1.0 INTRODUCTION

1.1 Purpose and Need for Proposed Action

The purpose of this Final Restoration Plan and Environmental Assessment (RP/EA) is to design, coordinate, and implement projects that restore, rehabilitate, replace and/or acquire the equivalent of natural resources injured from the discharge of oil by the *Tenyo Maru* on July 22, 1991. This document has been prepared on behalf of the public by the Natural Resource Trustees (Trustees) responsible for restoration implementation under a consent decree. The RP/EA describes the affected environment and illustrates restoration alternatives and their environmental consequences. This RP/EA was developed in accordance with the Oil Pollution Act of 1990 (OPA), 33 U.S.C. 2706(b), the National Environmental Policy Act (NEPA), 42 USC 4321-4370d, and its implementing regulations, 40 CFR Parts 1500-1508, and the Washington State Environmental Policy Act (SEPA).

1.2 Incident Background

On July 22, 1991, the Japanese fishing vessel *Tenyo Maru* and Chinese freighter *Tuo Hai* collided within Canadian Territorial waters in heavy fog approximately 20 miles northwest of Cape Flattery. The *Tenyo Maru* sank at the point of collision in 90 fathoms of water. It was reportedly carrying 354,800 gallons of intermediate fuel oil, 97,800 gallons of diesel fuel, and 22,500 gallons of fish oil. (*Tenyo Maru* Oil Spill Trustees 1993)

The vessel initially leaked a large amount of oil. For more than a month after the collision, an undetermined quantity of oil leaked from the sunken vessel, and fouled beaches from Vancouver Island, British Columbia to northern Oregon (Fig. 1-1). The heaviest oiling occurred along the Makah Indian Reservation and the Olympic National Park shoreline. Impacts were scattered along the entire Washington State shoreline and the northern beaches of Oregon.

In December 1994, the Trustees and defendants for the 1991 *Tenyo Maru* oil spill entered into a consent decree[1]. Under the consent decree, the defendants agreed to pay to a federal court-held restoration fund approximately $5.2 million to restore, replace, rehabilitate, or acquire the equivalent of natural resources injured as a result of the spill.

Restoration funds were recovered under the Oil Pollution Act of 1990 (33 USC 2701 *et seq*.) and the State's Water Pollution Control Act (90.48-56 RCW). Guidance applicable to restoration, replacement, or acquisition of equivalent resources and services is contained in 15 CFR Part 990, Department of Commerce natural resource damage assessment (NRDA)

[1] United States et al. v. Maruha Corporation et al., Civil No. C94-1537 (W.D. Wash., Dec. 23, 1994).

