wharves, floating homes, rafts and floats, marinas, mooring buoys, nearshore buildings, shipyards, and terminals). These activities are described in detail in Chapter 3: Description of Activities.

# 6.3.4 Conservation strategies

Under alternative 3, Washington DNR would implement the standards, programmatic strategies, and activity-specific conservation measures described in Chapter 5, Section 2 of the habitat conservation plan (operating conservation program). Site-specific implementation of the conservation program would be determined based on the type of authorized activity, the species predicted to be present, and the presence of important habitats (such as submerged aquatic vegetation and forage fish spawning areas). Both new and existing covered activities would be required to implement conservation program measures under the terms and conditions of the lease issued.

# 6.3.5 Monitoring

The monitoring plan developed under alternative 3 would include all covered activities within the nearshore and offshore ecosystems of the Puget Trough and Northwest Coast. The plan would be composed of two specific components:

1. Monitoring for compliance with the terms and conditions of the habitat conservation plan and incidental take permit (*compliance monitoring*).

2. Monitoring the effectiveness of the applied conservation measures for improving habitat conditions (*effectiveness monitoring*).

A more detailed discussion of both elements may be found in Chapter 5, Section 4 (Monitoring).

## 6.3.6 Adaptive management

Alternative 3 would include an adaptive management component, providing a process whereby the conservation actions implemented under the habitat conservation plan would be evaluated for effectiveness and alternative strategies adopted as needed to meet the goals of the habitat conservation plan. Information gathered in the course of effectiveness monitoring would be used to guide the adaptive management process. This program would be a collaborative process involving regional, divisional, and habitat conservation plan staff; external scientific oversight and review; and input from other natural resource management agencies.

# 6.4 Comparison of alternatives

The three alternatives described in this chapter are briefly described and compared in Table 6.7.

**Table 6.7** Comparison of three alternatives.

| | **1. No Action** | **2. Statewide Habitat Conservation Plan (HCP)** | **3. Habitat Conservation Plan (HCP) for Saltwater-Nearshore and Saltwater-Offshore Ecosystems of Puget Trough and NW Coast** |
|---|---|---|---|
| **Management Approach** | Washington DNR's current practices, policies, laws, and rules; compliance with all permitting no strategic long-term or landscape-scale conservation plan | Washington DNR's current practices, policies, laws, and rules; compliance with all permitting; habitat conservation plan for 50 years | Washington DNR's current practices, policies, laws, and rules; compliance with all permitting; habitat conservation plan for 50 years |
| **Area Covered** | Statewide: All state-owned aquatic lands managed by Washington DNR | Statewide: All state-owned aquatic lands managed by Washington DNR | All state-owned aquatic lands managed by Washington DNR in saltwater ecosystems of Puget Trough and Northwest Coast eco-regions |
| | 2,666,171 acres | 2,666,171 acres | 2,303,480 acres |
| **Species Covered** | None | 29 species | 23 species |
| **Activities Covered** | None | 3 activity groups: Aquaculture (shellfish), log booming and storage, overwater structures | 3 activity groups: Aquaculture (shellfish), log booming and storage, overwater structures |

| | 1. No Action | 2. Statewide Habitat Conservation Plan (HCP) | 3. Habitat Conservation Plan (HCP) for Saltwater-Nearshore and Saltwater-Offshore Ecosystems of Puget Trough and NW Coast |
|---|---|---|---|
| **Conservation Measures** | Existing measures are used at discretion of land managers and district staff | Activity-specific conservation measures and programmatic strategies implemented under HCP | Activity-specific conservation measures and programmatic strategies implemented under HCP |
| **Basis of Analysis** | Site by site | Species (life history, habitat use, distribution, potential threats, and limiting factors) | Species (life history, habitat use, distribution, potential threats, and limiting factors) |
| **Landscape-scale Factors** | Discretionary consideration | Sensitive areas, species presence, historical uses, land condition | Sensitive areas, species presence, historical uses, land condition |
| **Programmatic Measures** | Continue to implement existing programs | Continue to implement existing programs, plus commitment to new programmatic measures (protecting aquatic vegetation, protecting forage fish spawning habitat, aquatic landscape prioritization). | Continue to implement existing programs, plus commitment to new programmatic measures (protecting aquatic vegetation, protecting forage fish spawning habitat, aquatic landscape prioritization). |
| **Environmental Protections** | Rely on regulatory requirements and review by scientific stewardship staff | Specific avoidance, minimization, and compensation actions adopted by Washington DNR under HCP | Specific avoidance, minimization, and compensation actions adopted by Washington DNR under HCP |
| **Role of Other Regulations** | Normally rely on other agency regulations for establishing siting and construction standards if consistent with Washington DNR's existing rules and policies. | Washington DNR will implement its own siting and construction standards and not rely on regulators for standards | Washington DNR will implement its own siting and construction standards and not rely on regulators for standards |
| **Best Management Practices** | Not consistently incorporated | Consistently incorporated | Consistently incorporated |

| | 1. No Action | 2. Statewide Habitat Conservation Plan (HCP) | 3. Habitat Conservation Plan (HCP) for Saltwater-Nearshore and Saltwater-Offshore Ecosystems of Puget Trough and NW Coast |
|---|---|---|---|
| **Structure Upgrades** | Based on regulatory requirements | Based on Washington DNR's standards | Based on Washington DNR's standards |
| **Inspections** | Linked to a lease renewal (every 12–30 years) or revaluation of rental rate; inspection typically not based on environmental factors | Annual inspections for environmental impacts | Annual inspections for environmental impacts |
| **Compliance or Effectiveness Monitoring** | None | Monitoring plan for all covered activities and ecosystems: Monitor compliance of the HCP terms and conditions; monitor effectiveness of conservation measures | Monitoring plan for all covered activities and ecosystems: Monitor compliance of the HCP terms and conditions; monitor effectiveness of conservation measures |
| **Adaptive Management** | None | Collaborative adaptive management with internal and external involvement; evaluate and adapt strategies to meet HCP goals and objectives | Collaborative adaptive management with internal and external involvement; evaluate and adapt strategies to meet HCP goals and objectives |

# Chapter 7
# Glossary

# Chapter 7. Glossary

Note: These definitions are specific to the Washington State Department of Natural Resources' Aquatic Lands Habitat Conservation Plan. Additional definitions may exist in other contexts.

