Endangered Species Act
Biological Assessment

for

Anadromous Salmonids, Green Sturgeon, Pacific Eulachon,
Marine Mammals, & Marine Turtles

and

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat Assessment

for the

Major Rehabilitation of the Jetty System at the Mouth of the Columbia River

in

Pacific County, Washington

and

Clatsop County, Oregon

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TABLE OF CONTENTS

INTRODUCTION 1
Project Authority 2
Consultation History 3
Background 3
DESCRIPTION OF THE PROPOSED ACTION 8
Overview 8
General Terms and Features 11
Design Elements and Structural Features of Proposed Action 15
MCR North Jetty 15
MCR South Jetty 27
MCR Jetty A 40
Construction Measures and Implementation Activities 47
Construction Schedule and Timing 47
Sources and Transportation of Rock 51
Barge Offloading Facilities 61
Dredged Material Disposal Sites 70
Pile Installation and Removal 70
Rock Placement 70
Construction Staging, Storage, and Rock Stock Piles 72
Temporary Erosion Controls 74
Emergency Response 74
Hazardous Materials 75
Spill Containment and Control 75
Water Quality Monitoring 75
Wetland Mitigation and Habitat Improvements 77
Action Area 84
ENDANGERED SPECIES ACT ENVIRONMENTAL ASSESSMENT 88
Introduction 88
Status of the Species and Critical Habitat 89
Salmon and Steelhead 89
Salmon and Steelhead Critical Habitat 103
Eulachon 114
Marine Mammals 116
Marine Turtles 146
Environmental Baseline 166
Overview 166
Physical Characteristics 167
Sediment Quality 172
Other Activities and Conditions 173
Effects of the Action 174
Rock Transport 174
Construction Access, Staging, Storage, and Rock Stockpiling 175
Rock Placement 175

Dredging 178
Disposal 178
Barge Offloading Facilities 179
Pile Installation and Removal 180
Wetland and Lagoon Fill and Culvert Replacement 180
Dune Augmentation 181
Water Quality 181
Hydraulic and Hydrological Processes 182
Mitigation and Habitat Improvements 202
Effects of the Action on Listed Species 204
Listed Marine and Anadromous Fish 205
Green Sturgeon 215
Eulachon 216
Marine Mammals 228
Critical Habitat 237
Cumulative Effects 246
Synthesis and Integration of Effects 247
Species at the Population Scale 247
Critical Habitat at the Watershed Scale 256
Conclusion 259
MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT 260
Potential Effects of the Proposed Action on EFH 261
Salmon EFH 261
Coastal Pelagic EFH 262
Groundfish EFH 264
Determination for Essential Fish Habitat 270
REFERENCES 271

LIST OF FIGURES

Figure 1. Location of the Jetty System at the MCR 1
Figure 2. Rubble-mound Jetties at the MCR 4
Figure 3. Typical Spur Cross Section - Change with Depth 12
Figure 4. North Jetty Cross Section for Existing Condition and Scheduled Repair Template 15
Figure 5. Proposed Action for the MCR North Jetty 18
Figure 6. North Jetty Spur Groin NJ1C 20
Figure 7. North Jetty Spur Groin NJ2C 21
Figure 8. North Jetty Spur Groin NJ3O 22
Figure 9. North Jetty Spur Groin NJ4C 23
Figure 10. North Jetty Head Cap 25
Figure 11. Proposed Action for the MCR South Jetty 28
Figure 12. South Jetty Cross Section for Existing Condition and Scheduled Repair 29
Figure 13. South Jetty Spur Groin SJ1O 31
Figure 14. South Jetty Spur Groin SJ2C 32
Figure 15. South Jetty Spur Groin SJ3C 33
Figure 16. South Jetty Spur Groin SJ4C 34
Figure 17. South Jetty Spur Groin SJ5O 35

Figure 18. South Jetty Head Cap....37
Figure 19. Clatsop Spit and South Jetty Root Erosion....38
Figure 20. South Jetty Root Shoreline Area....39
Figure 21. Proposed Action for MCR Jetty A....41
Figure 22. Jetty A Cross Section for Proposed Action....42
Figure 23. Jetty A Spur Groin JA1C....43
Figure 24. Jetty A Spur Groin JA2O....44
Figure 25. Jetty A Head Cap....46
Figure 26. Construction Schedule....48
Figure 27. Potential Quarry Locations (red dots) for Repairs to MCR Jetties....54
Figure 28. Potential Canadian Rock Source Transportation Routes....56
Figure 29. Potential Washington Rock Source Transportation Routes....57
Figure 30. Potential Oregon Rock Source Transportation Routes....58
Figure 31. Potential Northern California Rock Source Transportation Routes....59
Figure 32. Potential Railway Transportation Routes....60
Figure 33. North Jetty Offloading, Staging, Storage and Causeway Facilities....62
Figure 34. South Jetty Offloading, Staging, Storage and Causeway Facilities....63
Figure 35. Jetty A Offloading, Staging, Storage and Causeway Facilities....65
Figure 36. Cross Section of Stone Access Ramp at Barge Offloading Facilities at East End of Clatsop Spit near Parking Area D and Photos of Typical Barge Offloading Facilities....66
Figure 37. Illustration of a Jack-up Barge....71
Figure 38. Fast Fuel System....76
Figure 39. Annual Monthly River Discharge at Bonneville Dam under Current Operations as Compared to Historical River Discharge with No Mainstem Dams....166
Figure 40. Clatsop Spit Vegetative Communities (Tetra Tech 2007b)....171
Figure 41. Sediment Trend Analysis in MCR Area....172
Figure 42. Residual Velocity Bed Layer for August/September Time Window....185
Figure 43. Residual Velocity Surface Layer for August/September Time Window....186
Figure 44. Residual Velocity near North Jetty and Jetty A for August/September Time Window....187
Figure 45. Residual Velocity near South Jetty for August/September Time Window....188
Figure 46. Residual Velocity Bed Layer for October/November Time Window....190
Figure 47. Residual Velocity near North Jetty and Jetty A for October/November Time Window....191
Figure 48. Residual Velocity near South Jetty for October/November Time Window....192
Figure 49. Mean Salinity for Bed Layer for August/September Time Window....194
Figure 50. Mean Salinity for Surface Layer for August/September Time Window....195
Figure 51. Mean Salinity for Surface Layer for October/November Time Window....196
Figure 52. Mean Salinity for Surface Layer for October/November Time Window....197
Figure 53. Bathymetry at the MCR....199
Figure 54. Difference in Bed Level (meters) for August/September Time Window....200
Figure 55. Difference in Bed Level (meters) for October/November Time Window....201
Figure 56. Timing of Salmonid Life History Events in the Lower Columbia River....205
Figure 57. Fish Presence in Lower Mainstem Columbia River below Sauvie Island (RM 87)....206
Figure 58. Locations of Acoustic Telemetry Receiver Arrays, 2009....210
Figure 59. Cross-channel Distribution of Acoustic-tagged Yearling Chinook Salmon....211
Figure 60. Cross-channel Distribution of Acoustic-tagged Steelhead....212
Figure 61. Cross-channel Distribution of Acoustic-tagged Subyearling Chinook Salmon....213
Figure 62. Tidal Elevations at the MCR for August/September and October/November Time Windows with Respect to Spur Groins Subjected to Periodic Submergence....220

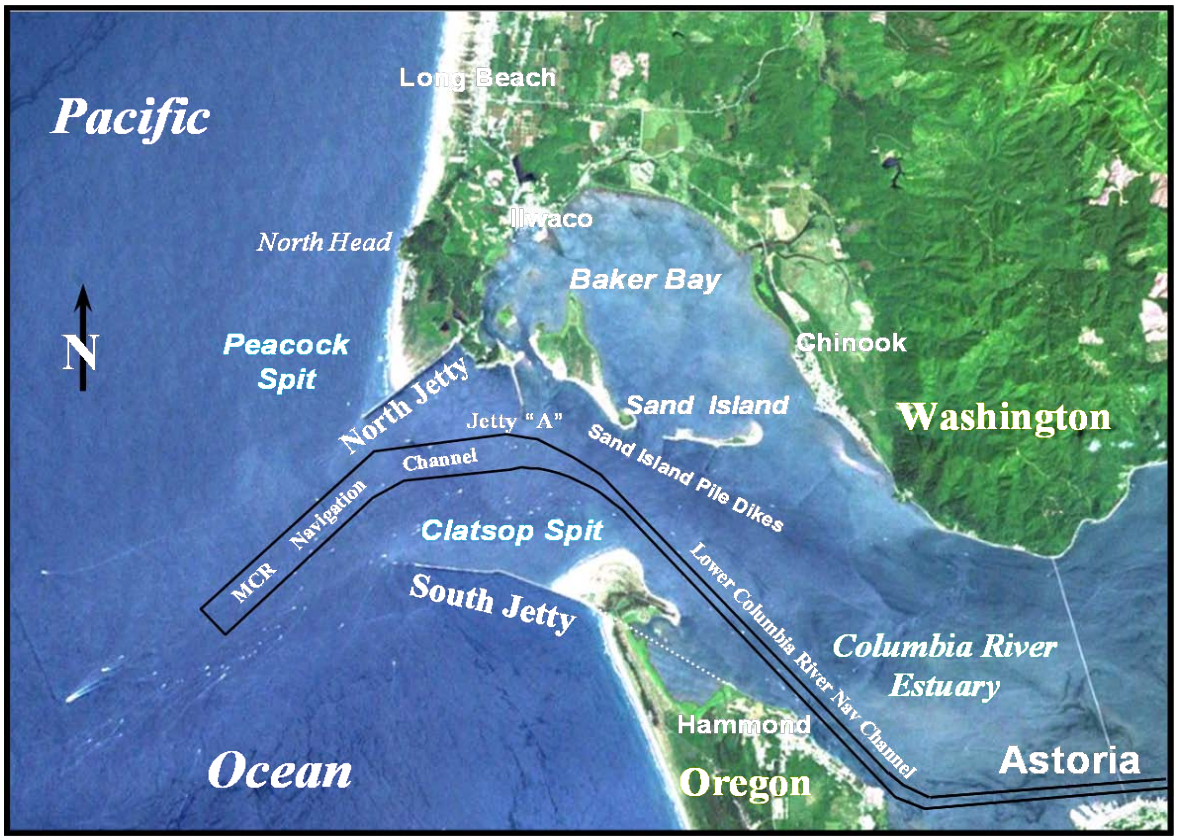
LIST OF TABLES

Table 1. Construction and Repair History for the MCR Jetties 6
Table 2. Preferred Plan Design Metrics Summary for MCR Jetties 14
Table 3. North Jetty Spur Groin Features 19
Table 4. North Jetty Head Cap Features 24
Table 5. North Jetty Lagoon and Wetland Fill Features 26
Table 6. South Jetty Spur Groin Features 30
Table 7. South Jetty Head Capping Features 36
Table 8. Jetty A Spur Groin Feature 42
Table 9. Jetty A Head Cap Feature 45
Table 10. Quarry Information 55
Table 11. Approximate Rock Volume and Area of Barge Offloading Facilities and Causeways 61
Table 12. Estimated Dredging Volumes for Barge Offloading Facilities 69
Table 13. Acreages Needed for Construction Staging, Storage, and Rock Stock Piles 72
Table 14. Possible Wetland Mitigation and Habitat Improvement Features 78
Table 15. Maximum Estimated Acreages for Habitat Improvement and Wetland Mitigation 82
Table 16. Federal Register Notices for Final Rules that List Threatened and Endangered Species, Designate Critical Habitats, or Apply Protective Regulations to Species under Consideration 85
Table 17. EFH Species and Potential Life Stages in the Action Area 86
Table 18. NMFS Recovery Planning Domains and ESA-listed Salmon and Steelhead Species 89
Table 19. Demographically Independent Salmonid Populations in the WLC Recovery Domain and Spawning Populations 91
Table 20. LCR Chinook Salmon Populations Spawning in Oregon 92
Table 21. UWR Chinook Salmon Populations 93
Table 22. CR Chum Salmon Populations Spawning in Oregon 93
Table 23. LCR Coho Salmon Populations Spawning in Oregon 94
Table 24. LCR Steelhead Populations Spawning in Oregon 95
Table 25. UWR Steelhead Populations 96
Table 26. Demographically Independent Salmonid Populations in the IC Recovery Domain and Spawning Populations 97
Table 27. SR Spring/Summer Run Chinook Salmon Populations in Oregon 98
Table 28. MCR Steelhead Populations in Oregon 99
Table 29. SRB Steelhead Populations in Oregon 100
Table 30. OC Coho Salmon Populations in Oregon 101
Table 31. SONCC Coho Salmon Populations in Oregon 102
Table 32. PCEs of Critical Habitats Designated for ESA-listed Salmon and Steelhead Species and Corresponding Species Life History Events 105
Table 33. PCEs of Critical Habitats Designated for SR Spring/Summer Run Chinook Salmon, SR Fall Run Chinook Salmon, SR Sockeye Salmon, SONCC Coho Salmon, and Life History Events 106
Table 34. North Jetty Wetland Scores 170
Table 35. Life Stages of Marine and Anadromous Species 217
Table 36. Depths of Spur Groins with Respect to MLLW 219
Table 37. Average Number of Pinnipeds by Month at South Jetty, 1995-2004 229
Table 38. PCEs of Critical Habitats Designated for ESA-listed Salmon and Steelhead and Corresponding Life History Events 238
Table 39. PCEs of Critical Habitats Designated for SR Spring/Summer-run Chinook Salmon, SR Fall-run Chinook Salmon, SR Sockeye Salmon, and SONCC Coho Salmon and Life History Events 239
Table 40. PCEs of Critical Habitats Proposed for Southern Green Sturgeon and Corresponding Life History Events 243

INTRODUCTION

The U.S. Army Corps of Engineers (Corps) prepared and is submitting this Biological Assessment (BA) to the National Marine Fisheries Service (NMFS) in compliance with the requirements of Section 7(c) of the Endangered Species Act of 1973, as amended. This BA evaluates effects to species listed on the Endangered Species Act (ESA) and their designated and proposed critical habitat, as well as an Essential Fish Habitat (EFH) analysis, in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for the Major Rehabilitation of the Jetty System at the mouth of the Columbia River (MCR). Federally listed marine and anadromous fish, mammal, and turtle species are present in the vicinity of the proposed action, as well as EFH species including five coastal pelagic species, numerous Pacific Coast groundfish species, and coho and Chinook salmon. The Corps also requests a Conference Opinion regarding effects to proposed critical habitat for leatherback turtles. Additionally, prior to construction activities, an incidental harassment authorization (IHA) for marine mammals at the South Jetty will be obtained. The Corps did not request a species list from NMFS. The Corps maintains this jetty system and navigational channels as appropriate based on necessity and appropriations. The Corps is currently proposing major repair and rehabilitation for the North Jetty, South Jetty, and Jetty A located at the MCR (Figure 1).

Figure 1. Location of the Jetty System at the MCR



PROJECT AUTHORITY

For the authorization for the actual construction of the MCR jetties, the present navigation channel and configuration of the inlet at the mouth of the Columbia River are the result of continuous improvement and maintenance efforts have been undertaken by the Corps Portland District since 1885. Congress has authorized the improvement of the MCR for navigation through the following legislation. Senate Executive Document 13, 47th Congress, 2nd Session (5 July 1884) authorized the Corps to construct the South Jetty (first 4.5 miles) for the purpose of attaining a 30-foot channel across the bar at the MCR. House Document 94, 56th Congress, 1st Session (3 March 1905) authorized the Corps to extend the South Jetty (to 6.62 miles) and construct a North Jetty (2.35 miles long) for the purpose of attaining a 40-foot channel (0.5 mile wide) across the bar at the MCR. House Document 249, 83rd Congress, 2nd Session (3 September 1954) authorized a bar channel of 48 feet in depth and a spur jetty ("B") on the north shore of the inlet. Funds for Jetty "B" construction were not appropriated. Public Law 98-63 (30 July 1983) authorized the deepening of the northern most 2,000 feet of the MCR channel to a depth of 55 feet below mean lower low water (MLLW). The MCR federal navigation project was originally authorized (in 1884) before formulation of local sponsor cost sharing agreements; therefore, all navigation maintenance and improvements at MCR are borne by the Federal Government.

The authority for maintenance of the MCR jetties comes from the original authority for construction of the project and then with Corps' policies for the operations, maintenance, and management of a Corps' project (Chapter 11 of EP 1165-2-1). For navigation, completed projects like the MCR have established that operations and maintenance (O&M) is solely a federal responsibility to be accomplished at federal cost.

When maintaining a Corps' project, there is regular O&M, major maintenance, and major rehabilitation. Major rehabilitation consists of either one or both of two mutually exclusive categories, reliability or efficiency improvements.

- Reliability. Rehabilitation of a major project feature that consists of structural work on a Corps operated and maintained facility to improve reliability of an existing structure, the result of which will be a deferral of capital expenditures to replace the structure. Rehabilitation will be considered as an alternative when it can significantly extend the physical life of the feature (such as a jetty) and can be economically justified by a benefit/cost relationship. Each year the budget EC delineates the dollar limits and construction seasons (usually two construction seasons).
- Efficiency Improvements. This category will enhance operational efficiency of major project components. Operational efficiency will increase outputs beyond the original project design.

Thus, the authority for maintenance of the MCR jetties comes from the authorization documents for the project and/or the authority to operate and maintain the structures.

CONSULTATION HISTORY

As the project's preferred alternative has evolved, the Corps has been coordinating with NMFS since 2005. On November 5, 2007, the Corps submitted an earlier version of this Biological Assessment (BA) proposing a larger jetty rebuilds. On January 11, 2008, the Corps provided a memo responding to inquiries NMFS had made regarding the BA. Subsequently, the BA was withdrawn later in January of 2008 due to significant changes in the project description.

Regular coordination with NMFS and was reinstituted in the spring of 2010 after publication of the revised Draft Environmental Assessment in which a new proposed action with a smaller project footprint was determined to be the preferred alternative with which the Corps of Engineers would be moving forward. In August of 2010, a site visit to view construction activities on the Tillamook North Jetty was conducted with NMFS and Corps representatives in order to observe and to compare construction activities and design elements associated with a similar, smaller-scale jetty rehabilitation project. To ensure development of the updated Biological Assessment fully addressed ESA Consultation requirements and expectations, since July 2010 the Corps also has been meeting on a nearly weekly basis with NMFS to further discuss and describe proposed actions, related studies, and jetty design model runs.

The Corps has determined that the proposed action will have **no effect** on the following species of marine turtles: loggerhead sea turtles (*Caretta caretta*), green sea turtles (*Chelonia mydas*), and olive ridley sea turtles (*Lepidochelys olivacea*). The Corps is also seeking a Conference Opinion regarding proposed critical habitat for leatherback sea turtles, and has determined the proposed actions may affect but are **not likely to adversely affect** (NLAA) leatherback sea turtles. The Corps has determined that the proposed action is **not likely to adversely affect** (NLAA) the following marine mammal species: blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), killer whales (*Orcinus orca*) and sei whales (*B. borealis*). Previously, for interim repairs on the South Jetty, the Corps obtained an IHA permit as it was believed that sea lions would be disturbed during construction (Corps 2007). The Corps has determined that the proposed action is **likely to adversely affect** Stellar sea lions (*Eumotopias jubatus*) and will again obtain an IHA permit from NMFS for incidental harassment of Steller sea lions during construction, as well as non-federally listed California sea lions and harbor seals. Through this Biological Analysis the Corps has further determined that the proposed action may affect and is **likely to adversely affect** eulachon (*Thaleichthys pacificus*). The Corps has also determined that the proposed action is **likely to adversely affect** green sturgeon (*Acipenser medirosris*). Finally, the Corps has determined that the proposed action may affect and is **likely to adversely** affect all runs of listed salmonids and steelhead discussed further in this BA.

BACKGROUND

The MCR project consists of a 0.5-mile wide navigation channel extending for about 6 miles (3 miles seaward and shoreward of the tip of the North Jetty) through a jettied entrance between the Columbia River and the Pacific Ocean on the border between Washington and Oregon. Figure 1 shows the navigation project and the three primary navigation structures, the North Jetty, South Jetty, and Jetty A. Those structures are shown in more detail in Figure 2. The North Jetty and Jetty A are located in Pacific County, Washington, near Ilwaco and Long Beach on the Long

Beach Peninsula. The South Jetty is located in Clatsop County, Oregon near Warrenton/Hammond and Astoria.

Figure 2. Rubble-mound Jetties at the MCR

Top left photo shows the South Jetty looking east. The remnant feature shown disconnected from the primary structure is the concrete monolith that was constructed in 1941. The top right photo shows Jetty A. The bottom photo illustrates the North Jetty and the shoreline north of the MCR.

South Jetty

Jetty A

North Jetty

From 1885 to 1939, three rubble-mound jetties with a total length of 9.7 miles were constructed at the MCR on massive tidal shoals. The jetties were constructed to accelerate the flow of the river, which helps maintain the depth and orientation of the navigation channel, and to provide protection for ships of all sizes (both commercial and recreational) entering and leaving the Columbia River. The intention was to secure a consistent navigation channel through the coastal inlet, though morphology of the inlet currently remains in a dynamic, high-energy state. Under such conditions, the jetties have experienced significant deterioration since construction, mainly due to extreme wave attack and foundation instability associated with erosion of the tidal shoals on which the jetties were built.

The initial 4.5-mile section of the South Jetty was completed in 1895-1896. The Rivers and Harbor Act of 3 March 1905 authorized the extension of the South Jetty to 6.6 miles, with the 2.4-mile extension completed in 1913. Historical records show that six spur groins were constructed along the channel side of the South Jetty. Four of the groins were subsequently buried by accreted shoreline or sand shoal. Nine repairs to the South Jetty have been completed with the latest one in 2007. To date, jetty rock placement at the South Jetty totals approximately 8.8 million tons. In spite of these repairs and structural features, over 6,100 feet of head loss has occurred at the South Jetty.

The North Jetty was completed in 1917. Three repairs to the North Jetty have been made with the last one completed in 2005. To date, jetty rock placement totals approximately 3.4 million tons. Since initial construction, about 0.4 miles of the North Jetty head has eroded and is no longer functional.

Jetty A was constructed in 1939 to 1.1 miles in length in connection with rehabilitation of the North Jetty for the purpose of channel stabilization. Its purpose was to assist in controlling the location and direction of the ebb tidal flow through the navigation entrance. Improvements made from 1930 to 1942 (including addition of Jetty A and Sand Island pile dikes) produced the present entrance configuration.

The construction and repair history of the MCR jetties is summarized in Table 1.

The Corps' dredging and in-water disposal of dredged sediments to maintain the above referenced authorized navigation channel is conducted under the provisions of sections 102 and 103 of the Marine Protection Reserve and Sanctuaries Act of 1972, sections 401 and 404 of the Clean Water Act of 1977, and in accordance with Regulations 33 CFR parts 335-338.

Table 1. Construction and Repair History for the MCR Jetties

1881: Proposed project to build a strong pile-dike, 3 feet high about at low tide, 8,000 feet long and 20 feet wide along a line previously established on the south side. The structure to start near the northeast corner of Fort Stevens, following the 12-foot curve, dike will be directed a little westward of the outer part of headland of Cape Hancock. It was stated that work commence soon (during summer and autumn) because channel maintenance is dependent upon building up Clatsop Spit.

1883: A jetty plan approved by the Board of Engineers from the south cape of the entrance on the spit. A survey was conducted in October-November of the south cape, Point Adams, to extreme low water. The jetty extends from Point Adams and makes the distance between the outer end of the jetty and Cape Disappointment the same as the distance between Chinook Point and Point Adams. The Board stated that any structures placed in-river should not harm the river and should keep the channel open using the tide; therefore, the jetty should not obstruct the entry of the flood tide. The jetty design called for a crest elevation at low water level. Estimated depths of various jetty sections from the landward end are: 5,000 feet - less than +6 feet; 7,500 feet – +6 to +11 feet; 4,000 feet – +11 to +16 feet; and 7,500 feet – +16 to +21 feet. Jetty crest elevation was designed to be at low water level because of wave violence that could harm a higher jetty. The logic was that a higher jetty could be built, if needed later, by placing more stone on the existing jetty. A jetty height to mid-tide level was suggested but not recommended because the lower jetty would be quite effective in directing the ebb tide and would interfere less with the flood tide. A higher jetty would result in higher maintenance costs due to the jetty being more exposed to wave action.

1884: The improvement plan for MCR was approved by the Rivers and Harbors Act of July 5, 1884 to maintain a channel 30 feet deep at mean low tide by constructing a low-tide jetty, about 4.5 miles long, from near Fort Stevens on the South Cape to a point about 3 miles south of Cape Disappointment.

1886-1896: Original construction South Jetty from Fort Stevens (station 25+80) across Trestle Bay and Clatsop Spit to station 250+20. Rock placed with a natural slope to an elevation from 4 to 12 feet, crest width roughly 10 feet. "The jetty, of a brush-mattress and stone ballast, was built for 1,020 feet from ordinary highest tide-line, and minor constructions added." Material has filled along the jetty's south side, moving the shoreline seaward. Highest tide-line is located at tramway station 30+50. A 115 feet long spur was built landward of the jetty for shore protection. A 510 feet long sand-catch, consisting of heavy beach drift and loose brush, was built on the south side of landward end of the jetty to continue filling the old outlet of a lagoon at extreme end of Point Adams. Jetty stone was originally dumped in ridges, but waves flattened and compacted the rocks to a width of 50 feet. The report indicated urgency to extend the jetty to prevent further deterioration of the bar channel.

1889: The South Jetty now under construction for 1.5 miles. Clatsop Spit has more material visible at low water and the river channel has a tendency towards a straight course out to sea. Tillamook Chute being closed. Sand building up south of the jetty adjacent to and in front of the mattresses as they are constructed.

1890: South Jetty construction is 3.25 miles underway. Jetty elevation at MLLW for about 3 miles. 1.25 miles of tramway to be constructed. Clatsop Spit building up, the outflowing waters being concentrated over the channel bar. Station 25+80 considered the beginning of the jetty. The jetty mattress has advanced from stations 99+04 to 194+08. The jetty elevation is at MLLW to station 170+00. From Station 170+00 to the end of mattress work, there is about 9 feet of rock on top of the mattress. At station 65+00, there were signs of sinking and a large amount of rock was dumped in place.

1903-1913: Extension of South Jetty. Crest elevation of jetty raised to 10 feet MLLW from stations 210+35 to 250+20, and rock placed from stations 250+20 to 375+52, elevation increasing in steps to 24 feet MLLW. Crest width is 25 feet and side slopes are natural slope of rock. Seaward bend in the jetty is added and called the "knuckle."

1913-1917: Original construction of North Jetty from stations 0+00 to 122+00. Side slopes are 1 vertical by 1.5 horizontal (1:1.5) and crest width is 25 feet. Crest elevation varies from 15 to 32 feet.

1931-1932: Repair South Jetty from stations 175+00 to 257+68.7 (shoreline to knuckle), side slopes 1:1.5, crest elevation 24 feet MLLW, and crest width 24 feet. This is first maintenance for South Jetty. The jetty had been flattened to about low water level. 2.2 million tons of stone placed in super-structure. The work completed in 1936. The end of jetty would unravel 300 feet or more, so a solid concrete terminal was constructed above low water level. The terminal was located 3,900 feet shoreward of the original jetty end that was completed in 1913.

1933-1934: Repair of South Jetty from stations 257+68.7 to 305+05 (knuckle to middle of outer segment). Two level cross section with crest elevations of 17 and 26 feet. Crest width of each level is 24 feet. Side slopes are 1:1.5 on channel side and vary from 1:1 to 1:1.75 to 1:2 on ocean side.

1935-1936: Repair South Jetty from stations 305+05 to 353+05 (middle of outer segment to existing end). Similar design to 1933-1934 repair.

Table 1 (continued). Construction and Repair History for the MCR Jetties

1936: Stone/asphalt cone-shaped terminal constructed on South Jetty from stations 340+30 to 344+30. Crest width of approximately 50 feet and elevation varied from 23 to 26 feet. Side slopes are 1:2.

1937-1939: Repair of North Jetty from stations 68+35 to 110+35. Crest elevation 26 feet and crest width 30 feet. Side slope 1:1.25 on ocean side and 1:1.5 on channel side.

1939: Original construction of Jetty A from stations 40+93.89 to 96+83. Crest width is 10 feet from beginning to station 53+00, 30 feet in width, and elevation at 20 feet from this point on. Four pile dikes completed at Sand Island.

1940: Repair of South Jetty with replacement rock in locations as needed.

1940-1942: South Jetty repair from stations 332+00 to 343+30. Concrete terminal/stone foundation added. Crest elevation from 8-20 feet and crest width from 50-75 feet, 10 inches. Side slopes determined by concrete terminal shape.

1945-1947: Repair Jetty A from stations 78+00 to 96+00. Crest elevation to 20 feet with crest width of 40 feet.

1948-1949: Repair 300 feet of Jetty A from stations 92+35 to 95+35 with a crest elevation of 20 feet, a crest width of 30 feet, and side slopes of 1:1.25.

1951: Repair Jetty A from stations 91+50 to 93+00 with a crest elevation of 20 feet MLLW, a crest width of 30 feet, and side slopes of 1:1.5.

1952: Repair of Jetty A from stations 90+00 to 94+00 with a crest elevation of 20 feet, a crest width of 30 feet, and side slopes of 1:1.5.

1958: Repair of Jetty A from Stations 41+00 to 79+00. Crest elevation raised to 20 feet and a crest width of 20 feet from Stations 41+00 to 56+00. Crest width is 30 feet from Stations 61+00 to 79+00.

1961-1962: Repair Jetty A from stations 50+00 to 90+50, with no repairs from Stations 68+00 to 76+50. Crest elevation built with a 10% grade from 20 feet to 24 feet from stations 50+00 to 68+00. The crest elevation was raised to 24 feet from stations 76+50 to 90+50.

1961: South Jetty repair from stations 194+00 to 249+00 (before knuckle, current stationing). Crest elevation varies from 24 to 28 feet and crest width is 30 feet. Channel side slope 1:1.25 and ocean side slope 1:1.5. Repairs from stations 38+00 to 93+00 (old stationing). Elevation at station 38+00 is +24 feet and then increased with a 0.5% grade up to +28 feet for the remainder of repair section. The repair centerline is located 13 feet north of the centerline of the original jetty design. The design crest width is 30 feet. North slope is 1:1.25 and south slope is 1:1.5.

1962-1965: South Jetty repair from stations 249+00 to 314+05 (beyond knuckle). Crest elevation begins at 28 feet and transitions to 25 feet for most of section. Side slopes vary from 1:1.5 to 1:2 and crest width is 40 feet (this appears to be the furthest seaward intact portion of current jetty). Repairs made from stations 93+00 to 157+50 (old stationing). The crest elevation is +28 feet at station 93+00, then decreases to +25 feet at station 95+00, and then continues with this elevation to end of the repairs. The crest width is 40 feet and has a slope of 1:1.5 from stations 93+00 to 152+00. Slope then transitions to 1:2 from stations 152+00 to 154+00. The centerline of the repair is 15 feet south of the trestle centerline.

1965: Repair North Jetty from stations 89+47 to 109+67 with a crest elevation of 24 feet and crest width is 30 feet. Side slopes vary from 1:1.5 to 1:2.

1982: Repair South Jetty from stations 194+00 to 249+00 (segment before knuckle). Crest elevation varies from 22 to 25 feet MLLW. Crest width varies from 25-30 feet and side slopes 1:1.5. Crest elevation varies from +22 feet at station 38+00 to +25 feet at station 80+35 (old stationing). From stations 44+50 to 80+35, crest width is 30 feet and slope is 1:1.5. Centerline of repairs has 10 feet maximum variance to the north for the South Jetty control line. From stations 80+35 to 93+00, centerline of repairs is the same as South Jetty control. Crest elevation +25 feet, width varies from 25-30 feet, side slope is 1:1.5.

2005: Interim repair of North Jetty (stations 55+00 to 86+00). Crest elevation +25 feet with side slope of 1:1.5.

2006: Interim repair of South Jetty (stations 223+00 to 245+00). Crest elevation +25 feet with side slope of 1:2.

2007: Interim repair of South Jetty (stations 255+00 to 285+00). Crest elevation +25 feet with side slope of 1:2.

DESCRIPTION OF THE PROPOSED ACTION

OVERVIEW

The Corps proposes to perform modifications and repairs to the North and South Jetties and Jetty A at the MCR that would strengthen the jetty structures, extend their functional life, and maintain deep-draft navigation.

Proposed actions are generally comprised of four categories applicable to each jetty: (1) engineered designs elements and features of the physical structures; (2) construction measures and implementation activities; (3) proposed 7(a)(1) habitat improvement measures and wetland mitigation actions to improve habitat for the benefit of listed species and to offset wetland fill, and (4) proposed establishment of and coordination with an Adaptive Management Team (AMT) comprised of Corps' staff and representatives from appropriate Federal and State agencies.

It is notable that the duration of the construction schedules is 20 years, with a 50-year operational lifetime for the MCR jetty system. Therefore, an inherent level of uncertainty exists regarding dynamic environmental conditions and actual conditions of and at each of the jetties. For this reason, in all cases where areas, weights, and volumes (tons, acres, cubic yards, etc.) or other metrics are indicated, these are best professional estimates and may vary by greater or lesser amounts within a 20% range when final designs are completed. These amounts represent Corps' and staff's best professional judgments of what the range of variability could entail as the design is further developed and as on-the-ground conditions evolve over the 20-year construction schedule. The Corps maintains an active jetty monitoring and surveying program that will further inform the timing and design of the proposed action in order to facilitate efficient completion of the project and whenever possible to avoid emergency repair scenarios.

(1) Design elements and structural features specific to each jetty include the following:

- North Jetty – Scheduled repairs addressing the existing loss of cross section and the addition of engineering features designed to minimize future cross section instability are planned. The cross section repairs are primarily above MLLW, with a majority of stone placement not likely to extend beyond -5 ft below MLLW. In order to address the structural instability of the jetty cross-section, four spur groins will be added and the jetty head (western-most section) will be capped with large stone. Groins will be constructed primarily on existing relic stone and the head capping will be placed on relic as well as jetty stone that is above MLLW. The shore-side improvements that have been identified are culvert replacement and lagoon fill. These actions are designed to stop the current ongoing erosion of the jetty root.

- South Jetty – Scheduled repairs addressing the existing loss of cross section and the addition of engineering features designed to minimize future cross section

instability are planned. The cross section repairs are primarily above MLLW, with a majority of stone placement not likely to extend beyond -5 ft below MLLW. In order to address the structural instability of the jetty cross-section, five spur groins will be added and the jetty head (western-most section) will be capped with large stone. Groins will be constructed primarily on existing relic stone and the head capping will be placed on relic as well as jetty stone that is above MLLW. Augmentation of the dune at the western shoreline extending south from the jetty root has been included in the repair plan. This action is intended to prevent the degradation of the jetty root and prevent the potential breaching of the fore dune.

- Jetty A – Scheduled rehabilitation addressing the existing loss of cross section and the addition of engineering features designed to minimize future cross section instability are planned for Jetty A. The cross section repairs are primarily above MLLW, with a majority of stone placement not likely to extend beyond -5 ft below MLLW. In order to address the structural instability of the jetty cross-section, two spur groins will be added and the jetty head (southern most section) will be capped with large stone. The groins will be constructed primarily on existing relic stone and the head capping will be placed on relic as well as jetty stone that is above MLLW. Immediate rehabilitation with small cross section, two spur groins, and head capping.

(2.) Construction measures and implementation activities for all three jetties include the following:

- Storage and staging areas for rock stockpiles and all associated construction and placement activities such as: roadways, parking areas, turn-outs, haul roads, weigh stations, yard area for sorting and staging actions, etc.
- Stone delivery from identified quarries either by barge or by truck. Possible transit routes have been identified. This also includes the construction and use of permanent barge offloading facilities and causeways with installation and removal of associated piles and dolphins.
- Stone placement either from land or water, which includes the construction, repair, and maintenance of a haul road on the jetty itself, crane set-up pads, and turnouts on jetty road. Placement by water could occur via the use of a jack-up barge on South Jetty, but will not occur by other means or on North Jetty to avoid impacts to crab and juvenile salmon migration.
- Regular dredging and disposal of infill at offloading facilities with frequency dependent on a combination of the evolving conditions at the site and expected construction scheduling and delivery. Disposal will occur at existing approved in-water sites.

(3.) A suite of potential projects to provide 7(a) (1) habitat improvement and wetland mitigation actions have been identified as beneficial to listed species. Depending on further development of alternatives within this list, a specific project or combination of projects will be selected and constructed concurrently to provide environmental

benefits as portions of the proposed action are completed over time. Estimates for wetland impacts are preliminary and may be reduced when final delineations are completed; therefore wetland restoration may be less than approximations noted, but will be commensurate with impacts from construction activities. These restoration and habitat improvement measures will therefore require additional consultations, and it is anticipated that the proposed AMT will be of assistance in this process. It is anticipated that a programmatic opinion similar to SLOPES Restoration or Limit 8 may be useful to fulfill clearance requirements. Possible restoration measures could include an individual project or a combination of projects and actions such as:

- Excavation and creation of wetlands to restore and improve wetland functions including water quality, flood storage, and salmonid refugia.
- Culvert and tide gate replacements or retrofits to restore or improve fish passage and access to significant spawning, rearing, and resting habitat.
- Dike breaches to restore estuarine brackish intertidal shallow-water habitat for fish benefits.
- Beneficial uses of dredged material from MCR hopper dredge to replenish littoral cells.
- Invasive species removal and control and revegetation of native plants to restore ecological and food web functions that benefit fisheries.

(4.) Due to the long duration of the MCR Jetty Rehabilitation schedule, the Corps proposes formation of a modified Adaptive Management Team (AMT). The Corps suggests annual meetings to discuss relevant design and construction challenges and modifications, technical data, and adaptive management practices as needed. The primary purpose of the proposed AMT and its implementation is to ensure construction, operation, and maintenance actions have no greater impacts than those described in the Biological Assessment, and that terms and conditions of the Biological Opinion are being met. This will also allow confirmation that any necessary construction or design refinements remain within the range and scope of effects described during Consultations. This forum will facilitate continued coordination and updating and allow the Corps to inform agency partners when unforeseen changes arise. Results regarding marine mammal and fish monitoring, wetland mitigation and habitat improvement monitoring, as well as water quality monitoring will also be made available to the AMT in order to fulfill reporting requirements and to address any unexpected field observations. Results of jetty monitoring surveys will also inform the AMT of the repair schedule and design refinements that become necessary as the system evolves over time. This venue will also provide greater transparency and allow opportunities for additional agency input. Final selection and design of the habitat improvement and wetland mitigation proposal will also be vetted through this forum to facilitate obtaining final environmental clearance documents for this component of the MCR proposed action. Potential principal partners include federal (National Marine Fisheries Service, U.S. Fish and Wildlife Service) and State (Washington, Oregon) resource management agencies. The strategy is designed to be consistent with the guidance provided in 65 Federal Register (FR) 35242.

GENERAL TERMS AND FEATURES

Previously during earlier design phases of the proposed action, the U.S. Geological Survey (USGS) in Menlo Park, California assisted the Corps with evaluating potential improvements and impacts of rebuilding and repairing the lengths of the MCR jetties. The USGS efforts focused on using the Delft-3D model of the Columbia River estuary and adjacent coast (Delft3D 2006) to identify potential changes in circulation, salinity and sediment transport that could result from the offshore re-build of the three jetties. Increased jetty lengths were investigated to determine if they could provide a more sustainable jetty system over the long term. Although rebuild of the jetties is no longer proposed, Corps' engineering staff has also indicated modeling results remain relevant and valid for evaluating jetty performance in the current proposed action, which caps jetty lengths in their current locations (Moritz 2010).

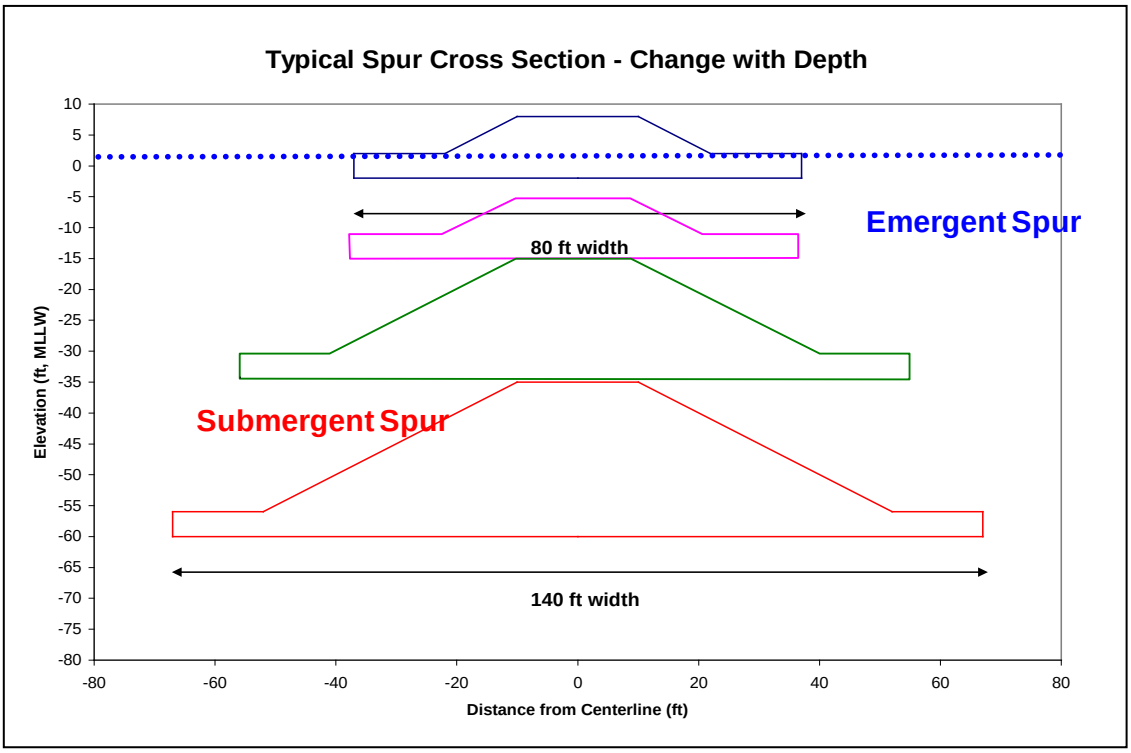
The Corps' Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi was also contracted to conduct a physical model of the jetty cross-section design. The range of structural repair types addressed in the model included crest elevation and crest widths variations, side-slope variations, underwater berms, armor stone, and concrete armor unit options. Both the North Jetty and South Jetty were tested under low and high water conditions. Physical modeling results showed that the primary failure modes for the North and South jetties were high water wave attack and overtopping. These results were used to determine cross-section design options for the jetties that achieve varying levels of structure reliability. The following design components are a result of a combination of these models and other modeling and engineering staff efforts (Moritz and Moritz 2010).

Each MCR jetty consists of three parts. The <u>head</u> is the seaward terminus and is exposed to the most severe wave action. Jetty head design is much more substantial than a typical jetty trunk section due to its increased exposure to wave attack and its critical protective function for the rest of the structure. The <u>trunk</u> forms the connection from jetty head to shore, retains sub-tidal shoals, and confines circulation in the navigation inlet. The <u>root</u> forms the connection from the jetty trunk to shore and prevents accreted landforms from migrating into the navigation channel.

A spur groin is a relatively short structure (in comparison to jetty length) usually extending perpendicular from the main axis of a jetty. Spur groins are constructed: (1) on the ocean or beach side of a jetty to deflect the long-shore (rip) current and related littoral sediment away from the jetty and prevent littoral sediment from entering the navigation channel; and (2) on the channel side of a jetty to divert the tidal or river current away from the channel side toe of the jetty. Spur groins also act to reduce the scour affecting the foundation while increasing the current in the navigation channel, thus reducing the deposition in the channel. In areas where foundation scour threatens the overall stability of the MCR jetties, spur groins constructed perpendicular to the structure facilitate stabilization by the accumulation of sediment along the jetty's foundation. Each spur groin will have a crest width of about 20 feet, and will be constructed using a bedding layer (mixture of gravel and rock) that will be covered

with large stone sized for the location and exposure. Submergent spur groins that located at greater depths also typically have wider bases than shallower, emergent groins (Figure 3).