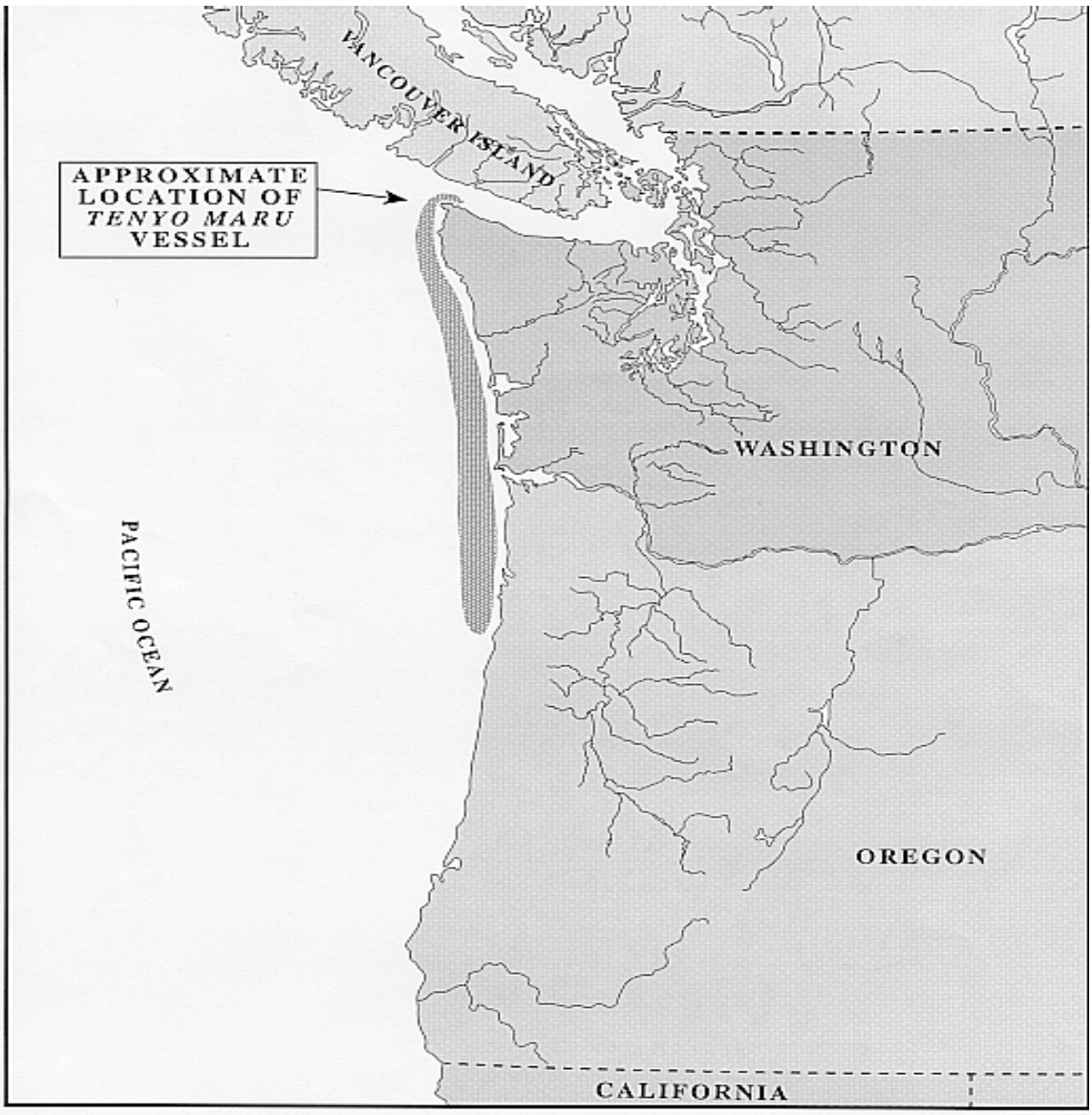

Figure 1-1. Approximate area impacted by *Tenyo Maru* Oil Spill

regulations. According to the consent decree, a restoration plan must be adopted and a mechanism for its implementation must be in place before expenditure of funds. A Trustee Committee was formed by a Memorandum of Agreement (MOA), consisting of the Makah Indian Tribe, the State of Washington (Department of Ecology, Department of Fish and Wildlife, and Department of Natural Resources), the U.S. Department of Commerce (National Oceanic and Atmospheric Administration [NOAA]) and, the U.S. Department of the Interior (Fish and Wildlife Service, National Park Service, and the Bureau of Indian Affairs). The objective for the *Tenyo Maru* Trustee Committee is to plan and design, coordinate and implement projects that restore, rehabilitate, replace and/or acquire the equivalent of natural resources injured by the *Tenyo Maru* oil spill.

1.3 Fish and Wildlife Resources and Natural Resource Injury

Spill-related natural resource injuries were documented primarily for marine birds, and secondarily for kelp (*Macrocystis* and *Nereocystis*) (*Tenyo Maru* Oil Spill Trustees 1993). Of the 740 oiled birds rescued alive, 97 (13 percent) survived rehabilitation and were released. Their ultimate fate is unknown. A total of 4,300 bird carcasses was recovered during search and rescue efforts (Table 1-1). However, this number is a minimum estimate for total seabird mortality because many carcasses may have sunk, been scavenged, or were not found by rescue workers. Thirty bird species were identified from birds recovered from the spill. Approximately 93 percent of the total number of birds recovered were from species known commonly to breed in Washington State (15 species). However, not all of these birds necessarily were Washington breeders or were hatched in Washington. For example, Warheit (1996) estimated that between 39 percent and 58 percent of the adult common murres (*Uria aalge)* killed by the spill in Washington were from Washington, and the remaining adult common murres were from Oregon.