| | |
|---|---|
| **abandoned structures** | Improvements or fixtures that are no longer in use. If the abandoned structures are also in poor condition, they may be referred to as *derelict*. |
| **accretion** | A natural or artificial process whereby the size of a beach, spit, bar, or flat gradually increases through the deposition of sand, gravel, or sediment particles. |
| **abiotic** | The non-living factors of a given area, such as temperature, wind, and substrate. |
| **adfluvial** | A fish life-history strategy whereby spawning and juvenile rearing take place in rivers or streams, but adults live in lakes or reservoirs. |
| **adjudicate** | To settle a dispute or conflict through the use of a judge or arbiter. |
| **affect** | To act upon or have an effect on somebody or something. (verb) |
| **aggregating area** | A relatively small area within which individuals of the same species gather in large numbers for various purposes. |
| **alevin** | A larval salmonid approximately 25 millimeters (1 inch) in length and still attached to the yolk sac. Alevins remain buried under the gravel of the redd for safety and live off the yolk sac. |
| **algae** | Photosynthetic organisms that are primarily aquatic. Algae are differentiated from plants by their lack of lignin and xylem. Algae range from microscopic single-celled forms to macroscopic multicellular forms 30 meters (98 feet) or more in length. Macroscopic algae include the seaweeds, and microscopic algae are included in the phytoplankton. *Algae* is plural; the singular form is *alga*. |
| **algal bloom** | The rapid reproduction of microscopic algae leading to large, dense populations. |
| **ambient light** | Natural light that is not filtered or blocked by water, structures, or organisms. |
| **anaerobic** | A situation in which molecular oxygen is virtually absent from the environment. Also referred to as *anoxic*. |
| **anadromous** | A fish life-history strategy whereby spawning and juvenile rearing take place in freshwater, but young fish then migrate to saltwater for their adult phase. |
| **anoxic** | A situation in which molecular oxygen is virtually absent from the environment. Also referred to as *anaerobic*. |

| | |
|---|---|
| **anthropogenic** | Caused by humans. |
| **aquatic vegetation** | Plants and algae that either require or tolerate partial or total submergence in water and that are rooted in water for most of each day. |
| **area of alteration** | The area around the footprint of a structure that is altered as a result of the structure or the operational components of the use (or both). |
| **areal** | Pertaining to a spatial area or the area covered by a structure or use. |
| **atmospheric deposition** | The addition of nitrogen compounds from the atmosphere to water bodies. |
| **authorization** | A generic term for instruments authorizing the use of state-owned aquatic lands. Authorizations include leases, licenses, and registrations. |
| **bank armoring** | The placement of materials (for example, along a stream bank) so as to resist erosion. |
| **barbel** | A whisker-like, tactile organ found near the mouth of some fish species, such as sturgeon and catfish. |
| **barrier beach** | A long and narrow strip of sand and gravel built by the action of waves, currents, and wind. Barrier beaches extend above ordinary high water and run parallel to the shoreline, protecting small embayments, such as lagoons. |
| **baseline condition** | The biological, chemical, and physical conditions in which a project or action will be located and on which impacts will occur. Baseline condition is the standard against which anticipated future conditions and actions are measured and assessed. |
| **basin** | A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water, together with all tributary surface streams and bodies of impounded surface water. |
| **bathymetry** | The measurement of depths of water in oceans, rivers, and lakes. Also, information derived from such measurements. |
| **beach nourishment** | See *nourishment*. |
| **beach seining** | A means of catching fish whereby a net (called a *seine*) is carried into the water, deployed, and pulled back into shore. Beach seining is useful for catching fish that school close to shore. |
| **behavioral avoidance** | Changing behavior to avoid something perceived as a threat or otherwise disliked. |
| **benthos/benthic** | A region of a water body that includes the bottom substrate, the zone of substrate-water interface, and the organisms that dwell within or on the substrate. |
| **berth/berthing** | A location alongside a dock or wharf where a boat may be moored. Also referred to as a *slip*. |

| | |
|---|---|
| **bioaccumulation** | An increase in the concentration of a chemical within the tissues of an organism over time. |
| **bioassay endpoint** | The point at which the biological effects of a chemical or toxin are exhibited in a laboratory test. |
| **biota** | All of the living organisms of a given area or time. |
| **biodiversity** | The number and variety of species within a given ecosystem or region. Biodiversity is often used as an indicator of the health of an ecosystem, with higher diversity usually meaning greater health. |
| **biological assessment** | A document, prepared for the Endangered Species Act Section 7 consultation process, wherein a federal agency that is undertaking a project describes the project and its potential biological consequences for listed species and their habitat. |
| **biological opinion** | A scientific judgment concerning whether a project described in a biological assessment is likely to result in jeopardy for threatened and endangered species and their habitat. A biological opinion can include conservation recommendations to avoid or minimize possible adverse effects, impose reasonable and prudent measures to minimize harmful impacts, and require monitoring and reporting. |
| **biological oxygen demand (BOD)** | A chemical procedure for determining how fast oxygen is used up by all of the organisms in a water body. Biological oxygen demand is used as an indicator of water quality, with higher levels indicating decreased water quality. |
| **biomass** | The amount of living or very recently dead organic matter in a given area. |
| **biotoxin** | A toxic substance produced by a living organism. |
| **bioturbation** | The displacement and mixing of sediment particles by benthic animals and plants. |
| **bivalve** | A group of invertebrates defined as having two shells connected by a hinge on one side. Mussels, clams, and oysters are bivalves. |
| **black water** | Wastewater comprised of untreated fecal matter or urine. |
| **boulder** | A rock with a diameter greater than 256 millimeters (10 inches). |
| **brackish water** | Water with salinities greater than those found in freshwater, but less than that in seawater. Brackish water occurs naturally in estuaries. |
| **breakwaters** | Structures that dissipate wave energy off-shore. Breakwaters can be floating or fixed structures and are used to protect shorelines and infrastructure. |
| **breeding chorus** | A dense aggregation of male frogs sending out mating calls. |
| **broadcast spawning** | Expelling both eggs and sperm into the water at the same time and relying on proximity for fertilization. |
| **brooding** | The action of incubating eggs. |

| | |
|---|---|
| **bulkheads** | A retaining structure to protect against slippage or erosion. |
| **bycatch** | Aquatic organisms other than the target species, or individuals of the target species that are too small or of the wrong gender to be legally kept, which are caught in a fishery. |
| **carapace** | The shell that covers the back of turtles. |
| **cetaceans** | Marine mammals from the order Cetacea, which includes all whales, dolphins, and porpoises. |
| **channel** | A natural or artificial waterway of perceptible extent that either periodically or continuously contains moving water, or forms a connecting link between two bodies of water. |
| **channel incision** | The process of a stream or river cutting into the substrate and lowering the level of the water body, undercutting banks, and making flood events less frequent or halting them altogether. |
| **chemical oxygen demand** | A measure of the oxygen that was consumed by the chemical reactions necessary for the decomposition of organic matter and the oxidation of inorganic chemicals, such as ammonia and nitrite, in order to form the concentrations of nitrogen and phosphorous compounds measured in the water column. |
| **circulation** | The flow of water currents within a large body of water. |
| **clan** | A large group of killer whales (orcas) consisting of several pods with common vocalizations and behaviors. |
| **clay** | Substrate particles with a diameter less than 0.004 millimeters (0.00016 inches). |
| **clutch** | The number of eggs laid in one batch. |
| **coarse sediment** | A mixture of sand and gravel. |
| **cobble** | Rocks with a diameter between 75 and 256 millimeters (approximately 3–10 inches). |
| **community** | Any naturally occurring group of species inhabiting a common environment, interacting with each other (especially through food relationships), and remaining relatively independent of other groups. |
| **conductivity** | A measure of the ability of water to conduct electricity through dissolved ions. Conductivity describes the total dissolved solids within freshwater in much the same way that salinity is used to describe the concentration of dissolved salts in saltwater. |
| **confluence** | The point where two or more water bodies flow together. |
| **connectivity** | Proximity of acceptable habitat to other areas of acceptable habitat, sufficient to allow species to travel from one area of acceptable habitat to another. *Connectivity* can also refer to a connection between parts of a process, such as sediment transport between feeder bluffs and beaches. |