Figure 3. Typical Spur Cross Section - Change with Depth



The ERDC analyzed the hydrodynamics and circulation patterns in the MCR entrance, as well as the potential impacts and effectiveness of placing spur groins on the jetties. This analysis was conducted with the coastal modeling system and other models to select the type, depth, and length of spur groins necessary to protect the each jetty from the processes causing increased scour (e.g., rip currents, eddies). Although the models were also evaluating a potential restoration of the jetties' former lengths, proposed construction of spur groins at each jetty has not changed since modeling was completed. Therefore, Corps' engineering staff has indicated that modeling results remain relevant and valid in their assessment of spur groin performance.

Two potential construction methods could be used for spur groins, either land-based or marine-based depending on location. Barges or similar equipment could be used to dump the bedding layer rock into place and a clamshell would be used to place larger stone on top of the bedding rock layer in locations with sufficient water depth. This type of marine placement activity will not require installation of additional piles or dolphins. Material could also be placed using land-based equipment from on top of the jetty. Land-based construction may require a wide turnout crane placement with over-excavation down to grade as the crane walks back onto the main jetty axis. In addition,

the emergent spur groins may be used as turnouts for construction equipment. The land-based construction method could be used for all but the deepest spur groins.

Head capping involves placing much larger armor stone at the terminus of the jetty where the highest degree of enforcement is necessary to withstand conditions. Enforcement could also include the use of concrete armor units (CAU). These will be fabricated off-site and then transported to the head via truck or barge. The armor stone at the head helps avoid recession and loss of length and by protecting the rest of the jetty from unraveling back towards the root.

Repair and rehabilitation are two proposed approaches that specifically describe construction and stone placement actions for the cross-sections and engineered features along the trunks and roots of the jetties. The economics and design model used to select Schedule Repair as the proposed action at the North and South jetties predicts a certain number of repair actions that will be needed to avoid a breaching scenario during the 20-year construction schedule and 50-year operational lifetime of the jetties.

Along certain sections of each jetty, wave cast and erosional forces have in some cases flattened the jetty prism and left a bedding of relic stone with little or only a partially complete jetty prism remaining. The Scheduled Repair approach prioritizes work on specific portions of the jetty so that sections in a greater degree of deterioration will be repaired with rock according to a programmed sequence developed as a result of regular jetty monitoring and inspections. Proposed repair alternatives involve adding limited amounts of stone to trunk, head, and root features in order to restore the damaged cross-sections back to a standard repair template. A repair action is generally triggered when the upper cross-sectional area falls below 30%-40% of its standard jetty template profile (only 30% or 40% of the current jetty structure remains; 60%-70% of the previously existing prism is gone). Then a standard repair template is implemented. For each repair action, a majority of stone placement will occur above MLLW. However, depending on conditions at specific jetty cross-sections, stone could extend deeper than -5 ft below MLLW in order to restore the reach back to the standard repair template. Therefore, repair actions could be slightly greater or smaller depending on the condition of the cross-section being repaired. Stone placement will remain mostly within the prism of the existing jetty and relic stone structures; though it is possible that wave actions and slope angles could result in a small percentage of further rock slipping off the relic slope.

Proposed rehabilitation alternatives generally incorporate engineering components and rock placement along the cross-section of the entire root and trunk. The construction and placement sequence for Immediate Rehabilitation at Jetty A means stone placement activities are initiated at one end of the jetty and are completed continuously in succession without prioritization based on conditions at any particular jetty section. The proposed rehabilitation action on Jetty A is more robust than a repair action and includes a small cross section along the entire length of the jetty. Sections in a greater state of deterioration may receive a relatively larger amount of rock compared to sections with less damage. The rehabilitation cross-section template is expanded

slightly beyond the existing prism template. This generally involves stone placement that primarily fits within the existing footprint of the jetty structure or relic stone, but may extend slightly beyond the existing prism. It also generally involves the bulk of the rock placement above MLLW, though it could extend below in some sections, again depending conditions in each reach.

The following discussions also mention station numbers on each jetty. These stations indicate lineal distance along the jetty relative to a fixed reference point (0+00) located at the landward-most point on the jetty root. Numbering begins at the reference point (0+00) and increases seaward such that each station number represents that distance in feet, multiplied by 100, plus the additional number of feet indicated after the station number. For instance, station 100+17 would be 10,017 feet seaward from the reference point. A summary of design parameters for the preferred plan at each jetty is shown in Table 2.

Table 2. Preferred Plan Design Metrics Summary for MCR Jetties

Note: volumes, lengths and areas may vary by ± 20% upon final design.

North Jetty Scheduled Repair with Engineering Features

Jetty Crest Elevation	Estimated Stone Density	Total Repair Length	Jetty Crest Width	Jetty Sideslope		Jetty Head Station	Head Length	Spur Groin Sta.	Spur Groin Tons
				Channel	Ocean				
25' above MLLW	167 #/ft3	8,100'	30'	1v:1.5h	1v:1.5h	99+00 to 101+00	200'	Sta 50-C Sta 70-C Sta 80-O Sta 90-C	3,895 12,870 2,340 33,960

South Jetty Scheduled Repair with Engineering Features

Jetty Crest Elevation	Estimated Stone Density	Total Repair Length	Jetty Crest Width	Jetty Sideslope		Jetty Head Station	Head Length	Spur Groin Sta.	Spur Groin Tons
				Channel	Ocean				
25' above MLLW	167 #/ft3	15,800'	30'	1v:1.5h	1v:2h	311+00 to 313+00	200'	Sta 165-O Sta 210-C Sta 230-C Sta 265-C Sta 305-O	1,496 2,095 2,095 2,841 16,747

Jetty A Rehab with Engineering Features

Jetty Crest Elevation	Estimated Stone Density	Total Repair Length	Jetty Crest Width	Jetty Sideslope		Jetty Head Station	Head Length	Spur Groin Sta.	Spur Groin Tons
				Estuary	Ocean				
20' above MLLW	167 #/ft3	5,300'	40'	1v:2h	1v:2h	91+00 to 93+00	200'	Sta 84-O Sta 90-E	12,272 12,272

DESIGN ELEMENTS AND STRUCTURAL FEATURES OF PROPOSED ACTION

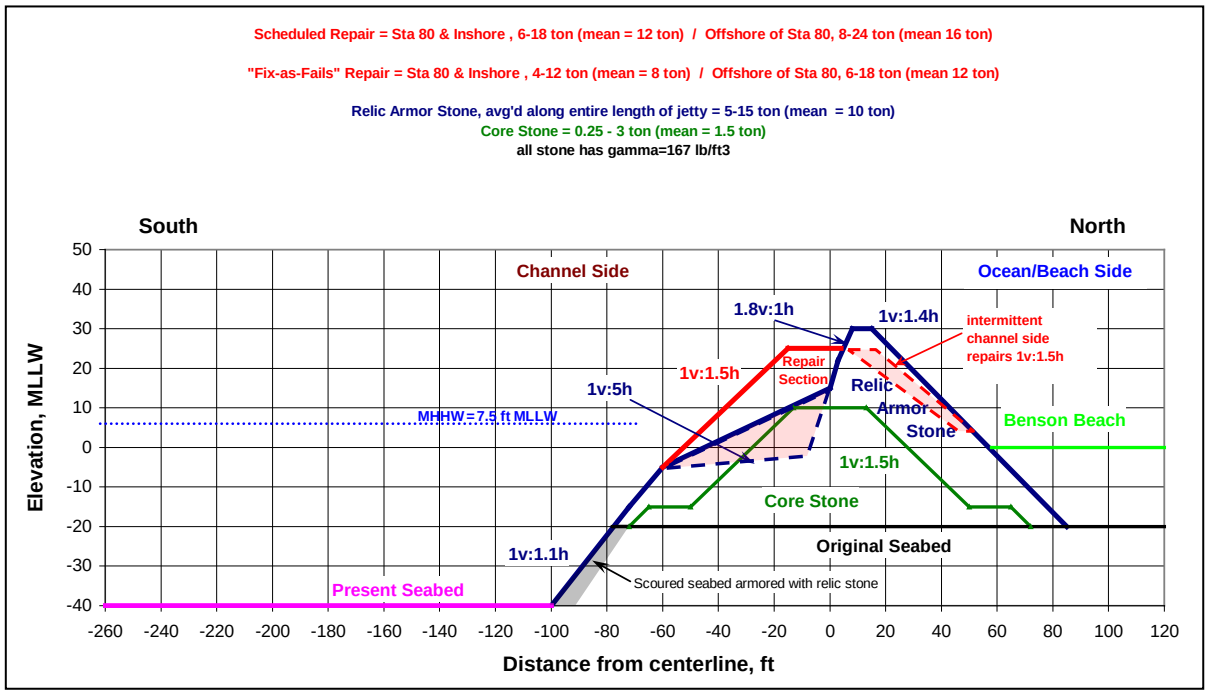
MCR North Jetty

The proposed action for the North Jetty is Scheduled Repair and construction of engineered features including four spur groins and head capping, culvert replacement, and lagoon fill to stop erosion of the jetty root (Figures 4 and 5). The jetty head and foundation at the most exposed portion of jetty will be stabilized.

North Jetty Trunk and Root

The cross-section design from stations 20+00 to 99+00 will have a crest width of approximately 30 feet and will lie essentially within the existing jetty footprint based on the configuration of the original cross section, previous repair cross sections, and redistribution of jetty rock by wave action. About 460,000 tons (~287,500 cy) of new rock will be placed on relic armor stone, with the majority of stone placement above MLLW. About four repair events were predicted over the next 20 years. Each repair action is expected to cover a length range of up to 1,700 feet and include stone volumes in the range of 45,000 to 100,000 tons (~28,125-62,500 cy) per season.

Figure 4. North Jetty Cross Section for Existing Condition and Scheduled Repair Template



At the time of repair, it is expected that 60%-70% of the standard jetty template cross-section has been displaced. Therefore, each repair event will increase the degraded cross-section from 30%-40% back to 100% of the desired standard cross-section template. This means the overall added rock will essentially triple what exists immediately prior to the time of repair. This could be described as a ~300% increase

in rock relative to the existing jetty rock volume. However, this will not increase the jetty prism or footprint beyond the scope and size of the historic structure, and does not include any modification that changes the character, scope, or size of the original structure design.

With placement divided into elevation zones per representative repair event, about 21,550 cy of rock will be placed above mean higher high water (MHHW). This represents 58% of the overall stone placement on these portions of the jetty and 376% change from the existing jetty prism. This means that currently only a small portion of the original profile remains in this zone and over three times as much stone must be placed compared to what presently remains. As described, above, this same concept applies characterizations about the rest of the zones. About 9,230 cy of rock will be placed between MHHW and MLLW. This represents 25% of the overall stone placement on these portions of the jetty and a 192% change from the existing jetty prism. About 6,675 cy of rock will be placed below MLLW. This represents 18% of the overall stone placement on these portions of the jetty and a 150% change from the existing jetty prism. The footprint of the trunk and root of the North Jetty will remain on relic stone and within its current jetty dimensions.

North Jetty Spur Groins

Three submergent spur groins will be placed on the channel side and one emergent spur groin will be placed on the ocean side of the North Jetty to stabilize the foundation (Figures 6 to 9). The approximate dimensions and other features of the spur groins are shown in Table 3. If possible, in order to avoid and minimize impacts to species and habitats, either one of the spur groins located around stations 50 or 70 may also serve a dual purpose as an offloading facility for stone delivery. This will occur at the contractor's discretion depending on channel current and wave conditions. Otherwise, a separate offloading facility will be constructed in the vicinity between these stations to take advantage of calmer waters. There is a dredge material disposal site along the North Jetty and adjacent disposal cells closest to the jetty and spur groins will be precluded from use to avoid interference with jetty construction and to ensure barge safety during disposal. Barge offloading structures and dredge activities are discussed in more detail later in this assessment.

Representing rock volume estimated totals divided into elevation zones for all newly constructed spurs on the North Jetty, about 25 cy of rock will be placed above MHHW. This represents 0.1% of the overall stone placement on these portions of the North Jetty spur groins and there is very little or no existing jetty stone expected to be present within this elevation range. About 1,146 cy of rock will be placed between MHHW and MLLW. This represents 4% of the overall stone placement on these portions of the North Jetty spur groins and there is very little or no existing jetty stone expected to be present within this elevation range. About 27,760 cy of rock will be placed below MLLW. This represents 95.9% of the overall stone placement on these portions of the North Jetty spur groins and there is very little or no existing jetty stone expected to be present within this elevation range. The footprint of the North Jetty spurs will increase

from 0 acres to 1.55 acres. In the relevant figures, note that the difference in the vertical and horizontal scales causes a slight representational distortion along the axes.

Figure 5. Proposed Action for the MCR North Jetty

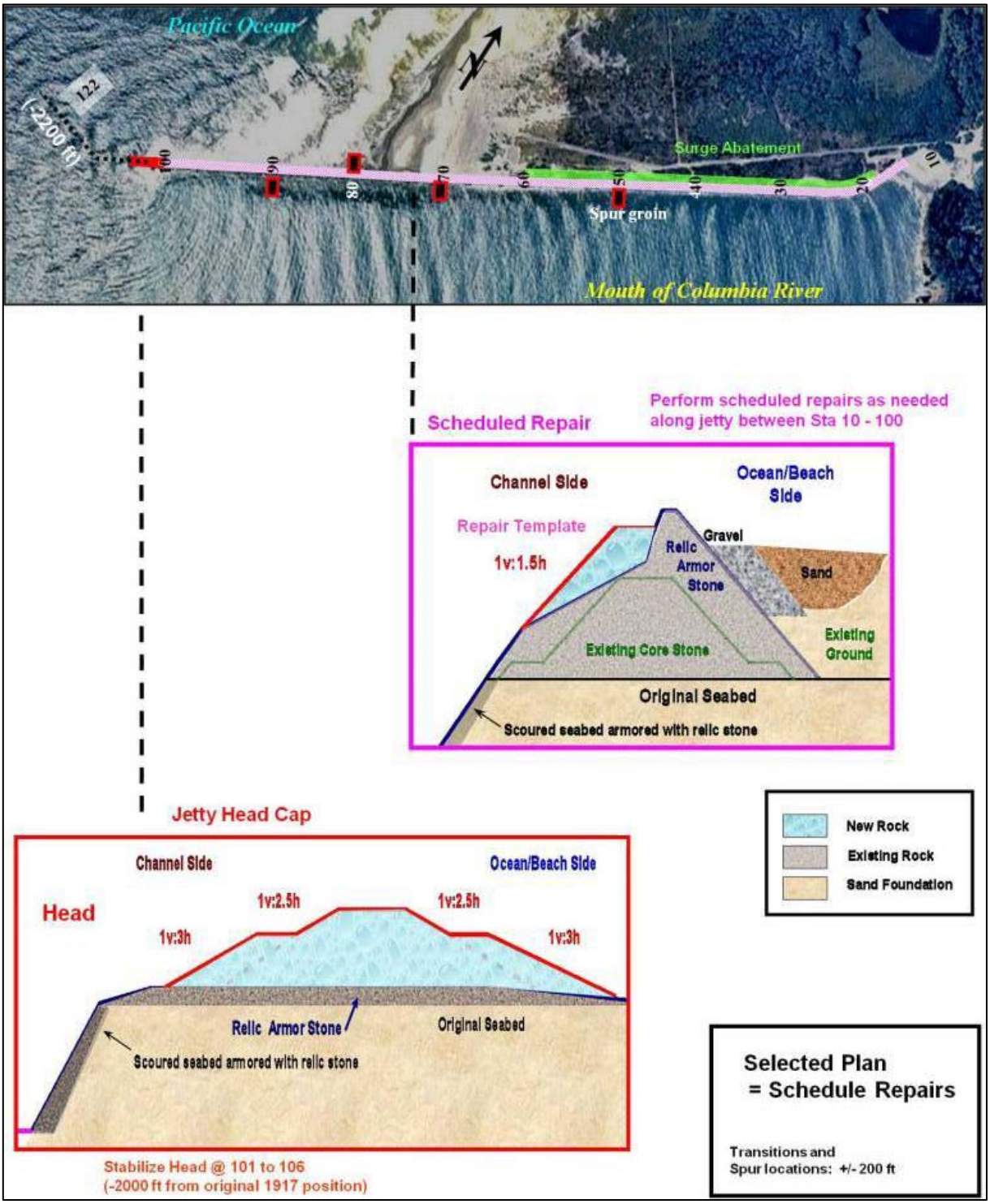
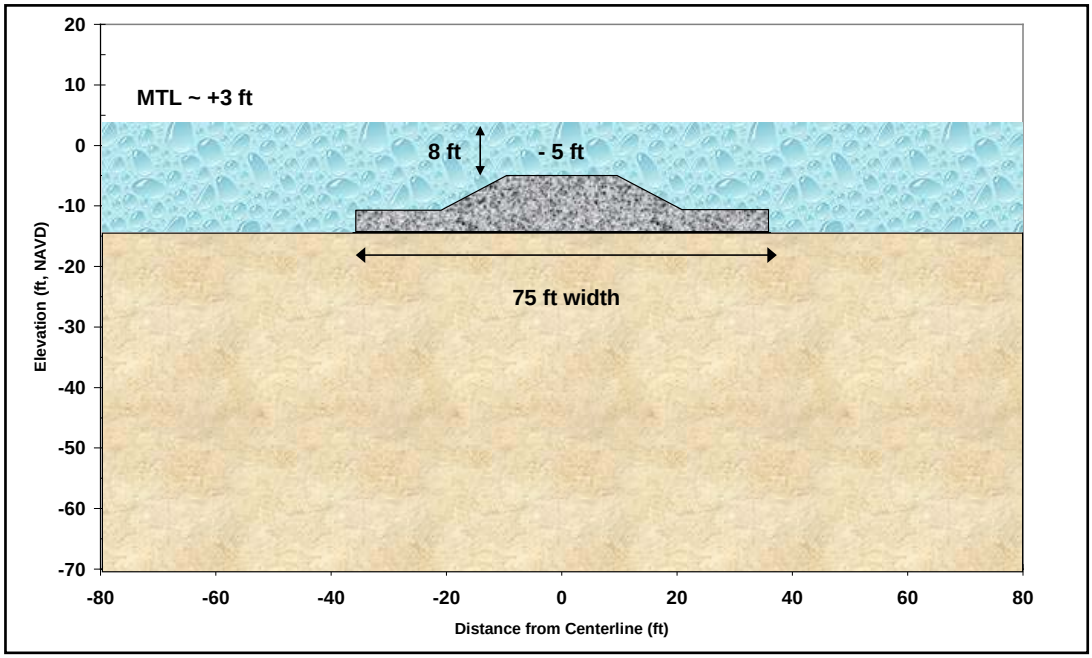


Table 3. North Jetty Spur Groin Features

Spur Groin Features	North Jetty
Number of spurs on channel side	3
Number of spurs on ocean side	1
Approximate total rock volume per spur (+/- 20%)	NJ1C: 3,350 tons (~2,094 cy) NJ2C: 11,090 tons (~6,931 cy) NJ3O: 2,010 tons (~1,256 cy) NJ4C: 29,250 tons (~18,281 cy)
Approximate total rock volume (all spurs) (+/- 20%)	53,000 tons (~33,125 cy)
Approximate area affected by each spur	NJ1C: 0.18 acres NJ2C: 0.45 acres NJ3O: 0.11 acres NJ4C: 0.80 acres
Approximate total area affected (all spurs)	1.55 acres
Approximate area of spurs above MLLW	NJ1C: 0% NJ2C: 0% NJ3O: 24% NJ4C: 0%
Approximate area of spurs below -20 MLLW	NJ1C: 0% NJ2C: 88% NJ3O: 0% NJ4C: 100%
Approximate dimension of spurs: length x width x height (feet)	NJ1C: 100 x 80 x 10 NJ2C: 170 x 115 x 19 NJ3O: 60 x 80 x 10 NJ4C: 170 x 115 x 19

Figure 6. North Jetty Spur Groin NJ1C

Note difference in scale between vertical and horizontal axes.



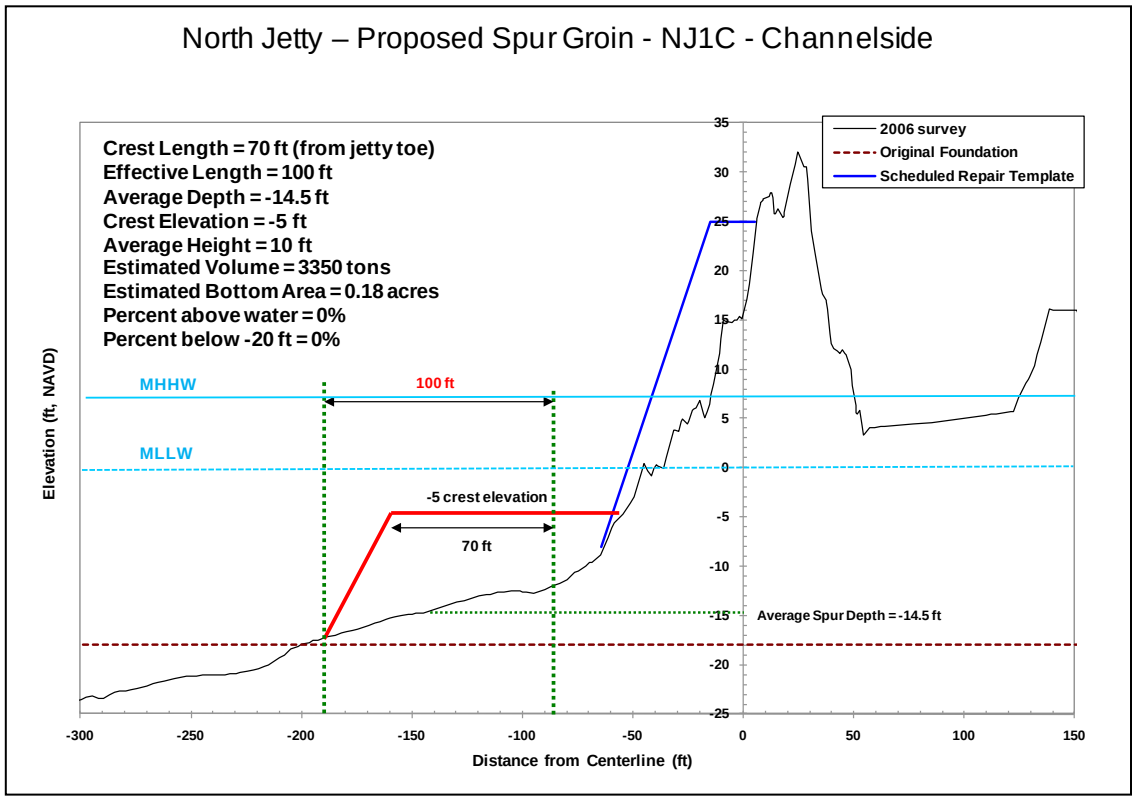
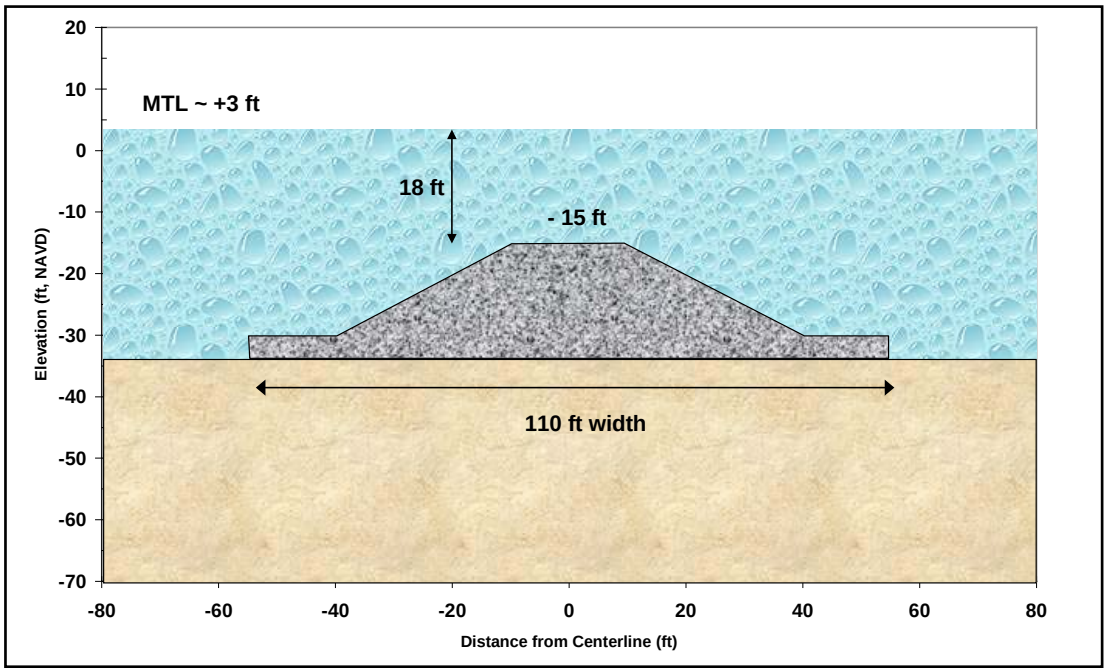


Figure 7. North Jetty Spur Groin NJ2C

Note difference in scale between vertical and horizontal axes.



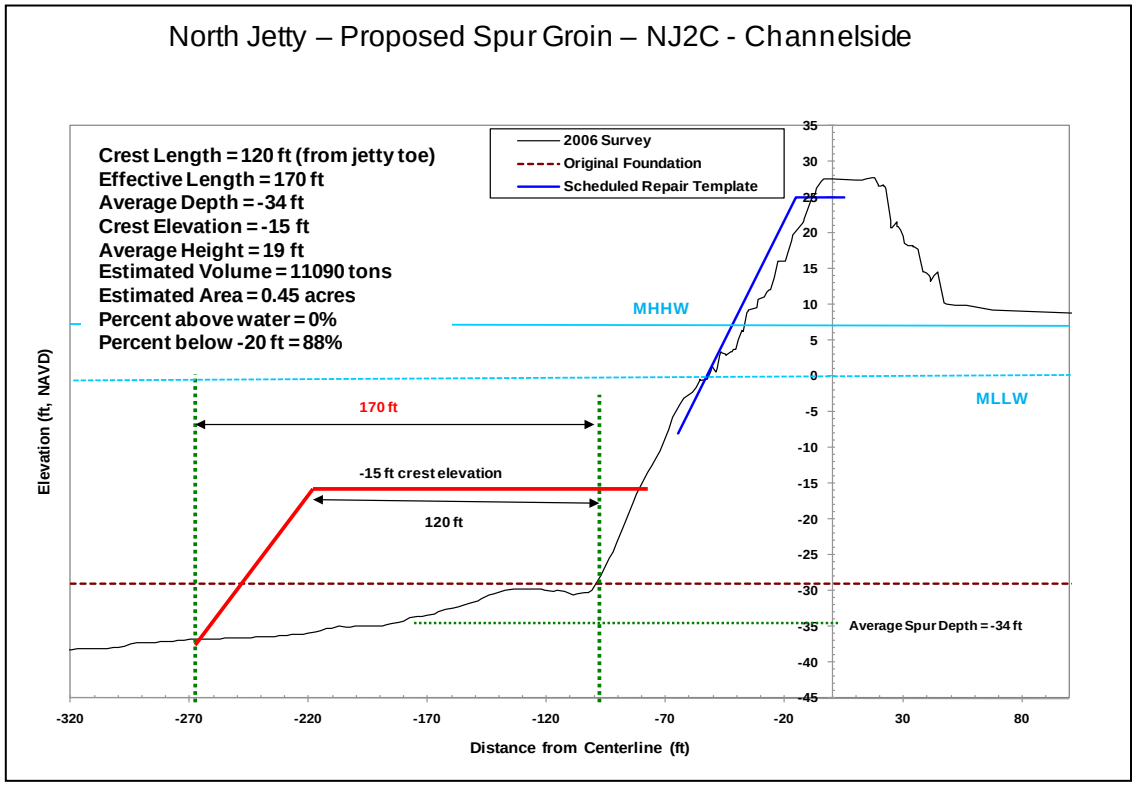
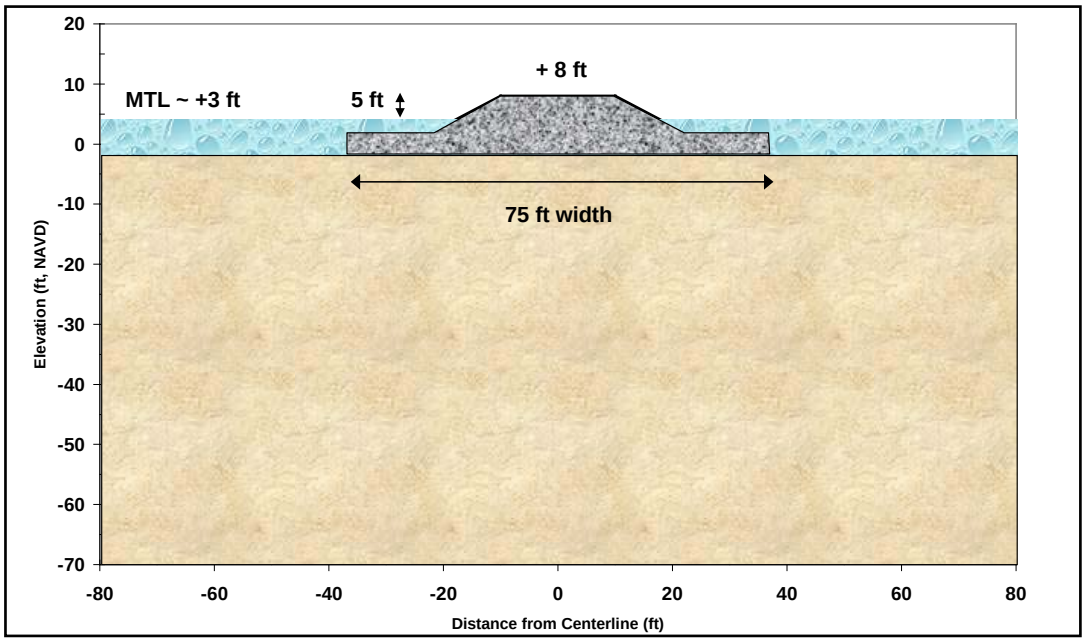


Figure 8. North Jetty Spur Groin NJ3O

Note difference in scale between vertical and horizontal axes.



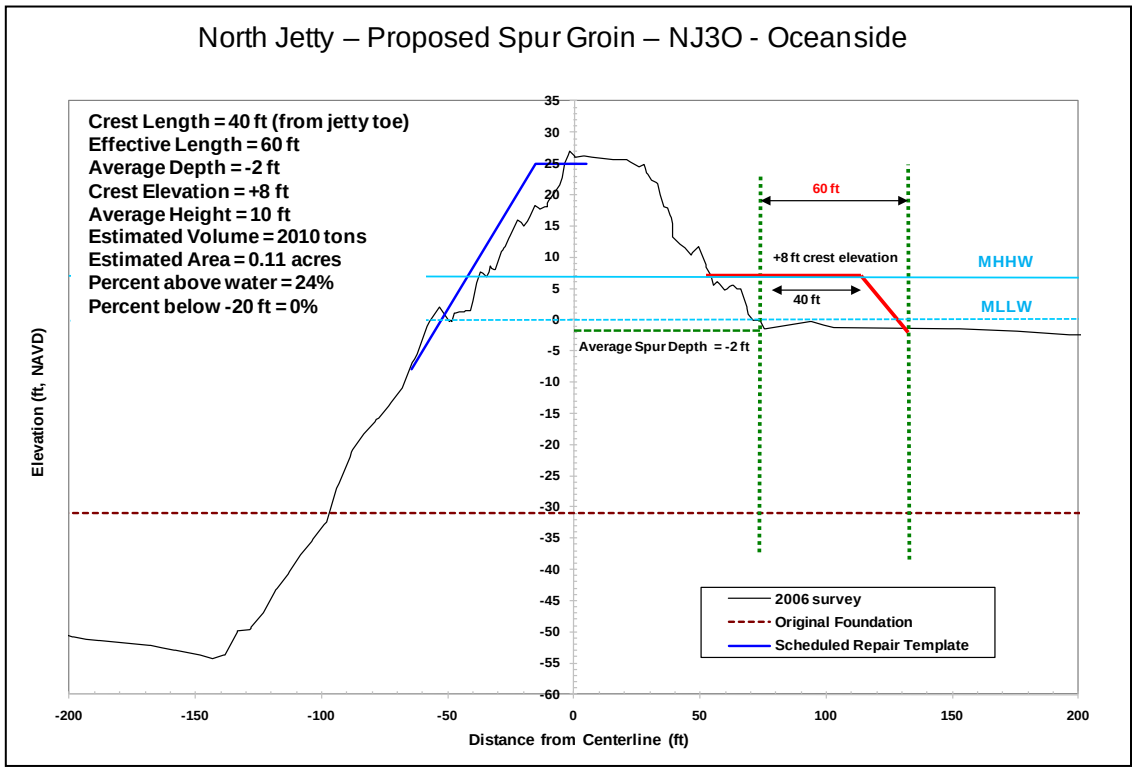
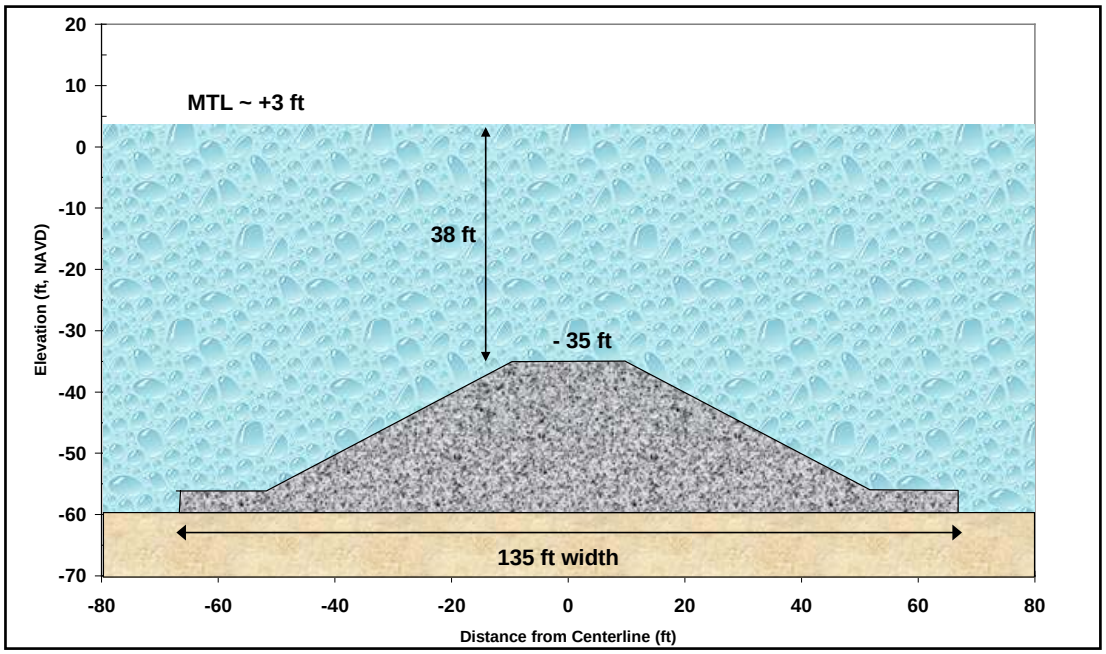
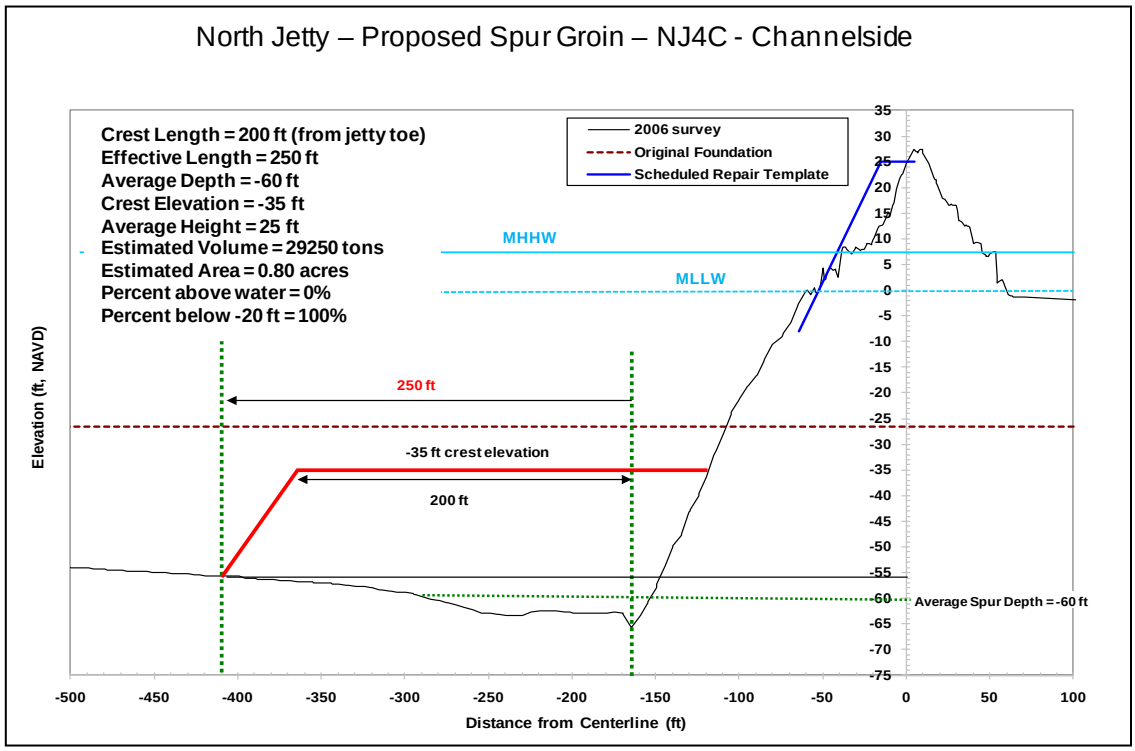


Figure 9. North Jetty Spur Groin NJ4C

Note difference in scale between vertical and horizontal axes.





North Jetty Head Capping

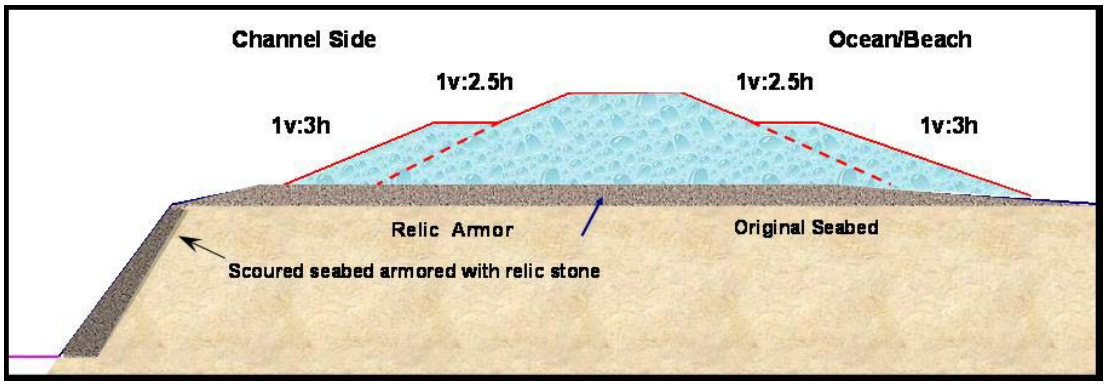
An armor stone cap or concrete armor units (CAU) will be placed on the head of the North Jetty to stop its deterioration (Table 4 and Figure 10). Approximately 38,000 tons (~23,750 cy) of stone or functionally equivalent CAUs will be placed on the relic stone to cap the jetty head. Future physical modeling will refine head capping features.

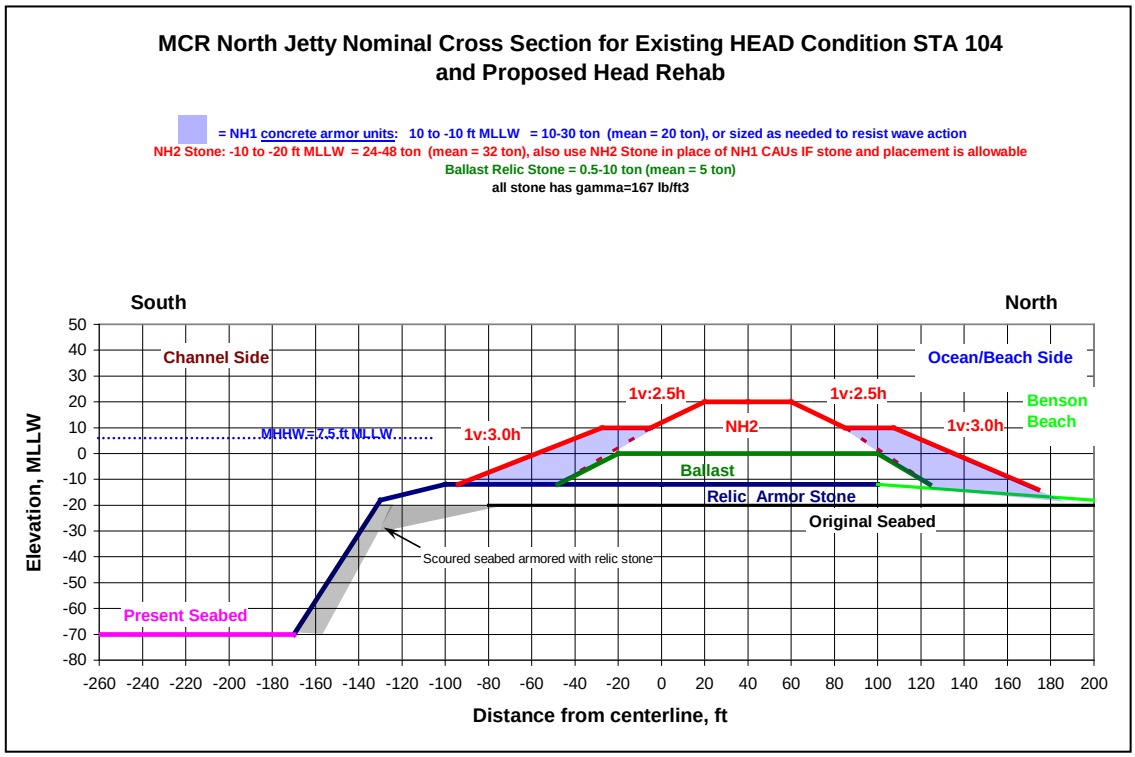
Table 4. North Jetty Head Cap Features

Head Cap Features	North Jetty
Location of cap	stations 99 to 101
Timing of construction	2015
Approximate dimensions of cap: length x width x height (feet)	350 x 270 x 45 (2.17 acres)
Stone size	30 to 50 tons
Area affected (outside relic stone)	None
% of cap constructed on relic stone	100%
Construction method	Cranes set on the jetty

For capping of the head, when stone placement is divided into elevation zones about 13,425 cy of rock will be placed above MHHW. This represents 49% of the overall stone placement on this portion of the jetty, and there is very little or no existing mounded jetty stone expected to be present within this elevation range. About 6,490 cy of rock will be placed between MHHW and MLLW. This represents 24% of the overall stone placement on this portion of the North Jetty, and there is very little or no existing jetty stone expected to be present within this elevation range. About 7,280 cy of rock will be placed below MLLW. This represents 27% of the overall stone placement on this portion of the North Jetty head, and a 2684% change from the existing jetty prism on this portion, as there is very little or no existing mounded jetty stone expected to be present within this elevation range. In all zones, all proposed stone placement will occur on existing base relic stone that formed the original jetty cross-section and was displaced and flattened by wave action, and does not include any modification that changes the character or increases the scope, or size of the original structure design. The terminus of the head is simply closer to shore on a shorter jetty structure. The footprint of the existing jetty mound on the flattened relic stone is approximately 1.37 acres, and the additional capping on the relic stone increases the width of the prism approximately 0.80 acres, for a total footprint of 2.17 acres, all of which will remain on the existing relic stone.