Models have been developed to extrapolate total seabird mortality from carcass counts. These models use the at-sea abundance and distribution of the seabirds; spill trajectories; and probabilities that birds will become oiled, that a particular carcass will be scavenged after reaching shore, and that an unscavenged carcass will be found by rescue workers (see Page et al. 1990, Ford et al. 1996). Because only at-sea seabird distribution information and spill trajectory data are available for the *Tenyo Maru* spill, there are no data to calculate the probabilities that a carcass washed ashore, was scavenged, or was recovered.

Table 1-1. Bird species with mortalities associated with the *Tenyo Maru* oil spill.

Species	# Oiled Birds Retrieved	Breeding Population Estimates Statewide	Outer coast	Source[1]
Common Loon	1	rare		
Red-throated Loon	1			
Western Grebe	2	rare		
Black-footed Albatross	11			
Northern Fulmar	67			
Sooty Shearwater	49			
Short-tailed Shearwater	5			
Unidentified Shearwater	1			
Fork-tailed Storm-petrel	1	3,878	3,878	(a)
Leach's Storm-petrel	1	35,700	35,700	(a)
Unidentified Storm-petrel	1			
Double-crested Cormorant	5	6,472[2]	(b)	
Brandt's Cormorant	10	700	700	(b)
Pelagic Cormorant	18	6,134	4,800	(b)
Unidentified Cormorant	12			
Surf Scoter	10			
White-winged Scoter	41			
Bufflehead	1	rare		
Black Turnstone	1			
Mew Gull	4			
California Gull	87	>500		
Western/Gl.-winged Gull	91	36,923	36,923	(a)
Unidentified Gull	39			
Caspian Tern	25	7,918	?	(a)
Arctic Tern	1	rare		
Common Murre	3,157	13,600[3]	13,600[3]	(e) (f)
Pigeon Guillemot	33	4,270	4,270	(a)
Marbled Murrelet	45	5,000	2,400[4]	(c) (d)
Cassin's Auklet	116	45,375[5]	45,375[5]	(b)
Rhinoceros Auklet	281	55,662	27,872	(b)
Horned Puffin	1			
Tufted Puffin	127	5,612[5]	5,582[5]	(b)
Crow spp.	1	common	common	
Unidentified bird	54			
Total	4,300			

[1] Source for population estimates: (a) Speich & Wahl (1989); (b) Ulrich Wilson, pers. comm (1996); (c) Speich et al. (1992); (d) Speich & Wahl (1995); (e) Wilson (1995); (f) Parrish (1996a)

[2] Statewide estimate for *marine* population

[3] Population estimate based on Wilson (1995) attendance data for murres nesting within FWS refuges (1995 median = 5,230) & Parrish (1996a) attendance data for murres nesting on Tatoosh Island in 1995 (3,270). Attendance total was multiplied by 1.6 to estimate breeding population.

[4] Speich et al (1992) estimated *total* population (adults, subadults, and juveniles) for outer coast

[5] Population estimates based, in part, on burrow counts and percent occupancy for those burrows on Carroll and Alexander Islands, and Cake Rock. Data collected in 1980's.

The Trustees identified and documented 3,157 common murres killed by the oil spill, which is a minimum estimate of actual mortality. The median attendance at common murre breeding colonies in Washington in 1991, 1995, 1996, and 1997 was roughly 7,700; 8,500; 6,738; 3,810 birds, respectively (Wilson 1995, Parrish 1996a, Wilson 1997). Therefore, a potentially sizable proportion of the total Washington state common murre population (includes breeding and nonbreeding adult, sub-adult, and juvenile birds) may have been killed by the *Tenyo Maru* oil spill.

The federally threatened marbled murrelet (*Brachyramphus marmoratus*) population in Washington was also impacted by the *Tenyo Maru* spill. Forty-five known murrelet mortalities were observed and documented from the spill. Approximately 70 percent of birds of known age were juveniles, and 62 percent of known sex were females (Warheit 1996). As with common murres, this spill may have affected a sizable proportion of marbled murrelets nesting in Washington.