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| **consolidated habitat** | Habitat where the substrate is solid material, such as bedrock, or where the material is so interlocked that it is not mobile. |
| **coulee** | A set of dry, braided stream channels formed by glacial drainage. |
| **critical habitat** | Specific geographic areas designated by NOAA Fisheries and the U.S. Fish and Wildlife Service. Critical habitat designations include those areas that are occupied by threatened and endangered species at the time of their listing and that contain the physical and biological features essential to the conservation of the species. |
| **cubic feet per second (CFS)** | A measure of water flow expressed as the number of cubic feet of water that flows past a given point in one second. |
| **cultch** | Fragmented shells used as a substrate for collecting wild shellfish larvae as seed for commercial shellfish aquaculture. |
| **cumulative impacts** | Large-scale impacts on the environment that result from the combination of many small-scale impacts. |
| **current** | The flow of water. |
| **deep-draft** | A boat that extends 2 meters (about 6.6 feet) below the waterline or more. |
| **delta** | A low-lying landform at the confluence of a river and a larger water body. Deltas are formed by the deposition of the sediment carried by the river. |
| **demersal** | The part of the water column that is close to, and significantly affected by, the benthos. *Demersal* also refers to fish that primarily inhabit the demersal zone. |
| **deposition** | The deposit of materials (for example, sediment or wood waste) in an area. This can occur by natural means, such as wave action or currents, or by human-induced means. |
| **depositional reach** | A stretch of river where water slows and suspended sediment is deposited. |
| **derelict fishing gear** | Fishing gear (such as pots, nets, lines, and hooks) that has been abandoned underwater. |
| **desalinization** | The removal of salts from seawater for the purpose of rendering the water drinkable or otherwise usable by humans. |
| **desiccation** | The loss of water; drying up. |
| **diatoms** | Single cell algae with glass shells. Diatoms are found in both marine and freshwater systems and comprise the bulk of the phytoplankton. Diatoms participate in algal blooms. |
| **dikes** | A bank, usually of earth, used to continually confine or control water. Dikes are similar to levees, but protect land that would be continuously underwater without a dike. |

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| **dinoflagellates** | Single-cell, mobile organisms found in both marine and freshwater. Half are photosynthetic and make up a large portion of the phytoplankton. The other half are included in the zooplankton. Dinoflagellates participate in algal blooms. |
| **displacement volume** | The amount of water that a vessel displaces when it is floating. The greater the displacement volume, the deeper the water needs to be to float the vessel. |
| **distributary channels** | A stream that branches off and flows away from a mainstream channel. Such channels are commonly seen in deltas. The opposite of a *tributary*. |
| **disturbance** | A temporary change in average environmental conditions that causes a pronounced change in an ecosystem. |
| **dissolved oxygen** | The amount of gaseous oxygen dissolved in the water column. |
| **dolphins** | Multiple pilings lashed together and used for moorage, as protection, or to mark boundaries. |
| **downwelling** | The accumulation and sinking of colder or more saline water, which allows warmer or less saline water to move in. The opposite of *upwelling*. |
| **drainage area** | See *watershed*. |
| **dredge** | To deepen by removing substrate material and depositing it in another location. Also, the mechanical or hydraulic equipment used for such excavation. |
| **dredge spoil piles** | The piles of sediment or other materials removed through the process of dredging and deposited in a new location. |
| **dry dock** | A structure used for building, repairing, or deconstructing vessels that are too large to be pulled up onto land. Dry docks are floated under the vessel that is to be worked on and then raised to lift the vessel out of the water. |
| **duff layer** | Organic matter in various stages of decomposition that lies on the floor of a forest. The duff layer is usually comprised primarily of leaves. |
| **dynamic equilibrium** | The balancing point where movement in one direction is equal to movement in the opposite direction. Movement continues, but there is no net gain in any direction. |
| **ecological function** | Any ecological process—including disturbance, nutrient cycling, water cycling, and succession—in any ecosystem. |
| **ecological services** | The benefits to humans arising from the ecological functions of healthy ecosystems. |
| **ecoregion** | A geographically distinct landform and all the biotic and abiotic factors found within that landform. |
| **ecosystem** | The combination and interaction of all biotic and abiotic factors in an area, usually delineated by natural geographic barriers. |

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| **ecosystem function** | Any ecological process in a given ecosystem. Ecosystem function is similar to ecological function, but limited to a given (or set of given) ecosystems. |
| **ectothermic** | Having a limited ability to produce warmth through biological processes and relying heavily on external sources of heat. Formerly referred to as *cold-blooded*. |
| **effect/impact** | Under NEPA regulations, a direct result of an action that occurs at the same time and place; or an indirect result of an action that occurs later in time or in a different place and is reasonably foreseeable; or the cumulative results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (40 Code of Federal Regulation (CFR) 1508.8). Under Endangered Species Act, Section 7 regulations, "effects of the action" means "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). |
| **effluent** | Wastewater, treated or otherwise. |
| **embayment** | An indentation of the shoreline. |
| **emergence** | For salmon, the emergence of salmon fry from the gravel of the redd: The point in salmonid life histories when they change from alevin to fry. |
| **emergent vegetation** | Aquatic plants that are rooted in the water, but extend most of their form above the water. |
| **encrusting** | Organisms that permanently attach themselves to a given substrate or object and do not extend very far from the surface. Examples include barnacles and lichens. |
| **endangered species** | Any species that is in danger of becoming extinct throughout all or a significant portion of its range. |
| **enhancement** | The improvement of existing habitat or the addition of new habitat through restoration. |
| **entrained** | Trapped. |
| **environmental impact statement (EIS)** | A document required by state and federal law for actions that may significantly alter the quality of the environment. An EIS is a decision making tool that describes both positive and negative effects, as well as alternatives to the proposed action. |
| **ephemeral** | A temporary stream or pool, usually existing only in the wetter periods of the year and drying up in the summer. |
| **epibenthic** | Living on top of the bottom substrate of a water body. |
| **epilimnion** | The top layer of water of a thermally stratified lake. The epilimnion is generally warmer than the other layers in the summer and colder than the other layers in the winter. |