Figure 10. North Jetty Head Cap





North Jetty Lagoon and Wetland Fill and Culvert Replacement

Approximately 109,000 tons (~68,125 cy) of gravel and sand will be added to the jetty's beach side as lagoon fill to eliminate the tidal flow through the jetty that is destabilizing the foundation. A recent berm repair action now precludes lagoon inundation by tidal waters. Scouring has taken place on the north side of the North Jetty resulting in formation of a backwater area (lagoon) that was previously inundated both by tidal waters that come through the jetty and by freshwater that drains from the O'Neil Lake-McKenzie Head Lagoon and wetland complex area through the accreted land to the north of the jetty and North Jetty Road. This area drains through a culvert under the road and provides some of the freshwater flow to the lagoon. The surrounding lagoon resembles a scoured-out tidal channel and is a non-vegetated (and

non-wetland) area of bare sand comprising approximately 4.71 acres. These wetland and waters will be filled to protect and stabilize the foundation of the North Jetty and to serve as a location for rock stockpiles and construction staging activities. The features of this work are shown in Table 5.

Table 5. North Jetty Lagoon and Wetland Fill Features

Features	North Jetty
Timing of construction	2014
Material used for fill	Sand, gravel, quarry stone
Short-term and long-term use	Stockpile area, long-term stabilization of root
De-watering	Culvert feeding into area will be re-placed
Impact on wetlands	1.78 acres
Impact on Section 404 waters	4.71 acres

After further hydraulic and hydrologic design, the aging culvert draining south from the wetland complex north of the roadway will be replaced, as it provides required drainage under the roadway. The design of the inlet, elevation, and culvert size will be determined so that hydrologic function in the adjacent wetland system is not negatively impacted. The outlet channel downstream of the culvert will not be filled. This area may provide an opportunity for minor stream and bank enhancement which will be evaluated when the culvert design is finalized, but this is uncertain until possible benefits can be further assessed. Under the proposed action, the existing channel will outlet to an engineered sump area comprised of newly placed lagoon fill material. In addition to infiltration through the jetty structure, this small portion of the creek currently connects the wetland to the lagoon and likely also receives some backwater flow from jetty infiltration. The current culvert is perched, and the regularly disconnected nature of the lagoon system does not appear to support anadromous fish use. Fish surveys were not completed for the stream inlet leading into this wetland complex and creek. The Corps proposes to conduct an initial sampling survey during peak juvenile salmon outmigration to determine whether or not fish salvage and fish exclusion efforts for listed species is warranted. The Corps will coordinate with NMFS if listed species are identified. Redesign of this system may provide an opportunity to accommodate improved hydrology to newly created wetlands excavated adjacent to the existing wetland complex. This will be further investigated during the hydraulic/hydrologic design analysis.

MCR South Jetty

The proposed action for the South Jetty includes scheduled repairs addressing mostly above MLLW water structural instability, five spur groins, head capping, and improving the jetty shoreline near the root (Figure 11). Seven Scheduled Repair events over the next 20 years were predicted at the South Jetty.

South Jetty Trunk and Root

The cross-section design from stations 155+00 to 311+00 will have a crest width of approximately 30 feet and will lie essentially within the existing jetty footprint based on the configuration of the original cross section, previous repair cross sections, and redistribution of jetty rock by wave action (Figure 12). The majority of the stone placement will be conducted above the MLLW. Each repair action is expected to cover a length up to 2,100 feet and include stone volumes in the range of 30,000 to 118,000 tons per season (18,750 - 73,750 cy).

As with the North Jetty repair action, it is expected that 60%-70% of the South Jetty's overall standard jetty template cross section has been displaced. Therefore, each repair event will increase the existing degraded cross section from 30%-40% back to 100% of the desired standard cross-section template. This means overall, the added rock will essentially triple what exists immediately prior to the time of repair. This could be described as a ~300% increase in rock relative to the existing jetty rock volume. However, this will not result in an increase the jetty prism or footprint beyond the scope and size of the historic structure, and does not include any modification that changes the character, scope, or size of the original structure design.

Per repair event, when divided into elevation zones, about 37,640 cy of rock will be placed above MHHW. This represents 68% of the overall stone placement on these portions of the South Jetty and a 1023% change from the existing jetty prism, as very little stone currently remains in the zone and a larger amount of stone must be placed compared to what presently remains. As described, above, this same concept applies characterizations about the rest of the zones. About 10,420 cy of rock will be placed between MHHW and MLLW. This represents 19% of the overall stone placement on these portions of the South Jetty and a 225% change from the existing jetty prism. About 6,940 cy of rock will be placed below MLLW. This represents 13% of the overall stone placement on these portions of the South Jetty and a 150% change from the existing jetty cross section. However, in all zones, all proposed stone placement will occur on existing base relic stone that formed the original jetty cross section. The footprint of the trunk and root of the South Jetty will remain within its current jetty dimensions and on relic stone.

Figure 11. Proposed Action for the MCR South Jetty

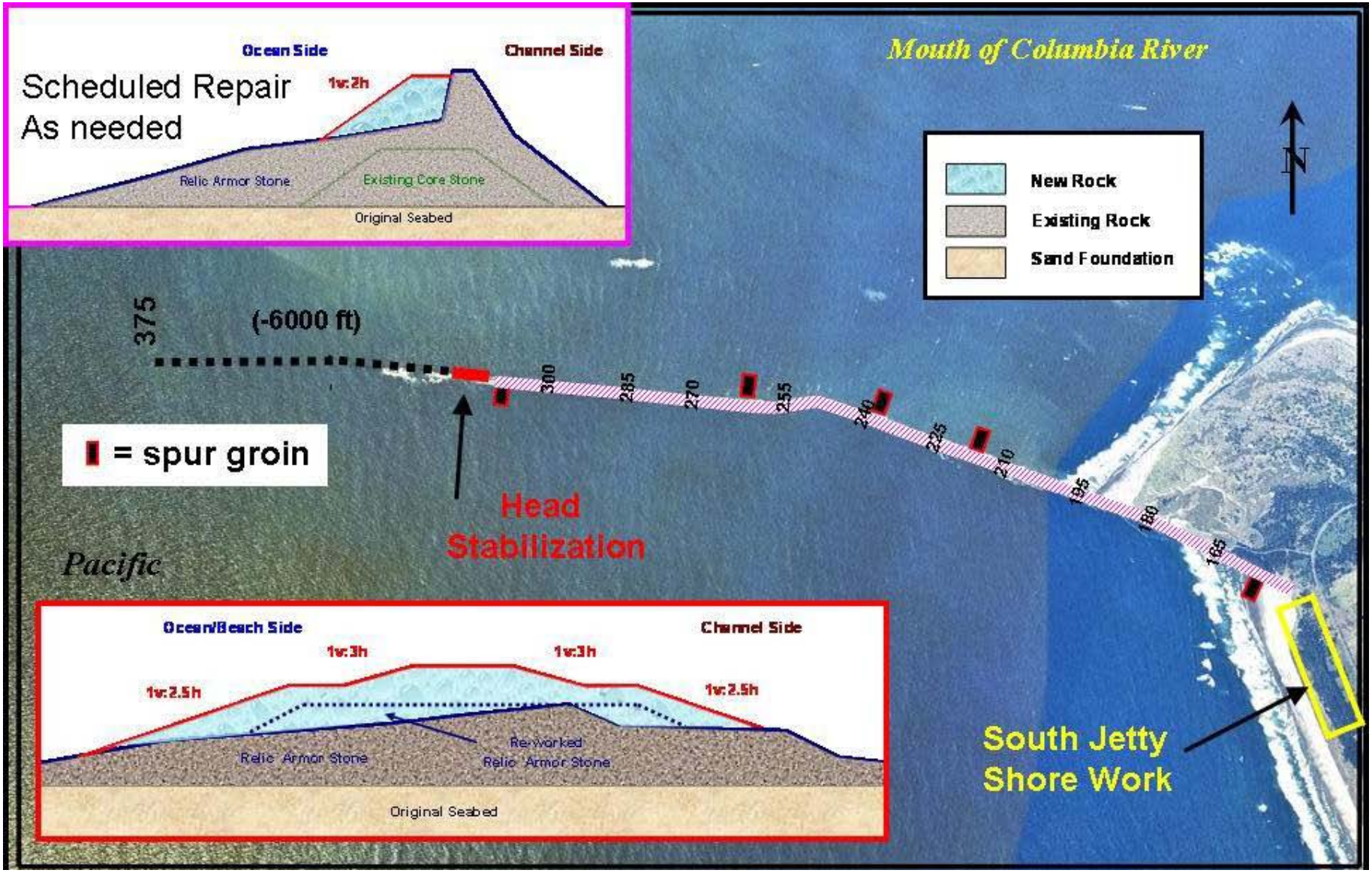
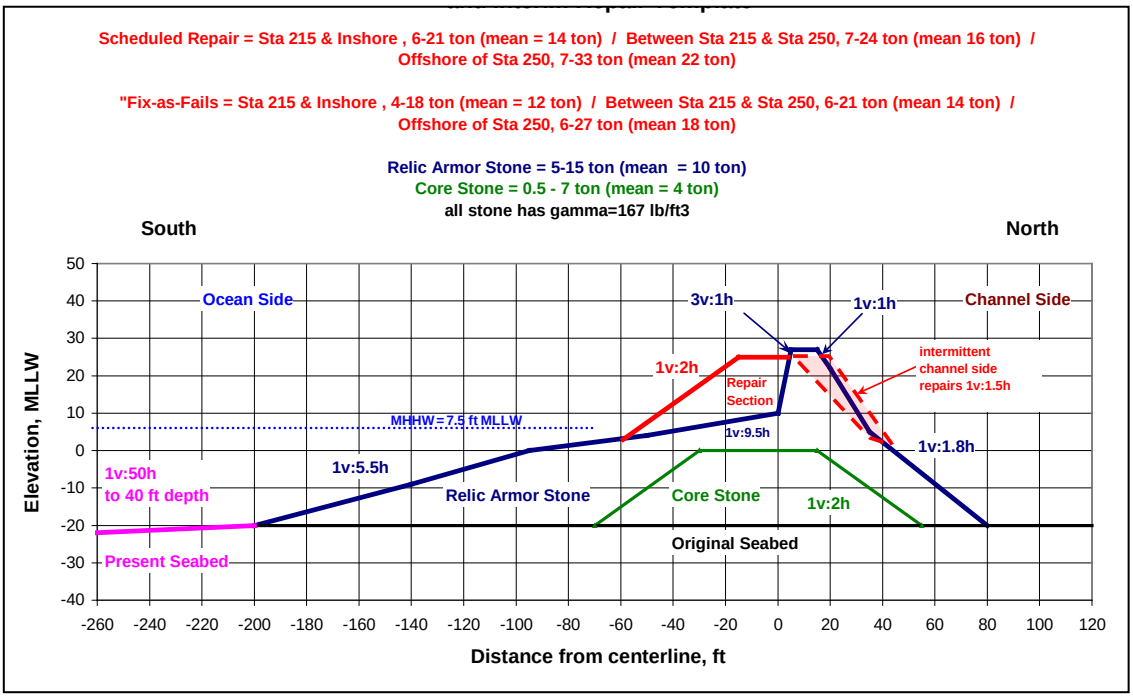


Figure 12. South Jetty Cross Section for Existing Condition and Scheduled Repair



South Jetty Spur Groins

Three emergent and two submergent spur groins will be constructed to stabilize the jetty's foundation (Figures 13 to 17). The dimensions and other features of the spur groins are shown in Table 6.

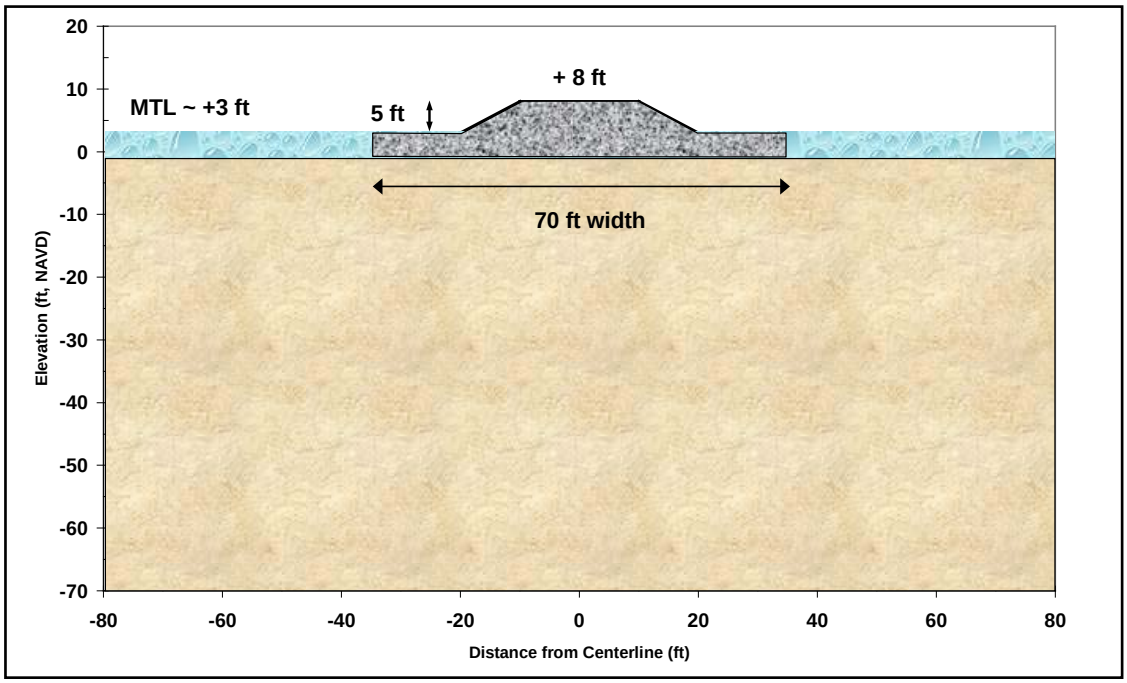
Representing estimated rock volume totals divided into elevation zones for all spurs on the South Jetty, about 21 cy of rock will be placed above MHHW. This represents 0.1% % of the overall stone placement on these portions of the South Jetty, and there is very little or no existing jetty stone expected to be present within this elevation range. About 2,190 cy of rock will be placed between MHHW and MLLW. This represents 12.3% of the overall stone placement on these portions of the South Jetty, and there is very little or no existing jetty stone expected to be present within this elevation range. About 15,700 cy of rock will be placed below MLLW. This represents 87.6% of the overall stone placement on these portions of the South Jetty, and there is very little or no existing jetty stone expected to be present within this elevation range. The footprint of the spurs on the South Jetty will increase from 0 acres to 1.10 acres. In the relevant figures, note that the difference in the vertical and horizontal scales causes a slight representational distortion.

Table 6. South Jetty Spur Groin Features

Spur Groin Feature	South Jetty
Number of spurs on channel side or downstream	3
Number of spurs on ocean side or upstream	2
Approximate total rock volume per spur (+/- 20%)	SJ1O: 1,680 tons (~1,050 cy) SJ2C: 2,350 tons (~1,469 cy) SJ3C: 2,350 tons (~1,469 cy) SJ4C: 3,180 tons (~1,988 cy) SJ5O: 18,750 tons (~11,719 cy)
Approximate total rock volume (all spurs) (+/- 20%)	25,000 tons (~15,625 cy)
Approximate area affected by each spur	SJ1O: 0.11 acres SJ2C: 0.13 acres SJ3C: 0.13 acres SJ4C: 0.19 acres SJ5O: 0.55 acres
Approximate total area affected (all spurs)	1.10 acres
Approximate area of spurs above water	SJ1O: 29% SJ2C: 7% SJ3C: 7% SJ4C: 0% SJ5O: 0%
Approximate area of spurs below -20 MLLW	SJ1O: 0% SJ2C: 0% SJ3C: 0% SJ4C: 0% SJ5O: 92%
Approximate dimension of spurs: length x width x height (feet)	SJ1O: 60 x 80 x 9 SJ2C: 70 x 80 x 10 SJ3C: 70 x 80 x 10 SJ4C: 90 x 90 x 12 SJ5O: 190 x 125 x 22

Figure 13. South Jetty Spur Groin SJ1O

Note difference in scale between vertical and horizontal axes.



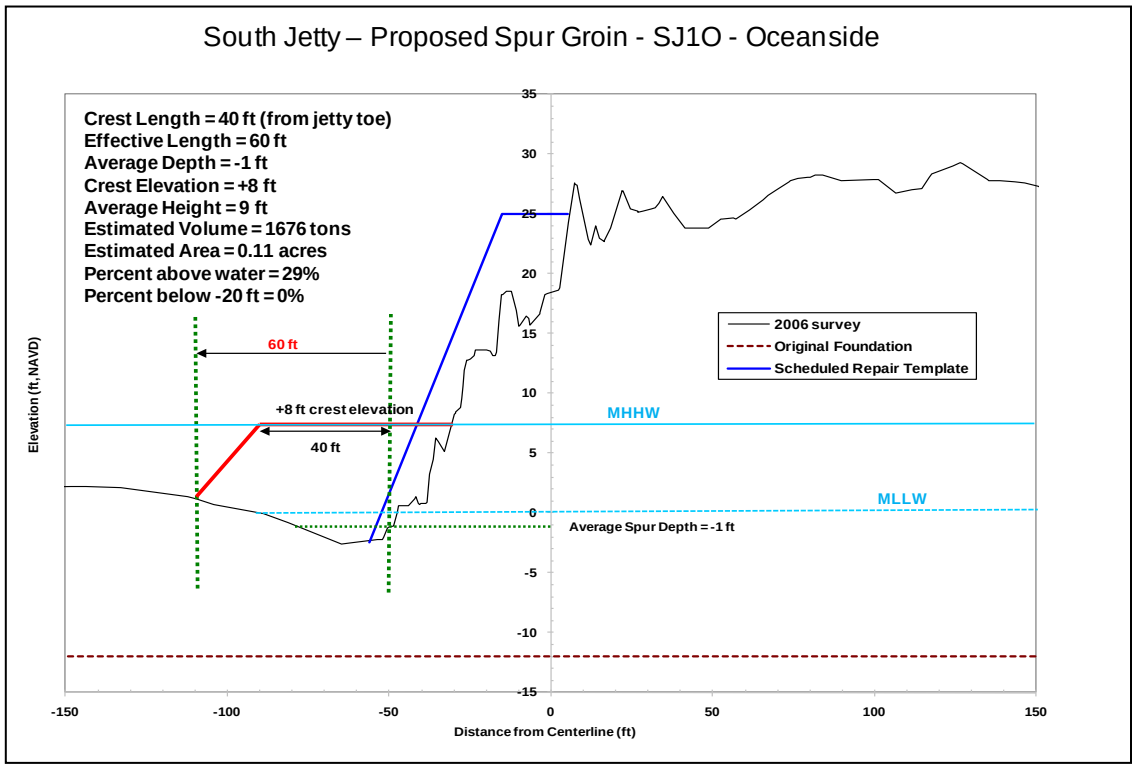
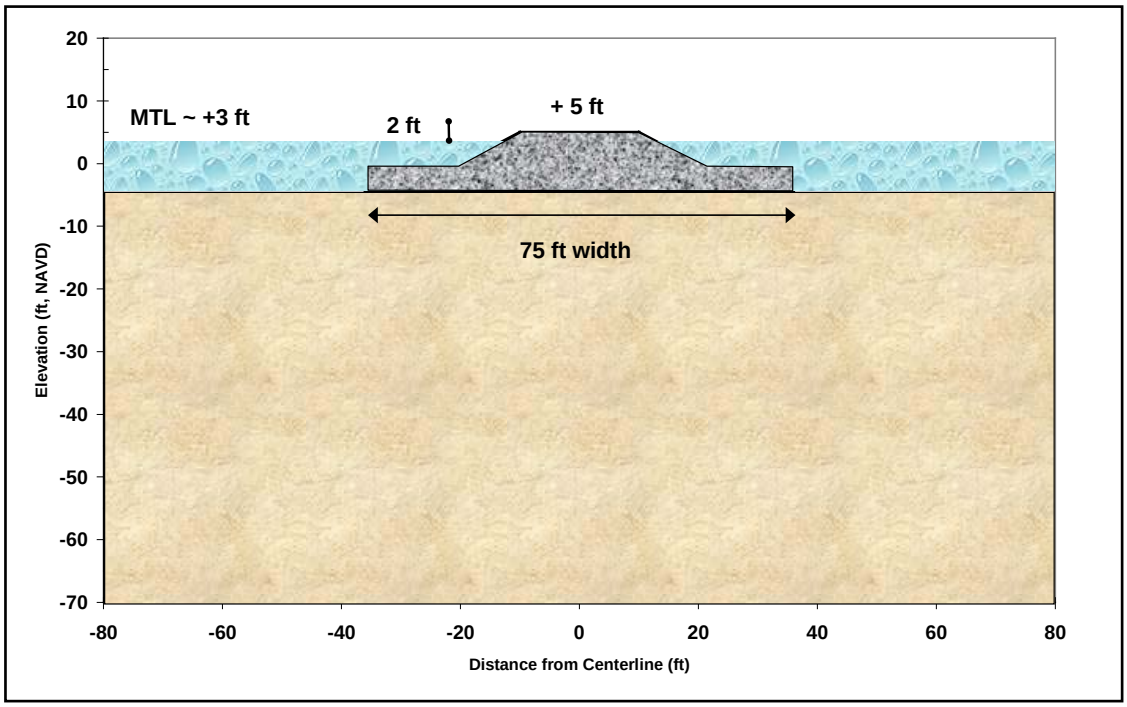


Figure 14. South Jetty Spur Groin SJ2C

Note difference in scale between vertical and horizontal axes.



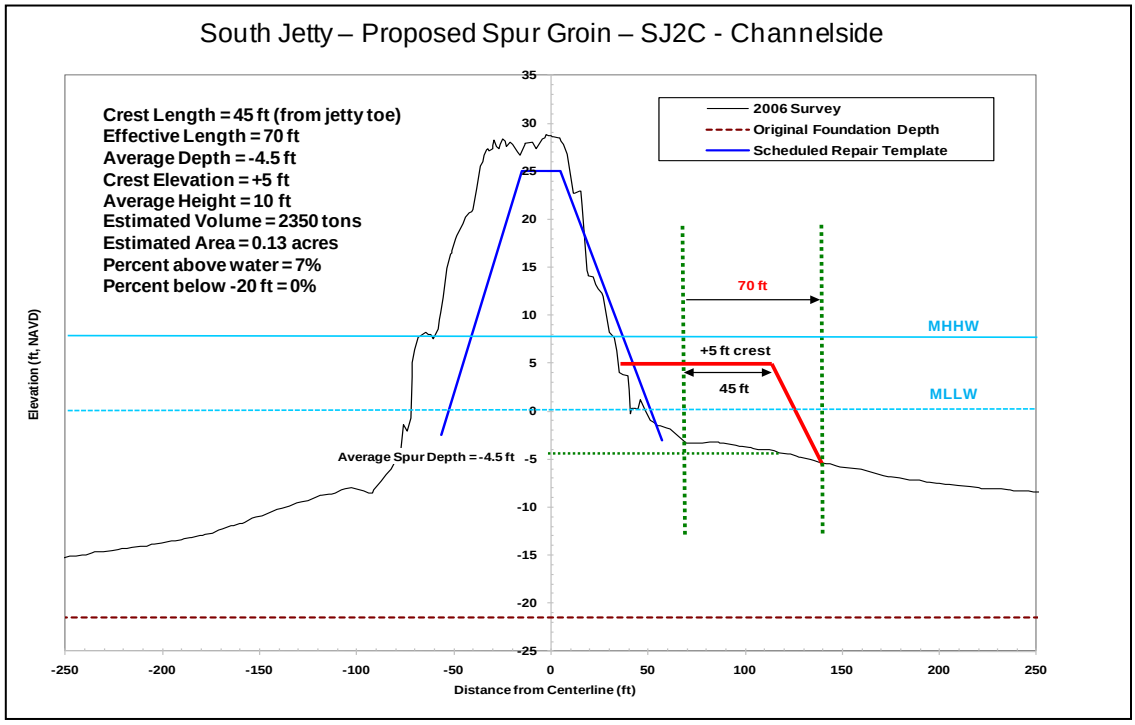
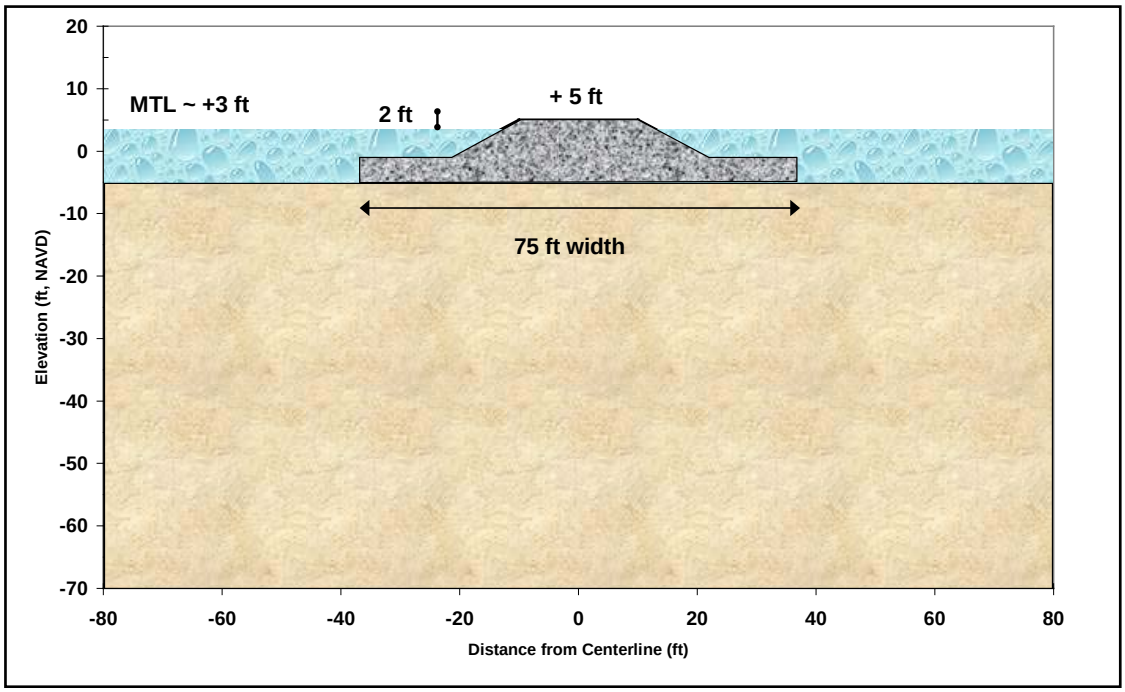


Figure 15. South Jetty Spur Groin SJ3C

Note difference in scale between vertical and horizontal axes.



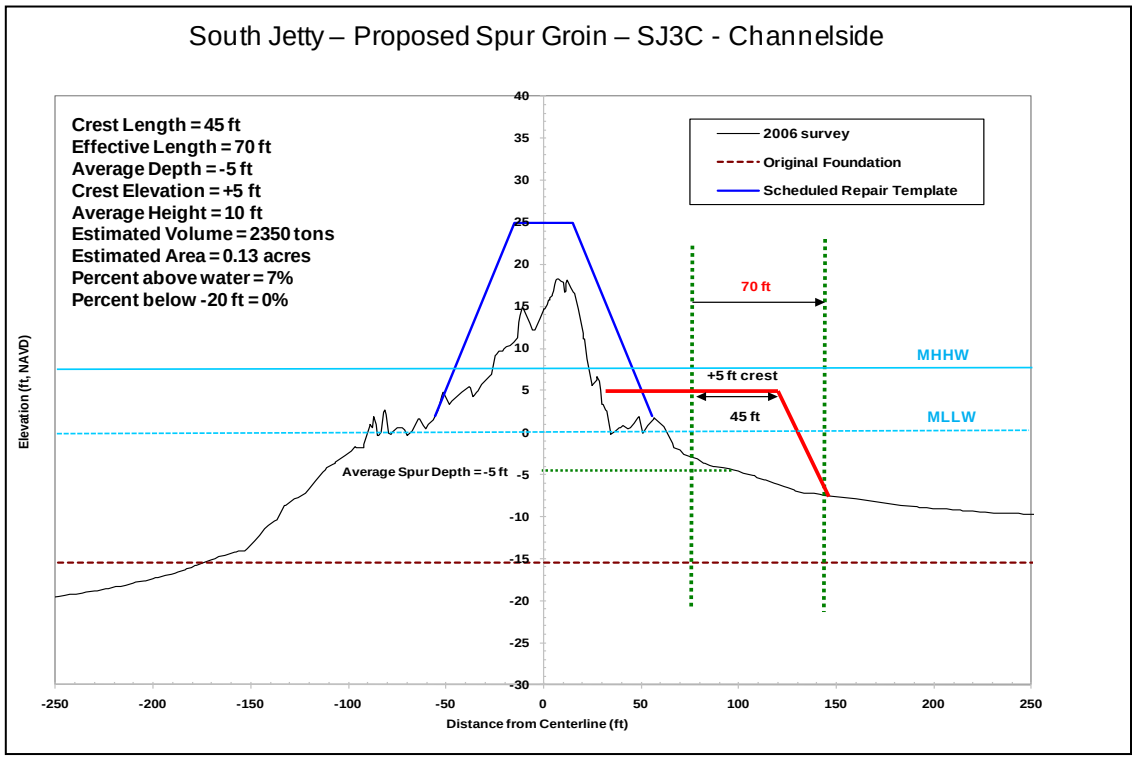
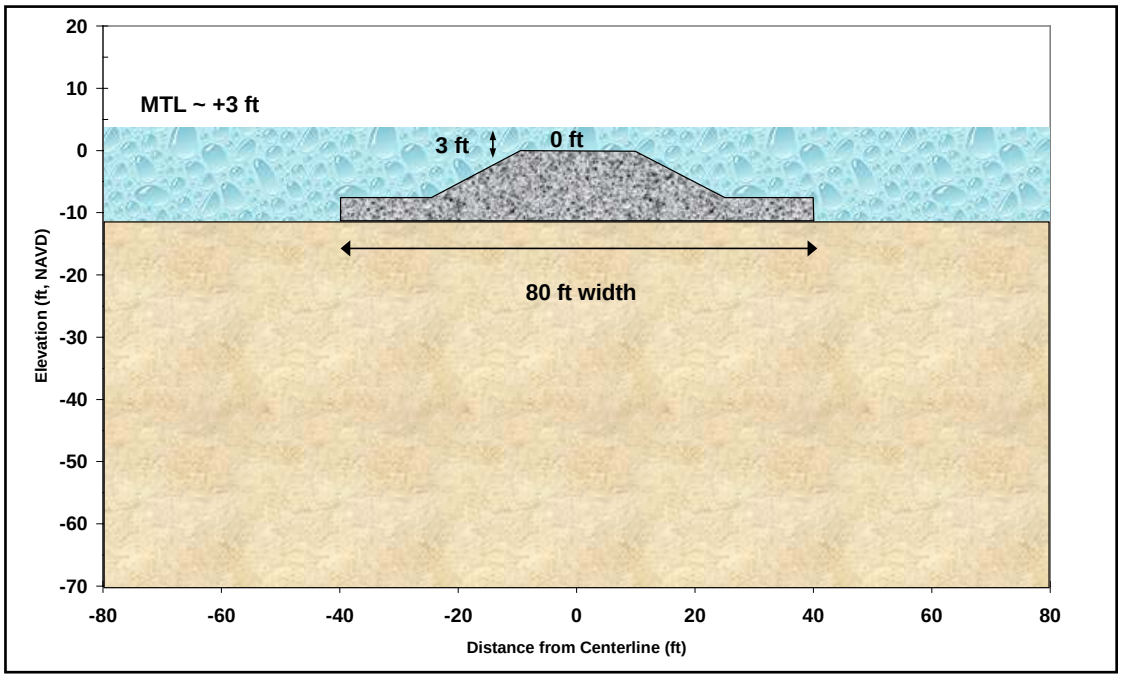


Figure 16. South Jetty Spur Groin SJ4C

Note difference in scale between vertical and horizontal axes.



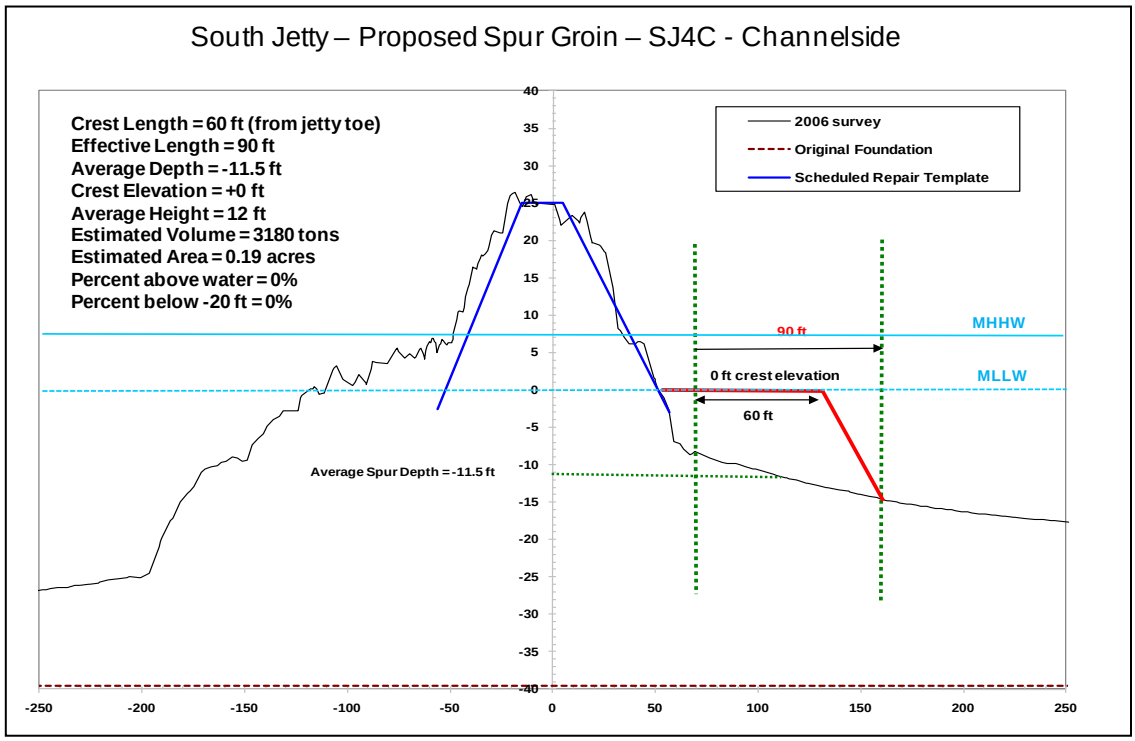
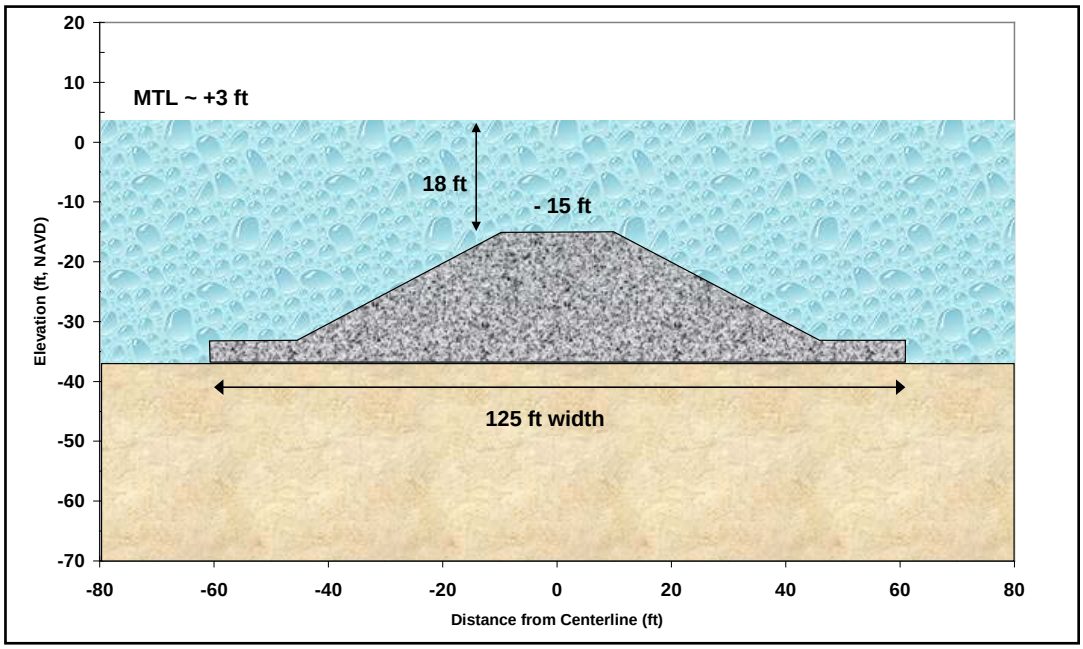
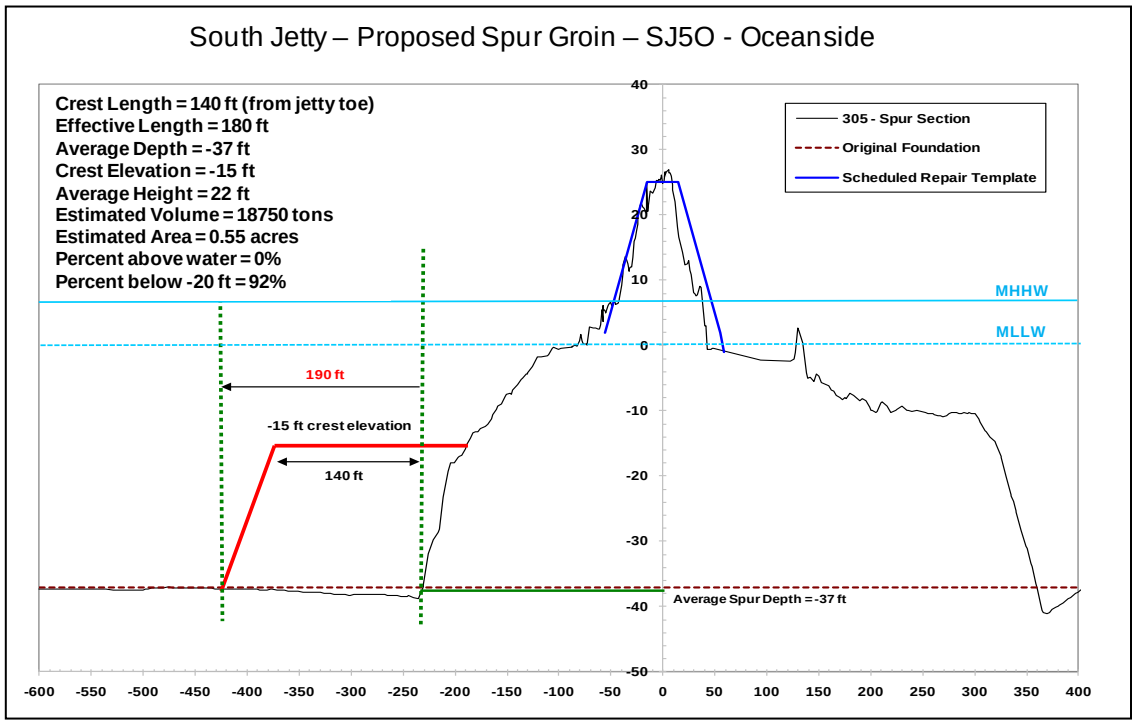


Figure 17. South Jetty Spur Groin SJ5O

Note difference in scale between vertical and horizontal axes.





South Jetty Head Capping

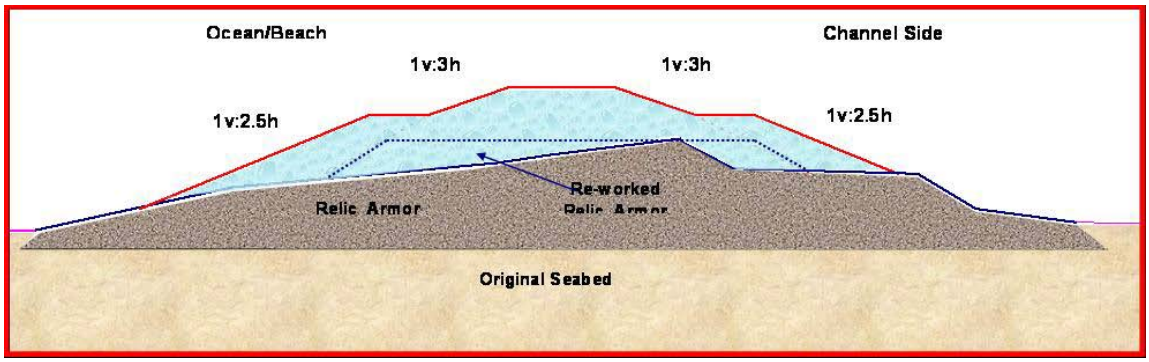
An armor stone cap with approximately 40,000 to 74,000 tons (~25,000 - 46,250 cy) of stone or equivalent concrete armor units will be placed on the head of the South Jetty to stop its deterioration (Figure 18). The features of this work are shown in Table 7.

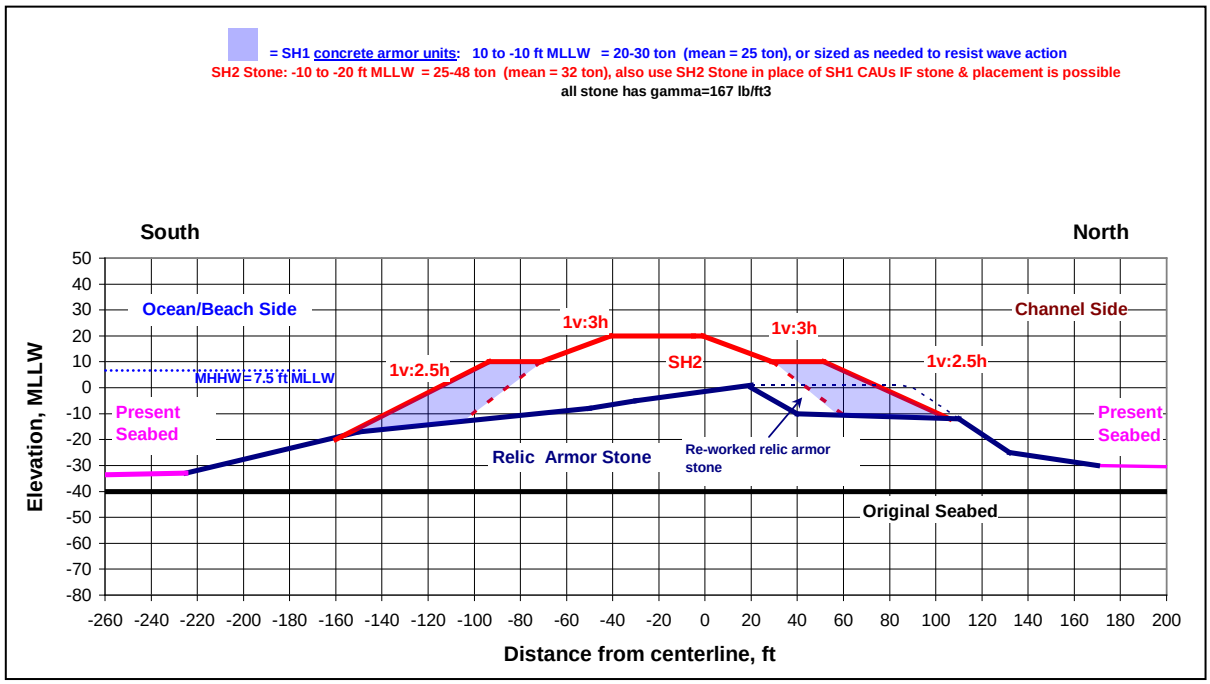
For capping of the head, divided into elevation zones about 13,425 cy of rock will be placed above MHHW. This represents 52% of the overall stone placement on this portion of the South Jetty and there is very little or no existing jetty stone expected to be present within this elevation range. About 6,490 cy of rock will be placed between MHHW and MLLW. This represents 25% of the overall stone placement on this portion of the South Jetty and there is very little or no existing jetty stone expected to be present within this elevation range. About 6,050 cy of rock will be placed below MLLW. This represents 23% of the overall stone placement on this portion of the South Jetty and 1150% change from the existing base condition as there is very little or no existing mounded jetty stone expected to be present within this elevation range. In all zones, all proposed stone placement will occur on existing base relic stone that formed the original jetty cross section and was displaced and flattened by wave action, and does not include any modification that changes the character or increases the scope or size of the original structure design. The terminus of the head is simply closer to shore on a shorter jetty structure. The footprint of the existing jetty mound on the flattened relic stone is approximately 1.69 acres, and the additional capping on the relic stone increases the width of the prism approximately 0.64 acres, for a total footprint of 2.33 acres, all of which will occur on existing relic stone.