Similar to many other oil spills in the north temperate to subarctic waters the Alcidae (murres, puffins, and their allies) comprised the highest percentage of known mortality (87 percent) from the *Tenyo Maru* oil spill. Besides common murres and marbled murrelets, substantial numbers of rhinoceros auklets (*Cerorhinca moncerata*), tufted puffins (*Fratercula cirrhata*), Cassin's Auklet (*Ptychoramphus aleuticus*) and pigeon guillemots (*Cepphus columba*) carcasses were recovered from the spill, with estimated total mortality for these species possibly ranging into several hundred individual birds per species.

Known mortality of rhinoceros auklets was second only to common murres; however, the statewide breeding population for this species may be among the largest for all seabirds in Washington, and the effects from the oil spill at the population level are unclear. The estimated breeding population of rhinoceros auklets within the spill zone is about half its total statewide population (27,872 and 55,662 birds, respectively), and if the *Tenyo Maru* oil spill affected only this portion of the population, upwards of 2 percent of that portion may have been killed. Tufted puffin mortality was nearly as high as or higher than that of rhinoceros auklets. However, this mortality may have totaled 9 percent of the tufted puffin's statewide population (5,582 birds) making the effects of this spill on this species considerably greater than the effects on the rhinoceros auklet population.

Oil lingered in giant kelp *(Macrocystis)* and bull kelp *(Nereocystis)* dominated kelp beds from Cape Alava north to Tatoosh Island and from Tatoosh Island east to Waadah Island, for up to two weeks following the spill. During the natural resource damage assessment process, laboratory and mesocosm studies conducted by Battelle's Pacific Northwest Marine Sciences Laboratory showed that samples of weathered and unweathered Bunker C, diesel, and crude oils can be toxic to *Nereocyctis* kelp by affecting blade growth and physiological functions. (Antrim et al. 1995)

Quantification of injuries to fish, shellfish, and the fisheries resources, including injury to fishery associated habitats, were not pursued as part of the damage assessment process. Therefore, little

data were collected that would either defend or refute assertions of injury to fisheries. Injury to human scale organisms (those visible by unaided sight) inhabiting the intertidal zone were not

observed to be sufficient to trigger efforts to quantify injuries. An oiled and dead harbor seal pup and a sea otter were found. Woodbury and Deither (1991:7) stated that the oil that washed ashore along Washington coastal beaches "affected only the high and very high intertidal or supra littoral zone . . . . which is relatively depauperate. The areas of direct impact were patchy, and no devastating destruction or mass mortality was observed . . . . [and] intertidal areas surveyed in August [1991] and resurveyed September [1991] showed no gross community change." Again, results from initial surveys did not indicate further studies were feasible.

1.4 Public Involvement and Plan Implementation

Public involvement is required in the development of a restoration plan. Toward this end, the Trustee Committee has made, and will continue to make, opportunities available for the public to participate in the restoration planning and implementation processes.

As part of the development of the restoration plan, a scoping document was prepared and released in November 1995. The scoping document contained information describing the incident and injured natural resources, restoration criteria, and possible restoration actions. The public was invited to review and provide recommendations to be considered during the restoration planning process. Two public meetings were held to give the public an early opportunity to engage in discussions regarding the preparation of the restoration plan. Meetings were held in Port Angeles and Seattle, Washington in November 1995.

A Draft Restoration Plan/Environmental Assessment (DRP/EA) was provided to the public for review and comment from February 1 through April 12, 1999. The Trustee Committee considered the comments received on the DRP/EA and elected to make modifications to the preferred alternative. Due to the substantial nature of the modification to the DRP/EA the Trustees published a Revised DRP/EA (RDRP/EA) public for an additional 30 day comment period. Notices regarding the availability of the draft documents were published locally and in the Federal Register, and copies of the draft documents were sent to interested members of the public, agencies, organizations and public representatives. All comments were reviewed and considered in the development of the final RP/EA. Responses to comments on the DRP/EA and RDRP/EA are provided in Appendix A of the final RP/EA and will be part of the Administrative Record. Public review of the DRP/EA and RDRP/EA was consistent with all federal and state laws and regulations that apply to the OPA, NEPA, and SEPA processes.