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| **escape cover** | Physical structures within which fish can hide to avoid predation. Escape cover includes aquatic vegetation, exposed tree roots, and large woody debris. |
| **estuary/estuarine** | The region near the mouth of a river where fresh water mixes with saltwater to create brackish water. This region includes the tidally influenced part of the river. |
| **euphotic zone** | The portion of the water column that receives sufficient light for photosynthesis to occur. |
| **eutrophic** | A water body with high nutrient enrichment and primary productivity rates. Eutrophic waters are usually oxygen poor and highly turbid. |
| **eutrophication** | The process of nutrient enrichment in a water body. |
| **evolutionarily significant units** | A population or subspecies that is considered genetically or behaviorally distinct for purposes of conservation. |
| **exceedance** | Exceeding a given threshold. Exceedance can be negative (for example, above the range of acceptable concentrations) or positive (for example, more light passage than is required). |
| **exotic species** | A species that is living outside its natural distribution due to having been brought there intentionally or accidentally by humans, but the species is not outcompeting all other species to the point that it is damaging biodiversity. Also referred to as *non-native*. |
| **exposed** | A section of coastline that is not sheltered from ocean waves and frequently or continually contends with strong waves. |
| **extreme higher high water** | The highest high tide recorded during a given period. |
| **extreme low tide** | The lowest low tide recorded during a given period. |
| **fallow** | Land normally impacted by shellfish cultivation that is not impacted by cultivation for a year or more to give it a chance to recover. |
| **fecal coliform bacteria** | Bacteria found in the intestinal tract of animals and excreted from the body in feces. Levels of fecal coliform bacteria in water bodies are used as an indicator of fecal contamination in the water and can lead to closures of shellfish harvesting. |
| **fecundity** | The potential reproductive capacity of an organism or population. Generally, fecundity is defined as the number of eggs or spores produced, which is impacted by both genetic and environmental factors. |
| **feeder bluffs** | A coastal cliff or headland that adds sediment to the nearby water body through erosion. |
| **fetch** | The distance over unobstructed open water on which waves are generated by a wind having a constant direction and speed. |

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| **fill/filling** | The transformation of aquatic land into terrestrial land by dumping rock, trash, dirt, or other materials into the water close to a shoreline until the substrate has been raised above the water column. |
| **filter feeder** | An animal that obtains food by filtering the water column through a membrane and straining out plankton and organic particles. Also referred to as a *suspension feeder*. |
| **fine sediment** | A type of unconsolidated habitat comprised of a mixture of silt and clay. |
| **finfish** | Fish with fins. The term is used to separate fish with fins from shellfish, jellyfish, starfish, and any other aquatic organism that might otherwise be lumped under the term *fish*. |
| **fitness** | The ability to successfully reproduce. |
| **fjord** | A long, narrow, marine water body with relatively steep sides carved by glacial activity. |
| **flats** | Areas of gently sloping shores that contain fine to coarse unconsolidated sediments. Also referred to as *mud flats*, *salt flats*, or *tidal flats*. |
| **fledging** | The stage in a bird's lifecycle when it grows flight feathers for the first time and starts flying. |
| **floating bog** | A mass of floating vegetation (such as algae, aquatic plants, grasses, and trees) that is not rooted to the lakebed. Floating bogs can reach several acres in size and change location as they are pushed by waves, wind, and currents. |
| **floodplain** | Any flat or nearly flat lowland that borders a stream or river and is covered by its waters when it is at flood stage. |
| **flood pulse** | The concept that recurrent, seasonal, short-term flooding is an important ecological factor driving the biology of rivers. |
| **flushing** | In the context of water bodies, flushing is the replacement of old water with new water through inputs or tidal cycles. In the context of birds, flushing is sudden flight due to fear. |
| **fluvial** | A salmonid life-history strategy in which spawning and juvenile rearing take place in small freshwater streams, but young fish then migrate to larger rivers for their adult phase. |
| **fouling** | The growth of invertebrates or algae on underwater structures or shellfish. The growth of something unwanted on something that is wanted. |
| **fry** | The life stage of a salmonid after it emerges from the redd and before it leaves the natal stream to migrate to another water body. |
| **FTE** | Stands for *full time equivalent* and is a means of measuring a Washington DNR employee's involvement in a program. |
| **fuel transfer** | The transfer of engine fuel from fueling facilities to vessels. |

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| **gabions** | Large, wire mesh boxes filled with rocks and generally stacked into a wall to protect a shoreline from erosion. A type of hard armoring. |
| **gangway** | A narrow ramp, usually with railings, that connects a dock to piers or to the shore. Also referred to as a *walkway*. |
| **geomorphology** | The shape or form of a natural surface or object. Also, the study of the forms of land and the processes that produce them. |
| **gestation** | Carrying an embryo. Pregnancy. |
| **grain size** | The size of soil or rock particles that comprise the substrate at a given location. Substrates usually include several different grain sizes in varying proportions. |
| **gravel** | Rocks with a diameter between 4.75 and 75 millimeters (about 0.2–3.0 inches). |
| **gray water** | Wastewater generated by dishwashing, laundry, and bathing. |
| **groundwater** | Underground water supplies, also called aquifers. Groundwater is formed by water soaking into the ground until it reaches a point where the ground is not permeable. Groundwater usually flows laterally underground toward a river, lake, or ocean. |
| **groundwater recharge** | The movement of water from the surface to an underground supply. |
| **habitat** | A location that provides all of the organisms and environmental conditions, including air, water, soil, mineral elements, moisture, temperature, and topography, that a given species needs to survive. Also, a general description of all of the species and environmental conditions present at a given location. |
| **habitat complexity** | The amount of natural variation in the physical characteristics of a habitat, such as vegetation, topography, or grain size of sediment. |
| **habitat connectivity** | The concept that patches of appropriate habitat need to be close enough together or joined by corridors of similar habitat in order to sustain animals that require large ranges. |
| **habitat creation** | A process whereby a location that has lost all natural processes as a result of human impacts and development has natural processes established. This includes the creation of natural processes that never previously existed at that location, such as the creation of intertidal habitat in deep water through the addition of fill. |
| **habitat fragmentation** | The patchy destruction of a given type of habitat, leaving islands of the given type of habitat surrounded by other types of habitat. |
| **habitat function** | Any ecological process in a given habitat. Habitat function is similar to ecological function, but is limited to a given or set of given habitats. |
| **hard armoring** | Materials (such as riprap, sea walls, bulkheads, and breakwaters) that deflect wave energy and block erosion in an unnatural fashion. |