Table 7. South Jetty Head Capping Features

Capping Feature	South Jetty
Location of cap	stations 311 to 313
Timing of construction	2019-2020
Dimensions of cap: length x width x height (feet)	350 x 290 x 45 (2.33 acres)
Stone size	30 to 50 tons
Area affected (outside relic stone)	None
% of cap constructed on relic stone	100%
Construction method	Land-based cranes or jack-up barge

Figure 18. South Jetty Head Cap





South Jetty Root Erosion and Dune Augmentation

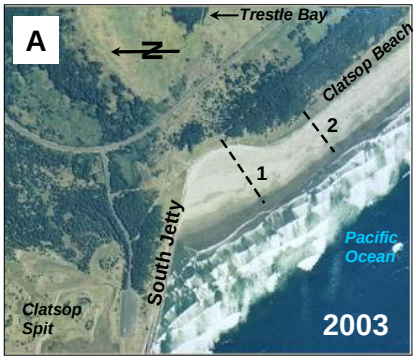
Currently, the coastal shore interface along the South Jetty is in a condition of advanced deterioration (Figure 19). The foredune separating the ocean from the backshore is almost breached. The backshore is a narrow strip of a low-elevation, accretion area that separates Trestle Bay from the ocean by hundreds of yards. The offshore area along the South Jetty (and to the south) continues to erode, promoting larger wave action to affect the shoreline along the South Jetty root. The back dune of Trestle Bay has continued to advance westward due to increased circulation in the bay, seasonal wave chop, and hydraulic surcharging. Under existing conditions, the shoreline at the root of the South Jetty will continue to erode and recede, resulting in a possible shoreline breach into Trestle Bay in about 8-16 years. If this sand spit breach occurs, the result would be catastrophic. The MCR inlet would establish a secondary flow way from the estuary to the ocean along this area (south of South Jetty). This condition would profoundly disrupt navigation at the MCR and bring lasting changes to the physical nature of the inlet.

Figure 19. Clatsop Spit and South Jetty Root Erosion

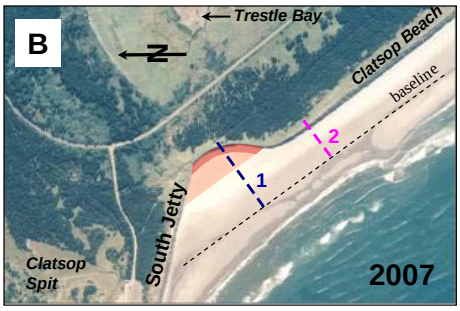
About 40,000 to 70,000 cy of cobble in the shape of angular or rounded graded stone is proposed at the South Jetty root in order to fortify the toe of the foredune and to improve the foreshore fronting to resist wave-induced erosion/recession (Figure 20). Maximum crest width of the template is estimated to extend 70 feet seaward from the seaward base of the present foredune. Construction of the berm augmentation would require 2 to 6 weeks. To adequately protect the foredune during storm conditions, this requires that the top of the stone berm (crest) extend vertically to approximately 25 feet NAVD and have an alongshore application length of approximately 1,100 feet, extending southward from the South Jetty root. This is equivalent to about 3 acres. The constructed template crest would be 10 to 15 feet above the current beach grade and have a 1 vertical to 10 horizontal slope aspects from crest to existing grade. Cobble is not expected to extend below MHHW. An additional layer of sand may be placed over this berm, or natural accretion may facilitate sand recruitment after construction of the adjacent spur groin.

Cobble material would be procured from upland sources and placed using haul trucks and dozers. The material would be transported on existing surface roads and through Fort Stevens State Park to a beach access point at the project site. There is an existing relic access road along the jetty root that will be refurbished and used to transport stone to the dune augmentation area. Though there is an existing razor clam bed adjacent to the vicinity of the proposed dune augmentation, species impacts are not expected because all of the stone placement will occur above MHHW, and haul traffic will be precluded using Parking Lot B and from driving on the beach during material delivery. Excavator and bulldozer work will be mostly confined to the dry sand areas to further avoid negative species effects.

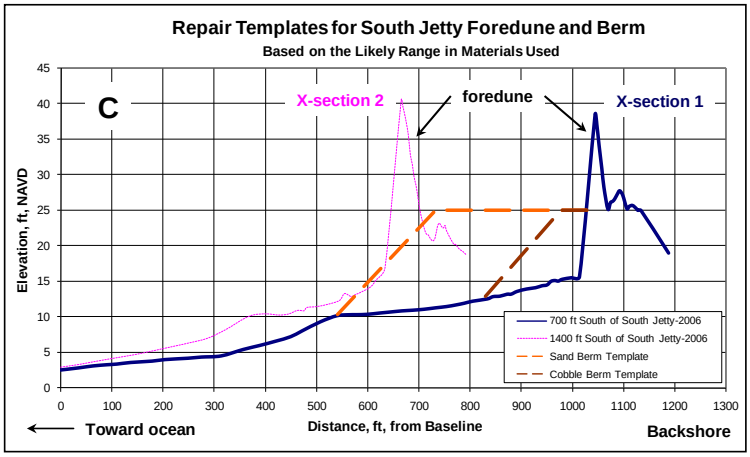
Figure 20. South Jetty Root Shoreline Area



MCR South Jetty root, south side where Clatsop Spit joins with Clatsop Plains/Beach. Panels A and B show the erosion embayment along the south jetty root for 2003 (hIgh tide) and 2007 (low tide). The embayment & adjacent shore have receded 40 ft landward during 2003-2007, reducing the protective foredune along the embayment.



Panel C shows cross-sections 1 and 2 for 2007(shown in panels A & B). Severe erosion in this area had threatened the inlet stability during early 1930s, when jetty rehabilitation and sand augmentation measures were implemented. Erosion has again become chronic since the late 1970s. The foredune protects the backshore (elevation 15-18 ft NAVD) from wave surge action during storms. If the foredune is breached, the backshore will be rapidly eroded. Without erosion abatement, it is estimated that that the Pacific Ocean will establish hydraulic connectivity with Trestle Bay in 10-15 years from 2009, and again threaten inlet stability. Panel C shows two options for protecting the foredune within the erosion embayment: A SAND berm template requires ~225,000 cy of sand placement, and a COBBLE berm template requires ~60,000 cy of cobble placement.



The dune augmentation may require maintenance every 4-10 years (assume 40% replacement volume). Consideration will be given to development of revegetation plans which incorporate native dune grasses to supplement foredune stabilization in the augmentation area. This bioengineering component could help restore habitat and take advantage of natural plant rooting functions that provide greater protection from erosive forces.

MCR Jetty A

The proposed action for Jetty A includes Immediate Rehabilitation with a small cross section, two spur groins, and head capping (Figure 21).

Jetty A Trunk and Root

The cross-section design from stations 40+00 to 91+00 will have a crest width of approximately 40 feet and will lie mostly within the existing jetty footprint based on the configuration of the original cross section, previous repair cross sections, and redistribution of jetty rock by wave action (Figure 22). About 55,000 tons (~34,375 cy) of new rock will be placed on the existing jetty cross section and relic armor stone on the estuary/channel side of the jetty and 75,000 tons (~46,875 cy) of new rock on the ocean side of the jetty. Though most of the work will occur above MLLW, there will also be some stone placement below this elevation. The small cross-section also has a higher likelihood of expanding beyond the relic base compared to repair actions.

About 63,700 cy of rock will be placed above MHHW. This represents 63% of the overall stone placement on these portions of Jetty A and a 2020% change from the existing jetty prism, as very little stone currently remains in the zone and a larger amount of stone must be placed compared to what presently remains. As described previously for North and South jetties, this same concept applies to characterizations about the rest of the zones. About 28,940 cy of rock will be placed between MHHW and MLLW. This represents 29% of the overall stone placement on these portions of Jetty A and a 280% change from the jetty prism. About 8,030 cy of rock will be placed below MLLW. This represents 8% of the overall rock on these portions of Jetty A and a 233% change from the existing jetty prism. In all zones, most of the proposed stone placement will occur on existing base relic stone that formed the original jetty cross-section. However, the footprint of the proposed prism could increase in width compared to the existing prism by up to 10 feet along the length of the jetty (though it would still be on the relic stone). This equals about 1.2 acres, but it is not expected to result in additional habitat conversion because it will be in a bottom location already comprised of jetty stone, and does not include any modification that changes the character, scope, or size of the original structure design.

Figure 21. Proposed Action for MCR Jetty A

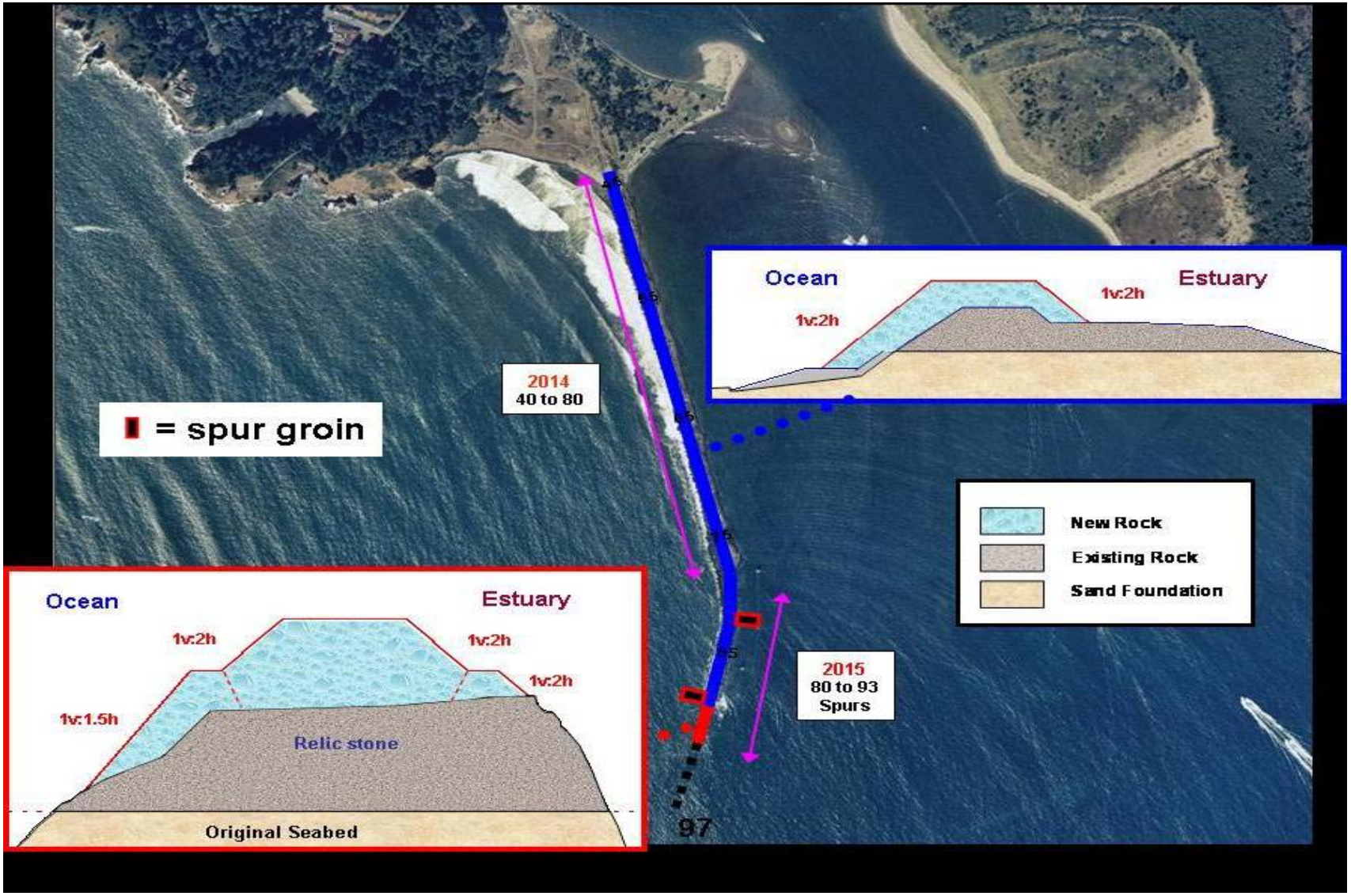
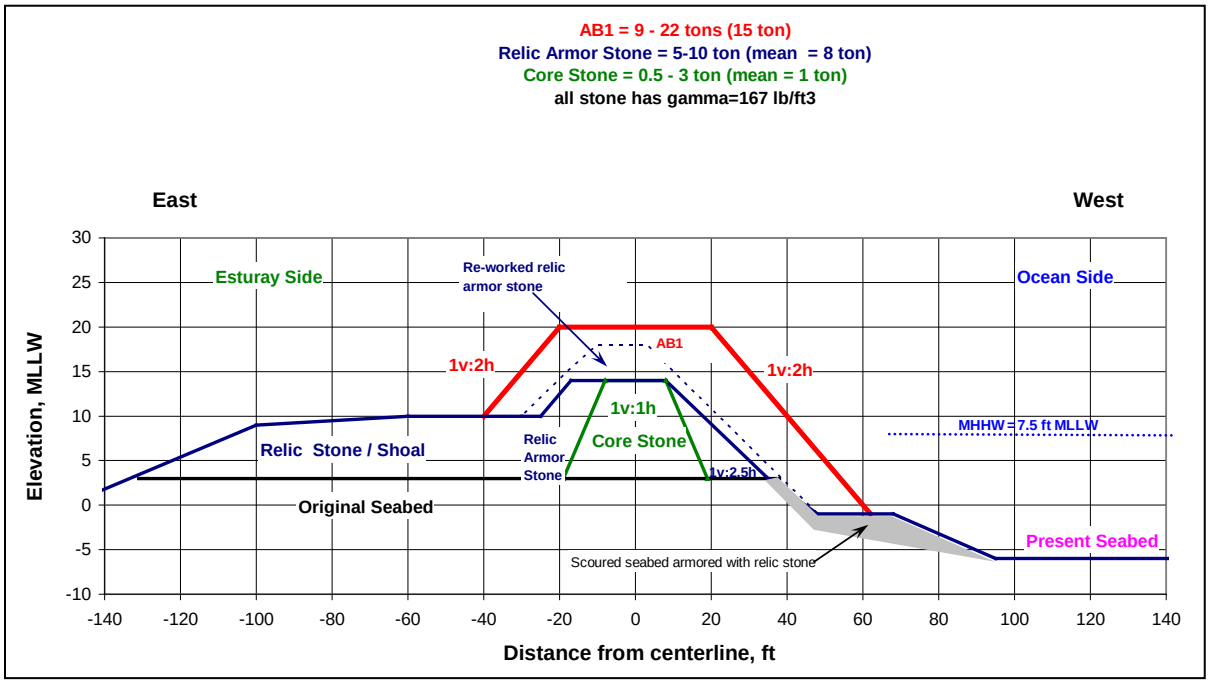


Figure 22. Jetty A Cross Section for Proposed Action



Jetty A Spur Groins

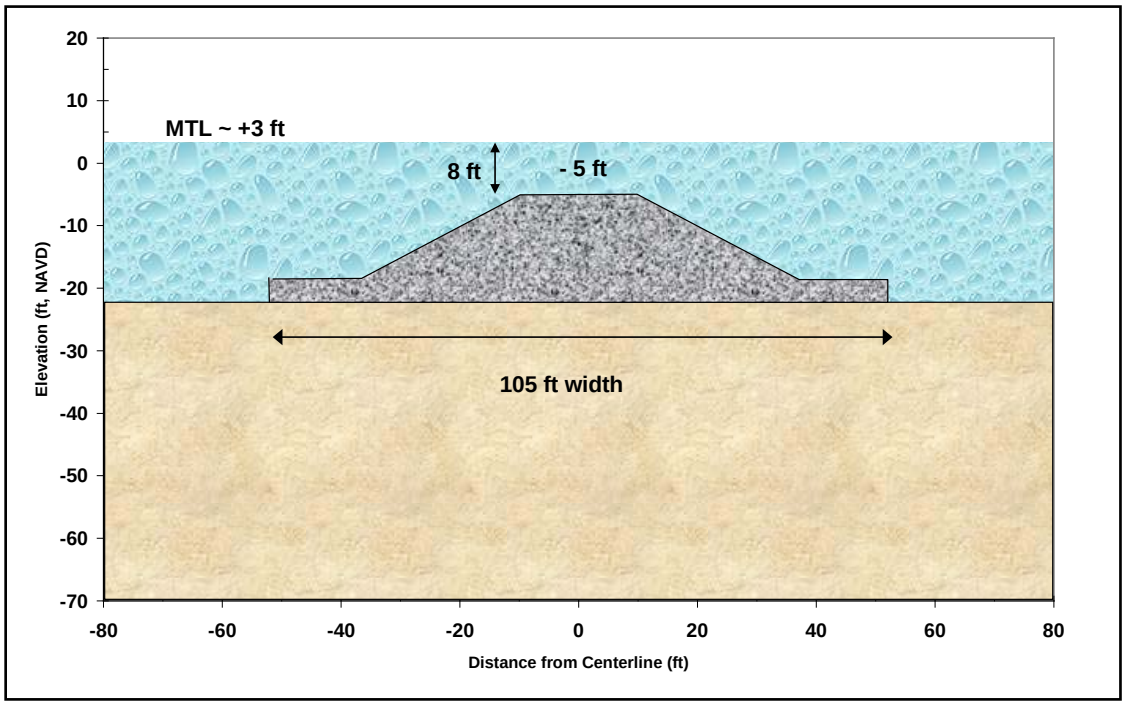
One submergent spur groin will be placed on the downstream (referred to as JA1C) side and one submergent spur groin will be placed on the upstream (referred to as JA2O) side to stabilize the jetty's foundation (Figures 23-24). The dimensions and other features of the spur groins are shown in Table 8. Representing estimated rock volume totals divided into elevation zones for all spurs on Jetty A, no stone will be placed above MLLW, and there is very little to no existing jetty stone expected to be present within either of these elevation ranges. About 10,800 cy of rock will be placed below MLLW and represents 100% of the overall stone placement on these portions of Jetty A. The footprint of the Jetty A spurs will increase from 0 acres to ~ 0.61 acres beyond existing relic stone. In the relevant figures, note that the difference in the vertical and horizontal scales causes a slight representational distortion.

Table 8. Jetty A Spur Groin Feature

Spur Groin Feature	Jetty A
Number of spurs on channel side or downstream for Jetty A	1
Number of spurs on ocean side or upstream for Jetty A	1
Approximate total rock volume per spur (+/- 20%)	JA1C: 9,650 tons (~ 6,031 cy) JA2O: 7,330 tons (~ 4,581 cy)
Approximate total rock volume (all spurs) (+/- 20%)	25,000 tons (~ 15,625 cy)
Approximate area affected by each spur	JA1C: 0.33 acres; JA2O: 0.29 acres
Approximate total area affected (all spurs)	0.61 acres
Approximate area of spurs above water	JA1C: 0%; JA2O: 0%
Approximate area of spurs below -20 MLLW	JA1C: 1%; JA2O: 0%
Approximate dimension of spurs: length x width x height (ft)	JA1C: 135 x 105 x 18 JA2O: 125 x 100 x 15

Figure 23. Jetty A Spur Groin JA1C

Note difference in scale between vertical and horizontal axes.



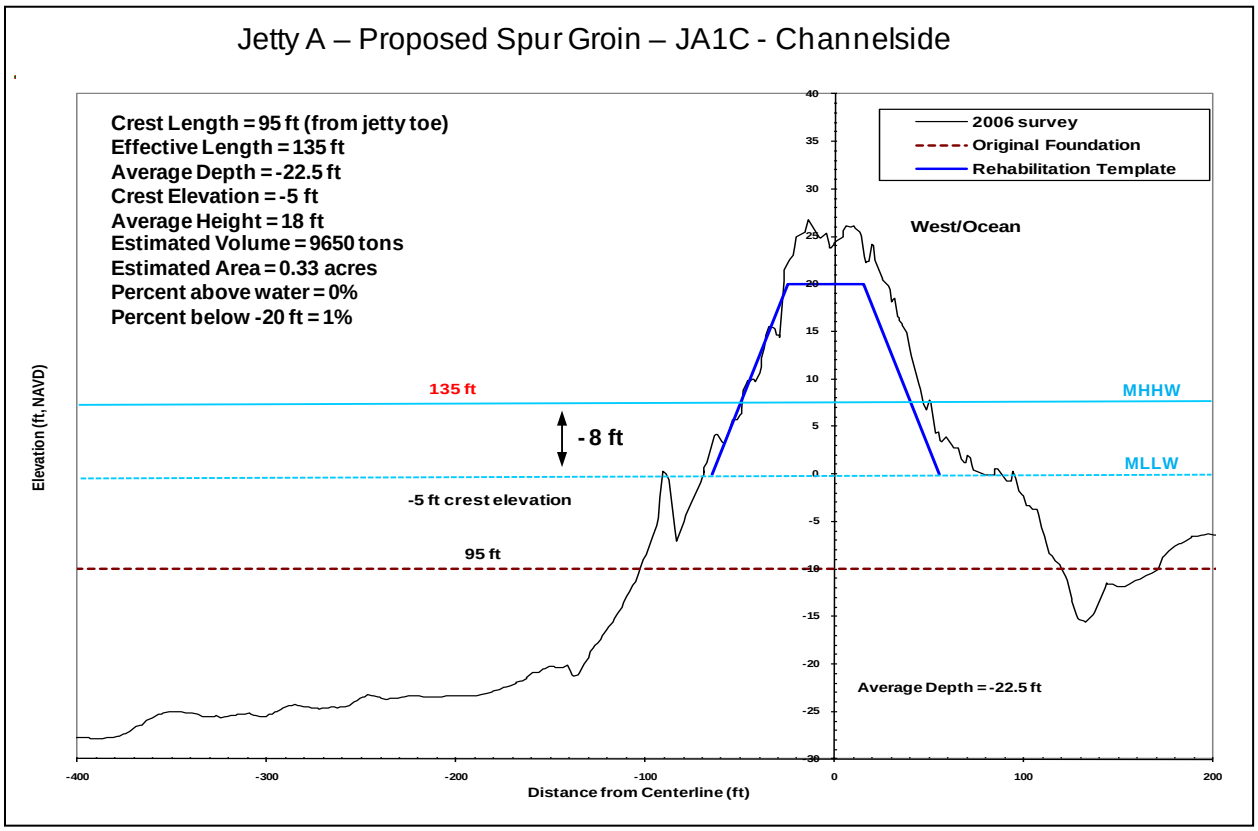
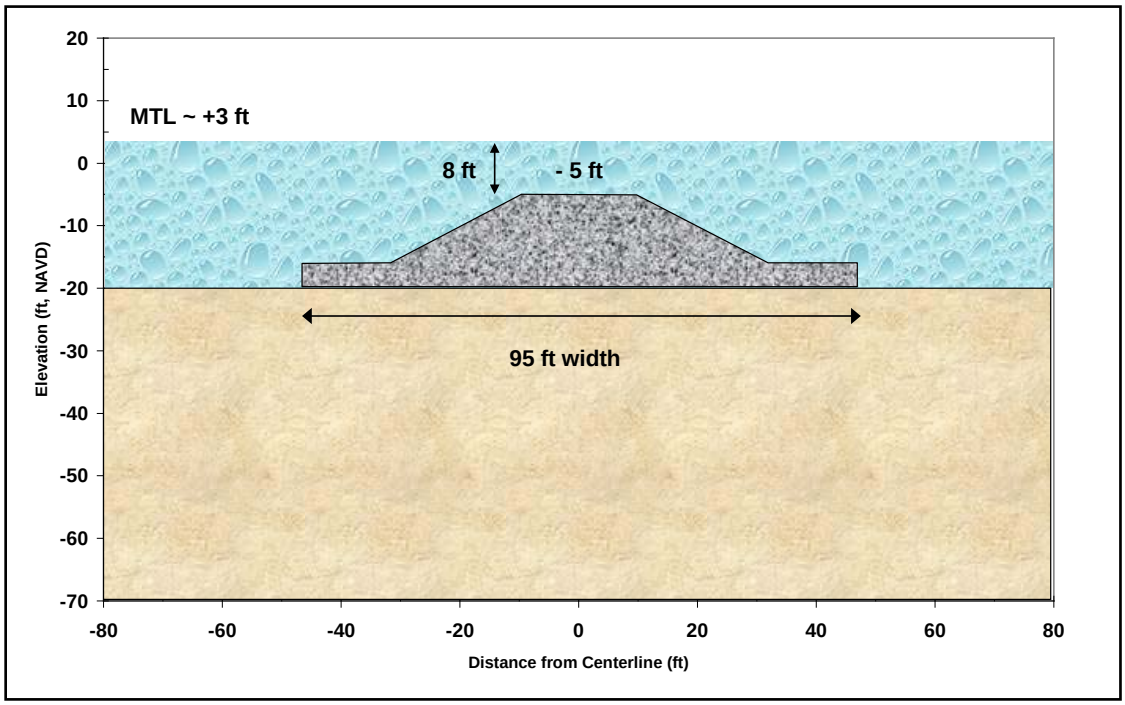
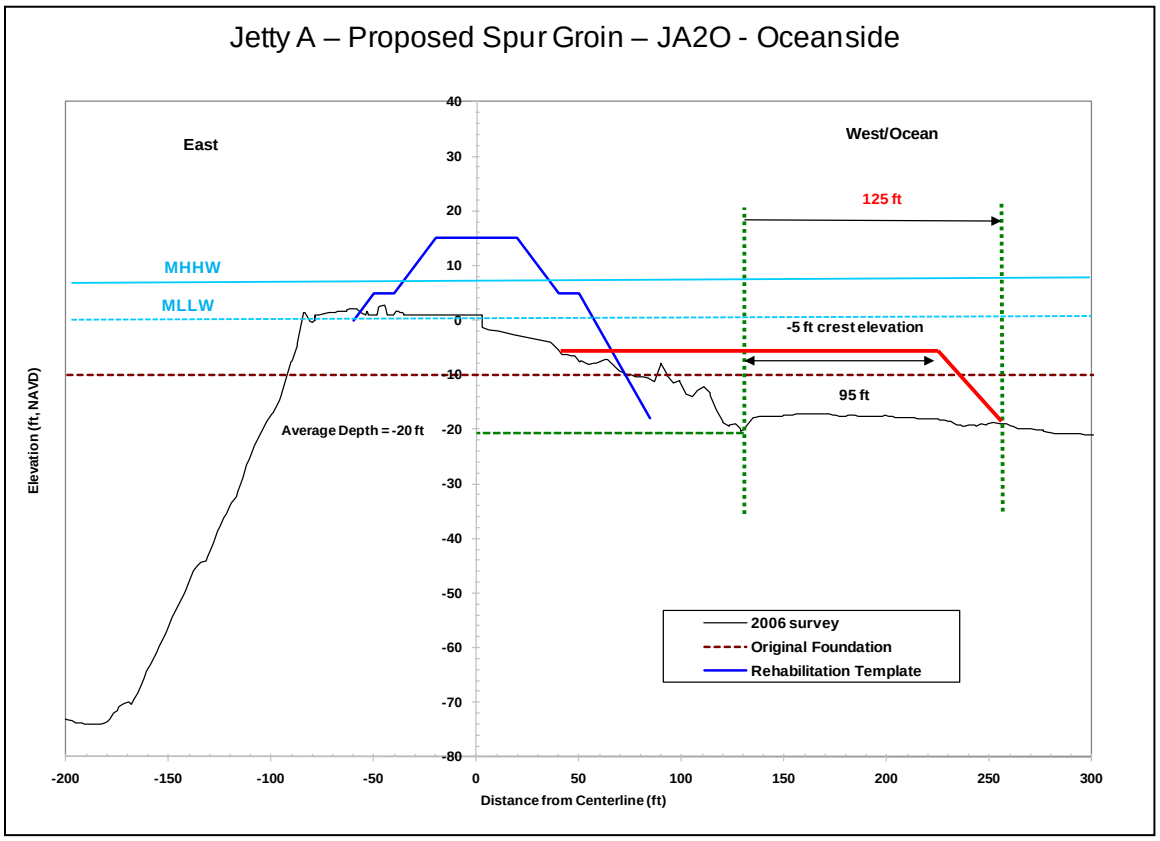


Figure 24. Jetty A Spur Groin JA2O

Note difference in scale between vertical and horizontal axes.





Jetty A Head Capping

An armor stone cap of approximately 24,000 tons (~ 15,000 cy) or equivalent concrete armor units will be placed on the head of the Jetty A to stop its deterioration (Figure 21). The features of this work are shown in Table 9.

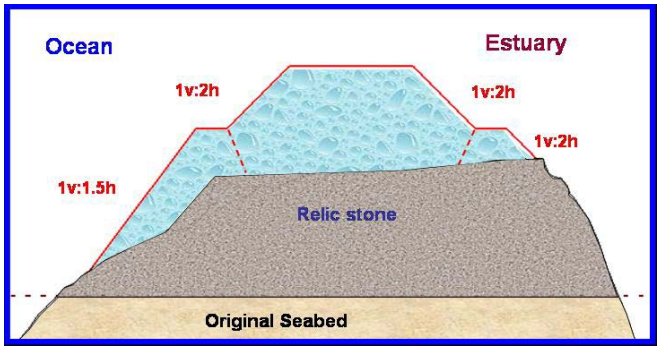
For capping of the head, divided into elevation zones about 7,920 cy of rock will be placed above MHHW. This represents 44% of the overall stone placement on this portion of Jetty A and there is very little or no existing jetty stone expected to be present within this elevation range. About 4,740 cy of rock will be placed between MHHW and MLLW. This represents a 26% of the overall stone placement on this portion of Jetty A and there is very little or no existing jetty stone expected to be present within this elevation range. About 5,420 cy of rock will be placed below MLLW. This represents 30% of the overall stone placement on this portion of Jetty A and a 1783% change from the existing jetty prism, as there is very little or no existing mounded jetty stone expected to be present within this elevation range.

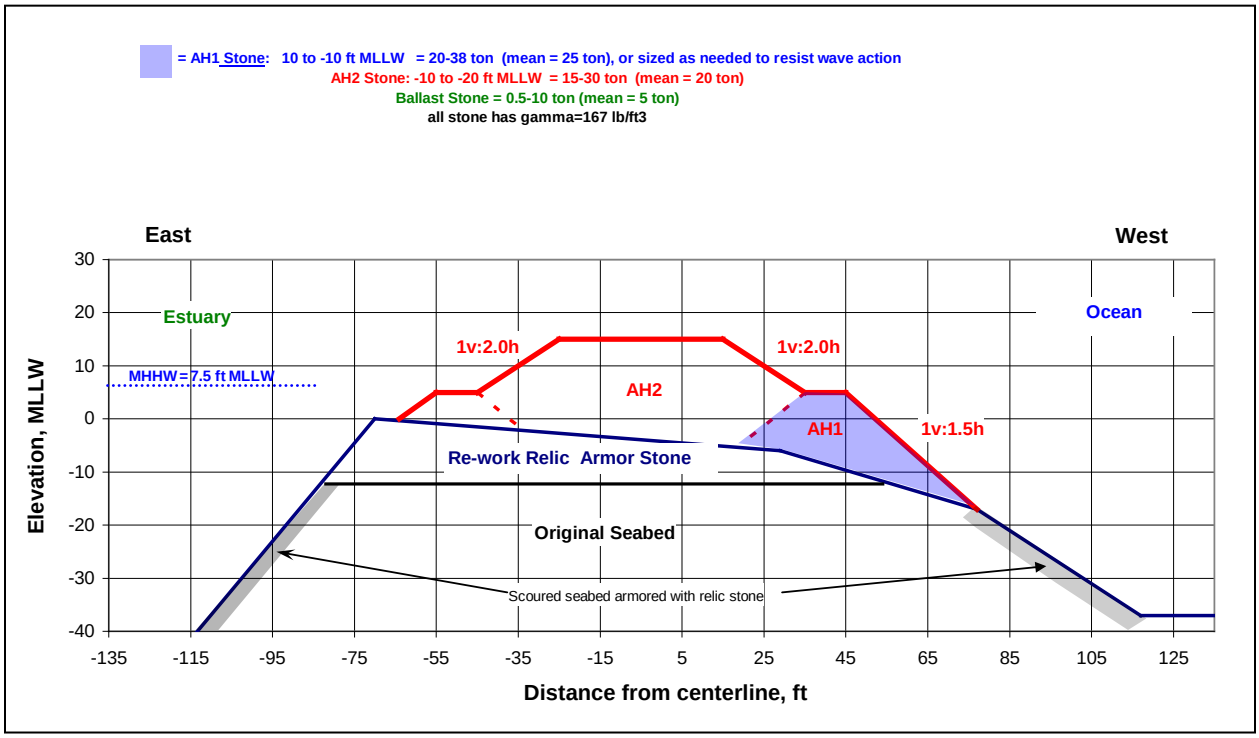
In all zones, all proposed stone placement will occur on existing base relic stone that formed the original jetty cross-section and was displaced and flattened by wave action, and does not include any modification that changes the character or increases the scope or size of the original structure design. The terminus of the head is simply closer to shore on a shorter jetty structure. . The footprint of the existing jetty mound on the flattened relic stone is approximately 0.64 acres, and the additional capping on the relic stone increases the width of the prism approximately 0.09 acres, for a total footprint of 0.73 acres on the existing relic stone.

Table 9. Jetty A Head Cap Feature

Features	Jetty A
Location of cap	stations 91 to 93
Timing of construction	2015
Dimensions of cap: length x width x height (feet)	200 x 160 x 40 (0.73 acres)
Stone size	30 to 40 tons
Area affected (outside relic stone)	None
% of cap constructed on relic stone	100%
Construction method	Land-based crane

Figure 25. Jetty A Head Cap





CONSTRUCTION MEASURES AND IMPLEMENTATION ACTIVITIES

Construction Schedule and Timing

The preferred in-water work window for the Columbia River estuary at the mouth is 1 November to 28 February. However, seasonal inclement weather and sea conditions preclude safe, in-water working conditions during this timeframe. Therefore, it is likely that most of in-water work for constructing spur groins, head capping, cross-section repairs, constructing off-loading facilities, etc. will occur outside this period during calmer seas, mostly between April and October.

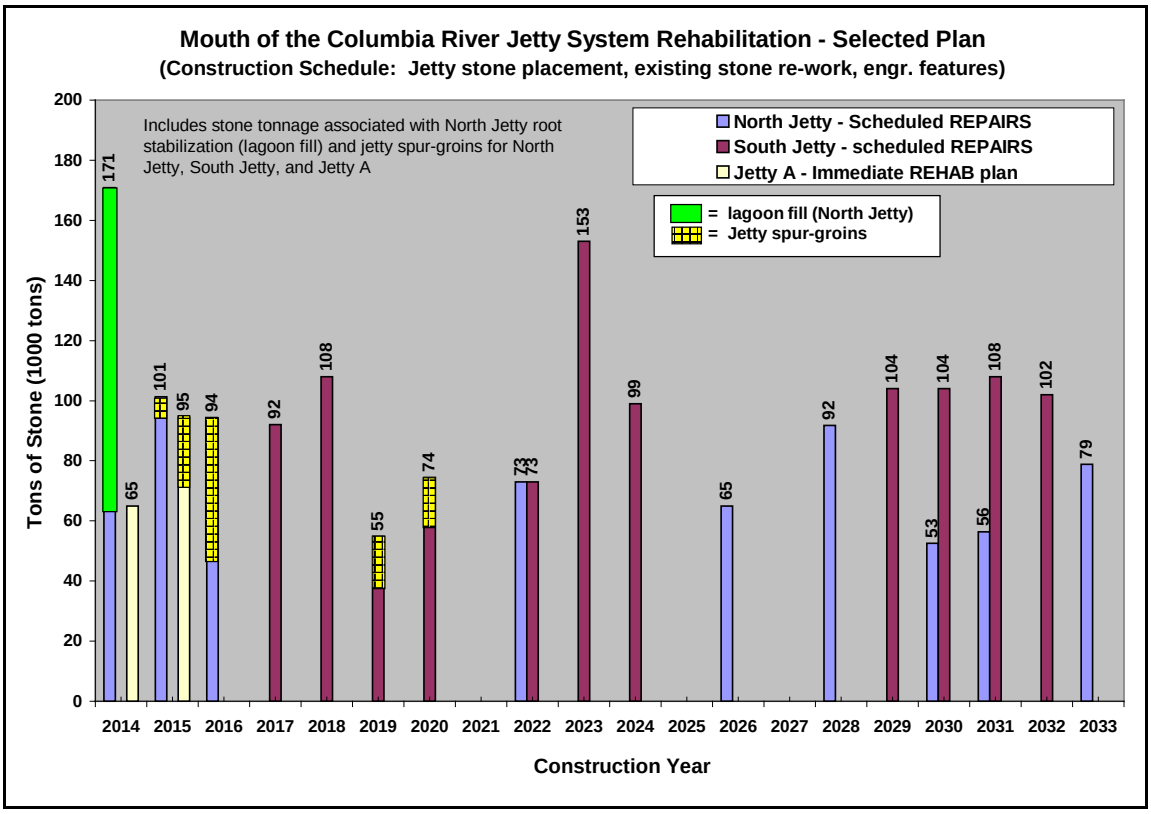
Most landward work on the jetties will be occurring from 1 April to 15 October. Work is assumed to occur 1 June to 15 October on the more exposed sections of the jetties. Placement work may extend beyond these windows if weather and wave conditions are conducive to safe construction and delivery. Stone delivery by land or water could occur year-round, depending on delivery location and weather breaks. Barge delivery would most likely occur during the months of April through October or at other times of the year depending on breaks in the weather and which jetty is being used. Quarrying of the rock may be limited to the months of April through October depending on the regulations pertinent to each quarry.

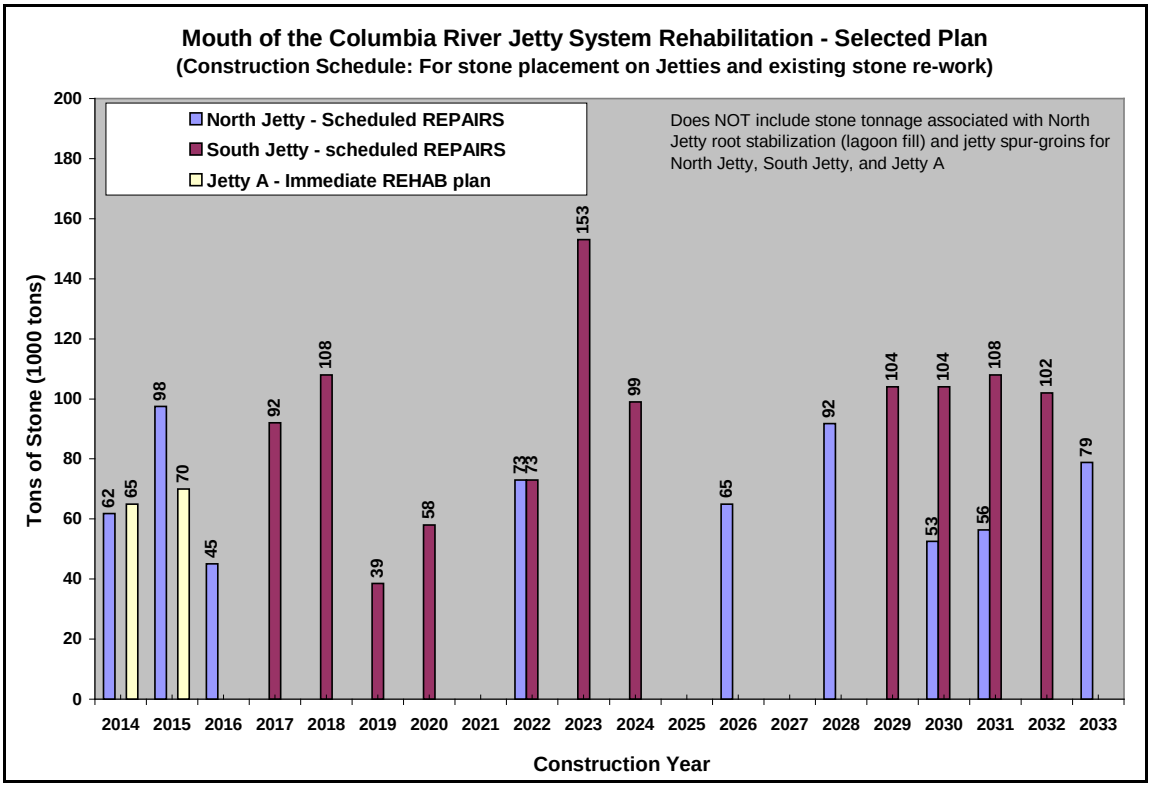
Work elements fall into four general categories for scheduling: (1) rock procurement, quarrying, and delivery transport, (2) construction site preparation, (3) lagoon fill and dune augmentations, and (4) jetty repair and rehabilitation work with construction of the design features including head capping and spur groins. Site preparation would consist of the preparation of the rock stockpile storage and staging areas, as well as the construction of any barge-offloading facilities that may be required. Approximate transport quantities by method are 30 tons per truck and 6,500 tons per barge. The majority of the jetty rehabilitation work is expected to be conducted from the top of the jetty downward using an excavator or a crane. Areas which may require marine plant work include construction at the jetty heads and some of the deeper spur groins.

For design and cost-benefit estimates, the project was modeled and designed for a 50-year operational lifespan. The schedule shown in Figure 26 illustrates construction actions related to building engineered features anticipated to occur at any one or some combination of all three of the jetties for the duration of 20 years. It also includes a predicted schedule of repair actions that the Corps' model estimates will be necessary within that same time period. Additional repairs have also been predicted to occur after the initial 20-year construction schedule and within the 50-year lifespan of the project. Additional repairs beyond the 20-year schedule will be similar in scale and nature to those described above in the standard repair template. Repair actions are generally triggered when a cross-section of the jetty falls below about 30%-40% of the standard repair template profile. The schedule described further in the narrative is a combined reflection of constructing specific engineered features and forecasting needed repairs. Real-time implementation of repair actions will likely vary based on evolving conditions at the jetties and could be shifted within and beyond this 20-year construction schedule.

In the construction schedule, rock production and stockpiling material begins in 2013. The first jetty installation is scheduled for late spring 2014 and continues through 2033. The estimate assumes the work will be accomplished with multi-year contracts.

Figure 26. Construction Schedule





Due to pinniped use at the South Jetty, the Corps proposes to conduct monitoring per conditions in the expected IHA permit. The Corps anticipates that the new IHA permit will entail requirements similar to those in the previous permit. These previous requirements included monitoring and reporting the number of sea lions and seals (by species if possible) present on the South Jetty for 1 week before (re)starting work on this jetty. During construction, the Corps provided weekly reports to the NMFS, which included a summary of the previous week's numbers of sea lions and seals that may have been disturbed as a result of the jetty repair construction activities. These reports included dates, time, tidal height, maximum number of sea lions and seals on the jetty and any observed disturbances. The Corps also included a description of construction activities at the time of observation. Post-construction monitoring occurred with one count every 4 weeks for 8 weeks, to determine recolonization of the south jetty. The Corp anticipates future monitoring and reporting requirements will be similar and will designate a biologically trained on-site marine mammal observer(s) to carry out this monitoring and reporting. The Corps will submit the required reports to the NMFS and the AMT. The Oregon Department of Fish and Wildlife, who monitors sea lion use of the South Jetty, will also be apprised of the Corps work and results of the monitoring efforts.

Conservation Measures the Corps will implement in order to minimize disturbance to Stellar sea lions includes the following; during land-based rock placement, the contractor vehicles and personnel will avoid as much as possible direct approach towards pinnipeds that are hauled out. If it is absolutely necessary for the contractor to make movements towards pinnipeds, the contractor shall approach in a slow and steady manner to reduce the behavioral harassment to the animals as much as possible. Monitoring and reporting will occur as required.