The Trustee Committee intends to review the restoration plan at least annually and evaluate the success of the projects being carried out by comparing results with stated goals of each restoration project and the baseline data collected before the spill and during the restoration planning process. Reviews will focus on determining the efficacy of, and suggestions for, improving the selected activities as well as determining that the restoration projects minimize,

avoid, or compensate for any potential environmental impacts which may arise during the project implementation. Any major revisions to the RP/EA will be subject to public review.

2. 0 AFFECTED ENVIRONMENT AND NATURAL RESOURCES OF CONCERN

This section describes the restoration area and identifies natural resources of concern that could be affected by the Plan. It provides a discussion of the current conditions that will be used as a comparison with conditions after restoration activities have been implemented. The primary restoration area refers to the geographic area primarily impacted by the spill (Fig. 1-1). The expanded restoration area refers to a larger area that has a biological connection to the primary area through an injured species or the food web to which it is a part. The primary and expanded restoration area extends from Waadah Island in the Strait of Juan de Fuca, down the outer Washington and Oregon coasts to the Winchuck River. Watersheds leading into the Washington marine waters within the primary restoration area are included. Because of the biological link to birds killed from the oil spill and the importance of seabird colonies, Protection Island National Wildlife Refuge (NWR), Smith Island and San Juan Island areas have been included in the expanded restoration area.

2.1 Affected Environment

2.1.1 Land Ownership

Makah Indian Reservation

The Makah Indian reservation is located on the northwestern tip of the Olympic Peninsula in Clallam County, Washington. The total land area of 47 square miles is bounded on the west by the Pacific Ocean and on the north by the Strait of Juan de Fuca. The shoreline of the Reservation is typically rocky headlands and sandy beaches. More than 1,000 acres of the land bordering the Pacific Ocean have been reserved as a Wilderness Area. Other reserved areas are Tatoosh and Waadah Islands. The Tatoosh Island complex supports the largest nesting colony of common murres in Washington. Ten species of marine birds, representing 88 percent of the birds known to be injured or killed from the *Tenyo Maru* oil spill, nest on Tatoosh Island (Parrish 1996a).

State Upland Properties

The terrestrial environment of the Olympic Peninsula encompasses diverse topography, geology, and biology. The forest and stream ecosystems that are connected to the area affected by the *Tenyo Maru* oil spill provide complex and numerous means of ecological support to various primary injured species. These connections can be direct, such as providing habitat for certain seabirds, or indirect, such as providing the sedimentation regime necessary to support kelp communities. Upland areas also support numerous plant, mammal, fish, and bird communities. Management of upland area use is determined by its ownership. The following paragraphs describe the Washington State management programs.

Upland Trust Lands. The WDNR manages substantial holdings of upland trust lands in the watersheds that drain to the primary marine area. A Habitat Conservation Plan for Western Washington has recently been adopted that will provide long-term protections for the northern spotted owl and other species of concern, including salmonids (Washington Department of Natural Resources 1997).

Washington Department of Natural Resources - Forest Practices Program. The WDNR, under the direction of the Forest Practices Board, regulates forest practices on private forest lands. The program evaluates forest practices and assesses environmental impacts.

Washington Department of Natural Resources - Special Lands Program. The WDNR acquires and manages special lands, of significance to unique or threatened plants or animals, as Natural Area Preserves or Natural Resources Conservation Areas and cooperates with other authorities to create parks or reserves as warranted.