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| **headwater streams** | The small creeks and streams with relatively small watersheds that are the origin of many rivers and lakes. |
| **heavy metals** | A metallic element that is toxic to organisms. At low concentrations, some heavy metals are necessary to organisms, while at high concentrations, these same metals are toxic (for example, iron, copper, and zinc); others are toxic at any concentration (for example, lead, mercury, and plutonium). |
| **herbivore** | An organism that primarily feeds on plants or algae (or both). |
| **herptofauna** | Amphibians and reptiles. |
| **high-energy** | In the context of water, the term *high-energy* refers to water moving with a lot of speed (current velocity) or a lot of force (waves). |
| **holding pools** | Deep riverine pools of slow-moving water where salmonids gather in large numbers. |
| **hydraulic residence time** | The amount of time necessary to flush a water body completely. |
| **hydrograph** | A graph that tracks the discharge of a stream or river over time. |
| **hydrology** | The dynamics of water movement through an area. |
| **hypereutrophic** | A water body with extremely high nutrient enrichment and rates of primary productivity. Usually, such a water body has dense mats of surface algae, is generally anoxic, and may frequently experience fish kills. |
| **hypolimnion** | The bottom layer of water in a thermally stratified lake. The hypolimnion is generally colder than the other layers in the summer and warmer than the other layers in the winter. |
| **hyporheic** | The mixing of surface water and shallow groundwater in the soil beneath a riverbed. River-influenced groundwater exchange. |
| **ichthyoplankton** | The eggs and larvae of fish floating or swimming in the water column. Icthyoplankton are included in the zooplankton. |
| **impervious surface** | A constructed surface (such as a building, street, sidewalk, or parking lot) that is covered by impenetrable materials, such as concrete, asphalt, or brick. Such surfaces increase runoff and can contribute toxins and pollutants to nearby water bodies. |
| **impounded river** | A section of river backed up behind a dam. Also referred to as *impoundments*. |
| **impoundments** | See *impounded river*. |
| **imprinting** | The process whereby salmonid fry memorize the odor of their natal stream, allowing them as adults to find their way back to that stream for spawning. |
| **infauna/infaunal** | Animals or invertebrates that live within the sediment. |
| **inlet** | A narrow body of water, often leading inland from a larger body of water. |

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| **insectivore** | An organism that primarily feeds on insects. |
| **interspecific competition** | Competition for resources between individuals of different species. |
| **interstitial** | Existing between and surrounding the particles of soil or rock in the sediment. |
| **intertidal** | The area that lies between the highest high tide and lowest low tide and is exposed to the air periodically. |
| **intraspecific competition** | Competition for resources between individuals of the same species |
| **invasive species** | A species that is living outside of its natural distribution (having been brought there intentionally or accidentally by humans) and is outcompeting all other species to the point that it is damaging biodiversity. |
| **invertebrates** | Animals that lack a bony or cartilaginous skeletal structure. |
| **iteroparous** | Capable of reproducing more than once in a lifetime. |
| **jetties** | Structures that extend into a water body and are intended either to prevent channels, river mouths, or bay entrances from shifting position, or to direct or confine a stream or tidal flow. |
| **lacustrine** | Pertaining to a lake or lakes. |
| **lagoon** | A body of shallow, salty, or brackish water separated from the ocean by a sand spit or other barrier. The barrier may be temporarily breached periodically. |
| **lake outlet** | A stream or river that flows away from a lake. |
| **laminar flow** | A smooth flow of water that generally does not include mixing or sudden changes in direction or speed. The opposite of *turbulence*. |
| **landscape planning** | Land use planning that facilitates decision-making by looking at entire watersheds or ecosystems, instead of treating each location as a separate entity that is completely isolated from its surroundings. |
| **larvae/larva** | The newly-hatched life stage of species that will undergo a metamorphosis. Many aquatic species have a larval stage during which they are included in the zooplankton. *Larvae* is the plural form; *larva* is singular. |
| **leachate** | See *wood leachate*. |
| **leaf detritus** | Leaves, twigs, and bark that have fallen to the ground or into the water. Also referred to as *leaf litter*. |
| **legacy wood** | Wood waste that is present in a leasehold as a result of the activities of a lessee prior to the one currently authorized to use the leasehold. |
| **levees** | A bank, usually of earth, used to confine or control riverine water during flood events. Levees are similar to dikes, but levees protect ground that would only be underwater during flood events. |

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| **life history** | A description of all the life stages of an organism, including birth, growth, maturity, reproduction, and death. |
| **life stage** | One particular phase of an organism's life history. |
| **limnetic** | The photic portion of the water column in the lacustrine ecosystem, starting offshore at the 2-meter (6.6-foot) depth. |
| **listed species** | Species listed in any Washington state or federal endangered, threatened, proposed, sensitive, candidate, concern, or monitor list. |
| **litterfall** | The movement of leaves, twigs, and bark from the plant to the ground or into the water. |
| **littoral** | The shallow waters where sunlight reaching the benthos is sufficient to support the growth of submerged vegetation. Also referred to as the *nearshore*. |
| **littoral drift** | The sediment that is transported parallel to the shore by waves and currents. |
| **loafing** | Bird behavior that is not connected with feeding or nesting. Loafing includes preening and resting. |
| **log dumping** | Putting logs into the water for booming, storage, and rafting. The term is used especially to refer to the practice of rolling the logs down a slope into the water. |
| **log handling** | A general term that includes log booming, log dumping, and log storage. |
| **longshore current** | A water current that moves parallel to the shoreline. |
| **low-energy** | In the context of water, the term *low-energy* refers to water moving with very little speed (current velocity) or very little force (waves). |
| **macroscopic** | Large enough to be visible to the human eye without the aid of a microscope. |
| **main stem river** | The primary river. The river that tributaries drain into. |
| **maintenance** | The repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure or fill, or of any currently serviceable structure or fill authorized by Washington DNR, provided that the structure or fill is not to be put to uses differing from those uses specified or contemplated for it in the original authorization or the most recently authorized modification. |
| **marine rails** | A pair of rails set parallel and running from land into the water, with a winch at the top. A boat is winched into or out of the water, and the rails guide the boat. |
| **marsh** | An area of soft, wet, or periodically inundated land, generally treeless and usually characterized by grasses, sedges, rushes, and other low growth. A marsh can be marine or freshwater. |

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| **matriline** | A population of organisms related along the maternal line. |
| **mean lower low water (MLLW)** | The average of all the lower low water heights of each tidal day observed over the previous 19 years. |
| **meander** | A curve in a shoreline or river channel. |
| **meander line** | An irregular, surveyed line following the outline of a water body. |
| **meander zone** | The area surrounding a river within which all meanders of that river occur. |
| **mesotrophic** | A water body with moderate nutrient enrichment and rates of primary productivity. The water usually has moderate oxygen levels and moderate turbidity. |
| **metalimnion** | The middle layer of water in a thermally stratified lake. The metalimnion generally contains a wider range of temperatures than any other layer. In a well-mixed lake, the metalimnion may not develop. It is also referred to as a *thermocline*. |
| **metamorphose/ metamorphosis** | Undergoing an extreme physical change as part of leaving one life stage and entering another, such as a tadpole changing into a frog. |
| **migration** | Either the seasonal travel of an animal between widely separated locations, or the shifting of a river, sand dune, or other topographic feature due to natural processes. |
| **minus tides** | Low tides that will be below mean sea level (0 elevation) at their lowest point. Minus tides usually do not occur on a daily basis, but occur twice per month (once during the full moon and once during the dark of the moon). Also referred to as *spring low tides*. |
| **monitoring** | Regularly scheduled testing, sampling, or surveys of defined parameters to determine a condition. |
| **monotypic** | Containing a single species. |
| **montane** | Pertaining to mountains. |
| **morphological** | Referring to the external appearance of an organism. |
| **mud** | Substrate particles with diameters between 0.075 and 0.062 millimeters (about 0.003–0.002 inches). |
| **natal** | Pertaining to birth. For salmonids, the natal stream is the one in which they were hatched. |
| **native species** | Any species of a given geographic location that includes that geographic location within its natural distribution. (*Natural distribution* in this context is defined as the total geographic area that a species has colonized without human assistance). |
| **nearshore** | The shallow waters where sunlight reaching the benthos is sufficient to support the growth of submerged vegetation. Also referred to as the *littoral*. |
| **nest flushing** | Sudden flight of birds from the nest due to fear. |