Construction Sequence and General Schedule

Rock procurement activities will be initiated for the North Jetty repair in 2013. In 2014, the on-site work will begin with filling the lagoon area behind the North Jetty root (stations 20 to 60) and installing a culvert to divert overland flow to another area that will not impact the North Jetty root stability. The lagoon area will be filled with rock, gravel, and sand. Once the lagoon is filled, the filled portion will serve as a staging and stockpile area for the rock delivered to the North Jetty site. To control further head recession of the North Jetty, in 2014 construction will focus on reconstructing the jetty head (station 88 to 99). This work will require haul road construction on top of the jetty from station 70 out to the head requiring approximately 31,000 tons of rock. The North Jetty will require installing a barge offloading facility on the channel side of the jetty at approximately station 45+00. Dredging of 30,000 cy is anticipated to provide the minimum 25-ft working clearance. Concurrently, work will begin on Jetty A beginning with constructing the off-loading facility, 60,000 cy of dredging to accommodate the rock delivery by barge, and constructing the jetty crest haul road from station 40+00 to 80+00. Total new stone consists of approximately 50,000 tons of imported rock, equivalent to 1,700 trucks or 8 barges.

In 2015 construction will continue on the North Jetty head from station 99 to 101 and installation of one spur groin at station 50 on the channel side. The haul road will need to be reworked with approximately 26,000 tons of new topping material. Work will occur concurrently with Jetty A beginning with 60,000 cy of dredging, completion of the jetty crest haul road from station 80 to 93, and installation of two spur groins. Total new stone for 2015 would consist of approximately

160,000 tons of imported rock, equivalent to 5,400 trucks or 25 barges. Work on Jetty A shall be completed this year.

In 2016, work continues on the North Jetty with placement of 36,000 tons of large armor near the head at station 80 to 88. This requires refurbishing the haul road and building vehicle turnouts. In addition, three spur groins will be installed at station 70-C, 80-O, and 90-C with a total of 50,000 tons of new stone. Total new stone would consist of approximately 86,000 tons of imported rock, equivalent to 2,900 trucks or 13 barges. Site preparation work and stockpiling stone at the South Jetty will occur to prepare staging and stockpile areas for 2017 construction.

In 2017, construction on the South Jetty is projected to begin, starting with construction work near the head from stations 173 to 176 and 180 to 195. South Jetty construction will require either a haul road be constructed on top of the jetty or constructed from a marine plant in order to get out to the head. Total work effort in 2017 is projected to consist of approximately 74,000 tons of rock; equivalent to 2,500 trucks or 12 barges.

Work continues on the South Jetty for the next 3 years working towards the head in 2018 with a total of 86,000 tons of new armor at station 290 to 311. Head construction begins in 2019 with 30,00 tons of new head armor and installation of 4 spur groins at stations 165–O, 210-C, 230-C, and 265-C for a total of 9,000 tons of spur groin rock. The South Jetty head completes in 2020 with 44,000 tons of new stone.

In 2022, construction is projected to occur concurrently on the North and South jetties: (1) continuation of North Jetty stone placement station 40 to 45 and station 65 to 73; and (2) continuation of stone placement on the South Jetty station 160 to 163, station 170 to 173, station 176 to 180, and station 195 to 200. Total rock tonnage for 2022 is estimated at 115,000 tons, equivalent to 3,850 trucks or 18 barges.

In 2023, construction continues on the South Jetty with the placement of approximately 118,000 tons of rock between stations 205 to 250. The haul road will need to be reworked with approximately 62,000 tons of quarry stone road base and topping material. Total jetty stone rock tonnage to be placed would require 4,000 trucks or 18 barge loads.

In 2024, construction continues on the South Jetty with the placement of approximately 76,000 tons of rock between stations 270 to 290. Total rock tonnage to be placed would require 2,600 trucks or 12 barge loads.

In 2026, construction resumes on the North Jetty with the placement of approximately 52,000 tons of rock between stations 20 to 30. The long time frame from the previous construction on the North Jetty will also require rebuilding the jetty haul road from station 20 to 30. Total rock tonnage to be placed would require 1,800 trucks or 8 barge loads.

In 2030, construction is projected to occur on the North and South jetties: (1) continuation of North Jetty stone placement station 30 to 40; and (2) continuation of stone placement on the South Jetty station 223 to 237, and station 250 to 253. Total rock tonnage to be placed is estimated at 129,000 tons, equivalent to 4,300 trucks or 20 barges.

In 2031, construction is projected to occur on the North and South jetties: (1) continuation of North Jetty stone placement station 88 to 99; and (2) continuation of stone placement on the South Jetty station 253 to 270. The North Jetty haul road will need to be re-built from station 65 to 99 and will require 30,000 tons of quarry waste material. Total armor stone rock tonnage to be placed is estimated at 135,000 tons, equivalent to 4,500 trucks or 21 barges.

In 2032, construction continues on the South Jetty with the placement of approximately 85,000 tons of rock between stations 295 to 311. Total rock tonnage to be placed would require 2,850 trucks or 13 barge loads. The offloading facility will be removed and scheduled construction will be complete for the South Jetty.

The final anticipated year of North Jetty rehabilitation is projected for 2033 with construction from stations 80 to 88. Total rock tonnage estimated is 63,000 tons, equivalent to 2,100 trucks or 10 barge loads. The offloading facility will be removed and scheduled construction will be complete for the North Jetty.

Because construction at the North and South jetties is spaced out from 2014 through 2033 with intermittent work, dredging at the barge offloading sites will only be required prior to a year of actual rock delivery in preparation for upcoming construction work. The Jetty A barge offloading site will only require dredging to make that site accessible for 2 years. Dredging will only be needed if the clearance depth at the barge offloading site is not found to be adequate prior to rock delivery activities.

Sources and Transportation of Rock

Rock Quarries and Transport

Currently, it is not exactly known where jetty rock will come from and how it will be transported to the jetty sites. However, one or more of the options discussed below would be employed (Figures 27 to 32 and Table 10). Stone sources located within 150 miles of a jetty are likely to be transported by truck directly to the jetty. Stone sources located at further distances, especially if they are located near waterways, are likely to be transported by truck to a barge onloading facility, then transported by tug and barge to either a Government-provided or commercial barge offloading site located nearby. Railway may also be an option for transporting stone, provided that an onloading site is convenient to the quarry. Most railroads follow main highway arterials, such as Interstate 5. The closest railroad terminal to the MCR South Jetty is at Tongue Point, east of Astoria, Oregon, which is about 15 miles from the jetty. The nearest railroad terminal to the MCR on the north side of the Columbia River is at Longview, Washington.

The Corps intends to use operating quarries rather than opening any new quarries. The Contractor and quarry owner/operator will be responsible for ensuring that quarries selected for use are appropriately permitted and in environmental compliance with all State and Federal laws.

Canadian Quarries. Quarries in British Columbia are typically located adjacent to waterways and rock produced from these quarries will likely have a limited truck haul. Due to the long distance to the MCR, plus the immediate availability to deep water, rock would likely be loaded onto barges and shipped down the Washington Coast to barge offloading sites.

Washington Quarries. Quarries located in northern Washington are typically not on the water, but are generally located within 50 miles of a potential barge on-loading site. As a result, rock would need to be hauled, at least initially, by truck. Rock would be transported by trucks most likely to a barge on-loading facility or possibly all the way to the staging site at the jetty. In the event of a combination of trucking and barging, trucks would be loaded at the quarry, and then traverse public roads to existing facilities. Once the rock is loaded on barges, it would be transported down the coast to barge offloading sites.

It also is possible that railway systems may be used to transport rock much of the way to the jetties. Burlington Northern Railroad operates a rail system that parallels Interstate 5 throughout Washington which would be the most likely route rock would be transported. Rock from the quarry would be taken by truck to a nearby railway station where they would be loaded onto railway cars and transported to an intermediate staging area. Trucks would then again take the rock the remainder of the way to the jetty staging areas.

Truck hauling of rock from northern Washington sources to the North Jetty or Jetty A most likely would be transported by public road to Interstate 5 or any of the main roads over to Highway 101. Trucks using Interstate 5 would either turn at Longview on Highway 4 to Highway 101, or cross over the Longview Bridge to Highway 30 near Rainier, Oregon. From this point they would proceed west to Astoria to Highway 101, crossing the Astoria-Megler Bridge through Ilwaco to the jetty staging areas. Delivery to the South Jetty most likely would use main roads to Interstate 5 or any of the main roads over to Highway 101.

Trucks using Highway 101 south through Washington would likely cross the Astoria-Megler Bridge, go through Warrenton using local roads into Fort Stevens State Park and the staging area. Trucks utilizing Interstate 5 would either turn at Longview on Highway 4 to Highway 101, or on Highway 30 near Rainier, proceeding through Astoria to Highway 101, going through Warrenton through local roads into Fort Stevens State Park and the jetty staging area.

Rock located within southern Washington would likely be trucked to the jetty staging areas. An exception to this would be a quarry that occurs within just a few miles of a port on the Washington Coast or a quarry that is near the Columbia River. In either of these two barge possibilities, rock would be delivered by truck to a barge on-loading facility, loaded on oceangoing or riverine barges, and delivered to one of the barge offloading facilities (see section on barge offloading facilities below). Truck hauling of rock from this area to the jetties would be as described above.

Oregon Quarries. Rock located in northern Oregon within 50 miles of the North Jetty and Jetty A would likely utilize any of the main roads over to Highway 101 or Highway 30. From this point they would cross the Astoria-Megler Bridge and proceed west through Ilwaco to the jetty staging areas. Quarries exceeding 50 miles from the jetties would likely utilize main roads at a farther distance from the jetty sites. This would involve longer haul distances on Highways 101, 30, 26, and others before crossing the Astoria-Megler Bridge and proceeding to the staging areas.

Truck hauling of rock from quarries within 50 miles of the South Jetty will most likely utilize any of the main roads over to Highway 101 or Highway 30. From this point they would proceed through Astoria and Warrenton, or Seaside and Gearhart to local roads leading to Fort Stevens State Park and the jetty staging areas. Quarries exceeding 50 miles from the jetty would likely utilize main roads at a farther distance from the jetty site. This would involve longer haul distances on Highways 101, 30, 26, and others before going through Astoria and Warrenton, or Seaside and Gearhart to local roads leading into Fort Stevens State Park and the staging areas.

The likely mode of transportation from southern Oregon quarries is trucking, or a combination of trucking and barging. Many of the quarries may be near the Oregon Coast; however, they may not be near a port facility that has barge on-loading capability. Providing that barge facilities are available, rock located south of Waldport would be loaded at the quarry onto trucks and traverse main public roads to the barge on-loading site, loaded on ocean-going barges, and shipped up the Oregon Coast to one of the barge offloading facilities (see section on barge offloading facilities below). Quarries north of Waldport would most likely be hauled by truck the entire distance.

Southern Oregon rock sources requiring trucking would be loaded onto lowboy trucks one to three at a time and would traverse main roads to more main arterials such as Highway 101 or, to a lesser degree, Interstate 5. An effort would be made to use the least distance possible to transport the rock without sacrificing transport time.

California Quarries. For northern California quarries, there would be a very long haul distance required to get rock to the jetty repair areas. Barging of rock would be the only economically feasible option. Rock would be transferred by truck from the quarries along main roads leading to Highway 101 to a barge offloading facility.

Figure 27. Potential Quarry Locations (red dots) for Repairs to MCR Jetties

See corresponding quarry information located in Table 10.

Table 10. Quarry Information

See Figure 27 for site map.

No.	Quarry	County and State	Nearest City	Road Miles from MCR	Unit Weight (pcf)	Reserves Available (tons)	Likely Transportation Method	Nearest Barge Facility
1	Columbia Granite Quarry	Thurston, WA	Vail, WA	129	168.5	28 M	Truck	N/A
2	Beaver Lake Quarry	Skagit, WA	Clear Lake, WA	251	181.1	1.86 M	Truck, then Barge	Anacortes, WA
3	Texada Quarry	BC, CANADA	Texada Island, BC	363	173.5+	275 M	Barge	Onsite
4	Stave Lake Quarry	BC, CANADA	Mission, BC	311	169.1	74 M	Truck, then Barge	Mission, BC, Canada
5	192nd Street Quarry	Clark, WA	Camas, WA	109	168.5	0.5 M	Truck/Barge	Camas, WA
6	Iron Mountain Quarry	Snohomish, WA	Granite Falls, WA	225	174	Unknown	Truck	N/A
7	Marble Mount Quarry	Skagit, WA	Concrete, WA	276	189.7	2 M	Truck, then Barge	Anacortes, WA
8	Youngs River Falls Quarry	Clatsop, OR	Astoria, OR	20	181.8	0.5 M+	Truck	N/A
9	Liscomb Hill Quarry	Humboldt, CA	Willow Creek, CA	515	179.1	0.5 M	Truck, then Barge	Eureka, CA
10	Baker Creek Quarry	Coos, OR	Powers, OR	275	200	Unknown	Truck, then Barge	Coos Bay, OR
11	Phipps Quarry	Cowlitz, WA	Castle Rock, WA	69	167.4	0.5 M	Truck	N/A
12	Cox Station Quarry	BC, CANADA	Abbotsford, BC	313	167.9	150 M	Barge	Onsite
13	Ekset Quarry	BC, CANADA	Mission, BC	309	172.2	10 M	Truck, then Barge	Mission, BC, Canada
14	Fisher Quarry	Clark, WA	Camas, WA	108	168.5	2 M	Barge	Camas, WA
15	Bankus Quarry	Curry, OR	Brookings, OR	347	183 & 195	0.7M	Truck, then Barge	Crescent City, CA

Figure 28. Potential Canadian Rock Source Transportation Routes

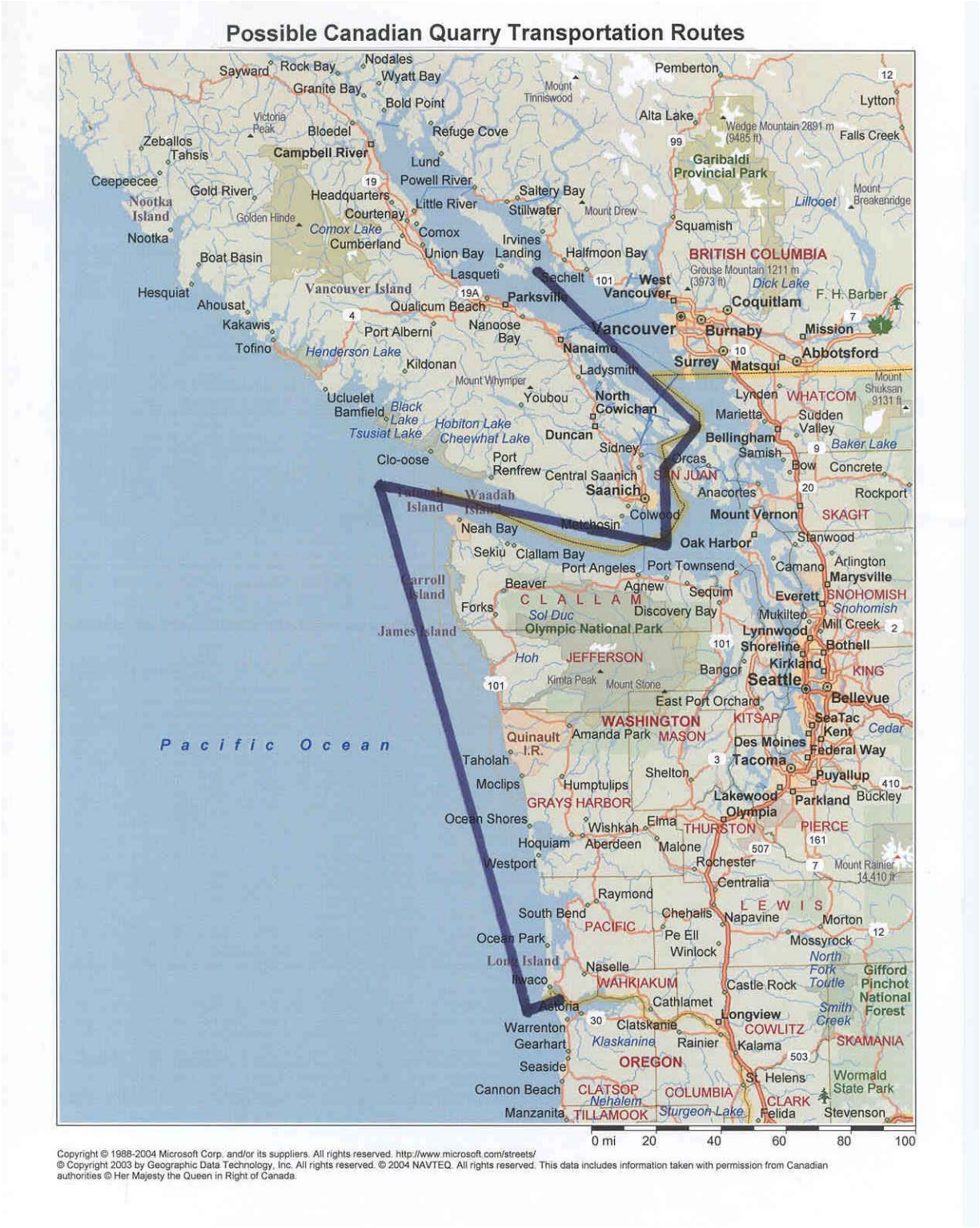


Figure 29. Potential Washington Rock Source Transportation Routes

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Figure 30. Potential Oregon Rock Source Transportation Routes

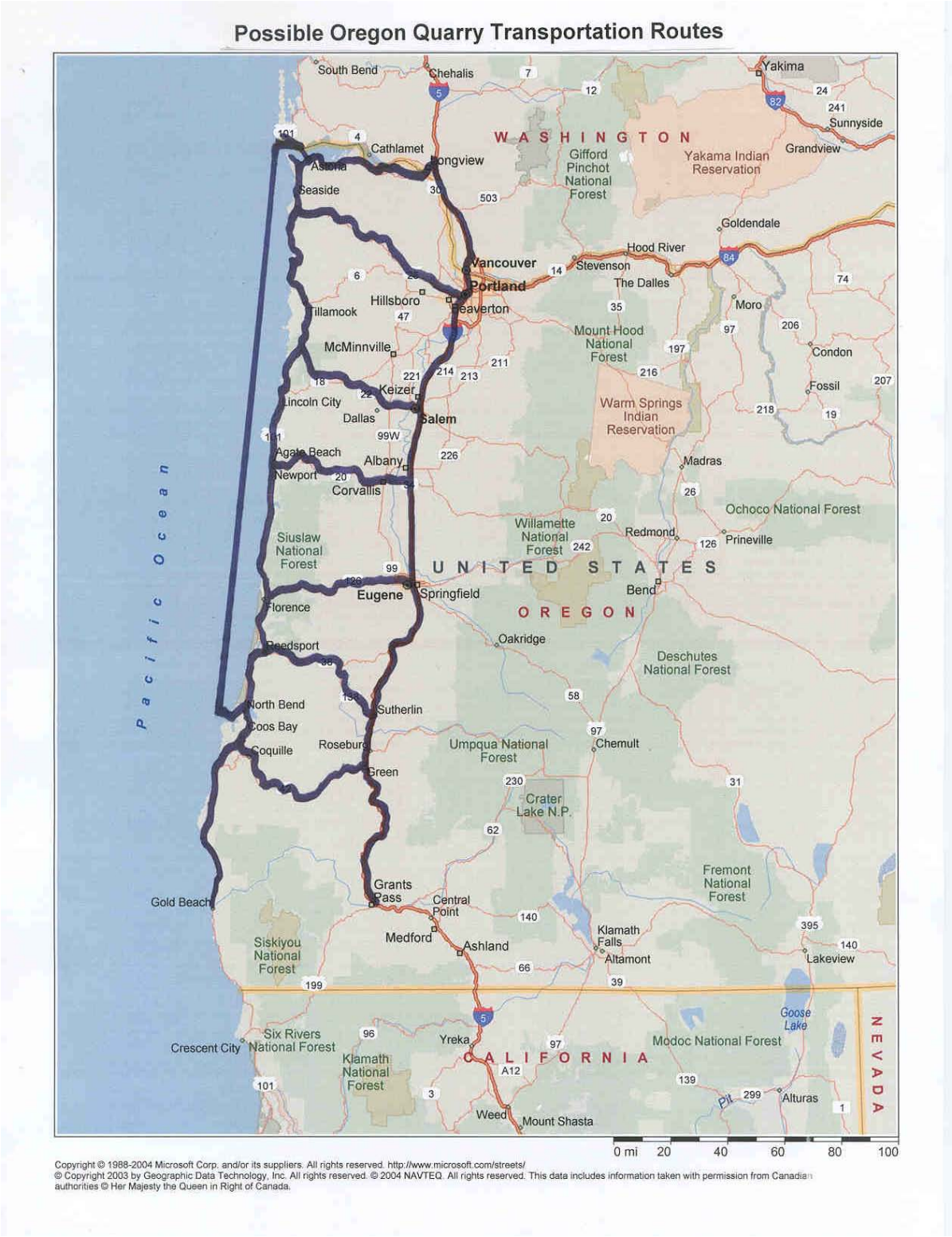


Figure 31. Potential Northern California Rock Source Transportation Routes

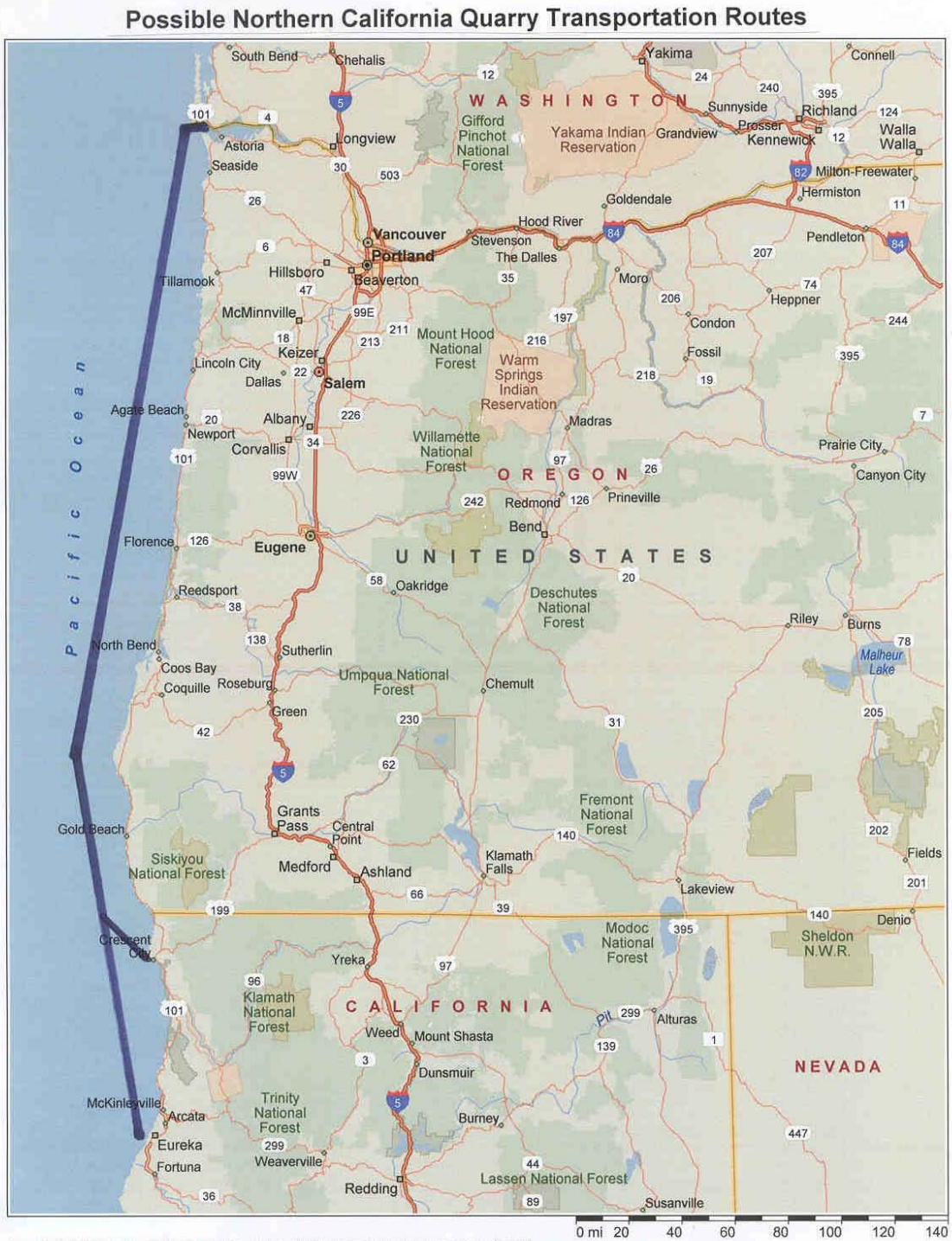


Figure 32. Potential Railway Transportation Routes

For water-based delivery of rock, a tow boat and barge would deliver the rock to the channel side of the jetties where water depth, waves, and current conditions permit. During rock offloading, the barge may be secured to approximately 4 to 8 temporary dolphins/H-piles to be constructed within 200 feet of the jetty. Rock would be off-loaded from the barge by a land- or water-based crane and either placed directly within the jetty work area or stock piled on the jetty crest for subsequent placement at a later time.

For land-based delivery of rock, jetty access for rock hauling trucks would be via an existing paved road to the Benson Beach parking lot at Cape Disappointment State Park (North Jetty) and via an existing paved road to the Parking Lots C and D at the South Jetty. An existing overland route between Jetty A and North Jetty may also be used for land-based hauling. Work areas for delivery of rock, maneuvering of equipment, and stockpiling of rock near the jetties have been identified and are shown in Figures 33-35.

Barge Offloading Facilities

Stone delivery by water could require up to four barge offloading facilities that allow ships to unload cargo onto the jetty so that it can then be placed or stockpiled for later sorting and placement. The range of locations for these facilities is shown in Figures 33-35. Depending on site-specific circumstances, offloading facilities may be converted to spur groins, may be partially removed and rebuilt, may be permanently removed, or may remain as permanent facilities upon project completion. Facility removal will depend on access needs and evolving hydraulic, wave, and jetty cross-section conditions at each offloading locations.

Facilities will range from approximately 200- to 500-ft long and 20- to 50-ft wide, which ranges from about 0.48 to 2.41 acres in total area. For initial construction of all four facilities combined, approximately up to 96 Z- or H-piles could be installed as dolphins, and up to 373 sections of Z- or H-piles to retain rock fill. Figure 36 shows a cross section diagram for stone access ramp at potential barge offloading facilities and photos illustrating typical barge offloading facilities. Facilities will have a 15-ft NGVD crest elevation and will be installed at channel depths between -20 and -30 NGVD. A vibratory hammer will be used for pile installation and only untreated wood will be used, where applicable. Removal and replacement of the facilities could occur within the duration of the construction schedule. Volume and acreage of fill for these facilities are shown in Table 11.

Table 11. Approximate Rock Volume and Area of Barge Offloading Facilities and Causeways

Location	Approximate Length (ft)	Approximate Rock Volume (cy) Below 0 MLLW	Total Approximate Rock Volume (cy)	Approximate Square Feet	Acres
North Jetty	200	7,778	29,640 cy	21,000	0.48
Jetty A – near head	200	7,778	29,640 cy	21,000	0.48
Jetty A – mid-section causeway	5000	38,888	38,888	105,000	2.41
South Jetty – Parking Area D	450	17,417	33,688 cy	47,250	1.08
South Jetty – Along Jetty Turn-out	200		18,640 cy	21,000	0.48

Figure 33. North Jetty Offloading, Staging, Storage and Causeway Facilities

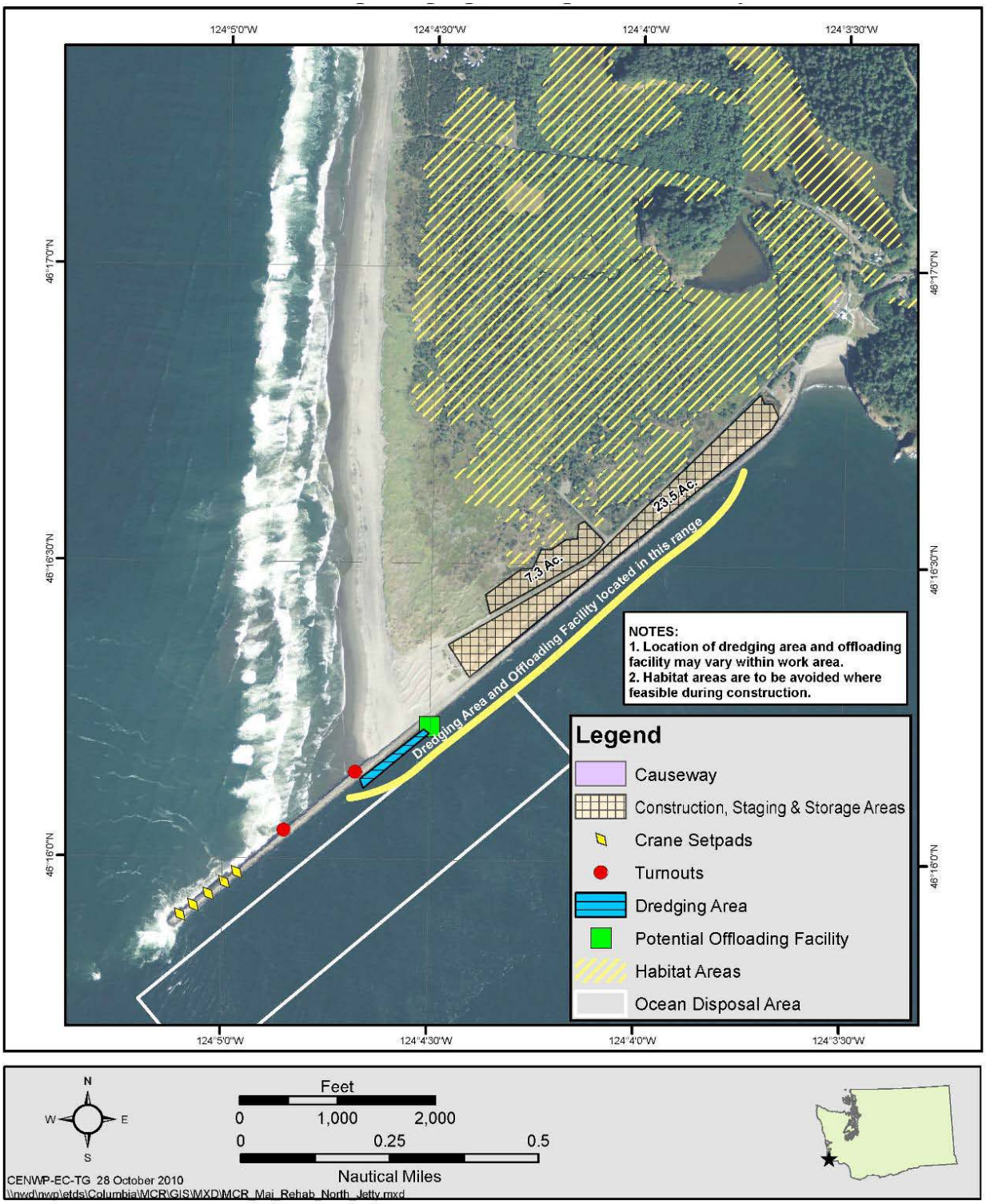


Figure 34. South Jetty Offloading, Staging, Storage and Causeway Facilities

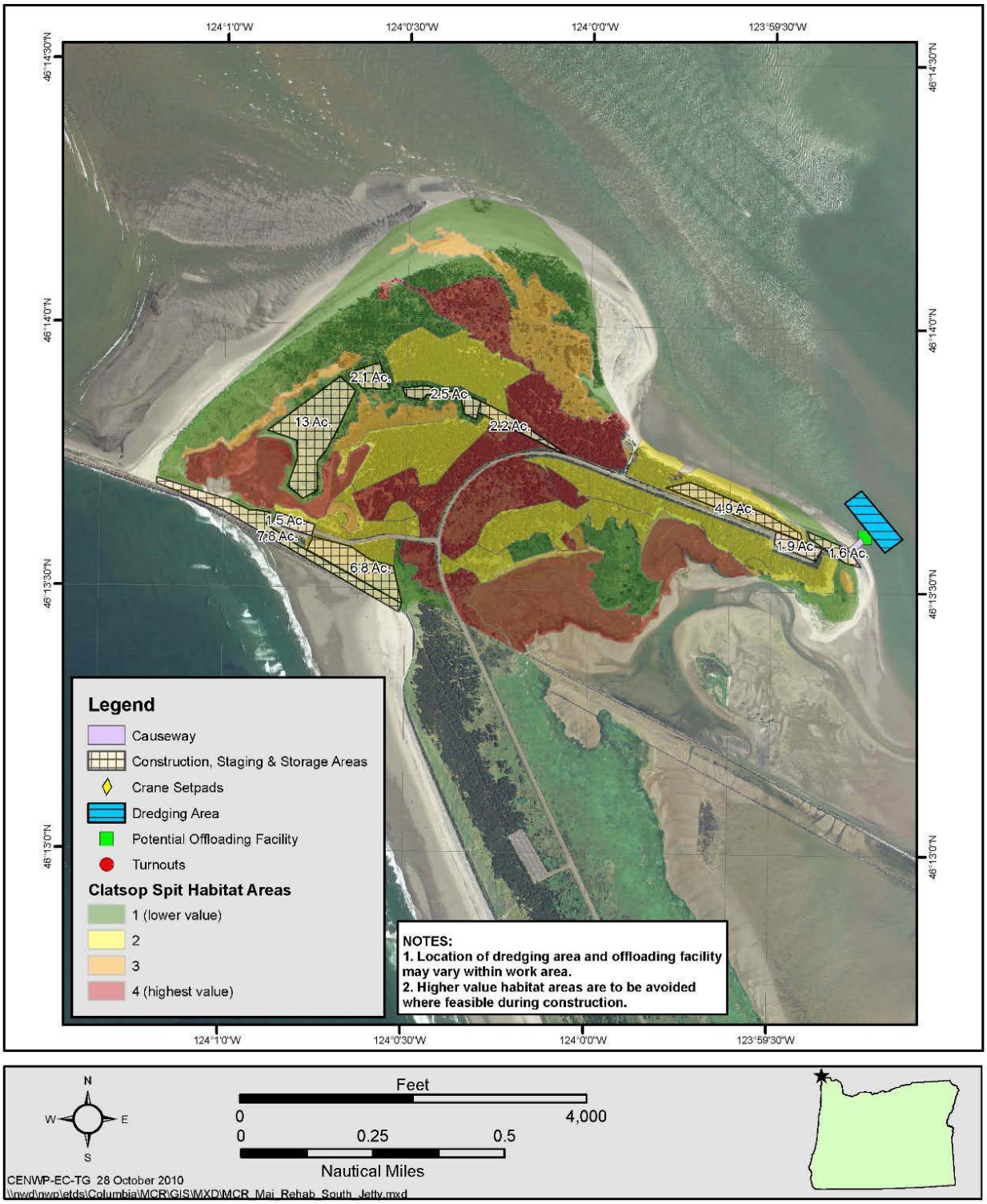


Figure 34 (continued). South Jetty Offloading, Staging, Storage and Causeway Facilities

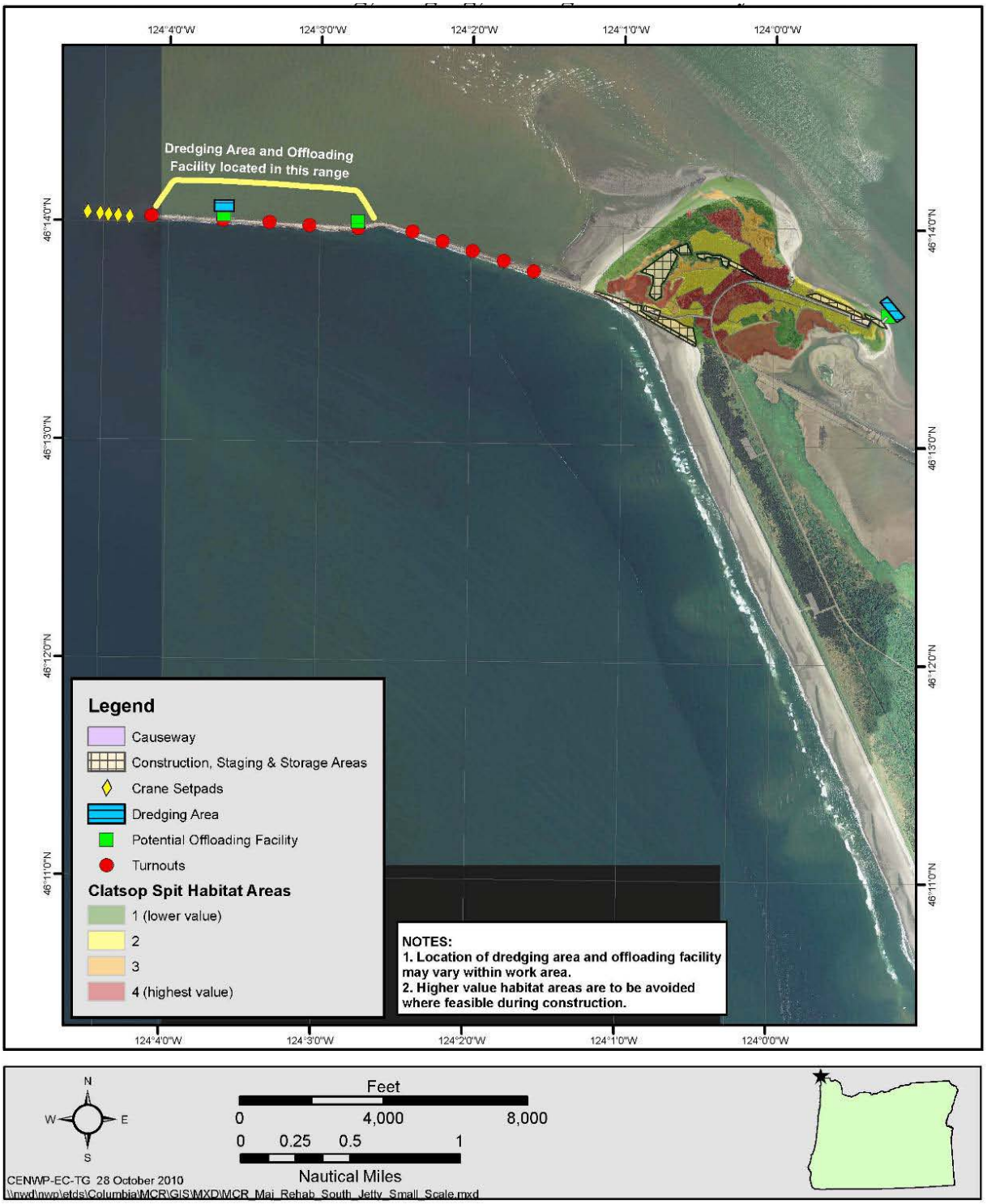


Figure 35. Jetty A Offloading, Staging, Storage and Causeway Facilities

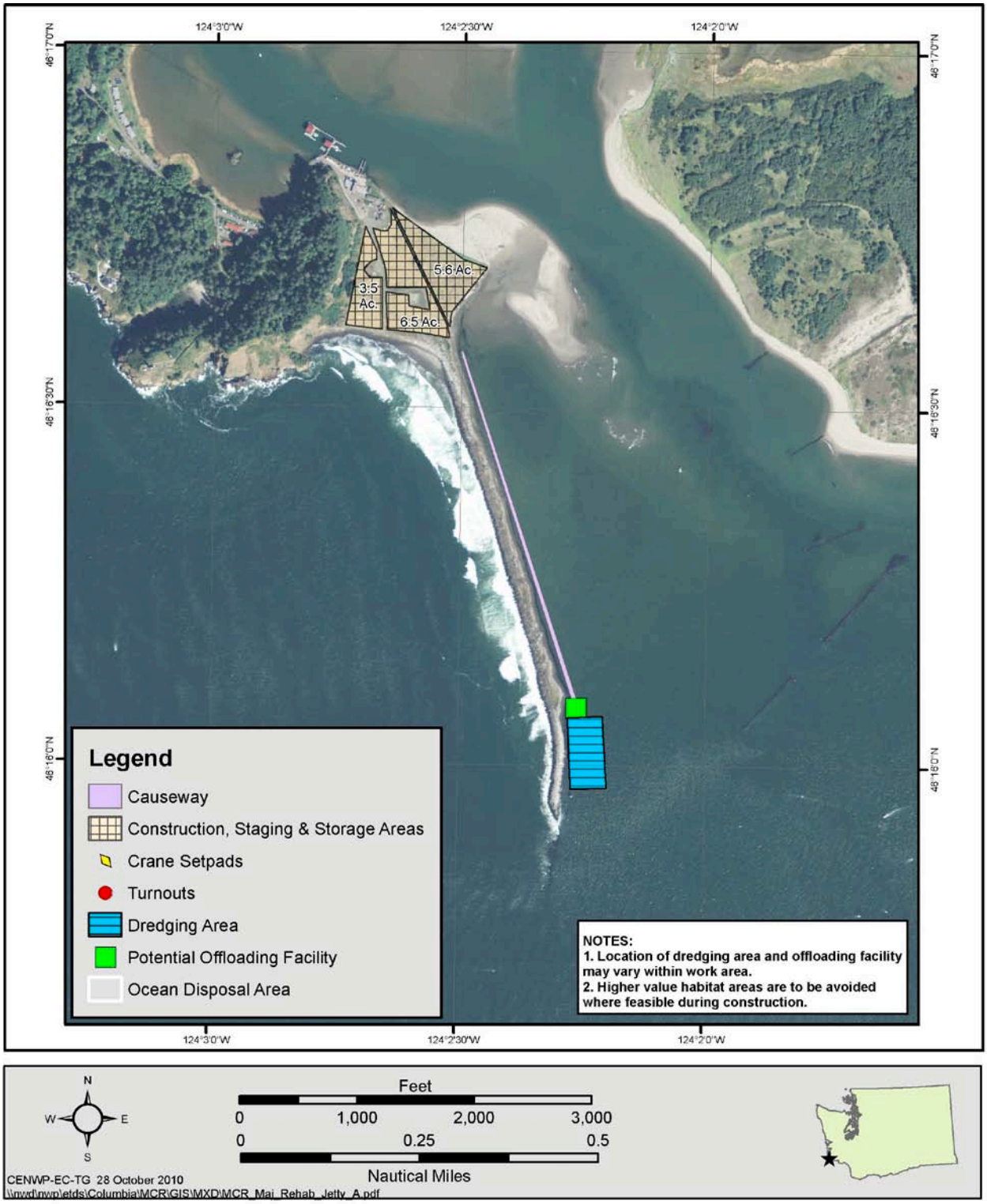


Figure 36. Cross Section of Stone Access Ramp at Barge Offloading Facilities at East End of Clatsop Spit near Parking Area D and Photos of Typical Barge Offloading Facilities

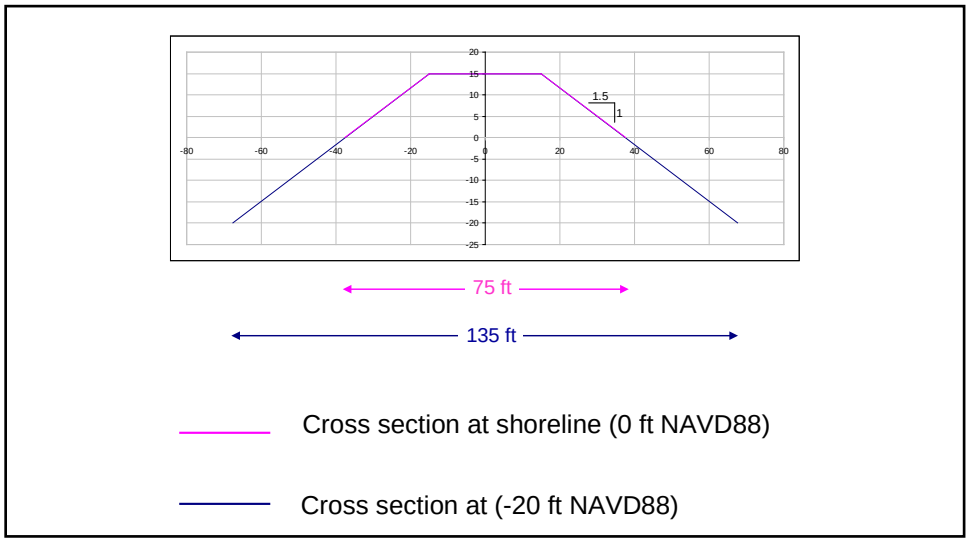


Figure 36 (continued)

The following existing private facilities may serve as potential offloading sites depending on availability for Corps' use:

- Commercial Site in Ilwaco. For the North Jetty, barges would pull up to a dock at Ilwaco where rock would be transferred by crane onto trucks that would proceed by public road to Cape Disappointment State Park. Trucks would then pass through the park grounds to the staging area adjacent to the jetty. For Jetty A, trucks would proceed through the Coast Guard facility to the staging area near the root of the jetty.