Olympic Coast National Marine Sanctuary

The northern Washington coast area also includes the Olympic Coast National Marine Sanctuary (OCNMS), covering an area of approximately 3,310 square miles. Seaward boundaries approximate the 100 fathom isobath, extending offshore an average of 25 miles, with the northern portion extending to 50 miles. The OCNMS is managed by the National Oceanic and Atmospheric Administration. From Koitlah Point west of Neah Bay in the north to the mouth of the Copalis River in the south, the shoreline boundary is mean higher high water where adjacent to federally owned land (including Olympic National Park and U.S. Fish and Wildlife Service Refuges) and mean lower low water mark when adjacent to state owned land or tribal land. Seaward boundaries approximate the 100 fathom isobath, extending offshore 30-40 miles. The Sanctuary supports one of the world's most diverse kelp communities and provides extensive habitat for myriad seabird and marine mammal species. It complements the area's other designations by providing protected status to marine waters that surround national wildlife refuge islands and national park coastal lands, which are vital foraging habitats for seabirds and marine mammals.

Olympic National Park

A narrow, detached portion of the Olympic National Park extends south from the Makah Tribal lands to Kalaloch. The Park is managed by the National Park Service. It is known as the coastal strip and has 57 miles of the most primitive natural coastline in the lower 48 states. The dramatic sea, cliffs, headlands, islands, and seastacks, coupled with the rich biological and archeological resources, provide a unique recreational experience. Five major intertidal habitat types have been described for this wilderness coast, making it one of the most complex and diverse shoreline communities in the United States. The coastal strip varies between 0.5 and 3 miles in width. The Park boundary extends seaward to the lowest low tide line and includes the intertidal beaches, rocky headlands and tidepools. About 70 percent of the 43,000 acres is Congressionally designated as wilderness. It has also been designated by the United Nations Educational Scientific and Cultural Organization (UNESCO) as a Biosphere Reserve and a World Heritage Site.

National Wildlife Refuges

The National Wildlife Refuges are managed by the U.S. Fish and Wildlife Service. The outer coast affected area in Washington includes five National Wildlife Refuges (NWR): Copalis NWR, Flattery Rocks NWR, Quillayute Needles NWR, Willapa NWR, and Protection Island NWR. Copalis, Flattery Rocks, and Quillayute Needles NWRs comprise approximately 870 islands and rocks strung along the coast. The Willapa Bay NWR provides feeding and resting habitat for migratory shorebirds. Protection Island NWR is the most important seabird nesting island in Washington's inner marine waters. It hosts more than 70 percent of the areas breeding seabirds. All the National Wildlife Refuge islands north of Grays Harbor, with the exception of Destruction Island, have been designated as federal wilderness areas. The San Juan Island NWR is made up of 83 rock islands and reefs scattered throughout the San Juan Island complex, including Smith Island, most of which have been established as federal wilderness areas. Six National Wildlife Refuges have been established along the Oregon coast. The Oregon Islands National Wildlife Refuge includes the Oregon Islands which extend almost the entire length of the Oregon Coast, Cape Meares NWR and Three Arch Rock NWR. The Refuge islands in Washington and Oregon provide nesting, foraging, and resting habitat for seabirds. They are also important as pupping, resting, and molting sites for marine mammals.

2.1.2 Species in the Affected Environment

Marine Birds

More than 72 percent of Washington's marine birds nest on the outer coast north from near Point Grenville to Seal and Sail Rocks near Neah Bay (Speich and Wahl 1989). Sixteen species of marine birds nest in this area with a total estimated population over 218,000 birds. The most numerous species include Cassin's auklets, Leach's storm-petrels (*Oceanodroma leucorhoa*), common murres, rhinoceros auklets, glaucous-winged (*Larus glaucescens*) and western gulls (*Larus occidentalis)*, and tufted puffins (Speich and Wahl 1989).

Approximately 22 percent (over 66,000 birds) of Washington's marine birds nest within the inner marine waters, with 16 percent found on Protection Island (Speich and Wahl 1989). Protection Island is one of the three main rhinoceros auklet colonies in the state with over 55 percent of the state's breeding population for this species. It supports 30 percent of the state's breeding populations of glaucous-winged gulls and pigeon guillemots, and 18 percent of the state's total number of pelagic cormorants (*Phalacrocorax pelagicus*) (Speich and Wahl 1989). Thirteen pairs of tufted puffins nested on Protection Island in 1993 (Wilson, pers. comm., 1996), which is the only puffin nesting colony currently in Washington's inner marine waters. Approximately 33 percent of Washington's double-crested cormorants (*Phalacrocorax auritus)* nest in the inner marine waters (Speich and Wahl 1989).