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| **nest predation** | Predation on the eggs in the nests of fish and birds and also on the unfledged chicks in birds' nests. |
| **net pen** | A type of finfish aquaculture in which the fish being farmed are kept in large, submerged pens made of netting to allow the passage of water. |
| **neurotoxin** | A poison that attacks the nervous system and can lead to paralysis and death. |
| **nexus** | A nexus, or connection, to the federal government triggers requirements under Section 7 of the Endangered Species Act. A federal nexus occurs when a federal agency funds, authorizes, or carries out a project or activity. |
| **non-native species** | A species that is living outside of its natural distribution (having been brought there, intentionally or accidentally, by humans), but is not outcompeting all other species to the point that it is damaging biodiversity. Also referred to as *exotic*. |
| **non-point source pollution** | Pollution that does not come from one specific location, but from many locations along and surrounding a water body. |
| **nonwater-dependent uses** | Uses of state-owned aquatic lands that could occur on uplands. |
| **nourishment** | The process of replenishing a beach, either naturally by longshore transport, or artificially by deposition of dredged material. Also referred to as *beach nourishment*. |
| **noxious weeds** | Any non-native plant designated by a federal, state, or county government as injurious to public health, agriculture, recreation, wildlife, or property and placed on a noxious weed list. |
| **nutrient flux** | Changes in nutrient concentrations in the water column or sediment that occurs over time or in response to environmental factors. |
| **nutrient load** | The total concentration of all nutrients in a given water body or section of a water body at a given point in time. |
| **offshore** | A type of marine habitat that begins at water depths greater than 20 meters (about 65.6 feet) and encompasses all deeper waters. Offshore habitat begins at a water depth where the level of photosynthetically active radiation (PAR) is certain to be insufficient to support the long-term survival of attached submerged vegetation. |
| **oligotrophic** | A water body with low or non-existent nutrient enrichment and low primary productivity rates. The water usually has high oxygen levels and very low turbidity. |
| **ordinal ranking** | A ranking system that uses ordinal numbers (1, 2, 3) as opposed to words (high, medium, low). |
| **ordinary high tide** | The average of all the high water heights of each tidal day observed over the previous 19 years. |

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| **ordinary high water** | The water level of a lake or river so common and usual and so long continued in ordinary years as to mark its presence upon the sediment and the vegetation. Ordinary high water is usually delineated by the line of permanent upland vegetation. |
| **ordinary mean high water** | See *ordinary high tide*. |
| **organic matter** | Material from a once-living organism or material that includes compounds created by living organisms. |
| **organic carbon content** | The concentration of carbon-containing organic compounds. |
| **orphan sites** | Leaseholds with a current authorization where all authorized users have gone bankrupt and there is no longer anyone legally responsible for complying with the use authorization. |
| **osmoregulatory** | A mechanism by which the osmotic pressure of body fluids is regulated to avoid dehydration or bloating. The mechanism is different for freshwater organisms than for saltwater organisms. |
| **outmigration** | The migration of anadromous salmonids from freshwater to saltwater. |
| **outwash fan** | The fan-shaped accretion of sediment deposited by the streams emanating from the base of a melting glacier. |
| **oversight** | The concept that separate government agencies have authority over each other and monitor each other's actions and decisions. |
| **oxbow lake** | A crescent-shaped lake that is formed as a river cuts through a meander channel to shorten its course, causing the old channel to be blocked off. |
| **oxygenation** | The process of adding oxygen to the water column, sediment, or other medium. |
| **particulate** | A tiny particle of solid matter suspended in air or water. |
| **patch** | An area of aquatic vegetation comprising a density of three individuals per square meter (about 10.8 square feet) of substrate. |
| **pectoral fins** | The two fins on a fish that are located where arms would be on a human. |
| **pelagic** | The water column from the surface down to 5 meters (about 16 feet) above the bottom. |
| **periphyton/periphytic** | Belonging to the group of organisms that live attached to submerged plants, rocks, or any other underwater structure other than the benthos. |
| **pesticide** | Poisons applied for the purpose of exterminating unwanted organisms. Pesticides include algicides, anti-fouling agents, biocides, fungicides, herbicides, insecticides, piscicides, and microbial pesticides. |

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| **pest management** | Regulation and management of a species that is defined as a pest. Pest management includes control and deterrence. |
| **pH** | A measure of the acidity or basicity of a solution. Solutions with a pH of less than 7 are acidic, solutions with a pH higher than 7 are basic, and solutions with a pH equal to 7 are neutral. |
| **photic zone** | The portion of the water column that receives light. |
| **phytoplankton** | Photosynthetic organisms that are carried by water currents in both the freshwater and saltwater systems. Phytoplankton includes single-cell green, red, and brown algae, cyanobacteria, dinoflagellates, and coccolithophores. |
| **piscicides** | A pesticide that specifically kills fish. |
| **piscivorous** | Primarily feeding on fish. |
| **planktivorous/planktivore** | Primarily feeding on plankton. |
| **plankton/planktonic** | Suspended microorganisms with relatively little power of locomotion that drift in the water and are subject to the action of waves or currents. These include phytoplankton and zooplankton. |
| **pocket water** | A section of the stream channel that contains numerous boulders or other large obstructions, which create eddies or scour pockets. |
| **pod** | A group of whales or dolphins. Among killer whales (orcas), pods are family groups that are related through a recent, common female ancestor. |
| **point source pollution** | Pollution that is discharged from a discrete point or pipe or from several discrete points or pipes. |
| **pool** | A topographic depression within a stream channel that is characterized by deeper water, laminar flow, and lower water velocities. |
| **population** | A collection of interbreeding organisms of the same species. |
| **possessory interest** | The intent and right of a person to occupy or exercise control over a given plot of land. |
| **prairie sloughs** | A freshwater wetland where the dominant vegetation is grasses. |
| **predicted habitat** | The potential distribution of covered species in Washington as determined by the Washington Gap Analysis. Predicted habitat includes habitat that is appropriate for spawning, foraging, or other uses with or without the documented occurrence of species. |
| **primary consumer** | An organism that feeds primarily on plants or algae. |
| **primary production** | The biomass produced by plants and algae via photosynthesis. |
| **priority habitat** | Habitat types with a unique or significant value to a diverse assemblage of species, as defined by the Washington Department of Fish and Wildlife. |