- Commercial Site in Warrenton. Nygaard Logging has a deep-water offloading site that could be used to offload rock. For the North Jetty/Jetty A, rock would be transferred to trucks that would likely use Highway 101 into Astoria, cross the Astoria-Megler Bridge, and head west through Ilwaco to Cape Disappointment State Park. Trucks would then pass through the park grounds to the staging area adjacent to the jetty. For the South Jetty, rock would be transferred to trucks which would then proceed west through Hammond to Fort Stevens State Park and use the existing park road to staging area adjacent to the jetty. This site needs no improvement to accommodate deep-draft vessels.

If existing facilities are not available or do not have adequate capacity to provide access, barge offloading facilities could be constructed at each jetty.

- North Jetty: Between or on the spur groin at/between Station 50 or 70, a barge offloading facility will be constructed. If wave conditions make it feasible, the spur groin designed for this area will first function as an offloading facility prior to conversion and stone removal to reach the spur's design depth. Otherwise, a separate facility will be installed in the reach between these two stations such that wave conditions allow safe offloading. This offloading facility will require 4-8 dolphins of 3 piles each for vessel tie-up, and sheet-pile installation will be required to shore-up and retain rock at the offloading point.

- Jetty A: An offloading facility will be sited near the location of the proposed spur groin around Station 81, at the upstream portion of the jetty near the head. The proposed spur groin could not be used for dual purposes, because it would have required additional, unnecessary rock in order to connect the offloading facility with the causeway. A 15-ft causeway will also be constructed along the entire length of the jetty on existing relic stone that runs adjacent to and abutting the upstream eastern portion of the jetty. This facility will likely remain a permanent facility, but may deteriorate due to wave and tidal action. This offloading facility will require 4-8 dolphins of 3 piles each for vessel tie-up, and sheet-pile installation will be required to shore-up and retain rock at offloading point.

- South Jetty: The South Jetty could have up to two associated offloading sites. One will be located at Parking Lot Area D near the northeastern-most corner of the Spit. The second facility will be located along the jetty and will resemble an extra-large turn-out facility. It is likely to be located somewhere on the northern, channel-side of the jetty and west of Station 270 in order to take advantage of deeper bathymetry and subsequently less need for dredging. The facility at Parking Lot Area D may be removed after 5 or more years depending on hydraulic impacts of the structure and spit. The facility along the jetty will likely be partially removed and rebuilt after each repair to avoid the

potential for wave-focusing on the jetty. Otherwise, it will remain in place until around 2033. Each offloading facility will require 4-8 dolphins of 3 piles each for vessel tie-up, and sheet-pile installation will be required to shore-up and retain rock at offloading point.

Dredging for Barge Offloading Facilities

Transport of rock would most likely be done by ocean-going barges that require deeper draft (20-22 feet) and bottom clearance than river-going barges when fully loaded. Therefore, dredging will be required to develop each of the barge offloading facilities. Under-keel clearance should be no less than 2 feet. The elevation at barge offloading sites should have access to navigable waters and a dredge prism with a finish depth no higher than -25 feet MLLW, with advance maintenance and disturbance zone depths not to extend below -32 feet MLLW. These facilities should also provide for a maneuvering footprint of approximately 400 feet x 400 feet. The depth along the barge unloading sites would be maintained during the active period for which the rock barges will be unloaded.

A clamshell dredge would likely be used for all dredging, though there is a small chance that a pipeline dredge could be feasible but is unlikely to be used. The material to be dredged is medium to fine-grained sand, typical of MCR marine sands. Disposal of material would occur in-water at an existing approved disposal site. The volume of material to be dredged is shown in Table 12; these estimates are based on current bed morphology and may change. Also, maintenance dredging to a finish depth of -25 feet MLLW will be needed before offloading during each year of construction. Dredging is likely to occur on a nearly annual basis for the duration of the project construction period, but this will be intermittent per jetty, depending on which one is scheduled for construction in a particular year.

Table 12. Estimated Dredging Volumes for Barge Offloading Facilities

Location*	Estimated Dredging Volume (cy)		Approximate Acres
	Initial	Est. Maintenance**	
North Jetty	30,000	30,000	3.73
Jetty A	60,000	80,000	3.73
South Jetty	20,000	20,000	4.19
South Jetty - Parking Area D	20,000	20,000	4.19

* Some of the locations will not be used on an annual basis; it depends on the construction schedule for each jetty.
**All dredging will be based on surveys that indicate depths shallower than -25 feet MLLW.

Clamshell dredging is done using a bucket operated from a crane or derrick that is mounted on a barge or operated from shore. Sediment removed from the bucket is generally placed on a barge before disposal. This type of dredge is typically used in shallow water areas.

The following overall impact minimization practices and best management practices (BMPs) will be used for all maintenance dredging for offloading facilities.

1. To reduce the potential for entrainment of juvenile salmon or green sturgeon, the cutterheads will remain on the bottom to the greatest extent possible and only be raised 3 feet off the bottom when necessary for dredge operations.

2. To reduce turbidity, if a clamshell bucket is used, all digging passes shall be completed without any material, once in the bucket, being returned to the wetted area. Not dumping of partial or half-full buckets of material back into the project area will be allowed. No dredging of holes or sumps below minimum depth and subsequent redistribution of sediment by dredging dragging or other means will be allowed. All turbidity monitoring will comply with Sate 401 Water Quality Certification Conditions.
3. If the Captain or crew operating the dredges observes any kind of sheen or other indication of contaminants, he/she will immediately stop dredging and notify the Corps' environmental staff to determine appropriate action.
4. If routine or other sediment sampling determines that dredged material is not acceptable for unconfined, in-water placement, then a suitable alternative disposal plan will be developed in cooperation with the NMFS, EPA, Oregon Department of Environmental Quality (ODEQ), Washington Department of Ecology (WDOE), and other agencies.

Dredged Material Disposal Sites

Two dredged material disposal sites, the Shallow Water Site (SWS) and the North Jetty site, are located near the North Jetty. These are the most likely sites to be used. Modeling has showed that the potential changes to the two disposal sites from the proposed action would not inhibit their use as disposal sites. Spur groin construction at the North Jetty would avoid the North Jetty disposal site. The northern-most cells of this site immediately adjacent to the jetty will be avoided to reduce the possibility of vessel impact with the spur groins.

Pile Installation and Removal

As mentioned earlier, inclement weather and sea conditions during the preferred in-water work window (IWWW) preclude safe working conditions during this time period. Therefore, installation of piles is most likely to occur outside the IWWW. For initial construction of all four facilities combined, approximately up to 96 Z- or H-piles could be installed as dolphins, and up to 373 sections of Z or H pile to retain rock fill. They will be located within 200-ft of the jetty structure. Because the sediments in the region are soft (sand), use of a vibratory driver to install piles is feasible and will be used when necessary. The presence of relic stone may require locating the piling further from the jetty so that use of this method is not precluded by the existing stone. The dolphins/Z- and H-piles would be composed of either untreated timber or steel piles installed to a depth of approximately 15 to 25 feet below grade in order to withstand the needs of off-loading barges and heavy construction equipment. Because vibratory hammers will be implemented in areas with velocities greater than 1.6 ft/s, the need for hydroacoustic attenuation is not an anticipated issue. Piling will be fitted with pointed caps to prevent perching by piscivorous birds to minimize opportunities for avian predation on listed species. Some of the pilings and offloading facilities will be removed at the end of the construction period.

Rock Placement

Placement of armor stone and jetty rock on the MCR jetties would be accomplished by land or limited water-based equipment. Only clean stone will be used for rock placement, where appropriate and feasible. Where appropriate, there may also be some re-working and reuse of the existing relic and jetty prism stone. Fill for the jetty haul roads will not be cleaned prior to

installation. Dropping armor stone from a height greater than 2 feet will be prohibited. During placement there is a very small chance of stone slippage down the slope of the jetty. However, this is unlikely to occur due to the size and cost of materials and placement.

Another approach to water-based rock placement would be via a jack-up barge. This would only be applicable at the South Jetty. For armor stone and rock placement at the head, a jack-up barge with crane could be used to serve as a stable work platform (Figure 37). Once into place, the jack-up barge would be jacked up on six legs so that the deck is at the same elevation as the jetty. The legs are designed to use high-pressure water spray from the end of the legs to agitate the sand and sink the legs under their own weight. The jacking process does not use any lubricants that contain oils, grease, and/or other hydrocarbons. The stone and rock will be barged to the jackup barge and offloaded onto the jetty head. The jackup barge will keep moving around the head of the jetty to complete the work. A jack-up barge would not be used on the North Jetty or Jetty A to avoid interference with navigation of fishing boats and crab and fish migrations.

Figure 37. Illustration of a Jack-up Barge

For land-based rock placement, a crane or a large track-hoe excavator could be situated on top of the jetty. The placement operation would require construction of a haul road along the jetty crest within the proposed work area limits. The crane or excavator would use the haul road to move along the top of jetty. Rock would be supplied to the land-based placement operation by land and/or marine-based rock delivery. For marine-based rock, the land-based crane or excavator would pick up rock directly from the barge or from a site on the jetty where rock was previously offloaded and stockpiled, and then place the rock within the work area. For land-based rock, the crane or excavator would supply rock via a truck that transports rock from the stockpile area. The crane or excavator would advance along the top of the jetty via the haul road as the work is completed.

In order to place stones, a haul road will be constructed on the 30-ft crest width of each jetty to allow crane and construction vehicle access. Roads will consist of an additional 3-ft of top fill material, which could also entail an additional 2-ft of width spill-over. These roads will remain in place for the duration of construction. Due to ocean conditions and the wave environment, these roads will likely need yearly repair and replacement. They will not be removed upon completion. Ramps from the beach up to the jetty road will also be constructed to provide access at each jetty.

At approximately 1000-ft intervals, turnouts to allow equipment access and passage will be constructed on the North and South jetties. These will consist of 50-ft long sections that are an additional 20-ft wide. Some of this stone for these facilities may encroach below MLLW. On the North Jetty, there will be approximately 2 turnouts. South Jetty will have approximately 8 turnouts with two additional larger-sized turnouts. These larger turnouts will be in the range of 300-ft long with an additional 20-ft width. One of these larger turnouts will function as an offloading facility on South Jetty. At Jetty A, the causeway will function as the turnout facility.

Towards the head of each jetty, additional crane set up pads will be constructed at approximately 40-ft increment to allow crane operation during the placement of the larger capping stones. Set-up pads will roughly entail the addition of 8 extra feet on each side of the crest for a length of about 50-ft. Some of this stone for these facilities may encroach below MLLW. Approximately 5 set-up pads will be required to construct each jetty head.

Construction Staging, Storage, and Rock Stock Piles

Jetty repairs and associated construction elements entail additional footprints for activities involving equipment and supply staging and storage, parking areas, access roads, scales, general yard requirements, and rock stock pile areas. It was determined that for most efficient work flow and placement, a 2-year rock supply would be maintained on site and would be continuously replenished as placement occurred on each jetty. In order to estimate the area needed, a surrogate area was determined for a reference volume of 8,000 cy, which was then used to extrapolate the area needed at each jetty. These results are shown in Table 13.

Table 13. Acreages Needed for Construction Staging, Storage, and Rock Stock Piles

Location	Approximate Acres
North Jetty	31
Jetty A	23
South Jetty	44

Several actions will be taken to avoid and minimize impacts from these activities. Staging and stockpiles will remain above MHHW and where feasible have also been sited to avoid impacts to wetlands and habitats identified as having higher ecological value. In order to maintain erosive resilience along the shoreline, a vegetative buffer will be preserved. When available and possible, partial use will be made of existing parking lots. Additional measures specific to each jetty have also been considered. Besides access roads in the areas identified in Figures 33-35, no

additional roadways or significant roadway improvements are anticipated. Some roadway repair and maintenance will likely be required on existing roads experiencing heavy use by the Corps.

At the North Jetty, the lagoon and wetland fill necessary for root stabilization will also serve a dual purpose as for the bulk of staging and storage activities.

At the South Jetty, a small spur road will be required to connect the existing road with the proposed staging area and is indicated in Figures 33-35. The existing road along the neck of the South Jetty that will be used for dune augmentation work may require minor repair/improvements for equipment access. Construction access to the area receiving dune augmentation will be limited to an existing access road along the relic jetty structures at the neck of the spit. Equipment will be precluded from delivery using the access point from Parking Lot B in order to avoid impacts to water quality and razor clam beds in the vicinity of the proposed dune fill area. Grading equipment may have to access the area by driving along the shore, but this route will be used as a last resort and equipment will be limited to dry sand where feasible. Additionally, the proposed actions will avoid the more sensitive habitat areas south of Parking Lot D.

If possible, the project will avoid and minimize impacts to the adjacent marshland by allowing crossing between the construction area and jetty via a Bailey bridge, which may require small removable abutments on either end of the marsh crossing. Otherwise a series of culverts and associated fill will be installed, or equipment will be required to enter and exit from the same access road on the northeast end of the main staging area indicated in Figures 33-35.

Additionally, at the outlet of the marsh complex a culvert will be installed under the construction access road, which will allow continuous hydrologic connectivity between affected portions of the marsh and ocean exchange through the jetty. This will also avoid equipment passage through marsh waters. To connect the staging area to the jetty haul road, a temporary gravel access road would be constructed from the staging area nearest the jetty to the jetty crest. The access road would measure approximately 400 ft in length by 25 ft in width, would be above MHHW, would require approximately 4,000 cy of sand, gravel and rip rap, and would require the installation and removal of a temporary culvert near station 178+00 to maintain tidal exchange into and out of the intertidal wetland and through the jetty. The staging areas and haul roads, except for the jetty haul road, would be removed and restored to pre-construction conditions once repairs to the jetty are completed.

Prior to in-water work for installing the construction access road and culverts across the southern portion of the marsh wetland outlet at the South Jetty, the Corps will conduct fish salvage and implement fish exclusion to and from the wetland complex upstream of the proposed culvert. Also, post-installation of the culvert, the Corps will develop and implement fish monitoring as necessary to ensure that no listed fish species are stranded. If listed fish species are found, NMFS will be contacted immediately to determine the appropriate course of action.

At Jetty A, adequate area may not be available for the estimated storage and staging needs. Therefore, construction sequencing will accommodate the supply that can be fit into the acreage

available. Land-based delivery options may be precluded due to road access constraints, though some existing access may prove available and feasible depending on load and truck sizes.

The following measures will also be required at each location to further avoid and minimize impacts to species. Before significant alteration of the project area, the project boundaries will be flagged. Sensitive resource areas, including areas below ordinary high water, wetlands and trees to be protected will be flagged. Chain link fencing or something functionally equivalent will likely encircle much of the construction areas.

Temporary Erosion Controls

Temporary erosion controls will be in place before any significant alteration of the site. If necessary, all disturbed areas will be seeded and / or covered with coir fabric at completion of ground disturbance to provide immediate erosion control. Erosion control materials (and spill response kits) will remain on-site at all times during active construction and disturbance activities (e.g., silt fence, straw bales). If needed these measures will be maintained on the site until permanent ground cover or site landscaping is established and reasonable likelihood of erosion has passed. When permanent ground cover and landscaping is established, temporary erosion prevention and sediment control measures, pollution control measures and turbidity monitoring will be removed from the site, unless otherwise directed.

An Erosion Sediment and Pollution Control Plan (ESPCP) or Stormwater Pollution Prevention Plan (SWPPP), as applicable to each State, will outline facilities and Best Management Practices (BMPs) that will be implemented and installed prior to any ground disturbing activities on the project site, including mobilization. These erosion controls will prevent pollution caused by surveying or construction operations and ensure sediment-laden water or hazardous or toxic materials do not leave the project site, enter the Columbia River, or impact aquatic and terrestrial wildlife. The Corps retains a general 1200-CA permit from Oregon Department of Environmental Quality (DEQ), and will also work with EPA to obtain use of the NPDES General Permit for Stormwater Discharge from Construction Activities. At a minimum, these ESCP and SWPPP plans will include the following elements and considerations. Construction discharge water generated on-site (debris, nutrients, sediment and other pollutants) will be treated using the best available technology. Water quality treatments will be designed, installed, and maintained in accordance with manufacturer's recommendation and localized conditions. In addition, the straw wattles, sediment fences, graveled access points, and concrete washouts may be used to control sedimentation and construction discharge water. Construction waste material used or stored on-site will be confined, removed, and disposed of properly. No green concrete, cement grout silt, or sandblasting abrasive will be generated at the site.

Emergency Response

To avoid the need for emergency response a Corps' Government Quality Assurance Representative (GQAR) will be on-site or available by phone at all times throughout construction. Emergency erosion/pollution control equipment and best management practices will be on site at all times; Corps' staff will conduct inspections and ensure that a supply of sediment control materials (e.g., silt fence, straw bales), hazardous material containment booms

and spill containment booms are available and accessible to facilitate the cleanup of hazardous material spills, if necessary.

Hazardous Materials

A description of any regulated or hazardous products or materials to be used for the project, including procedures for inventory, storage, handling and monitoring, will be kept on-site. Fuels or toxic materials associated with equipment will not be stored or transferred near the water, except in a confined barge. Equipment will be fueled and lubricated only in designated refueling areas at least 150 feet away from the MHHW, except in a confined barge.

Spill Containment and Control

A description of spill containment and control procedures will be on-site, including: notification to proper authorities, specific cleanup and disposal instructions for different products, quick response containment and cleanup measures that will be available on the site including a supply of sediment control materials, proposed methods for disposal of spilled materials, and employee training for spill containment. Generators, cranes, and any other stationary power equipment operated within 150-feet MHHW will be maintained as necessary to prevent leaks and spills from entering the water. Vehicles / equipment will be inspected daily for fluid leaks and cleaned as needed before leaving staging and storage area for operation within 150 feet of MHHW. Any leaks discovered will be repaired before the vehicle / equipment resumes service. Equipment used below MHHW will be cleaned before leaving the staging area, as often as necessary to remain grease-free. Additionally, the Corps proposes to use a Wiggins fast fuel system or equivalent to reduce leaks during fueling of cranes and other equipment in-place on the jetties (Figure 38). Also, spill pans will be mounted under the crane and monitored daily for leaks.

Water Quality Monitoring

In-water work will require turbidity monitoring that will be conducted in accordance with 401 Water Quality Certifications Conditions to ensure the project maintains compliance with State water quality standards. Turbidity exceedences are expected to be minimal due to the large size of stone being placed. Dynamic conditions at the jetties in the immediate action area preclude the effective use of floating turbidity curtains (or approved equal). Sedimentation and migration of turbid water into the Columbia is not expected to be a significant issue. Best management practices will be used to minimize turbidity during in-water work. Turbidity monitoring will be conducted and recorded each day during daylight hours when in-water work is conducted. Representative background samples will be taken according to the schedule set by the resource agencies at an undisturbed area up-current from in-water work. Compliance samples will be taken on the same schedule, coincident with timing of background sampling, down-current from in-water work. Compliance sample will be compared to background levels during each monitoring interval. Additional 401 Water Quality Certification conditions and protocols may be required.

Figure 38. Fast Fuel System

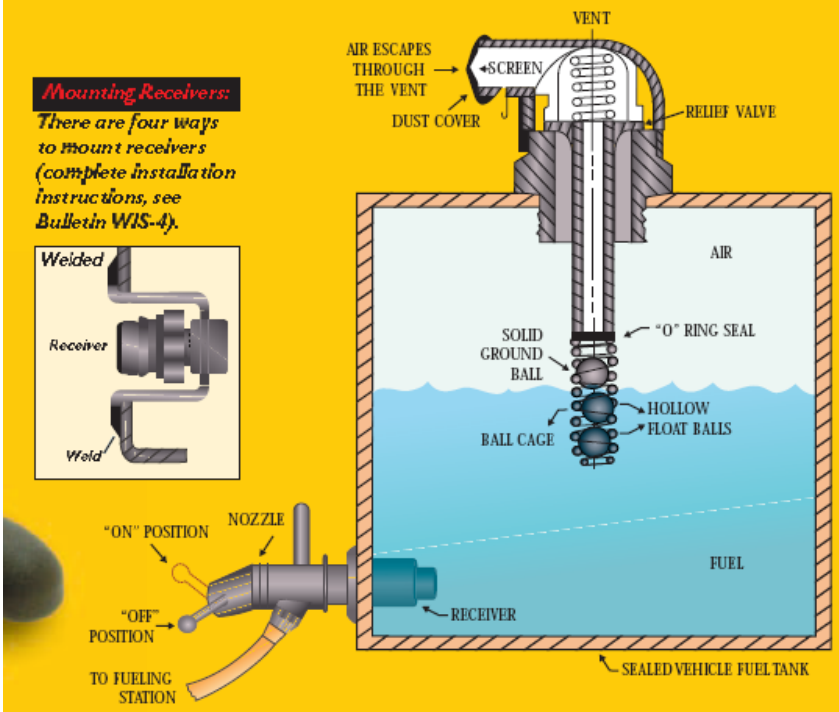
WIGGINS Service Systems

How It Works

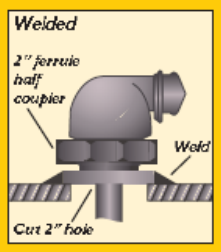
The Wiggins "fast fuel" System is based on the simple concept of using a sealed vehicle tank to allow a small amount of back pressure to build up and automatically shut off the nozzle. A receiver is mounted on the tank, located near the bottom. Bottom filling helps eliminate foaming which can occur during top fueling "splash fill".

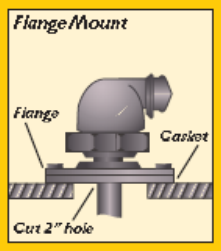
The Wiggins ZZ9A1 nozzle is attached to the receiver, the handle is turned to the "ON" position, and fuel begins to fill the fuel tank at a rate up to 150 gallons per minute. As fuel enters the tank, it forces the air inside the tank to exit through the Wiggins vent. When the fuel level nears the top of the tank, the "hollow floating balls" force the third "solid ball" to seal against the vent "stem", sealing the tank and stopping the air flow out of the tank. As fuel continues to flow, pressure inside the tank builds until it reaches 8 to 10 PSIG. At 8 to 10 PSIG, the nozzle automatically shuts off. The nozzle shut off is gradual, preventing a hammer effect which could damage the fuel line. The nozzle can then be removed, and is ready to fuel the next vehicle!

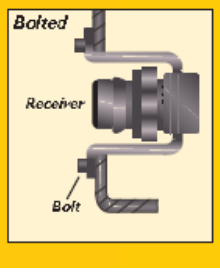
Mounting Receivers:
There are four ways to mount receivers (complete installation instructions, see Bulletin WIS-4).

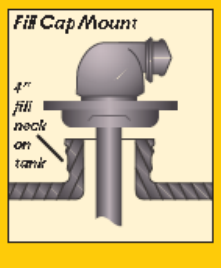


Mounting Vents:
There are three ways to mount vents (for complete installation instructions, see Bulletin WIS-4).









WETLAND MITIGATION AND HABITAT IMPROVEMENTS

The selected plan design and construction methods for repair and rehabilitation of the MCR jetties have been developed and refined to take advantage of opportunities to avoid and minimize the project's ecological impacts to habitats and species. As required under the Clean Water Act, the Corps will mitigate for impacts to wetlands which could not be otherwise avoided or minimized. The Corps has also incorporated habitat improvements into the proposed action to assist with the recovery of ESA-listed salmonid habitats and ecosystem functions and processes. These actions are not proposed to directly mitigate or compensate for any Project-related impacts to ESA-listed salmonids. The habitat improvement components of the overall ecosystem restoration action are proposed as Conservation Measures under Section 7(a) (1) of the ESA and have been included into the proposed action by the Corps. These actions are the Corps' affirmative commitment to fulfill responsibility to assist with conservation and recovery of ESA-listed salmonids.

Habitat improvement features will be designed to create or improve salmonid habitat, specifically tidal marsh, swamp, and shallow water and flats habitat, and to improve fish access to these habitat features. In addition, one of the features would create habitat for snowy plover. Habitat improvement and wetland mitigation plans currently address three general categories: actions that create, improve, and restore wetlands, actions that improve in-water habitats, and actions that restore upland habitats. From the list of possible wetland mitigation and habitat improvement features shown in Table 14, one or a combination of projects will be selected for further development and implementation. Selection will occur with input from the AMT and work is anticipated to occur concurrent with jetty repair actions.

Table 14. Possible Wetland Mitigation and Habitat Improvement Features

Feature/Site	Area Affected	Type and Function
Trestle Bay	5-8 acres with potential of additional acres	Estuarine Saltwater Marsh Wetland and Intertidal Mudflat Creation and Restoration • Create and expand estuarine intertidal brackish saltwater marsh wetland habitat. • Expand and restore Lyngby sedge plant community. • Expand/increase intertidal shallow water habitat, including dendritic mud flats and off-channel habitat. • Remove and control invasive species and improve/restore diversity and density of native plant assemblages. • Increase habitat complexity for fisheries benefit. • Potentially expand floodplain terrace and improve riparian function. • (Re)introduce natural tidal disturbance regime to area currently upland dunes.
Walooskee to Youngs Bay	~151 acres	Levee Breach for Estuarine Emergent Wetland and Brackish Intertidal Shallow-water Habitat Restoration • Restore connection between Walooskee and Youngs River via levee breach. • Restore and expand estuarine intertidal brackish marsh wetland habitat. • Expand and restore Lyngby sedge and native estuarine vegetation community to improve trophic foodweb functions. • Restore and expand brackish intertidal shallow water habitat including dendritic mud flats and off-channel edge habitat. • Remove and control invasive species and improve/restore diversity and density of native plant assemblages. • Increase habitat access and complexity for fisheries benefit including expanded foraging, rearing, and refugia habitat types. • Improve riparian function. • Potentially restore floodplain terrace and increase flood storage capacity. • (Re)introduce natural tidal disturbance regime to area currently diked pasture land. • Restore hydrologic regime and restore/improve water quality function. • Improve capacity for additional carbon sequestration via native root masses. • Increase and restore hyporheic functions for improved water quality and potential creation of cold water refugia.
Walooskee to Youngs Bay	~39 acres	Levee Breach and/or Tide Gate Retrofits for Emergent Wetland and Intertidal Shallow-water Habitat Restoration • Restore connection with Walooskee River via levee breach and/or tide gate retrofits. • Restore and expand intertidal marsh wetland habitat. • Expand and restore native vegetation community to improve trophic foodweb functions. • Restore and expand intertidal shallow water habitat including dendritic and off-channel edge habitat. • Remove and control invasive species and improve/restore diversity and density of native plant assemblages. • Increase habitat access and complexity for fisheries benefit including expanded foraging, rearing, and refugia habitat types. • Improve riparian function. • Potentially restore floodplain terrace and increase flood storage capacity. • Restore hydrologic and natural tidal disturbance regime and restore/improve water quality function to area currently functioning as diked pasture land. • Improve capacity for additional carbon sequestration via native root masses. • Increase and restore hyporheic functions for improved water quality and potential creation of cold water refugia.
Slough to Youngs River	~250-500 acres	Levee Breach for Estuarine Wetland and Intertidal Restoration • Restore connection between Slough and Youngs River via levee breach. • Restore and expand estuarine intertidal brackish marsh wetland habitat. • Expand and restore Lyngby sedge and native estuarine vegetation community to improve trophic foodweb functions. • Restore and expand brackish intertidal shallow water habitat including dendritic mud flats and off-channel edge habitat.

Feature/Site	Area Affected	Type and Function
		• Remove and control invasive species and improve/restore diversity and density of native plant assemblages. • Increase habitat access and complexity for fisheries benefit including expanded foraging, rearing, and refugia habitat types. • Improve riparian function. • Potentially restore floodplain terrace and increase flood storage capacity. • Restore hydrologic and natural tidal disturbance regimes to an area currently functioning as diked pasture land. • Improve capacity for additional carbon sequestration via native root masses. • Increase and restore hyporheic functions for improved water quality and potential creation of cold water refugia.
Youngs River - Diked Farmland, Freshwater Intertidal Restoration	45-50 acres With potential up to 80 acres	Levee Breach for Wetland and Intertidal Restoration • Restore connection with Youngs River via levee breach. • Restore and expand freshwater intertidal wetland habitat. • Expand and restore native vegetation community to improve trophic foodweb functions. • Restore and expand intertidal shallow water habitat including dendritic mud flats and off-channel edge habitat. • Remove and control invasive species and improve/restore diversity and density of native plant assemblages. • Increase habitat access and complexity for fisheries benefit including expanded foraging, rearing, and refugia habitat types. • Improve riparian function. • Potentially restore floodplain terrace and increase flood storage capacity. • (Re)introduce natural tidal disturbance regime to area currently diked pasture land. • Restore hydrologic regime and restore/improve water quality function. • Increase and restore hyporheic functions for improved water quality and potential creation of cold water refugia.
Tributary Cr. to Youngs River	~5 or more acres	Estuarine Wetland and Intertidal Restoration; Tributary Reconnection to Youngs Bay • Convert diked pasture land to brackish estuarine wetland and shallow water intertidal habitat. • Improve and restore hydrologic regime and increase regular hydrologic connectivity between Crosel Cr. And Youngs Bay estuary. • Improve and restore fish passage and provide access throughout greater range of flows to off-channel juvenile rearing, refuge and foraging habitats. • Remove and control invasive species and improve/restore diversity and density of native plant assemblages. • Increase habitat complexity for fisheries benefit. • Improve adult salmonid access to headwaters and potential spawning habitat. • Potentially expand floodplain terrace and improve riparian function. • (Re)introduce natural flow regime and tidal disturbance regime to area currently functioning as pasture land.
Tributary Cr. and Slough to the Columbia River - near Clatskanie	Up to ~43 acres	Levee Breach and/or Tide Gate Retrofits for Emergent Wetland and Intertidal Shallow-water Habitat Restoration and Tributary Reconnection • Restore connection between Tandy and Graham creeks and Westport Slough and Columbia River via levee berach and/or tide gate retrofits. • Restore and expand intertidal wetland habitat. • Expand and restore native vegetation community to improve trophic foodweb functions. • Restore and expand intertidal shallow water habitat including dendritic and off-channel edge habitat. • Remove and control invasive species and improve/restore diversity and density of native plant assemblages. • Increase habitat access and complexity for fisheries benefit including expanded foraging, rearing, and refugia habitat types. • Improve riparian function. • Potentially restore floodplain terrace and increase flood storage capacity. • Restore hydrologic and natural tidal disturbance regime and restore/improve water quality function to area currently functioning as diked pasture hayfields.

Feature/Site	Area Affected	Type and Function
		• Improve capacity for additional carbon sequestration via native root masses. • Increase and restore hyporheic functions for improved water quality and potential creation of cold water refugia. • Improve adult salmonid access to headwaters and potential spawning habitat.
Knappa - Warren Slough	~100 or more acres	Preservation and Expansion of Estuarine Intertidal Restoration; Improve Tributary Reconnection for Fish Passage • Maintain and enhance evolving restoration that has occurred since inundation of previously diked pasture land to estuarine wetland and shallow intertidal habitat. Maintain restored ecosystem function and intertidal shallow water habitat established post-breach. • Maintain and enhance restored hydrologic regime and increase regular hydrologic connectivity between Hall Cr. and Warren Slough. • Maintain and improve existing fish passage and provide access throughout greater range of flows to off-channel juvenile rearing, refuge and foraging habitat types. • Maintain and increase habitat complexity for fisheries benefit. • Improve adult salmonid access to headwaters and potential spawning habitat. • Remove and control invasive species and improve/restore diversity and density of native plant assemblages; Improve riparian function as appropriate. • Potentially expand floodplain terrace. • Maintain restored natural tidal disturbance regime, dendritic channels, and connection between Hall Cr. and Warren Slough.
Snowy Plover Work on Clatsop Spit	Up to ~22 acres	Forego Revegetation and Convert Upland Areas to Snowy Plover Habitat • Convert upland scrub-shrub habitat with invasive species to snowy plover habitat via periodic tilling and application of shell hash.
Wetland Creation at Cape Disappointment	Up to ~10 acres	Creation and Expansion of Interdunal Wetland Complex • Excavation of new interdunal wetlands adjacent to existing wetlands. • Establishment of native wetland plant communities and removal of invasive species around a buffer zone. • Restoration or provision of hydrology to newly excavated wetlands via appropriate elevation design. • Restoration of wetland connectivity between existing fragmented wetlands via culvert retrofits, if feasible.
Tide Gate Retrofits for Salmonid Passage	Variable	Select Tributaries from ODFW Priority Culvert Repair List - Tributary Reconnection • Restore and improve existing fish passage and provide access throughout greater range of flows to off-channel juvenile rearing, refuge and foraging habitat types. • Restore and increase habitat complexity for fisheries benefit. • Restore and improve adult salmonid access to headwaters and potential spawning habitat.

Wetlands and shallow-water habitat will be filled and converted as a result of the project. Official wetland delineations have not yet been completed for all three of the jetties. However, available preliminary information has allowed the Project Delivery Team (PDT) to site construction activities and features to reduce anticipated impact to wetlands. This information has also been used to calculate initial estimates regarding the possible acreage of impacts. The approximated acreages identified as potentially impacted are North Jetty ~4.78, South Jetty up to ~22 and Jetty A up to ~11. This comes to an estimated total of ~38.28 acres of potential wetlands impacts. To reiterate, official delineations must be completed, and these numbers will be revised accordingly after report results and project design details are further developed and available. These estimates are on the conservatively high end of what final wetland impacts will likely be.

In-water habitats, both shallow intertidal and deeper subtidal areas will also be affected by the project. Habitat conversions will occur from maintenance dredging and placement of the spur groins, jetty cross-sections, turnouts, barge offloading facilities, and causeways. There will also be permanent lagoon fill at the North Jetty root. Without drawing a distinction between depths, initial acreage estimates for all in-water impacts include North Jetty ~11.75, South Jetty ~21.2, and Jetty A ~7.23. This comes to an approximated total of ~40.18 acres of potential in-water conversions. Shallow-water habitat is especially important to several species in the estuary; therefore, specific initial estimates were also calculated regarding shallow-water habitat (shallow here defined as -20-ft or -23-ft below MLLW). About 30 acres (out of the ~40 mentioned above) of area at these depths will be affected by groins, maintenance dredging, and construction of the causeways and barge offloading facilities. However, this estimate does NOT including any expansion of the jetty's existing footprint or overwater structures from barge offloading facilities. The approximate acreage breakdowns entail: spur groin fill = 1.56 (shallow defined as -20-ft or less below MLLW; ~3.26 total area including all depths); dredge for barges ~20, likely all shallow (less than -23-ft deep below MLLW); and causeway fill~ 7, likely all shallow (less than -23 ft deep below MLLW). For this analysis, there was no distinction drawn between periodically exposed intertidal habitat and shallow-water sandflat habitat. As with wetland estimates, these approximations will be updated as project designs are refined and as additional analyses and surveys are completed to quantify changes in jetty and dune cross sections.

Ultimately the project seeks to achieve no net loss in wetland habitat, to protect, improve and restore overall ecosystem functions, and to provide actions that are anticipated to benefit listed species in the vicinity of the project. Towards that end, specific project footprints and activities described above have been identified, categorized, and quantified with conservative estimates where appropriate. The calculated extents were strictly based on the area of habitat that was converted. They did not include value or functional assignments regarding the significance of the conversion, whether it was a beneficial, neutral, or detrimental effect, nor if conversions created unforeseen, indirect far-field effects. For example, acreage of conversion for shallow sandy sub-tidal habitat to rocky sub-tidal habitat was calculated in the same manner as conversion from shallow intertidal habitat to shallow sub-tidal habitat. Per initial consultation with resource agencies, a preliminary suggested ratio of 2:1 for wetland mitigation will likely be required. This is described in Table 15. These estimated footprints will likely change slightly during final design and after updated wetland delineations are completed.

Table 15. Maximum Estimated Acreages for Habitat Improvement and Wetland Mitigation

Jetty	Wetland	In-water	Upland Replanting
North Jetty Total	9.56	--	--
South Jetty Total	44.00	--	--
Jetty A Total	23.00	--	--
TOTAL Wetland and Habitat Improvements	76.56	60.00	55.00

Specific opportunities have been identified in the Columbia River estuary and Youngs Bay (see Table 14) and are under consideration to improve and restore functions affected in each of the generalized habitat categories (wetland, in-water, and upland). Depending on further development of wetland mitigation and habitat improvement alternatives, a specific project or combination of projects will be designed and constructed concurrently as the proposed repair and rehabilitation options are completed over time. Mitigation actions and extents will be commensurate with wetland impacts and ratios identified. Proposed projects are subject to further analysis, and unforeseen circumstances may preclude further development of any specific project. In all cases, final selection, design, and completion of specific improvement features is contingent on evolving factors and further analyses including hydraulic and hydrologic conditions, real estate actions, cultural resource issues, etc. For this reason a suite of potential proposals has been identified, and subsequent selection of one or some combination of projects and designs will occur during continued discussion with resource agencies participating on the Adaptive Management Team. These wetland mitigation and habitat improvement measures will therefore require additional Consultations, and it is anticipated that the AMT will facilitate in this process. It is also anticipated that a programmatic Opinion similar to SLOPES or Limit 8 may be useful to fulfill clearance requirements.

Actions adjacent to or onsite in the vicinity of the North and South Jetties that could potentially mitigate wetland impacts include: excavation of low and high saltwater marsh wetlands and new interdunal wetlands adjacent to existing wetlands; establishment of native wetland plant communities and removal of invasive species around a buffer zone for wetlands; restoration or provision of hydrology to newly excavated wetlands via appropriate elevation design; and/or restoration of wetland connectivity between existing fragmented wetlands. Offsite opportunities for wetland mitigation in the estuary that warrant further investigation are associated with: levee breaches, inlet improvements, or tide gate retrofits, as appropriate. Purchasing mitigation bank credits may be a possibility, though this is currently constrained by limitations of service area and availability of appropriate wetland types. However, private farmlands behind existing levees may provide wetland mitigation opportunities to pursue further. Hydrology and vegetative communities are heavily influenced by elevation; therefore providing improved hydrology combined with strategic excavation and appropriate plantings should result in a simple and self-sustaining design and outcome.

Actions to provide benefits and improvements to in-water habitat include the following opportunities: levee breaches, inlet improvements, or tide gate retrofits, as appropriate. Additional associated actions include: excavation in sand dunes and uplands to specified design elevations in order to create additional intertidal shallow water habitat with dendritic channels

and mud flats, and excavation for potential expansion of the floodplain terraces. Though conceptually considered, specific opportunities for additional projects such as the following were not identified but could warrant further investigation if none of the projects in the list is determined to be feasible: removal of overwater structures and fill in the estuary; removal of relic pile-dike fields; removal of fill from Trestle Bay or elsewhere; removal of shoreline erosion control structures and replacement with bioengineering features; beneficial use of dredge material to create ecosystem restoration features (Lois Island Embayment is an example from Columbia River Channel Improvement that may be applicable here); and restoration of eelgrass beds. Certain pile fields and engineering features may be providing current habitat benefits that could be lost with removal, and such actions would require appropriate hydraulic analysis coordination with engineers and resource agencies.

For potential habitat improvement projects located in Trestle Bay, there is additional monitoring and assessment opportunity. A separate hydraulic/engineering study should investigate whether or not an expansion of low-energy, intertidal habitat near Swash Lake could effectively provide additional storage capacity and affect circulation in the Bay such that erosive pressure at neck of Clatsop Spit could be reduced. The previous 1135 action which breached a section of the relic jetty structure is speculated to have been the cause of increased circulation and erosion. It would be worth evaluating whether or not projects that expand floodplain and intertidal areas in the Bay provide significant energy dissipation and additional low-energy storage capacity to offset or redirect erosive pressures. Alternatively, if other habitat improvement concepts are pursued that include removal of additional piles or creation of additional inlets; it would be worth investigating whether these actions could have indirect positive impacts that further reduce concern with erosion at the neck. Evaluating actions in this light would provide valuable information and insight regarding possible solutions and concerns for erosion and breaching at the neck area of Clatsop Spit on Trestle Bay.

Post-construction upland restoration would include the following actions: re-establishing native grasses, shrubs, and trees where appropriate; controlling and removing invasive species like scotch broom and European beach grass in the project vicinity; and re-grading/tilling the area to restore natural contours. Oregon Parks and Recreation Department has requested that the Corps utilize the State Forester as one resource for determining optimal revegetation plans.

On the Clatsop Spit there is also a unique opportunity to partner with U.S. Fish and Wildlife and Oregon Parks and Recreation Department (OPRD) regarding creation and management of snowy plover habitat on the Spit. This would be an alternative to re-vegetative restoration of the uplands. The OPRD is currently developing a Habitat Conservation Plan in the area to address snowy plover habitat management prior to an anticipated designation of Critical Habitat by US Fish and Wildlife. There may be locations in the vicinity and away from projected construction and staging areas to convert upland habitat to snowy plover habitat via invasive species removal, tilling, and application of shell hash. Ongoing operation and maintenance during the project via regular tilling and shell hash distribution could possibly be coordinated between the agencies through a vehicle such as a Memorandum of Agreement or similar avenue.

Refinement and implementation of this wetland mitigation and habitat improvement plan will help protect species and habitats while restoring wetland functions affected by the MCR project.

Monitoring and maintenance of wetland mitigation and habitat improvement actions will likely be required to ensure successful establishment of goals and satisfactory return on investment. Regular coordination with the AMT will further facilitate selection and implementation of wetland mitigation and habitat improvement actions that appropriately meet the framework for successful restoration, protection, and preservation of ESA listed species and high-value habitat.

ACTION AREA

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). For this consultation, the action area includes (see Figure 1): (1) an area extending 10 miles offshore from Columbia River mile -1; (2) extending 5 miles north and 5 miles south of river mile -1, including all terrestrial habitats; (3) extending upstream as far as the Astoria-Megler Bridge, river mile 13.5; and (4) all areas where quarried stone will be transported, including offshore and inland navigation channels in the Pacific ocean extending as far north as Vancouver B.C. in the Puget Sound, and as far south as Eureka, and Humbolt Bay, California. See Figures 28-32 for route illustrations. The sixth field HUCs in the vicinity of the MCR include: Baker Bay-Columbia River – 1708000605; Necanicum River-Frontal Pacific Ocean – 1710020101; Youngs River-Frontal Columbia River – 1708000602; Long Beach-Frontal Pacific Ocean – 1710010607 and Wallacut River-Frontal Columbia River – 1708000604.

Federally listed marine and anadromous fish, mammal, and turtle species are present in the action area (Table 16), as well as EFH species including five coastal pelagic species, numerous Pacific Coast groundfish species, and coho and Chinook salmon (Table 17).

Vessels transporting rock from Canada or Puget Sound sources will travel through areas where bocaccio (*Sebastes paucispinis*), canary rockfish (*Sebastes pinniger*), yelloweye rock fish (*Sebastes ruberrimus*), and Puget Sound Steelhead (*Oncorhynchus mykiss*) are generally found. However, barge traffic is not expected to encounter these species and therefore will not affect behavior or habitat of these species. Furthermore, these species are not expected to occur in the vicinity of the MCR jetties where the bulk of the proposed actions will occur. Critical habitat also has not been designated for these species. Therefore, it is anticipated that the proposed action will have no effect on these species, and they will not be included further in this analysis. The same scenario is applicable to Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal summer-run Chum salmon (*O. keta*), and Ozette Lake Sockeye salmon (*O. nerka*), which do have critical habitat listed in areas where barge traffic may occur. However, the proposed action is also not expected to have any effects on these species or their critical habitat; therefore, these species will also not be included further in this analysis.

Table 16. Federal Register Notices for Final Rules that List Threatened and Endangered Species, Designate Critical Habitats, or Apply Protective Regulations to Species under Consideration

Listing status: 'T' means listed as threatened under the ESA; 'E' means listed as endangered; 'P' means proposed.