More than a dozen species of seabirds nest on the rocks and islands of the 300-mile Oregon Coast. The Oregon Islands and Three Arch Rocks NWRs provide critical nesting habitat for more than one million seabirds. Common murres are the most numerous with an estimated mean breeding population since 1988 of 722,500 birds (Lowe and Pitkin 1996). Other nesting seabirds

include rhinoceros auklets, pigeon guillemots, tufted puffins, cormorants, and western and glaucous-winged gulls.

Common murres, marbled murrelets and rhinoceros auklets will likely benefit from many of the restoration projects. The following species discussions provide information as to why their populations are of particular interest in Washington.

Common Murres. Common murre populations in Washington are of concern for the following reasons: 1) a precipitous decline in colony attendance throughout the state occurred during the 1983 El NiNo, principally at the southern colonies around Pt. Grenville, and at Split and Willoughby Rocks, attendance has remained depressed through at least the 1996 breeding season; 2) during the time period of little or no recovery since the 1983 El NiNo, two major oil spills have occurred off the coast of Washington, the *Nestucca* and the *Tenyo Maru*, and common murres were the principal seabird species killed in both spills; 3) common murres are the principal seabird species killed in gillnets; oil spills and gillnet mortality may have contributed to the lack of common murre recovery since the 1983 El NiNo (see Takekawa et al. [1990] for effects of gillnet and oil spill mortalities on common murres nesting in California) and; 4) common murres on Tatoosh Island, the only stable colony in Washington, have been seriously disrupted by bald eagles and predation by gulls (Parrish 1995, 1996a).

Marbled Murrelets. The Washington, Oregon, and California populations of marbled murrelets were listed as threatened under the Endangered Species Act (ESA) on September 28, 1992 (57 Fed. Reg. 45328). The Washington State Wildlife Commission (now Fish and Wildlife Commission) classified the Washington population of marbled murrelets as threatened in October 1993 (Protected Wildlife Classification, subcategory Threatened; WAC 232-12-011).

The most recent estimate of the Washington breeding population of marbled murrelets was 5,000 birds (Speich and Wahl 1995). This estimate is based on surveys in the early 1980s. Using current juvenile/adult ratios and a population model, Beissinger (1995) indicated that the marbled murrelet population is declining 4 to 7 percent annually. This decline is primarily due to the loss of old growth forests. Nest predation, mortality through net fisheries, and oil spills have also contributed to this decline.

Rhinoceros Auklets. Washington's population of rhinoceros auklets is estimated at less than 60,000 birds (Speich and Wahl 1989). Approximately 50 percent of the population is located on the outer coast of the Olympic peninsula (primarily on Destruction Island) and the remainder are located in the Straits of Juan de Fuca on Protection Island and the San Juan Islands (primarily on Smith Island) (Speich and Wahl 1989). The population trend for rhinoceros auklets on the outer coast is unknown. However, a decline in the number of rhinoceros auklets nesting in the inner marine waters has been observed. Between 1976 and 1993, a 26 percent and 40 percent decline of rhinoceros auklet nesting burrow densities was recorded on Kannen and Violet Points, respectively, on Protection Island. A decline in the number of rhinoceros auklets nesting on Smith Island, observed the past 6 to 7 years, has been attributed to disturbance by a double-crested cormorant colony situated on top of the auklet colony. The number of rhinoceros auklets

drowned in gillnets is second only to common murres. The *Nestucca* and *Tenyo Maru* oil spills also killed rhinoceros auklets in Washington State.

Kelp Community

A number of species of considerable ecological, commercial, and recreational value are known to rely on kelp beds for refuge and feeding, and potentially could benefit from kelp restoration activities. The importance of kelp beds can be divided into three functions: productivity, habitat, and hydrodynamics.