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| **process water** | Water used as a coolant for machinery. |
| **productive** | Adding a lot of biomass through high rates of photosynthesis. |
| **profundal** | The deep part of the water column within a lake, below the extent of light penetration. Also referred to as the *aphotic zone*. |
| **prop scour** | The formation of depressions in the sediment, increased turbidity, and physical uprooting of aquatic vegetation due to the high level of water turbulence produced by boat propellers. |
| **propeller wash** | The surface waves produced by the propeller of a boat. |
| **proprietary** | The authority provided by ownership of a piece of property. |
| **pseudofeces** | The means by which filter feeding bivalves eliminate indigestible particles strained out of the water column. The particles are formed into pellets and expelled. |
| **pump-outs** | Facilities that are used to empty vessels' black-water and gray-water holding tanks. |
| **qualitative** | A non-numeric value (for example: presence or absence; high, medium, or low). |
| **quantitative** | A numeric value. |
| **race** | Fish of the same salmon species that also share the same run-time and inhabit the same general geographic area. Within a salmon species, there are multiple races, each with different run-times (spring, summer, or fall), when the salmon return from the ocean to spawn. |
| **redd** | A pocket that a female salmonid excavates within the gravel substrate for her eggs. |
| **refuge** | An area of habitat that provides protection from predators or disturbance. |
| **refugia** | An area that has avoided ecological changes happening elsewhere and therefore still provides suitable habitat for an isolated population of a given species. |
| **reliction** | A gradual lowering of the water level that leaves the land permanently dry. |
| **remediation** | The removal of pollutants or contaminants from the environment. |
| **resident** | For salmonids, refers to spending their entire lives in smaller streams; for southern resident killer whales, refers to spending every spring, summer, and fall in Washington waters. |
| **resource cycling** | A natural process whereby resources, such as water or nutrients, are taken up by one individual and then passed on during life or after death. |
| **restoration** | The repair, improvement, or reestablishment of the original natural processes at a site where those original natural processes have been damaged or destroyed. |

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| **re-suspended** | Sedimentary or biological particles that have been swept up from the substrate and suspended in the water column through increased water energy or turbulence. |
| **riffle** | Shallow riverine areas characterized by surface water turbulence, high water velocity, and exposed substrate. |
| **rip current** | A strong marine surface current flowing seaward from the shore. |
| **riparian** | Pertaining to the banks or shoreline of a water body. Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. |
| **riparian buffers** | Bands of terrain on the bank or shoreline of a water body that protect terrestrial lands from erosion and the water body from increased sediment loads. Human activities are typically regulated or controlled within riparian buffers, and buffers typically require maintenance of native vegetation. |
| **riprap** | Large boulders stacked against a steep shoreline or piled on a flatter shoreline to protect the shoreline from erosion caused by waves. |
| **risk pathway** | A specific path by means of which damage can occur. |
| **riverine** | Pertaining to a river or rivers. |
| **root wad** | The root mass of a tree, removed from the ground, plus a portion of the tree trunk. Rootwads are usually lined up along river banks to protect the bank from erosion. The roots extend into the water and provide habitat for aquatic species. |
| **run** | Fish migration. For salmonids, the term *run* is often used to refer to a return to the natal stream for spawning. |
| **salinity** | A measure of the concentration of dissolved salts in water, generally expressed as either parts per thousand (ppt), or as practical salinity units (psu). |
| **salt pan** | A flat expanse of ground covered with salt and other minerals that can form when shallow pools of saltwater evaporate. |
| **salt pond** | A shallow brackish embayment, with freshwater input at the head and saltwater input through an inlet from the sea, that may occasionally and temporarily close up. Salinity varies widely and seasonally, depending on the amount of freshwater and saltwater input. |
| **sand** | Rocks with a diameter between 0.075 and 4.75 millimeters (about 0.003–0.19 inches). |
| **sand spit** | A long, narrow landform created as a result of the deposition of sand by water currents. |
| **scour** | The removal of underwater material or re-suspension of sediment by waves, turbulence, and currents. |

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| **seasonal flow regimes** | The amount of water that flows down a river and how that amount changes with the seasons. |
| **seawall** | A structure that separates areas of land from areas of water and is primarily designed to protect land from wave action. A type of hard armoring. |
| **secchi depth** | The water depth at which a secchi disk is visible when lowered into a water column. This method is used to measure water turbidity. |
| **secondary consumer** | An animal that eats primary consumers. |
| **sediment** | Rock and soil particles deposited by water, wind, or glaciers. |
| **sediment load** | The amount of sediment being carried suspended in the water column. |
| **sediment storage** | Maintaining a build-up of sediment by avoiding re-suspension of sediment. |
| **sediment transport** | The movement of sediment particles along a current pathway. |
| **sediment trapping** | The removal and storage of sediment from the water column, usually by slowing the flow of water. |
| **sedimentation** | The accumulation of sediment particles that have settled out of the water column. |
| **seeps** | Springs where water flows through very small openings and at a very slow rate. |
| **seiche** | Wind driven oscillation of the surface water of a lake. The phenomenon that occurs when prolonged wind from one direction drives water away from one shore, causing it to “pile up” on the opposite shore. With the cessation of the wind, the water oscillates back and forth, producing a series of standing waves. |
| **semelparous** | Only reproducing once in a lifetime, with death occurring shortly after reproduction. |
| **semi-colonial** | A nesting strategy whereby a small group of birds nest in relatively close proximity, but each bird defends only its own nest against predators. |
| **sensitive species** | Native species that are at risk of decline or are now declining and are likely to become endangered or threatened throughout a significant portion of their range. |
| **sexually dimorphic** | A species in which males are externally different from females. |
| **shallow water habitat** | Aquatic habitat with water less than 1.5 meters (5 feet) deep. |
| **shear force** | The force acting on a substance in a direction perpendicular to the extension of the substance, such as the pressure of air along the front of an airplane’s wing. |
| **sheltered** | Protected from the wind and from wave energy. The opposite of *exposed*. |