Species	Listing Status	Critical Habitat	Protective Regulations
Marine and Anadromous Fish			
Chinook salmon (*Oncorhynchus tshawytscha*)			
Lower Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Chum salmon *(O. keta*)			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Coho salmon (*O. kisutch*)			
Lower Columbia River	T 6/28/05; 70 FR 37160	Not applicable	6/28/05; 70 FR 37160
Oregon Coast	T 2/11/08; 73 FR 7816	2/11/08; 73 FR 7816	2/11/08; 73 FR 7816
S. Oregon/N. California Coasts	T 6/28/05; 70 FR 37160	5/5/99; 64 FR 24049	6/28/05; 70 FR 37160
Sockeye salmon (*O. nerka*)			
Snake River	E 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	2/018/06; 71 FR 5178
Snake River Basin	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Green sturgeon (*Acipenser medirosris)*			
Southern	T 4/07/06; 71 FR 17757	10/09/09; 74 FR 52300	P 5/21/09; 74 FR 23822
Eulachon (*Thaleichthys pacificus*)	T 3/18/10; 75 FR 13012	Not applicable	Not applicable
Marine Mammals			
Steller sea lion (*Eumetopias jubatus*)			
Eastern	T 5/5/1997; 63 FR 24345	8/ 27/93; 58 FR 45269	11/26/90; 55 FR 49204 10/1/09; 50 CFR 223.202
Blue whale (*Balaenoptera musculus*)			
	E 12/02/70; 35 FR 18319	Not applicable	ESA section 9 applies
Fin whale (*Balaenoptera physalus*)			
	E 12/02/70; 35 FR 18319	Not applicable	ESA section 9 applies
Humpback whale (*Megaptera novaeangliae*)			
	E 12/02/70; 35 FR 18319	Not applicable	ESA section 9 applies
Killer whale (*Orcinus orca*)			
Southern Resident	E 11/18/05; 70 FR 69903	11/26/06; 71 FR 69054	ESA section 9 applies
Sei whale (*Balaenoptera borealis*)			
	E 12/02/70; 35 FR 18319	Not applicable	ESA section 9 applies
Sperm whale (*Physeter macrocephalus*)			
	E 12/02/70; 35 FR 18319	Not applicable	ESA section 9 applies
Marine Turtles			
Green turtle (*Chelonia mydas*)			
Excludes Pacific Coast of Mexico & FL	ET 7/28/78; 43 FR 32800	9/02/98; 63 FR 46693	ESA section 9 applies
Leatherback turtle (*Dermochelys coriacea*)	E 6/02/70 ; 39 FR 19320	1/5/10; 75FR319;	ESA section 9 applies
Loggerhead turtle (*Caretta caretta*)	T 7/28/78; 43 FR 32800	Not applicable	7/28/78; 43 FR 32800
Olive ridley turtle (*Lepidochelys olivacea*)	ET 7/28/78; 43 FR 32800	Not applicable	ESA section 9 applies

Table 17. EFH Species and Potential Life Stages in the Action Area

EFH Species	Egg	Larvae	Young Juvenile	Juvenile	Adult	Spawning
Salmon Species						
Coho salmon *(Oncorhynchus kisutch)*			X	X	X	
Chinook salmon *(Oncorhynchus tshawytscha)*			X	X	X	
Coastal Pelagic Species						
Northern anchovy (*Engraulis mordax*)	X	X		X	X	
Pacific sardine (*Sardinops sagax*)	X	X		X	X	
Pacific mackerel (*Scomber japonicus*)	X	X		X	X	
Jack mackerel (*Trachurus symmetricus*)					X	
Market squid (*Loligo opalescens*)					X	
California Skate (*Raja inornata*)	X		X		X	X
Soupfin Shark (*Galeorhinus galeus*)	X		X		X	X
Spiny Dogfish (*Squalus acanthias*)	X		X	X	X	
Ratfish (*Hydrolagus colliei*)			X		X	X
Lingcod (*Ophiodon elongates*)	X	X	X	X	X	X
Cabezon (*Scorpaenichthys marmoratus*)	X	X	X	X	X	X
Kelp Greenling (*Hexagrammos decagrammus*)	X	X	X	X	X	X
Pacific Cod (*Gadus macrocephalus*)	X	X	X		X	X
Pacific Hake (*Merluccius productus*)	X	X	X		X	
Sablefish (*Anoplopoma fimbria*)				X		
Butter Sole (*Isopsetta isolepis*)					X	X
Curlfin Sole (*Pleuronichthys decurrens*)					X	X
English Sole (*Parophyrs vetulus*)	X	X	X		X	X
Flathead Sole (*Hippoglossoides elassodon*)			X			
Pacific Sanddab (*Citharichthys sordidus*)	X	X	X		X	
Petrale Sole (*Eopsetta jordani*)			X		X	
Rex Sole (*Glyptocephalus zachirus*)			X		X	
Rock Sole (*Lepidopsetta bilineata*)	X		X		X	X

EFH Species	Egg	Larvae	Young Juvenile	Juvenile	Adult	Spawning
Sand Sole (*Psettichthys melanostictus*)			X		X	X
Starry Flounder (*Platichthys stellatus*)	X	X	X		X	X
Black Rockfish (*Sebastes melanops*)			X		X	
Brown Rockfish (*Sebastes auriculatus*)	X	X	X		X	X
China Rockfish (*Sebastes nebulosus*)						
Copper Rockfish (*Sebastes caurinus*)	X	X	X	X	X	X
Quillback Rockfish (*Sebastes maliger*)	X	X	X	X	X	X
Vermilion Rockfish (*Sebastes miniatus*)			X			

ENDANGERED SPECIES ACT ENVIRONMENTAL ASSESSMENT

INTRODUCTION

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this Assessment. More detailed information on the status and trends of these listed resources, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the Federal Register (see Table 16) and in many publications available from the NMFS Northwest Region, Protected Resources Division in Portland, Oregon.

It is likely that climate change will play an increasingly important role in determining the abundance of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. During the last century, average regional air temperatures increased by 1.5°F, and increased up to 4°F in some areas (USGCRP 2009). Warming is likely to continue during the next century as average temperatures increase another 3° to 10°F (USGCRP 2009). Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009).

Precipitation trends during the next century are less certain than for temperature but more precipitation is likely to occur during October through March and less during summer, and more of the winter precipitation is likely to fall as rain rather than snow (ISAB 2007, USGCRP 2009). Where snow occurs, a warmer climate will cause earlier runoff so stream flows in late spring, summer, and fall will be lower and water temperatures warmer (ISAB 2007, USGCRP 2009).

Higher winter stream flows increase the risk that winter floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (USGCRP 2009). Earlier peak stream flows will also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and the risk of predation (USGCRP 2009). Lower stream flows and warmer water temperatures during summer will degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (USGCRP 2009). Other adverse effects are likely to include altered migration patterns, accelerated embryo development, premature emergence of fry, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable inter-annual and inter-decadal variability superimposed on the longer-term trend (Bindoff et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2005, Zabel et al. 2006, USGCRP 2009). Ocean conditions adverse to salmon and steelhead may be more likely under a warming climate (Zabel et al. 2006).

STATUS OF THE SPECIES AND CRITICAL HABITAT

Salmon and Steelhead

Species Description and Limiting Factors

The summaries that follow describe the status of ESA-listed salmon and steelhead, and their designated critical habitats that occur within the geographic area of the Proposed Action. Over the past few decades, the sizes and distributions of the populations considered generally have declined due to natural phenomena and human activity, including the operation of hydropower systems, over-harvest, hatcheries, and habitat degradation. Enlarged populations of terns, seals, sea lions, and other aquatic predators in the Pacific Northwest have been identified as factors that may be limiting the productivity of some Pacific salmon and steelhead populations (Bottom et al. 2005, Fresh et al. 2005).

The status of species and critical habitat sections are organized by recovery domains to better integrate recovery planning information that NMFS is developing on the conservation status of the species and critical habitats considered in this consultation. Recovery domains are the geographically-based areas that NMFS is using to prepare multi-species recovery plans. Southern green sturgeon are under the jurisdiction of the NMFS Southwest Region, which has not yet convened a recovery team for this species. The four recovery domains relevant to this consultation and the ESA-listed salmon and steelhead species that reproduce in each recovery domain are shown in Table 18. For this consultation, populations that reproduce in Oregon are also identified as one indication of the importance of the action area to the recovery of these species. However, all populations spawning within the Columbia River Basin use the Columbia River mainstem and estuary to complete part of their life history.

Table 18. NMFS Recovery Planning Domains and ESA-listed Salmon and Steelhead Species

Recovery Domain	Species
Willamette-Lower Columbia (WLC)	LCR Chinook salmon
	UWR Chinook salmon
	CR chum salmon
	LCR coho salmon
	LCR steelhead
	UWR steelhead
Interior Columbia (IC)	UCR spring-run Chinook salmon
	SR spring/summer Chinook salmon
	SR fall-run Chinook salmon
	SR sockeye salmon
	UCR steelhead
	MCR steelhead
	SRB steelhead
Oregon Coast (OC)	OC coho salmon
Southern Oregon Northern California Coasts	SONCC coho salmon

For each recovery domain, a technical review team (TRT) appointed by NMFS has developed, or is developing, criteria necessary to identify independent salmon populations within each species, recommend viability criteria for that species, and analyze factors that limit species survival. The definition of a population used by each TRT is set forth in the "viable salmonid population" (VSP) document prepared by NMFS for use in conservation assessments of Pacific salmon and steelhead (McElhany et al. 2000). The boundaries of each population are defined using a combination of genetic information, geography, life-history traits, morphological traits, and population dynamics that indicate the extent of reproductive isolation among spawning groups.

Understanding population size and spatial extent is critical for the viability analyses, and a necessary step in recovery planning and conservation assessments for any species. If a species consists of multiple populations, the overall viability of that species is a function of the VSP attributes of its constituent populations. Until a viability analysis of a species is completed, the VSP guidelines recommend that all populations should be managed to retain the potential to achieve viable status to ensure a rapid start along the road to recovery, and that no significant parts of the species are lost before the full recovery plan is implemented (McElhany et al. 2000).

The status of critical habitat was based primarily on a watershed-level analysis of conservation value that focused on the presence of listed ESA-listed salmon and steelhead and the biological and physical features (i.e., the PCEs) that are essential to their conservation. This analysis for the 2005 designations was completed by Critical Habitat Analytical Review Teams (CHARTs) that focused on large geographical areas corresponding approximately to recovery domains (NOAA Fisheries 2005). Each watershed was ranked using a conservation value attributed to the quantity of stream habitat with PCEs, the present condition of those PCEs, the likelihood of achieving PCE potential (either naturally or through active restoration), support for rare or important genetic or life history characteristics, support for abundant populations, and support for spawning and rearing populations. In some cases, our understanding of these interim conservation values has been further refined by the work of TRTs and other recovery planning efforts that have better explained the habitat attributes, ecological interactions, and population characteristics important to each species.

Natural variations in freshwater and marine environments have substantial effects on the abundance of Pacific salmon and steelhead populations. Of the various natural phenomena that affect most populations of salmon and steelhead, changes in ocean productivity are generally considered the most important. Pacific salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation probably contributes to significant natural mortality, although the levels of predation are largely unknown. In general, Pacific salmon and steelhead are eaten by pelagic fishes, birds, and marine mammals.

Over the past few decades, the size and distribution of the salmon and steelhead populations considered here, like the other salmon and steelhead that NMFS has listed, generally have declined because of natural phenomena and human activity, including the operation of hydropower systems, over-harvest, hatcheries, and habitat degradation. Enlarged populations of terns, seals, and sea lions in the Pacific Northwest have reduced the survival of some Pacific salmon and steelhead populations. As noted more fully in the status of the critical habitats section below, climate change is likely to play an increasingly important role in determining the

abundance of salmon and steelhead by exacerbating long-term problems related to temperature, stream flow, habitat access, predation, and marine productivity (CIG 2004, Scheuerell and Williams 2005, Zabel et al. 2006, ISAB 2007).

Willamette and Lower Columbia (WLC) Recovery Domain. Species in the WLC Recovery Domain include LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, and UWR steelhead. The WLC-TRT identified 107 demographically-independent populations of those species (Table 19), including 47 populations that spawn within Oregon. These populations were further aggregated into strata, groupings above the population level that are connected by some degree of migration, based on ecological subregions. All 107 populations use parts of the mainstem of the Columbia River and the Columbia River estuary that flow through Oregon for migration, rearing, and smoltification.

The WLC-TRT recommended viability criteria that follow the VSP framework and described biological or physical performance conditions that, when met, indicate a population or species has a 5% or less risk of extinction over a 100-year period (McElhany et al. 2006, see also, NRC 1995). McElhany et al. (2007) applied those criteria to populations in Oregon and found that the combined extinction risk is very high for LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, and moderate for LCR steelhead and UWR steelhead, although the status of those species with populations in Washington is still under assessment.

Table 19. Demographically Independent Salmonid Populations in the WLC Recovery Domain and Spawning Populations

Species	Populations in WLC	Spawning Populations in Oregon
LCR Chinook salmon	32	12
UWR Chinook salmon	7	7
CR chum salmon	17	8
LCR coho salmon	24	9
LCR steelhead	23	6
UWR steelhead	5	5

LCR Chinook salmon. This species includes all naturally-spawned populations of Chinook salmon in the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River; the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River; and progeny of seventeen artificial propagation programs. The WLC-TRT identified 32 historical populations of LCR Chinook salmon – seven in the coastal subregion, six in the Columbia Gorge, and nine in the western Cascades. Twelve of those populations occur within the action area (Table 20) and only Sandy River late fall Chinook is considered “viable” (McElhany et al. 2007). The major factors limiting recovery of LCR Chinook salmon include altered channel morphology, loss of habitat diversity, excessive sediment, high water temperature, reduced access to spawning/rearing habitat, and harvest impacts (NMFS 2006).

Table 20. LCR Chinook Salmon Populations Spawning in Oregon

Overall viability risk within 100 years: "extinct or very high" means greater than 60% chance of extinction; "relatively high" means 60% to 25% risk of extinction; "moderate" means 25% to 5% risk of extinction, "low or negligible" means 5% to 1% risk of extinction, "very low" means less than 1% chance of extinction, and NA means not available. A low or negligible risk of extinction is considered "viable."

Stratum		**Spawning Population In Oregon (Watershed)**	**Overall Viability Risk**
Ecological Subregion	**Run Timing**		
Coast Range	Fall	Young Bay	Very High
		Big Creek	Very High
		Clatskanie	Relatively High
		Scappoose	Very High
Columbia Gorge	Spring	Hood	Very High
	Early fall ("tule")	Upper Gorge	Very High
	Fall	Hood	Very High
		Lower Gorge	Very High
West Cascade Range	Spring	Sandy	Moderate
	Early fall ("tule")	Clackamas	Very High
		Sandy	Very High
	Late fall ("bright")	Sandy	Low

UWR Chinook salmon. The species includes all naturally-spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls, Oregon, and progeny of seven artificial propagation programs. All seven historical populations of UWR Chinook salmon identified by the WLC-TRT occur within the action area and are contained within a single ecological subregion, the western Cascade Range (Table 21); only the Clackamas population is characterized as "viable" (McElhany et al. 2007). The major factors limiting recovery of UWR Chinook salmon identified by NMFS include lost/degraded floodplain connectivity and lowland stream habitat, degraded water quality, high water temperature, reduced streamflow, and reduced access to spawning/rearing habitat (NMFS 2006).

Table 21. UWR Chinook Salmon Populations

Overall viability risk within 100 years: "extinct or very high" means greater than 60% chance of extinction; "relatively high" means 60% to 25% risk of extinction; "moderate" means 25% to 5% risk of extinction, "low or negligible" means 5% to 1% risk of extinction, "very low" means less than 1% chance of extinction, and NA means not available. A low or negligible risk of extinction is considered "viable."

Stratum		Spawning Population In Oregon (Watershed)	Overall Viability Risk
Ecological Subregion	**Run Timing**		
West Cascade Range	Spring	Clackamas	Low
		Molalla	Relatively High
		North Santiam	Very high
		South Santiam	Very high
		Calapooia	Very high
		McKenzie	Moderate
		Middle Fork Willamette	Very high

CR Chum salmon. This species includes all naturally-spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon, and progeny of three artificial propagation programs. The WLC-TRT identified 17 historical populations of CR chum salmon and aggregated these into four strata (Myers et al. 2006). Unlike other species in the WLC Recovery Domain, CR chum salmon spawning aggregations were identified in the mainstem Columbia River. These aggregations generally were included in the population associated with the nearest river basin. Three strata and eight historical populations of CR chum salmon occur within the action area (Table 22); of these, none are "viable" (McElhany et al. 2007). The major factors limiting recovery of CR chum salmon include altered channel morphology, loss of habitat diversity, excessive sediment, reduced streamflow, harassment of spawners and harvest impacts (NMFS 2006).

Table 22. CR Chum Salmon Populations Spawning in Oregon

Overall viability risk within 100 years: "extinct or very high" means greater than 60% chance of extinction; "relatively high" means 60% to 25% risk of extinction; "moderate" means 25% to 5% risk of extinction, "low or negligible" means 5% to 1% risk of extinction, "very low" means less than 1% chance of extinction, and NA means not available. A low or negligible risk of extinction is considered "viable."

Stratum		Spawning Population In Oregon (Watershed)	Overall Viability Risk
Ecological Subregion	**Run Timing**		
Coast Range	Fall	Young's Bay	Very high
		Big Creek	Very high
		Clatskanie	Very high
		Scappoose	Very high
Columbia Gorge	Fall	Lower Gorge	Very high
		Upper Gorge	Very high
West Cascade Range	Fall	Clackamas	Very high
		Sandy	Very high

LCR coho salmon. This species includes all naturally-spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood rivers, in the Willamette River to Willamette Falls, Oregon, and progeny of 25 artificial propagation programs. The WLC-TRT identified 24 historical populations of LCR coho salmon and divided these into two strata based on major run timing: early and late (Myers et al. 2006). Three strata and nine historical populations of LCR coho salmon occur within the action area (Table 23). Of these nine populations, Clackamas River is the only population characterized as "viable" (McElhany et al. 2007). The major factors limiting recovery of LCR coho salmon include degraded floodplain connectivity and channel structure and complexity, loss of riparian areas and large wood recruitment, degraded stream substrate, loss of stream flow, reduced water quality, and impaired passage (NMFS 2007).

In general, late coho salmon spawn in smaller rivers or the lower reaches of larger rivers from mid-November to January, coincident with the onset of rain-induced freshets in the fall or early winter. Spawning typically takes place within a few days to a few weeks of freshwater entry. Late-run fish also tend to undertake oceanic migrations to the north of the Columbia River, extending as far as northern British Columbia and southeast Alaska. As a result, late coho salmon are known as "Type N" coho. Alternatively, early coho salmon spawn in the upper reaches of larger rivers in the Lower Columbia River and in most rivers inland of the Cascade Crest. During their oceanic migration, early coho salmon tend to migrate to the south of the Columbia River and are known as "Type S" coho salmon. They may migrate as far south as the waters off northern California. While the ecological significance of run timing in coho salmon is fairly well understood, it is not clear how important ocean migratory pattern is to overall diversity and the relative historical abundance of Type N and Type S life histories largely is unknown.

Table 23. LCR Coho Salmon Populations Spawning in Oregon

Overall viability risk within 100 years: "extinct or very high" means greater than 60% chance of extinction; "relatively high" means 60% to 25% risk of extinction; "moderate" means 25% to 5% risk of extinction, "low or negligible" means 5% to 1% risk of extinction, "very low" means less than 1% chance of extinction, and NA means not available. A low or negligible risk of extinction is considered "viable."

Stratum		**Spawning Population In Oregon (Watershed)**	**Overall Viability Risk**
Ecological Subregion	**Run Type**		
Coast Range	N	Young's Bay	Very High
		Big Creek	Very High
		Clatskanie River	Relatively High
		Scappoose River	Relatively High
Columbia Gorge	N and S	Lower Gorge	Very High
		Upper Gorge	NA
		Hood River	Very high
West Cascade Range	S	Clackamas River	Low
		Sandy River	Relatively High

LCR steelhead. The species includes all naturally-spawned steelhead populations below natural and artificial impassable barriers in streams and tributaries to the Columbia River between and including the Cowlitz and Wind rivers, Washington; in the Willamette and Hood rivers, Oregon; and progeny of ten artificial propagation programs; but excluding all steelhead from the Upper Willamette River basin above Willamette Falls, Oregon, and from the Little and Big White Salmon rivers, Washington. The WLC-TRT identified 23 historical populations of LCR steelhead (Myers et al. 2006). Within these populations, the winter-run timing is more common in the west Cascade subregion, while farther east summer steelhead are found almost exclusively.

Summer steelhead return to freshwater long before spawning. Winter steelhead, in contrast, return from the ocean much closer to maturity and spawn within a few weeks. Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. Where no temporal barriers exist, the winter-run life history dominates. Three strata and six historical populations of LCR steelhead occur within the action area (Table 24). Of the populations in Oregon, only Clackamas is "viable" (McElhany et al. 2007). The major factors limiting recovery of LCR steelhead include altered channel morphology, lost/degraded floodplain connectivity and lowland stream habitat, excessive sediment, high water temperature, reduced streamflow, and reduced access to spawning/rearing habitat (NMFS 2006).

Table 24. LCR Steelhead Populations Spawning in Oregon

Overall viability risk within 100 years: "extinct or very high" means greater than 60% chance of extinction; "relatively high" means 60% to 25% risk of extinction; "moderate" means 25% to 5% risk of extinction, "low or negligible" means 5% to 1% risk of extinction, "very low" means less than 1% chance of extinction, and NA means not available. A low or negligible risk of extinction is considered "viable."

Stratum		Population Spawning In Oregon (Watershed)	Overall Viability Risk
Ecological Subregion	**Run Timing**		
Columbia Gorge	Summer	Hood River	Very High
	Winter	Lower Gorge	Relatively High
		Upper Gorge	Moderate
		Hood River	Moderate
West Cascade Range	Winter	Clackamas	Low
		Sandy	Relatively High

UWR steelhead. This species includes all naturally-spawned steelhead populations below natural and artificial impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River. The WLC-TRT identified four historical populations of UWR steelhead, all with winter run timing and all within Oregon (Myers et al. 2006). Only winter steelhead historically existed in this area, because flow conditions over Willamette Falls allowed only late winter steelhead to ascend the falls, until a fish ladder was constructed in the early 1900s and summer steelhead were introduced. Summer steelhead have become established in the McKenzie River where historically no steelhead existed, although these fish were not considered in the identification of historical populations.

UWR steelhead currently are found in many tributaries that drain the west side of the Upper Willamette River basin. Analysis of historical observations, hatchery records, and genetic analysis strongly suggested that many of these spawning aggregations are the result of recent introductions and do not represent a historical population. Nevertheless, the WLC-TRT recognized that these tributaries may provide juvenile rearing habitat or may be temporarily (for one or more generations) colonized during periods of high abundance.

One stratum and five historical populations of UWR steelhead occur within the action area (Table 25), although the west-side tributaries population was included only because it is important to the species as a whole, and not because it is independent. Of these five populations, none are "viable" (McElhany et al. 2007). The major factors limiting recovery of UWR steelhead include lost/degraded floodplain connectivity and lowland stream habitat, degraded water quality, high water temperature, reduced streamflow, and reduced access to spawning/rearing habitat (NMFS 2006).

Table 25. UWR Steelhead Populations

Overall viability risk within 100 years: "extinct or very high" means greater than 60% chance of extinction; "relatively high" means 60% to 25% risk of extinction; "moderate" means 25% to 5% risk of extinction, "low or negligible" means 5% to 1% risk of extinction, "very low" means less than 1% chance of extinction, and NA means not available. A low or negligible risk of extinction is considered "viable."

Stratum		Population Spawning In Oregon (Watershed)	Overall Viability Risk
Ecological Subregion	**Run Type**		
West Cascade Range	Winter	Molalla	Moderate
		North Santiam	Moderate
		South Santiam	Moderate
		Calapooia	Moderate
		West-side Tributaries	Moderate

Interior Columbia (IC) Recovery Domain. Species in the IC Recovery Domain include UCR spring-run Chinook salmon, SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, UCR steelhead, MCR steelhead, and SRB steelhead. The IC-TRT identified 82 demographically-independent populations of those species based on genetic, geographic (hydrographic), and habitat characteristics (Table 26). In some cases, the IC-TRT further aggregated populations into "major groupings" based on dispersal distance and rate, and drainage structure, primarily the location and distribution of large tributaries (IC-TRT 2003). Of the 82 populations identified, 24 have all or part of their spawning range in Oregon, and all 82 use the lower mainstem of the Snake River, the mainstem of the Columbia River, and the Columbia River estuary, or part thereof, in Oregon for migration, rearing, and smoltification.

Table 26. Demographically Independent Salmonid Populations in the IC Recovery Domain and Spawning Populations

Species	Populations in IC	Spawning Populations in Oregon
UCR spring-run Chinook salmon	3	0
SR spring/summer Chinook salmon	31	7
SR fall-run Chinook salmon	1	1
SR sockeye salmon	1	0
UCR steelhead	4	0
MCR steelhead	17	10
SRB steelhead	25	6

The IC-TRT also recommended viability criteria that follow the VSP framework (McElhany et al. 2006) and described biological or physical performance conditions that, when met, indicate a population or species has a 5% or less risk of extinction over a 100-year period (IC-TRT 2007, see also, NRC 1995). As of this writing, the IC-TRT has applied the viability criteria to 68 populations although it has only completed a draft assessment for 55 populations (see IC-TRT - Current Status Assessments, as of April 21, 2006, available from NMFS Northwest Region, Protected Resources Division in Portland, Oregon). Of those assessments, the only population that the TRT found to be viable was the North Fork John Day population of MCR steelhead. The strength of this population is due to a combination of high abundance and productivity, and good spatial structure and diversity, although the genetic effects of the large number of out-of-species strays and of natural spawners that are hatchery strays are still significant long-term concerns.

UCR spring-run Chinook salmon. This species includes all naturally-spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington (excluding the Okanogan River), the Columbia River from a straight line connecting the west end of the Clatsop jetty (South Jetty, Oregon side) and the west end of the Peacock jetty (North Jetty, Washington side) upstream to Chief Joseph Dam in Washington, as well as progeny of six artificial propagation programs. The IC-TRT identified four independent populations of UCR spring-run Chinook salmon in the upriver tributaries of Wenatchee, Entiat, Methow, and Okanogan (extirpated), but no major groups due to the relatively small geographic area affected (IC-TRT 2003, McClure et al. 2005). Although none of these populations spawn in Oregon, they all use the Columbia River mainstem and estuary so all adult and juvenile individuals of this species must pass through part of the action area. The IC-TRT considered that this species, as a whole, is at high risk of extinction because all extant populations are at high risk (IC-TRT - Current Status Assessments, as of April 21, 2006, available from NMFS Northwest Region, Protected Resources Division in Portland, Oregon). The major factors limiting recovery of UWR spring-run Chinook salmon include altered channel morphology and floodplain, riparian degradation and loss of in-river large wood, reduced streamflow, impaired passage, hydropower system mortality, and harvest impacts (NMFS 2006).

SR spring/summer run Chinook salmon. This species includes all naturally-spawned populations of spring/summer run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins; and progeny

of fifteen artificial propagation programs. The IC-TRT identified 31 historical populations of SR spring/summer run Chinook salmon, and aggregated these into major population groups (IC-TRT 2003, McClure et al. 2005). This species includes those fish that spawn in the Snake River drainage and its major tributaries, including the Grande Ronde River and the Salmon River, and that complete their adult, upstream migration past Bonneville Dam between March and July. Of the 31 historical populations of SR spring/summer run Chinook salmon identified by the IC-TRT, seven occur entirely or partly within Oregon (Table 27). Each of these populations is part of the Grande Ronde and Imnaha River major group, and all face a high risk of extinction (IC-TRT - Current Status Assessments, as of April 21, 2006, available from NMFS Northwest Region, Protected Resources Division in Portland, Oregon).

The major factors limiting recovery of SR spring/summer run Chinook salmon include altered channel morphology and floodplain, excessive sediment, degraded water quality, reduced streamflow, and hydropower system mortality (NMFS 2006).

Table 27. SR Spring/Summer Run Chinook Salmon Populations in Oregon

Overall viability risk within 100 years: "high" means greater than 25% risk of extinction; "moderate" means 5% to 25% risk of extinction, "low" means 1% to 5% risk of extinction; and "very low" means less than 1% chance of extinction.

Major Group	Spawning Populations in Oregon (Watershed)	Viability Assessment		
		Abundance Productivity Risk	Spatial Diversity Risk	Overall Viability Risk
Grande Ronde and Imnaha Rivers	Wenaha River	High	Moderate	High
	Wallowa-Lostine River	High	Moderate	High
	Minam River	High	Moderate	High
	Catherine Creek	High	Moderate	High
	Upper Grande Ronde	High	High	High
	Imnaha River mainstem	High	Moderate	High
	Big Sheep Creek	High	Moderate	High

SR fall-run Chinook salmon. This species includes all naturally-spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River, and progeny of four artificial propagation programs. The IC-TRT identified three populations of this species, although only the lower mainstem population exists at present, and it spawns in the lower main stem of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers (IC-TRT 2003, McClure et al. 2005). Unlike the other listed Chinook species in this recovery domain, most SR fall-run Chinook have a subyearling, ocean-type life history in which juveniles outmigrate the next summer, rather than rearing in freshwater for 13 to 14 months before outmigration. Adults return to the Snake River basin in September and October and spawn shortly thereafter. The lower mainstem population spawns in the Columbia River mainstem, in part adjacent to Oregon. All adult and juvenile individuals of this species must pass through part of the action area. The IC-TRT has not completed a viability assessment of this species. The

major factors limiting recovery of SR fall-run Chinook include reduced spawning/rearing habitat, degraded water quality, hydropower system mortality, and harvest impacts (NMFS 2006).

SR sockeye salmon. This species includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, and artificially-propagated sockeye salmon from the Redfish Lake captive propagation program. The IC-TRT identified historical sockeye production in at least five Stanley Basin lakes and in lake systems associated with Snake River tributaries currently cut off to anadromous access (e.g., Wallowa and Payette lakes), although current returns of SR sockeye are extremely low and limited to Redfish Lake (IC-TRT 2007). SR sockeye salmon do not spawn in Oregon, but all adult and juvenile individuals of this species must pass through part of the action area. The major factors limiting recovery of SR sockeye salmon include altered channel morphology and floodplain, reduced streamflow, impaired passage, and hydropower system mortality (NMFS 2006).

MCR steelhead. This species includes all naturally-spawned steelhead populations below natural and artificial impassable barriers in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding steelhead from the Snake River basin; and progeny of seven artificial propagation programs. The IC-TRT identified 20 historical populations of MCR steelhead in major groups (IC-TRT 2003, McClure et al. 2005). Ten populations of MCR steelhead occur in Oregon, divided among three major groups (Table 28). Of the 20 historical populations of MCR steelhead identified by the IC-TRT, only the North Fork John Day population currently meets viability criteria, and none of the major groups or the species are considered viable (IC-TRT - Current Status Assessments, as of April 21, 2006, available from NMFS Northwest Region, Protected Resources Division in Portland, Oregon). The major factors limiting recovery of MCR steelhead include altered channel morphology and floodplain, excessive sediment, degraded water quality, reduced streamflow, impaired passage, and hydropower system mortality (NMFS 2006).

Table 28. MCR Steelhead Populations in Oregon

The Walla Walla population also occurs partly in Washington.

Major Group	Population (Watershed)
Cascade East Slope Tributaries	Fifteenmile Creek
	Deschutes Eastside Tributaries
	Deschutes Westside Tributaries
John Day River	Lower Mainstem John Day River
	North Fork John Day River
	Middle Fork John Day River
	South Fork John Day River
	Upper Mainstem John Day River
Walla Walla and Umatilla Rivers	Umatilla River
	Walla Walla River

UCR steelhead. This species includes all naturally-spawned steelhead populations below natural and artificial impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S./Canada border, and progeny of six artificial

propagation programs. Four independent populations of UCR steelhead were identified by the IC-TRT in the same upriver tributaries as for the previous species (*i.e.*, Wenatchee, Entiat, Methow, and Okanogan) and, similarly, no major population groupings were identified due to the relatively small geographic area involved (IC-TRT 2003, McClure et al. 2005). None of these populations spawn in Oregon, although all adult and juvenile individuals of this species must pass through part of the action area. The IC-TRT has not completed a viability assessment of this species, although all extant populations are considered to be at high risk of extinction (IC-TRT - Current Status Assessments, as of April 21, 2006, available from NMFS Northwest Region, Protected Resources Division in Portland, Oregon). The major factors limiting recovery of UCR steelhead include altered channel morphology and floodplain, riparian degradation and loss of in-river large wood, excessive sediment, degraded water quality, reduced streamflow, hydropower system mortality, harvest impacts, and hatchery impacts (NMFS 2006).

SRB steelhead. This species includes all naturally-spawned steelhead populations below natural and artificial impassable barriers in streams in the Snake River basin of southeast Washington, northeast Oregon and Idaho, and progeny of six artificial propagation programs. These fish are genetically differentiated from other interior Columbia steelhead populations and spawn at higher altitudes (up to 6,500 feet) after longer migrations (more than 900 miles). The IC-TRT identified 24 populations in five major groups (IC-TRT 2003, McClure et al. 2005). Of those, six populations divided among three major groups spawn in Oregon (Table 29). The IC-TRT has not completed a viability assessment of this species. The major factors limiting recovery of SRB steelhead include altered channel morphology and floodplain, excessive sediment, degraded water quality, reduced streamflow, hydropower system mortality, harvest impacts, and hatchery impacts (NMFS 2006).

Table 29. SRB Steelhead Populations in Oregon

Major Group	Population (Watershed)
Grande Ronde	Lower Grande Ronde
	Joseph Creek
	Wallowa River
	Upper Grande Ronde
Imnaha River	Imnaha River
Hells Canyon Tributaries	Hells Canyon Tributaries

Oregon Coast (OC) Salmon Recovery Domain. The OC recovery domain includes one species, the OC coho salmon, and covers Oregon coastal streams south of the Columbia River and north of Cape Blanco. Streams and rivers in this area drain west into the Pacific Ocean, and vary in length from less than a mile to more than 210 miles in length. All, with the exception of the largest, the Umpqua River, drain from the crest of the Coast Range. The Umpqua transects the Coast Range and drains from the Cascade Mountains. The OC recovery domain covers cities along the coast and inland, including Tillamook, Lincoln City, Newport, Florence, Coos Bay and Roseburg, and has substantial amounts of private forest and agricultural lands. It also includes portions of the Siuslaw and Umpqua National Forests, lands managed by the U.S. Bureau of Land Management, and the Tillamook and Elliott State Forests.

OC coho salmon. This species includes all naturally-spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco, and progeny of five artificial propagation programs. The OC-TRT identified 56 historical populations, grouped into five major "biogeographic strata," based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 30) (Lawson et al. 2007). The OC-TRT concluded that, if recent past conditions continue into the future, OC coho salmon are moderately likely to persist over a 100-year period without artificial support, and have a low to moderate likelihood of being able to sustain their genetic legacy and long-term adaptive potential for the foreseeable future (Wainwright et al. 2008). The major factors limiting recovery of OC coho salmon include altered stream morphology, reduced habitat complexity, loss of overwintering habitat, excessive sediment, high water temperature, and variation in ocean conditions (NMFS 2006).

Table 30. OC Coho Salmon Populations in Oregon

Population type "D" means dependent; "FI" means functionally independent; and "PI" means potentially independent.

Stratum	Population	Type	Stratum	Population	Type
North Coast	Necanicum	PI	Mid-Coast (cont.)	Alsea	FI
	Ecola	D		Big (Alsea)	D
	Arch Cape	D		Vingie	D
	Short Sands	D		Yachats	D
	Nehalem	FI		Cummins	D
	Spring	D		Bob	D
	Watseco	D		Tenmile	D
	Tillamook	FI		Rock	D
	Netarts	D		Big (Siuslaw)	D
	Rover	D		China	D
	Sand	D		Cape	D
	Nestucca	FI		Berry	D
	Neskowin	D		Sutton	D
Mid-Coast	Salmon	PI	Lakes	Siuslaw	FI
	Devils	D		Siltcoos	PI
	Siletz	FI		Tahkenitch	PI
	Schoolhouse	D		Tenmile	PI
	Fogarty	D	Umpqua	Lower Umpqua	FI
	Depoe	D		Middle Umpqua	FI
	Rocky	D		North Umpqua	FI
	Spencer	D		South Umpqua	FI
	Wade	D	Mid-South Coast	Threemile	D
	Coal	D		Coos	FI
	Moolack	D		Coquille	FI
	Big (Yaquina)	D		Johnson	D
	Yaquina	FI		Twomile	D
	Theil	D		Floras	PI
	Beaver	PI		Sixes	PI

Southern Oregon and Northern California Coasts (SONCC) Recovery Domain. The SONCC recovery domain includes one ESA-listed species: the SONCC coho salmon. The SONCC recovery domain extends from Cape Blanco, Oregon, to Punta Gorda, California. This area includes many small-to-moderate-sized coastal basins, where high quality habitat occurs in the lower reaches of each basin, and three large basins (Rogue, Klamath and Eel) where high quality habitat is in the lower reaches, little habitat is provided by the middle reaches, and the largest amount of habitat is in the upper reaches.

SONCC coho salmon. This species includes all naturally-spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California; and progeny of three artificial propagation programs. The SONCC-TRT identified 50 populations that were historically present based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Williams et al. 2006). In some cases, the SONCC-TRT also identified groups of populations referred to as "diversity strata" largely based on the geographical arrangement of the populations and basin-scale environmental and ecological characteristics. Of those populations, 13 strata and 17 populations occur within the action area (Table 31). The SONCC-TRT has not yet developed viability criteria for use in setting recovery goals. The major factors limiting recovery of SONCC coho salmon include loss of channel complexity, loss of estuarine and floodplain habitat, loss of riparian habitat, loss of in-river wood, excessive sediment, degraded water quality, high water temperature, reduced streamflow, unscreened water diversions, and structures blocking fish passage (NMFS 2006).

Table 31. SONCC Coho Salmon Populations in Oregon

Populations that also occur partly in California are marked with an asterisk. Population type "D" means dependent; "E" means ephemeral; "FI" means functionally independent; and "PI" means potentially independent.

Population		Population Type
River Basin	**Subbasin**	
Elk River		FI
Mill Creek		D
Hubbard Creek		E
Brush Creek		D
Mussel Creek		D
Euchre Creek		E
Rogue River *	Lower Rogue River	PI
	Illinois River*	FI
	Mid Rogue/Applegate*	FI
	Upper Rogue River	FI
Hunter Creek		D
Pistol River		D
Chetco River		FI
Winchuck River		PI
Smith River *		FI
Klamath River *	Middle Klamath River	PI
	Upper Klamath River	FI

Southern green sturgeon. The southern green sturgeon was recently listed as threatened under the ESA (see Table 16). This species includes all naturally-spawned populations of green sturgeon that occur south of the Eel River in Humboldt County, California. The principal factor for the decline of southern green sturgeon is the reduction of its spawning area to a single known population limited to a small portion of the Sacramento River. Unless spawning, green sturgeon are broadly distributed in nearshore marine areas from Mexico to the Bering Sea and are commonly observed in bays, estuaries, and sometimes the deep riverine mainstem in lower elevation reaches of non-natal rivers along the west coast of North America. The principal threat to southern green sturgeon is the reduction of available spawning habitats due to the construction of barriers along the Sacramento and Feather rivers. Other threats are insufficient flow rates, increased water temperatures, water diversion, nonnative species, poaching, pesticide and heavy metal contamination, and local fishing. The viability of this species is still under assessment.

Salmon and Steelhead Critical Habitat

The NMFS designated critical habitat for all species considered, except LCR coho salmon and southern green sturgeon, for which critical habitat has not been proposed or designated (see Table 16). To assist in the designation of critical habitat in 2005, NMFS convened CHARTs, organized by major geographic areas that roughly correspond to salmon recovery planning domain (NOAA Fisheries 2005). Each CHART consisted of federal biologists and habitat specialists from NMFS, U.S. Fish and Wildlife Service, Forest Service, and Bureau of Land Management, with demonstrated expertise regarding salmon and steelhead habitat and related protective efforts within that domain.

Each CHART assessed biological information pertaining to areas under consideration for designation as critical habitat to identify the areas occupied by ESA-listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species, and whether unoccupied areas existed within the historical range of the ESA-listed salmon and steelhead that may also be essential for conservation. The CHART then scored each habitat area based on the quantity and quality of the physical and biological features; rated each habitat area as having a ‘‘high,’’ ‘‘medium,’’ or ‘‘low’’ conservation value; and identified management actions that could affect habitat for ESA-listed salmon and steelhead. CHART reports are available from NMFS Northwest Region, Protected Resources Division in Portland, Oregon.

The ESA gives the Secretary of Commerce discretion to exclude areas from designation if he determines that the benefits of exclusion outweigh the benefits of designation. Considering economic factors and information from CHARTs, NMFS partially or completely excluded the following types of areas from the 2005 critical habitat designations:

1. Military areas. All military areas were excluded because of the current national priority on military readiness, and in recognition of conservation activities covered by military integrated natural resource management plans.

2. Tribal lands. Native American lands were excluded because of the unique trust relationship between tribes and the federal government, the federal emphasis on respect for tribal sovereignty and self governance, and the importance of tribal participation in numerous activities aimed at conserving salmon.

3. Areas With Habitat Conservation Plans. Some lands covered by habitat conservation plans were excluded because NMFS had evidence that exclusion would benefit our relationship with the landowner, the protections secured through these plans outweigh the protections that are likely through critical habitat designation, and exclusion of these lands may provide an incentive for other landowners to seek similar voluntary conservation plans.

4. Areas With Economic Impacts. Areas where the conservation benefit to the species would be relatively low compared to the economic impacts.

In designating these critical habitats, NMFS organized information at scale of the watershed or 5th field hydrologic unit code (HUC5) because that scale largely corresponds to the spatial distribution and site fidelity of Pacific salmon and steelhead populations (WDF et al. 1992, McElhany et al. 2000). For earlier critical habitat designations for Snake River salmon and SONCC coho salmon, similar information was not available at the watershed scale, so NMFS used the scale of the subbasin or 4th field HUC to organize critical habitat information.

The NMFS reviews the status of designated critical habitat affected by the proposed action by examining the condition and trends of PCEs throughout the designated area. PCEs consist of the physical and biological features identified as essential to the conservation of the listed species in the documents that designate critical habitat (Tables 32 and 33).

Climate change is likely to have negative implications for the conservation value of designated critical habitats in the Pacific Northwest (CIG 2004, Scheuerell and Williams 2005, Zabel et al. 2006, ISAB 2007). Average annual Northwest air temperatures have increased by approximately 1°C since 1900, or about 50% more than the global average warming over the same period (ISAB 2007). The latest climate models project a warming of 0.1 to 0.6^{o}C per decade over the next century. According to the Independent Scientific Advisory Board (ISAB), these effects may have the following physical impacts within the next forty or so years:

- Warmer air temperatures will result in a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a shift to more rain and less snow, the snowpacks will diminish in those areas that typically accumulate and store water until the spring freshet.
- With a smaller snowpack, these watersheds will see their runoff diminished and exhausted earlier in the season, resulting in lower streamflows in the June through September period.
- River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures will continue to rise, especially during the summer months when lower streamflow and warmer air temperatures will contribute to the warming regional waters.

Table 32. PCEs of Critical Habitats Designated for ESA-listed Salmon and Steelhead Species and Corresponding Species Life History Events

Except SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, and SR sockeye salmon.

Primary Constituent Elements		**Species Life History Event**
Site Type	**Site Attribute**	
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence Fry/parr growth and development
Freshwater migration	Free of artificial obstructions Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration, holding Kelt (steelhead) seaward migration Fry/parr seaward migration
Estuarine areas	Forage Free of obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation Adult “reverse smoltification” Adult upstream migration, holding Kelt (steelhead) seaward migration Fry/parr seaward migration Fry/parr smoltification Smolt growth and development Smolt seaward migration
Nearshore marine areas	Forage Free of obstruction Natural cover Water quantity Water quality	Adult sexual maturation Smolt/adult transition
Offshore marine areas	Forage Water quality	Adult growth and development

Table 33. PCEs of Critical Habitats Designated for SR Spring/Summer Run Chinook Salmon, SR Fall Run Chinook Salmon, SR Sockeye Salmon, SONCC Coho Salmon, and Life History Events

Primary Constituent Elements		**Species Life History Event**
Site	**Site Attribute**	
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook and coho) Spawning gravel Water quality Water temperature (sockeye) Water quantity	Adult spawning Embryo incubation Alevin development Fry emergence Fry/parr growth and development Fry/parr smoltification Smolt growth and development
Juvenile migration corridors	Cover/shelter Food Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Fry/parr seaward migration Smolt growth and development Smolt seaward migration
Areas for growth and development to adulthood	Ocean areas – not identified	Adult growth and development Adult sexual maturation Fry/parr smoltification Smolt/adult transition
Adult migration corridors	Cover/shelter Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult “reverse smoltification” Adult upstream migration Kelt (steelhead) seaward migration

These changes will not be spatially homogeneous across the entire Columbia River basin. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early spring would be less affected. Low-lying areas that historically have received scant precipitation contribute little to total streamflow and are likely to be more affected. The ISAB also identified the likely effects of projected climate changes on Columbia basin salmon. These long-term effects may include, but are not limited to, depletion of cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species.