Productivity. Kelp plants provide input to the food web in four ways: (1) directly while the plant material is still attached to a substrate, (2) directly while the plant material is detached but still respiring (floating mats, etc.), (3) indirectly by providing detritus that fall to the bottom and is eaten, and (4) by producing dissolved organic matter (DOM) that is food for many microorganisms. Productivity of kelp beds is estimated at between 350-1500 g carbon/m^2 /yr, making them one of the most productive systems on earth.

Kelp beds support a rich and diverse community of planktonic, epiphytic, and epibenthic organisms that serve as prey for fish and invertebrates. Kelp is an important part of the diet of herbivorous invertebrates such as purple urchins (*Strongylocentrotus pupuratus*), red sea urchins (*S. fanciscanus*) and northern abalone (*Haliotis kamtschatkana*). Young- of-the-year, juvenile, and adult forage fish species such as Pacific herring (*Clupea pallasii*), northern anchovy (*Engraulis mordax*), and sand lance (*Ammodytes hexapterus*) are abundant in and around kelp beds and feed extensively on planktonic invertebrates associated with these beds. These forage fish also form an important component of the diet of piscivorous seabirds (e.g., common murre, rhinoceros auklet) occurring in the northeastern Pacific Ocean (e.g., Vermeer et al. 1987). Adult lingcod (*Ophiodon elongatus*), true cod (*Gadus macrocephalus*), cabezon (*Scorpaenichthys marmoratus*), and large schools of black rockfish (*Sebastes melanops*) and yellowtail rockfish (*S. flavidus*) aggregate in and along the periphery of kelp beds and forage to a large extent on other fish using the kelp beds.

Habitat. Bull whip kelp, *Nereocystis luetkeana,* and giant kelp, *Macrocystis integrifolia,* beds provide significant habitat for a number of organisms. The beds provide a place of refuge, and a substrate for reproduction. The canopy formed during the summer and fall shades the plants below, thereby influencing the amounts and kinds of plants that co-exist in the kelp beds.

"The *Nereocystis luetkeana* plants create a habitat wherein diversity and abundance of fish species increases over non-kelp areas" (Leaman 1976). Wheeler (1990) states " larger pink salmon, lingcod and Pacific cod were found more frequently in *Macrocystis* beds than in non-kelp areas. Large lingcod, large Pacific cod, small pink salmon and small chinooks are more commonly found in *Nereocystis* beds over non-kelp areas."

Sea otters (*Enhydra lutris*), recently reintroduced to the Washington coast, have a close association with kelp beds. They feed on many of the associated organisms, use kelp to rest in, and their feeding activities profoundly change the kelp community (Bowlby et al. 1988).

Some marine birds and shorebirds, such as marbled murrelets, have been demonstrated to be closely associated with the kelp beds along the north coast and western Strait of Juan de Fuca (Thompson 1996).

Hydrodynamics. Hydrodynamic effects can be divided into those with physical and biological ramifications. Kelp beds absorb wave energy and dampen wave action shoreward of the bed. Wave action influences beach slope and stability, and beach material makeup and therefore loss of kelp and the resultant wave dampening may change the beach makeup and the types or numbers of organisms that use the beach material.

Kelp plants act as active transporters of rock material (Emery 1941). Young sporophytes begin growth on any rock surface in size from sand grains up to boulders. When the plant reaches the size at which the hydrodynamic drag of the plant can move the rock substrate, the plant/rock may be moved into deeper water, onto the shore, or along the shore. Significant amounts and sizes and rocks up to one foot in diameter can be moved in this manner. Reduction in the number of plants or plant size will reduce this material transport. (Duggins 1988)

Marine Mammals

Several populations of pinnipeds are common to the Olympic Coast, including harbor seals (*Phoca vitulina*), California sea lions (*Zalophus californianus*), and Stellar sea lions (*Eumetopias jubatus*) (NOAA 1993). An important sea otter population numbering about 500 individuals, is located along the Olympic Coast (Jameson 1997). The California gray whale (*Eschrichtius robustus*) and harbor porpoise (*Phocoena phocoena*) are also common to the area (NOAA 1993). Several marine mammals species in the Pacific are listed under the ESA as threatened and endangered; others are being considered or proposed for listing.