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| **shoal** | Localized shallowing of the water due to an underwater sand bar. |
| **shorebirds** | Birds that live, nest, and obtain their food along shorelines or in wetlands. They are often insectivores that dig their bills into the sediment for insects and worms. |
| **shoreline** | The area of land at the edge of water bodies that lies between extreme high water and ordinary high water. |
| **shoreline armoring** | Physical modifications of the shoreline that are implemented by humans to decrease erosion at a specific location. |
| **shore zone** | A zone that extends 100 meters (about 328 feet) from the shoreline, both waterward and landward. |
| **silt** | Substrate particles with diameters between 0.062 to 0.004 millimeters (about 0.002–0.0016 inches). |
| **slack water** | The turning point of the tide, where all tidal currents briefly cease prior to reversing direction. |
| **slip** | See *berth*. |
| **slump** | The slow movement of soil down the slope of a hill. A slump is similar to a landslide, but encompasses the entire hillside and usually slides at the rate of an inch or two per day. |
| **smolt** | An anadromous salmonid that has entered or is entering the marine life stage, but is not yet reproductively mature. |
| **smoltification** | The physical changes that anadromous salmonids go through during the transition from freshwater to marine life stages. |
| **soft bottom** | Unconsolidated habitats comprised of mud, silt, and clay. |
| **soft shoreline protection system** | Materials that deflect wave energy and block erosion in a natural fashion, such as beach slopes, vegetation, large woody debris, and root wads. |
| **spat** | The post-larval, bivalve life stage that occurs immediately after metamorphosis and attachment to the substrate. |
| **species distribution** | A geographic description of where a given species may be found on the planet. Also, a description of how clumped or spread out a given species is within one area. |
| **species richness** | The number of different species present in a community. This is considered indicative of the health of the community and is used to compare the diversity of species among ecosystems. |
| **staging** | The act of gathering together prior to a communal event. |
| **standard error** | A statistical term referring to the estimated error in a series of measurements when compared to the true value. |
| **stock ponds** | A pond, often manmade, that serves as a water supply for farm animals. |

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| **storm water** | Water that originates from precipitation events. |
| **stratification** | The natural division of the water column into horizontal layers with differing temperatures or salinity (or both). |
| **stratospheric ozone** | The ozone layer, found 9.6 to 48.3 kilometers (6–30 miles) above the ground, which blocks ultraviolet radiation from the sun. |
| **subadult** | The life stage between juvenile and adult when some adult characteristics have developed, but the organism is not yet reproductively mature. |
| **subalpine** | The biotic zone immediately below the tree line on a mountain. Subalpine trees are often stunted and twisted due to high winds, and shrubs often grow as groundcover. |
| **sublethal effects** | Negative effects that do not directly result in death. |
| **subpopulation** | A group within a population that is reproductively isolated from the rest of the population. For example, the spring run of Chinook salmon is reproductively isolated from the summer run and is therefore a subpopulation. |
| **substrate** | Any surface to which something can attach. Also, any lake, river, or ocean bottom. |
| **substrate composition** | All of the grain sizes present in the sediment at a given location. |
| **subtidal** | The part of the ocean that is never exposed to the air, even at the lowest low tides. The marine environment below the extreme low tide. |
| **subyearling** | See *young-of-the-year*. |
| **succession** | A process whereby the biological community of an area changes over time in response to the environmental alterations made by earlier inhabitants. Succession ends with a climax community that will not alter further until disturbance destroys or damages it and restarts succession. |
| **surface-schooling fish** | Fish that typically gather in large groups at or near the surface of the water. Such fish are easy prey for waterbirds and pelagic predators. |
| **suspension feeder** | See *filter feeder*. |
| **tagging studies** | A type of animal survey in which individuals are caught, marked with a tag, released and recaptured at a later date to gain information regarding migration, distribution, and changes in physical attributes over time. |
| **tailrace** | The downstream part of a dam where the impounded water rejoins the river. |
| **taxonomic** | Pertaining to the classification of organisms into groups or referring to one or more of those groups. |
| **terrestrial** | Growing on, living on, or particular to the land, as opposed to the aquatic environment. |

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| **thalli/thallus** | The body of an alga. *Thalli* is plural; *thallus* is singular. |
| **thermoregulatory** | A mechanism for regulating the internal temperature of an organism. |
| **thread** | A river channel. |
| **threatened species** | Any species that is likely to become endangered in the foreseeable future. |
| **threshold** | A measurable standard for a physical or chemical characteristic that, when exceeded, begins producing a given effect, result, or response. |
| **tidal eddies** | Areas of circling water formed when the tidal current hits an obstruction, such as an island or headland. |
| **tidal stage** | A given point in the tidal cycle. A given tidal height. |
| **tidally influenced** | Lands and waters that see daily fluctuations in water level and salinity due to the tidal cycle of a marine water body. Rivers that empty into an ocean will be tidally influenced for a certain distance upstream. |
| **torrent** | A stream or river flowing with great velocity and turbulence. |
| **toxicant** | A chemical substance that has a negative impact on organisms. Also referred to as a *toxin*. |
| **toxin** | See *toxicant*. |
| **transitional reach** | A stretch of a river that transitions from one type of habitat to another. Such a transition often includes a change in elevation. |
| **treated wood** | Wood treated with chemical preservatives to extend the service life of the wood products. |
| **tributary** | A stream or river that flows into a larger stream or river. |
| **trophic** | Pertaining to nutrition or nutritional processes. For organisms, this involves the feeding habits or food relationships of different organisms in a food chain. In the case of lacustrine ecosystems, the term *trophic* refers to a classification system used to describe the productivity status and nutrient richness of lakes. |
| **turbidity** | A measure of the cloudiness of water, indicating the quantities of suspended particles and plankton. Higher turbidity results in lower levels of light penetration through the water column. |
| **ultraviolet radiation** | A component of sunlight with wavelengths ranging from 10 to 400 nanometers. |
| **unconsolidated habitat** | Aquatic habitat comprised of clay, silt, mud, sand, gravel, or cobble substrates, or any combination of those substrates. |
| **undercut banks** | Stream banks that have been eroded at the base by water, sometimes leading to the collapse of the top portion due to a lack of support. |
| **upland** | Terrestrial land. |

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| **upwelling** | The process in which northwesterly winds push the upper 100 meters (about 328 feet) of the water column farther offshore, thus enabling the upwelling of relatively cold, high-salinity, nutrient-rich waters from beneath. |
| **vertical dimension** | The dimension between the substrate and surface waters. This term is generally used in relation to riverine ecosystems. |
| **vessel scour** | See *prop scour*. |
| **water column** | The dimension between the substrate and surface waters. |
| **water quality** | The physical, chemical, and biological characteristics of water in relation to a set of standards. |
| **water-dependent use** | A use that is authorized by Washington DNR and that cannot exist without being located on or in the water. |
| **watershed** | A topographic area where water from rain or snow melt drains downhill into a large body of water, such as a river, lake, or ocean. The watershed includes the streams that carry the water, as well as the land surfaces from which water drains into those streams. Also referred to as a *drainage basin* or *drainage area*. |
| **wave boards** | A type of floating breakwater comprised of a vertical wall. |
| **wetlands** | Lands that are transitional between terrestrial and aquatic systems and are covered by shallow water for a substantial portion of the growing season, as reflected in the plant community and soil profile. |
| **wharf** | An overwater platform that is similar to a dock, but is always raised above the water on pilings and attached directly to shore. |
| **wood leachate** | Natural or manmade compounds that leach out of wood once it is immersed in water. |
| **wood recruitment potential** | The likelihood of woody debris being added to an aquatic ecosystem. |
| **young-of-the-year** | Animals less than a year old. Also referred to as *subyearling*. |
| **zooplankton** | Microscopic animals that are carried by water currents. |

# Chapter 8
# References

# Chapter 8. References


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