To mitigate for the effects of climate change on listed salmonids, the ISAB (2007) recommends planning now for future climate conditions by implementing protective tributary, mainstem, and estuarine habitat measures; as well as protective hydropower mitigation measures. In particular,

the ISAB (2007) suggests increased summer flow augmentation from cool/cold storage reservoirs to reduce water temperatures or to create cool water refugia in mainstem reservoirs and the estuary; the protection and restoration of riparian buffers, wetlands, and floodplains; removal of stream barriers; implementation of fish ladders; and assurance of high summer and autumn flows.

Willamette and Lower Columbia (WLC) River Recovery Domain

Critical habitat was designated in the WLC Recovery Domain for UWR spring-run Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, and CR chum salmon. In addition to the Willamette and Columbia river mainstems, important tributaries on the Oregon side of the WLC include Youngs Bay, Big Creek, Clatskanie River, and Scappoose River in the Oregon Coast subbasin; Hood River in the Gorge; and the Sandy, Clackamas, Molalla, North and South Santiam, Calapooia, McKenzie, and Middle Fork Willamette rivers in the West Cascades subbasin.

The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75%. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Agriculture, urbanization, and gravel mining on the valley floor and timber harvesting in the Cascade and Coast ranges contribute to increased erosion and sediment loads throughout the basin.

The mainstem Willamette River has been channelized and stripped of large wood. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Frogatt 1984). Hulse et al. (2002) calculated that total mainstem Willamette River channel area decreased from 41,000 to 23,000 acres between 1895 and 1995. They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50-120) incurred losses of 12% primary channel area, 16% side channels, 33% alcoves, and 9% islands. Even greater changes occurred in the upper reach from Albany to Eugene (RM 187). There, approximately 40% of both channel length and channel area were lost, along with 21% of the primary channel, 41% of side channels, 74% of alcoves, and 80% of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the Corps. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26% of the total length is revetted, 65% of the meander bends are revetted (Hulse et al. 2002). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Hulse et al. 2002).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Hulse et al. 2002). Sedell and Frogatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of large wood in

the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, organic inputs from litter fall, entrained allochthonous materials, and flood flow filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Hulse et al. (2002) described the changes in riparian vegetation in river reaches from the mouth to Newberg, from Newberg to Albany, and from Albany to Eugene. They noted that the riparian forests were formerly a mosaic of brush, marsh, and ash tree openings maintained by annual flood inundation. Below the City of Newberg, the most noticeable change was that conifers were almost eliminated. Above Newberg, the formerly hardwood-dominated riparian forests along with mixed forest made up less than half of the riparian vegetation by 1990, while agriculture dominated. This conversion represents a loss of recruitment potential for large wood, which functions as a component of channel complexity, much as the morphology of the streambed does, to reduce velocity and provide habitat for macroinvertebrates that support the prey base for salmon and steelhead. Declining extent and quality of riparian forests have also reduced rearing and refugia habitat provided by large wood, shading by riparian vegetation which can cool water temperatures, and the availability of leaf litter and the macroinvertebrates that feed on it.

Hyporheic flow in the Willamette River has been examined through discharge measurements and was found to be significant in some areas, particularly those with gravel deposits (Fernald et al. 2001). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic exchange was found to be significant in the National Water Quality Assessment of the Willamette Basin (Wentz et al. 1998). In the transient storage zone, hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald et al. 2001).

On the mainstem of the Columbia River, hydropower projects, including the Federal Columbia River Hydropower System (FCRPS), have significantly degraded salmon and steelhead habitats (Bottom et al. 2005, Fresh et al. 2005, NMFS 2005a, NOAA Fisheries 2006). The series of dams and reservoirs that make up the FCRPS block an estimated 12 million cubic yards of debris and sediment that would otherwise naturally flow down the Columbia and replenish shorelines along the Washington and Oregon coasts.

Industrial harbor and port development are also significant influences on the Lower Willamette and Lower Columbia rivers (Bottom et al. 2005, Fresh et al. 2005, NMFS 2005a, NOAA Fisheries 2006). Since 1878, 100 miles of river channel within the mainstem Columbia River, its

estuary, and Oregon's Willamette River have been dredged as a navigation channel by the Army Corps of Engineers. Originally dredged to a 20-foot minimum depth, the Federal navigation channel of the Lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The Lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. These ports primarily focus on the transport of timber and agricultural commodities. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, high levels of several sediment chemicals, such as arsenic and polycyclic aromatic hydrocarbons (PAHs), have been identified in Lower Columbia River watersheds in the vicinity of the ports and associated industrial activities.

The most extensive urban development in the Lower Columbia River subbasin occurs in the Portland/Vancouver area. Outside of this major urban area, the majority of residences and businesses rely on septic systems. Common water quality issues with urban development and septic systems include higher water temperatures, lowered dissolved oxygen, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff.

The Columbia River estuary has lost a significant amount of tidal marsh and tidal swamp habitat that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom et al. 2005, Fresh et al. 2005, NMFS 2005a, NOAA Fisheries 2006). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates which feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming habitat for salmon and steelhead during flooding river discharges or flood tides. Sherwood et al. (1990) estimated that the estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production.

Habitat and food-web changes within the estuary, and other factors affecting salmon population structure and life histories, have altered the estuary's capacity to support juvenile salmon (Bottom et al. 2005, Fresh et al. 2005, NMFS 2005a, NOAA Fisheries 2006). Diking and filling activities that decrease the tidal prism and eliminate emergent and forested wetlands and floodplain habitats have likely reduced the estuary's salmon-rearing capacity. Moreover, water and sediment in the lower Columbia River and its tributaries have levels of toxic contaminants that are harmful to fish and wildlife (LCREP 2007). Contaminants of concern include dioxins and furans, heavy metals, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. Simplification of the population structure and life-history diversity of salmon possibly is yet another important factor affecting juvenile salmon viability. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns might significantly enhance the estuary's productive capacity for salmon, although historical changes in population structure and salmon life histories may prevent salmon from making full use of the productive capacity of estuarine habitats, even in their presently altered state.

Interior Columbia (IC) Recovery Domain

Critical habitat has been designated in the IC Recovery Domain, which includes the Snake River basin, for SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, UCR spring-run Chinook salmon, SR sockeye salmon, MCR steelhead, UCR steelhead, and SRB steelhead. Major tributaries in the Oregon portion of the IC Recovery Domain include the Deschutes, John Day, Umatilla, Walla Walla, Grande Ronde, and Imnaha rivers.

Habitat quality in tributary streams in the IC Recovery Domain varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994, Carmichael 2006). Critical habitat throughout the IC recovery domain was degraded by intense agriculture, alteration of stream morphology (*i.e.*, channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, timber harvest, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas.

Migratory habitat quality in this area has been severely affected by the development and operation of the FCRPS dams and reservoirs in the mainstem Columbia River, Bureau of Reclamation tributary projects, and privately-owned dams in the Snake and Upper Columbia river basins. For example, construction of Hells Canyon Dam eliminated access to several likely production areas in Oregon and Idaho including the Burnt, Powder, Weiser, Payette, Malheur, Owyhee, and Boise river basins (Good et al. 2005), and Grande Coulee and Chief Joseph dams completely block anadromous fish passage on the upper mainstem Columbia River. Hydroelectric development modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

Similarly, development and operation of extensive irrigation systems and dams for water withdrawal and storage in tributaries have drastically altered hydrological cycles. A series of large regulating dams on the middle and upper Deschutes River affect flow and block access to upstream habitat, and have extirpated one or more populations from the Cascades Eastern Slope major population (IC-TRT 2003). Pelton Round Butte Dam blocked 32 miles of MCR steelhead habitat in the mainstem Deschutes below Big Falls and removed the historically-important tributaries of the Metolius River and Squaw Creek from production. Similarly, Condit Dam on the White Salmon River extirpated another population from the Cascades Eastern Slope major group. In the Umatilla River subbasin, the Bureau of Reclamation developed the Umatilla Project beginning in 1906. The project blocked access to more than 108 miles of historically highly productive tributary habitat for MCR steelhead in upper McKay Creek with construction of the McKay Dam and Reservoir in 1927. A flood control and irrigation dam on Willow Creek was built near RM 5, completely blocking MCR steelhead access to productive habitat upstream in this subbasin. Construction of Lewiston Dam, completed in 1927, eliminated access for Snake River basin steelhead and salmon to a major portion of the Clearwater basin. Continued operation and maintenance of large water reclamation systems such as the Umatilla Basin and

Yakima Projects have significantly reduced flows and degraded water quality and physical habitat in these rivers.

Many stream reaches designated as critical habitat in the IC Recovery Domain are over-allocated under state water law, with more allocated water rights than existing streamflow conditions can support. Irrigated agriculture is common throughout this region and withdrawal of water increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence et al. 1996). Reduced tributary stream flow has been identified as a major limiting factor for all listed salmon and steelhead species in this area except SR fall-run Chinook salmon (NMFS 2005).

Summer stream temperature is the primary water quality problem, with many stream reaches designated as critical habitat listed on the Clean Water Act's section 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevated stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

Oregon Coast (OC) Coho Salmon Recovery Domain

In this recovery domain, critical habitat has been designated for OC coho salmon. Many large and small rivers supporting significant populations of coho salmon flow through this domain, including the Nehalem, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, and Coquille. The historical disturbance regime in the central Oregon Coast Range was dominated by a mixture of high and low-severity fires, with a natural rotation of approximately 271 years. Old-growth forest coverage in the Oregon Coast Range varied from 25-75% during the past 3000 years, with a mean of 47%, and never fell below 5% (Wimberly et al. 2000). Currently the Coast Range has approximately 5% old-growth, almost all of it on Federal lands. The dominant disturbance now is timber harvesting on a cycle of 30-100 years, with fires suppressed.

In 2005, ODFW mapped the distribution of streams with high intrinsic potential for coho salmon rearing by land ownership categories (ODFW 2005). Agricultural lands and private industrial forests have by far the highest percentage of land ownership in high intrinsic potential (HIP) areas and along all coho stream miles. Federal lands have only about 20% of coho stream miles and 10% of HIP stream reaches. Because of this distribution, activities in lowland agricultural areas are particularly important to the conservation of coastal coho.

The coho assessment concluded that at the scale of the entire domain, pools are generally abundant, although slow-water and off-channel habitat (which are important refugia for coho during high winter flows) are limited in the majority of streams when compared to reference streams in minimally-disturbed areas. Amounts of large wood in streams are low in all four ODFW monitoring areas and land-use types relative to reference conditions. Amounts of fine sediment are high in three of the four monitoring areas, and were comparable to reference conditions only on public lands. Approximately 62% to 91% of tidal wetland acres (depending

on estimation procedures) have been lost for functionally and potentially independent populations of coho.

As part of the coastal coho assessment, the Oregon Department of Environmental Quality (ODEQ) analyzed the status and trends of water quality in the range of OC coho using the Oregon water quality index, which is based on a combination of temperature, dissolved oxygen, biological oxygen demand, pH, total solids, nitrogen, total phosphates, and bacteria. Using the index at the species scale, 42% of monitored sites had excellent to good water quality, and 29% show poor to very poor water quality. Within the four monitoring areas, the North Coast had the best overall conditions (six sites in excellent or good condition out of nine sites), and the Mid-South coast had the poorest conditions (no excellent condition sites, and only two out of eight sites in good condition). For the 10-year period monitored between 1992 and 2002, no sites showed a declining trend in water quality. The area with the most improving trends was the North Coast, where 66% of the sites (six out of nine) had a significant improvement in index scores. The Umpqua River Basin, with one out of nine sites (11%) showing an improving trend, had the lowest number of improving sites.

Southern Oregon and Northern California Coasts (SONCC) Coho Salmon Recovery Domains

Critical habitat in this recovery domain has been designated for SONCC coho salmon. Many large and small rivers supporting significant populations of coho salmon flow through the area, including the Elk, Rogue, Chetco, Smith and Klamath. The following summary of critical habitat information in the Elk, Rogue, and Chetco rivers is also applicable to habitat characteristics and limiting factors in other basins in this area.

The Elk River flows through Curry County, drains approximately 92 square miles (or 58,678 acres) (Maguire 2001). Major tributaries of the Elk River include the North Fork, South Fork, Blackberry Creek, Panther Creek, Butler Creek, and Bald Mountain Creek. The upper portion of the Elk River basin is characterized by steeply sloped forested areas with narrow valleys and tributary streams that have steep to very steep gradients. Grazing, rural and residential development and other agricultural uses are the dominant land uses in the lower basin (Maguire 2001). Over half of the Elk River basin is in the Grassy Knob wilderness area. Historical logging, mining, and road building have degraded stream and riparian habitats in the basin. Limiting factors identified for salmon and steelhead production in this basin include sparse riparian cover, especially in the lower reaches, excessive fine sediment, high water temperatures, and noxious weed invasions (Maguire 2001).

The Rogue River drains approximately 5,160 square miles within Curry, Jackson and Josephine counties in southwest Oregon. The mainstem is about 200 miles long and traverses the coastal mountain range into the Cascades. The Rogue River estuary has been modified from its historical condition. Jetties were built by the Corps in 1960, which stabilized and deepened the mouth of the river. A dike that extends from the south shore near Highway 101 to the south jetty was completed in 1973. This dike created a backwater for the large shallow area that existed here, which has been developed into a boat basin and marina, eliminating most of the tidal marsh.

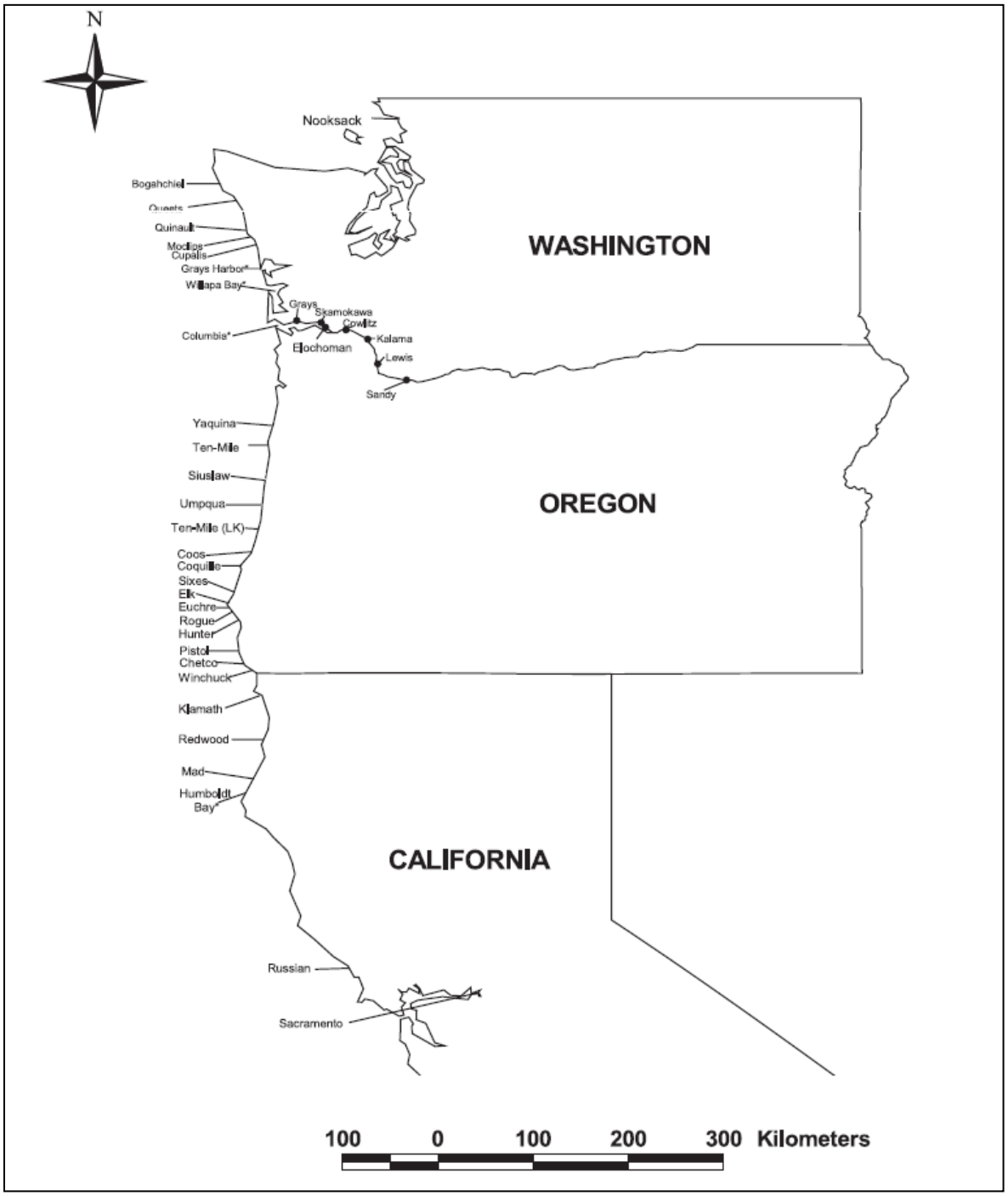
The quantity of estuary habitat is naturally limited in the Rogue River. The Rogue River has a drainage area of 5,160 square miles, but the estuary at 1,880 acres is one of the smallest in Oregon. Between 1960 and 1972, approximately 13 acres of intertidal and 14 acres of subtidal land were filled in to build the boat basin dike, the marina, north shore riprap and the other north shore developments (Hicks 2005). Jetties constructed in 1960 to stabilize the mouth of the river and prevent shoaling have altered the Rogue River, which historically formed a sill during summer months (Hicks 2005).

The Lower Rogue Watershed Council's watershed analysis (Hicks 2005) lists factors limiting fish production in tributaries to Lower Rogue River watershed. The list includes water temperatures, low stream flows, riparian forest conditions, fish passage and over-wintering habitat. Limiting factors identified for the Upper Rogue River basin include fish passage barriers, high water temperatures, insufficient water quantity, lack of large wood, low habitat complexity, and excessive fine sediment (RBCC 2006).

The Chetco River is in the southwest corner of Oregon, almost entirely within Curry County, with a drainage of approximately 352 square miles. The Chetco River mainstem is about 56 miles long, and the upper 28 miles are within the Kalmiopsis Wilderness Area. Elevations in the watershed range from sea level to approximately 5,098 feet. The upper portion of the basin is characterized by steep, sloping forested areas with narrow valleys and tributary streams that have moderately steep to very steep gradient. The lowest 11 miles of the river are bordered by private land in rural/residential, forestry, and urban land uses.

The Chetco River estuary has been significantly modified from its historical condition. Jetties were erected by the Corps 1957, which stabilized and deepened the mouth of the river. These jetties have greatly altered the mouth of the Chetco River and how the estuary functions as habitat for salmon migrating to the ocean. A boat basin and marina were built in the late 1950s and eliminated most of the functional tidal marsh. The structures eliminated shallow water habitats and vegetation in favor of banks stabilized with riprap. Since then, nearly all remaining streambank in the estuary has been stabilized with riprap. The South Coast Watershed Council's watershed analysis (Maguire 2001) states the factors limiting fish production in the Chetco River appear to be high water temperature caused by lack of shade, especially in tributaries, high rates of sedimentation due to roads, poor over-wintering habitat due to a lack of large wood in tributaries and the mainstem, and poor quality estuary habitat (Maguire 2001).

Eulachon



Eulachon (smelt) are endemic to the eastern Pacific Ocean ranging from northern California to southwest Alaska and into the southeastern Bering Sea. Eulachon occur only on the coast of northwestern North America, from northern California to southwestern Alaska. In the portion of the species' range that lies south of the U.S./Canada border, most eulachon production originates in the Columbia River Basin. In this basin, the major and most consistent spawning runs occur

in the mainstem of the Columbia River (from just upstream of the estuary, RM 25 to immediately downstream of Bonneville Dam at RM 146). Periodic spawning occurs in the Grays, Skamokawa, Elochoman, Kalama, Lewis, Cowlitz, and Sandy rivers (Emmett et al. 1991, Musick et al. 2000). In the Columbia River and its tributaries, spawning usually begins in January or February (Beacham et al. 2005).

Eulachon are anadromous fish that spawn in the lower reaches of rivers in early spring. They typically spend 3 to 5 years in saltwater before returning to freshwater to spawn from late winter through mid-spring. Spawning occurs over sand or coarse gravel substrates, eggs are fertilized in the water column, sink, and adhere to the river bottom. Most adults die after spawning and eggs hatch in 20-40 days. Larvae are carried downstream and are dispersed by estuarine and ocean currents shortly after hatching. Runs tend to be erratic, appearing in some years but not others, and appearing only rarely in some river systems (Hinrichsen 1998). Eulachon are important in the food web as a prey species (Alaska Department of Fish and Game 1994). Newly-hatched and juvenile eulachon are food for a variety of larger marine fish such as salmon and for marine mammals including seals, sea lions and beluga whales. Spawned-out eulachon are eaten by gulls, eagles, bears and sturgeon.

Eulachon spawning runs have declined in the past 20 years, especially since the mid-1990s (Hay and McCarter 2000). The cause of these declines remains uncertain. Eulachon are caught as bycatch during shrimp fishing, but in most areas the total bycatch is small (Beacham *et al*. 2005). Predation by pinnipeds may be substantial, and other risk factors could include global climate change and deterioration of marine and freshwater conditions (73 FR 13185).

In 1999, NMFS received a petition to list the Columbia River populations of eulachon as an endangered or threatened species and to designate critical habitat under the ESA. NMFS determine the petition did not present enough substantial evidence to warrant the listed (64 FR 66601). In 2007, NMFS received a petition from the Cowlitz Indian Tribe to list southern eulachon (populations in Washington, Oregon and California) as a threatened or endangered species under the ESA. After reviewing the information contained in the petition and other information, NMFS proposed listing eulachon as a threatened on March 13, 2009 (74 FR 10857). The final listing of the southern DPS of Pacific eulachon as threatened under the ESA by NOAA Fisheries occurred on March 18, 2010 (NMFS 2010b). Take prohibitions via section 4(d) of the ESA have not yet been promulgated, nor has critical habitat yet been designated for the southern DPS, although both actions are expected to occur in 2011.

Limiting Factors

The major factors limiting recovery of eulachon include climate change on ocean conditions, climate change on freshwater habitat, eulachon by-catch, dams and water diversions, and predation (NMFS 2009).

Critical Habitat

NMFS has not designated critical habitat for eulachon.

Marine Mammals

Blue Whale

Blue whales occur primarily in the open ocean from tropical to polar waters worldwide. Blue whales are highly mobile, and their migratory patterns are not well known (Perry et al. 1999; Reeves et al. 2004). However, the distribution of blue whales is probably determined primarily by food requirements, with seasonal migration toward the poles in spring to feed on zooplankton during the summer months. Blue whales migrate toward the warmer waters of the subtropics in the fall to reduce energy costs, to avoid ice entrapment, and to reproduce (NMFS 1998a). Blue whales are typically found swimming alone or in groups of two or three to up to five animals, although larger foraging aggregations of up to 50 blue whales have been reported including aggregations mixed with other rorquals such as fin whales (Corkeron et al. 1999; Shirihai 2002).

Little is known about population and stock structure[1] of blue whales. Studies suggest a wide range of alternative population and stock scenarios based on movement, feeding, and acoustic data. Some suggest that as many as 10 putative stocks of blue whales exist globally, while others suggest that the species is composed of a single panmictic stock (see Gambell 1979, Clark 1994, and Reeves et al. 1998). For management purposes, the International Whaling Commission (IWC) considers all Pacific blue whales as a single stock, whereas under the MMPA, NMFS presently recognizes four stocks of blue whales: western North Pacific Ocean, the eastern North Pacific Ocean, the Northern Indian Ocean, and the Southern Hemisphere.

Historical catch records suggest that "true" blue whales (*Balaenoptera musculus*) and "pygmy" blue whale (*B. m. brevicada*) may be geographically distinct (Brownell and Donaghue 1994, Kato *et al.* 1995). "Pygmy" blue whales occur north of the Antarctic Convergence (between 60° to 80° E and 66° to 70° S), while "true" blue whales are south of the Convergence (58° S) in the austral summer (Kato et al. 1995; Kasamatsu et al. 1996). During austral summers, "true" blue whales are found close to edge of Antarctic ice with concentrations.

Until recently, blue whale stock structure had not been tested using molecular or nuclear genetic analyses (Reeves et al. 1998). A recent study by Conway (2005) suggests that the global population can be divided into four major subdivisions, which roughly correspond to major ocean basins: the eastern North and tropical Pacific Ocean, the Southern Indian Ocean, the Southern Ocean, and the western North Atlantic Ocean. The eastern North/tropical Pacific Ocean subpopulation, which according to the samples analyzed by Conway (2005) includes California, western Mexico, western Costa Rica, and Ecuador, and the western North Atlantic Ocean subpopulation occur within the action area for the aquatic life criteria. Further study is needed to firmly establish population structures, but it is apparent that blue whale populations do not interbreed enough to maintain the genetic cohesion of a single stock. For the purposes of this assessment and until further information is available, NMFS is treating blue whales as four distinct populations.

"Populations" herein are a group of individual organisms that live in a given area and share a common genetic heritage. While genetic exchange may occur with neighboring populations, the rate of exchange is greater between individuals of the same population than among populations - a population is driven more by internal dynamics, birth and death processes than by immigration or emigration of individuals. To differentiate populations, NMFS considers geographic distribution and spatial separation, life history, behavioral and morphological traits, as well as genetic differentiation where it has been examined. In many cases, behavioral and morphological differences may evolve and be detected before genetic variation occurs. In some cases, the term "stock" is synonymous with this definition of "population" while other usages of "stock" are not.

In the North Pacific, acoustic monitoring has recorded blue whales off Oahu and the Midway Islands), although sightings or strandings in Hawaiian waters have not been reported (Northrop et al. 1971; Thompson and Friedl 1982; Barlow et al. 1997. Nishiwaki (1966) notes the occurrence of blue whales among the Aleutian Islands and in the Gulf of Alaska, but no one has sighted a blue whale in Alaska for sometime despite several surveys (Leatherwood et al. 1982; Stewart et al. 1987; Forney and Brownell 1996; Carretta et al. 2005). Minimal distributional information suggest that whales in the western region of the North Pacific may summer southwest of Kamchatka, south of the Aleutians, and in the Gulf of Alaska, and winter in the lower latitudes of the western Pacific (Sea of Japan, the East China, Yellow, and Philippine seas) and less frequently in the central Pacific, including Hawaii (Watkins et al. 2000; Stafford 2003; Carretta et al. 2005; Stafford et al. 2001 *in* Carretta et al. 2005). However, acoustic recordings made off Oahu showed bimodal peaks of blue whales, suggesting that the animals were migrating into the area during summer and winter (Thompson and Friedl 1982; McDonald and Fox 1999). In the eastern North Pacific, blue whales appear to summer off the U.S. West Coast in waters off California and occasionally as far north as British Columbia, migrating south to productive areas off Mexico and as far south as the Costa Rica Dome (10° N) from June through November due to high prey density (Reilly and Thayer 1990; Calambokidis et al. 1990; Calambokidis et al. 1998; Mate et al. 1999; Stafford et al. 1999). Blue whale sightings have occurred year-round in the northern Indian Ocean (Gulf of Aden, Persian Gulf, Arabian Sea, and across the Bay of Bengal to Burma and the Strait of Malacca; Mizroch et al. 1984).
Blue whale reproductive activities occur primarily in winter (see Yochem and Leatherwood 1985). Gestation takes 10-12 months, followed by a nursing period that continues for about 6-7 months. They reach sexual maturity at about 5 years of age (see Yochem and Leatherwood 1985). The age distribution of blue whales is unknown and little information exists on natural sources of mortality (such as disease) and mortality rates. Killer whales are known to attack blue whales, but the rate of these attacks or their effect on blue whale populations is unknown.

Important foraging areas include the edges of continental shelves and ice edges in polar regions (Yochem and Leatherwood 1985; Reilly and Thayer 1990). Data indicate that some summer feeding takes place at low latitudes in upwelling-modified waters, and that some whales remain year-round at either low or high latitudes (Yochem and Leatherwood 1985; Reilly and Thayer 1990; Clark and Charif 1998). The krill species, *Thysanoessa inermi*s, *T. longipe*s, *T. raschii*, and *Nematoscelis megalops* have been listed as prey of blue whales in the North Pacific (Kawamura 1980; Yochem and Leatherwood 1985).

Generally, blue whales make 5 to 20 shallow dives at 12 to 20 second intervals followed by a deep dive of 3 to 30 minutes (Mackintosh 1965; Leatherwood et al. 1976; Maser et al. 1981; Yochem and Leatherwood 1985; Strong 1990; Croll et al. 1999). Croll et al. (1999) found that daytime blue whale foraging dives off California averaged 433 feet, with a maximum recorded depth of 672 feet, and a mean dive duration of 7.2 minutes. Nighttime dives are generally shallower (165 feet). Blue whales occur singly or in groups of two or three (Ruud 1956; Slijper 1962; Nemoto 1964; Mackintosh 1965; Pike and MacAskie 1969; Aguayo 1974). However, larger foraging aggregations, even with other species such as fin whales, are regularly reported (Schoenherr 1991; Fiedler et al. 1998).

Status and Trends

Blue whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973. The estimated size of the global population of blue whales is about 12,000 animals (Maser et al. 1981; U.S. Department of Commerce 1983), which is a fraction of pre-whaling population estimates of 200,000 animals. These estimates, however, are more than 20 years old. The actual size of the blue whale population in the North Atlantic is uncertain, but estimates range from a few hundred individuals to about 2,000 (Allen 1970; Mitchell 1974; Sigurjónsson 1995). Gambell (1976) estimated there were between 1,100 and 1,500 blue whales in the North Atlantic before whaling began, and Braham (1991) estimated there were between 100 and 555 blue whales in the North Atlantic during the late 1980s and early 1990s. Sears et al. (1987) identified 308 individual blue whales in the Gulf of St. Lawrence, which provides a minimum estimate for their population in the North Atlantic. Sigurjónsson and Gunnlaugson (1990) concluded that the blue whale population had been increasing since the late 1950s. These authors concluded that the blue whale population increased at an annual rate of about 5% between 1979 and 1988.

In the eastern North Pacific, the minimum population is thought to be 1,384 whales but due to a lack of sightings in the western North Pacific, no minimum population has been established (Carretta et al. 2006). A lot of uncertainty surrounds estimates of blue whale abundance in the North Pacific Ocean. The population has been estimated to be as high as 3,300 and as low as 1,400 (Wade and Gerrodette 1993; Barlow 1997; Barlow et al. 1997). Estimates of the southern hemisphere population range from 5,000 to 6,000 (review by Yochem and Leatherwood 1985) with an average rate of increase of 4% to 5% per year, but Butterworth et al. (1993) estimated the Antarctic population at 710 individuals. More recently, Branch et al. (2004) estimated the blue whale population in the Southern Ocean at between 860 and 2,900 animals, which is only 0.7% of their pre-exploitation population. The pygmy blue whale population has been estimated at 6,000 individuals (Yochem and Leatherwood 1985).

Threats

As the largest animals in the world, blue whales are only occasionally known to be taken by killer whales (Tarpy 1979; Sears et al. 1990). Blue whales engage in a flight responses to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). However, prey limitations may be more significant in population recovery, particularly around Antarctica. After several whale species were severely reduced by hunting in the Southern Ocean, crab eater seal population size exploded due to lack of competition for krill. As a result, populations of crab-eater seals in Antarctica exceed five million individuals, making them the most populous marine mammal species, and reducing prey availability for recovering whale populations. Blue whales are known to become infected with the nematode *Carricauda boopis*, which are believed to have caused fin whales to die as a result of renal failure (Lambertsen 1986).

Blue whales have faced threats from several historical and current sources. Blue whale populations are severely depleted originally due to historical whaling activity. From 1910 to 1965, roughly 9,500 blue whales were taken in the North Pacific (Ohsumi and Wada 1972).

Although the IWC banned commercial whaling in the North Pacific in 1966, Soviet whaling fleets continued to hunt blue whales in the North Pacific. By 1967, Soviet scientists wrote that blue whales in the North Pacific Ocean (including the eastern Bering Sea and Prince William Sound) had been so overharvested by Soviet whaling fleets that some scientists concluded that any additional harvests were certain to cause the species to become extinct in the North Pacific (Latishev 2007). As its legacy, whaling has reduced blue whales to a fraction of their historic population size and, as a result, makes it easier for other human activities to push blue whales closer to extinction. However, since the IWC moratorium was placed on hunting of most whales, blue whale populations appear to be rebounding at an average of 8.2% positive population growth per year from 1978 to 2004 for the most heavily hunted population in the Southern Ocean (IWC 2008).

Ship strike is presently a concern for blue whale recovery. Ship strikes have recently averaged roughly one every other year (eight ship strike incidents are known [Jensen and Silber 2004]), but in September 2007, ships struck five blue whales within a few day period off southern California (Calambokidis pers. comm. 2008). Dive data support a surface-oriented behavior during nighttime that would make blue whales particularly vulnerable to ship strikes. There are concerns that, like right whales, blue whales may surface when approached by large vessels; a behavior that would increase their likelihood of being struck. Protective measures are not currently in place. It is believed based upon gray whale studies that the vast majority of ship strike mortalities are never identified, and that actual mortality is higher. In the California/Mexico stock, annual incidental mortality due to ship strikes averaged one whale every 5 years, but we cannot determine if this reflects the actual number of blue whales struck and killed by ships (i.e., individuals not observed when struck and those who do not strand; Barlow et al. 1997).

Increasing oceanic noise may impair blue whale behavior. Although available data do not presently support traumatic injury from sonar, the general trend in increasing ambient low-frequency noise in the deep oceans of the world from primarily ship engines could impair the ability of blue whales to communicate or navigate through these vast expanses (Aburto et al. 1997; Clark 2006).

There is a paucity of contaminant data regarding blue whales. Available information indicates that organochlorines, including dichloro-diphenyl-trichloroethane (DDT), polychlorinated biphenyls (PCB), benzene hexachloride (HCH), hexachlorobenzene (HCB), chlordane, dieldrin, methoxychlor, and mirex have been isolated from blue whale blubber and liver samples (Gauthier et al. 1997a; Metcalfe et al. 2004). Contaminants transfer between mother and calf mean that young often start life with concentrations of contaminants equal to their mothers, before accumulating additional contaminant loads during life and passing higher loads to the next generation (Gauthier et al. 1997b; Metcalfe et al. 2004).

Critical Habitat

NMFS has not designated critical habitat for blue whales.

Fin Whale

The fin whale is the second largest baleen whale and is widely distributed in the world's oceans. Most fin whales in the Northern Hemisphere migrate seasonally from Antarctic feeding areas in the summer to low latitude breeding and calving grounds in winter. Fin whales tend to avoid tropical and pack ice waters, with the high latitude limit of their range set by ice and the lower latitude limit by warm water of approximately 15°C (60°F) (Sergeant 1977). There are two recognized subspecies of fin whales, *Balaenoptera physalus physalus*, which occurs in the North Atlantic Ocean, while *B. p. quoyi*, which occurs in the Southern Ocean. These subspecies and the North Pacific fin whales appear to be organized into separate populations, although there appears to be a lack of consensus in the published literature as to the population structure of fin whales. In the North Atlantic Ocean, the IWC recognizes seven management units or "stocks" of fin whales: (1) Nova Scotia, (2) Newfoundland-Labrador, (3) West Greenland, (4) East Greenland-Iceland, (5) North Norway, (6) West Norway-Faroe Islands, and (7) British Isles-Spain-Portugal. In addition, a genetically distinct population of fin whales resides in the Ligurian Sea, in the northwestern Mediterranean Sea.

In the North Pacific Ocean, the IWC recognizes two management stocks: (1) East China Sea and (2) the rest of the North Pacific (Donovan 1991). Other author's have suggested other subpopulation structuring for fin whales (Mizroch et al. 1984). Genetic studies by Berube et al. (1998) indicate that there are significant genetic differences among fin whales in differing geographic areas (e.g., Sea of Cortez, Gulf of St. Lawrence and Gulf of Maine). Further, individuals in the Sea of Cortez may represent an isolated population from other eastern North Pacific fin whales (Berube et al. 2002). Even so, mark-recapture studies also demonstrate that individual fin whales are migrating between management units (Mitchell 1974; Gunnlaugsson and Sigurjónsson 1989), which suggests that management units are not geographically isolated. Until further information is available to reduce uncertainties in the fin whale population structure, under the MMPA, NMFS recognizes four stocks, or populations, of fin whales, one in the Atlantic and three in the Pacific: the (1) Western North Atlantic, (2) Northeast Pacific (or Alaska stock), (3) California-Oregon-Washington, and (4) the Hawaii stock.

In the North Atlantic, fin whales are ubiquitous and occur during the summer from Baffin Bay to near Spitsbergen and the Barents Sea, south to Cape Hatteras in North Carolina and off the coasts of Portugal and Spain (Rice 1998). In areas North of Cape Hatteras where fin whales accounted for about 46% of the large whales observed in surveys conducted between 1978 and 1982. Little is known about the winter habitat of fin whales, but in the western North Atlantic the species has been found from off Newfoundland south to the Gulf of Mexico and Greater Antilles, and in the eastern North Atlantic the winter range extends from the Faroes and Norway south to the Canary Islands. In the Atlantic Ocean, a general migration in the fall from the Labrador and Newfoundland region, south past Bermuda, and into the West Indies has been theorized (Clark 1995). A genetically distinct population occurs year-round in the northwestern Mediterranean (IWC 2006a). In the Southern Hemisphere, fin whales are broadly distributed south of 50° S in the summer and migrate to the coasts of South America (as far north as Peru and Brazil), Africa, and the islands in Oceania north of Australia and New Zealand (Gambell 1985a).

Fin whale concentrations generally form along frontal boundaries, or mixing zones between coastal and oceanic waters, which corresponds roughly to the 660 foot isobath (the shelf edge; Nasu 1974). Fin whales are common off the Atlantic coast of the U.S. in waters immediately off the coast seaward to the continental shelf (about the 1,000-fathom contour). In the North Pacific, fin whales are observed year-round off central and southern California with peak numbers in the summer and fall. Peak numbers of fin whales are seen during the summer off Oregon, and in summer and fall in the Gulf of Alaska and southeastern Bering Sea (Perry et al. 1999). Fin whales are observed feeding in Hawaiian waters during mid-May, and their sounds have been recorded there during the autumn and winter (Northrop et al. 1968; Shallenberger 1981; Thompson and Friedl 1982; Balcomb 1987). Fin whales in the western Pacific winter in the Sea of Japan, the East China, Yellow, and Philippine seas (Gambell 1985a).

Fin whales reach sexual maturity between 5 and 15 years of age (Lockyer 1972; Gambell 1985a). Mating occurs primarily in winter, and gestation lasts about 12 months and nursing occurs for 6 to 11 months (Perry et al. 1999). The average calving interval in the North Atlantic is estimated at about 2 years, based on whaling data (Christensen et al. 1992a in NMFS 2006a). The location of winter breeding grounds is uncertain (Perry et al. 1999).

Fin whales in the North Atlantic eat pelagic crustaceans (mainly euphausiids or krill, including *Meganyctiphanes norvegica* and *Thysanoessa inermis*) and schooling fish such as capelin *(Mallotus villosus*), herring (*Clupea harengus*), and sand lance (*Ammodytes* spp.) (Hjort and Ruud 1929; Ingebrigtsen 1929; Jonsgård 1966a; Mitchell 1974; Sergeant 1977; Overholtz and Nicolas 1979; Christensen et al. 1992b; Borobia et al. 1995). In the North Pacific, fin whales apparently prefer euphausiids (mainly *Euphausia pacifica*, *T. longipes*, *T. spinifera*, *T. inermis*, and *Nyctiphanes simplex*) and large copepods (mainly *Calanus cristatus*), followed by schooling fish such as herring, walleye pollock (*Theragra chalcogramma*), and capelin (Nemoto 1970; Kawamura 1982a, b; Ladrón De Guevara et al. 2008; Paloma et al. 2008). Antarctic fin whales feed on krill, *Euphausia superba*, which occurs in dense near-surface schools (Nemoto 1959). However, off the coast of Chile, fin whales are known to feed on the euphausiid *E. mucronata* (Antenzana 1970; Perez et al. 2006). Feeding may occur in waters as shallow as 33 feet when prey are at the surface (Paloma et al. 2008).

The amount of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5 to 20 shallow dives, each of 13 to 20 seconds duration, followed by a deep dive of between 1.5 and 15 minutes (Gambell 1985a). Other authors have reported that the fin whale's most common dives last between 2 and 6 minutes (Watkins 1981; Hain et al. 1992). In waters off the U.S. Atlantic Coast, individual or duos of fin whales represented about 75% of sightings during the Cetacean and Turtle Assessment Program (Hain et al. 1992). Individual whales or groups of less than five individuals represented about 90% of the observations. Out of 2,065 observations, mean group size was 2.9, with a range of 1-65 individuals (Hain et al. 1992).

Status and Trends

Fin whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973. Although population structure remains undetermined for fin whales, various studies and estimates of abundance are available. Sergeant (1977) suggested

that between 30,000 and 50,000 fin whales once populated the North Atlantic Ocean based on assumptions about catch levels during the whaling period. Sigurjónsson (1995) estimated that between 50,000 and 100,000 fin whales once populated the North Atlantic, although he provided no data or evidence to support that estimate. More recently, Palumbi and Roman (2006) estimated that about 360,000 fin whales (95% confidence interval = 249,000 to 481,000) populated the North Atlantic Ocean before whaling based on mutation rates and estimates of genetic diversity. Globally, Braham (1991) compiled available regional estimates and reported a pre-exploitation abundance for fin whales of more than 464,000 individuals worldwide. The estimate for 1991 indicated a global fin whale abundance of 120,000 (Braham 1991).

Current size estimates of fin whale populations and estimates of their global abundance vary widely. NMFS estimates that at least 2,200 fin whales populate the North Atlantic Ocean, with slightly more than 3,000 individuals off California, Oregon, and Washington based on ship surveys in summer/autumn of 1996, 2001, and 2005 (Barlow and Taylor 2001; Barlow 2003; Forney 2007; NMFS 2007a). An estimated 5,000 fin whales inhabit areas off the Kenai Peninsula and estimates suggest only a few hundred fin whales occur around the Hawaiian Islands (Moore et al. 2002; Zerbini et al. 2006; Caretta et al. 2007). These estimates and estimates of the East Greenland-Iceland fin whale population (10,000 animals, 95% C.I. = 7,600 to 14,200), the eastern Atlantic fin whales, which includes the British Isles-Spain-Portugal population (17,000 animals, 95% CI = 10,400 to 28,900), and the western Mediterranean fin whale population (3,583 individuals SE = 967; 95% CI = 2,130 to 6,027) suggest that the global population of fin whales consists of tens of thousands of individuals (Buckland et al. 1992; Forcada et al. 1996; Notarbartoli-di-Sciara et al. 2003).

Threats

Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest annual natural mortality rates may range from 0.04 to 0.06 (based on studies of northeast Atlantic fin whales). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale populations from recovering from whaling (Lambertsen 1992 *in* Perry et al. 1999). Adult sei whales engage in a flight responses (up to 25 miles per hour) to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Killer whale or shark attacks may also result in serious injury or death in very young and sick whales (Perry et al. 1999).

As early as the mid-seventeenth century, the Japanese were capturing fin, blue, and other large whales using a fairly primitive open-water netting technique (Tønnessen and Johnsen 1982; Cherfas 1989). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species. After blue whales were depleted in most areas, the smaller fin whale became the focus of whaling operations. Between 1904 and 1970, more than 700,000 fin whales were killed in the Southern Hemisphere, and more than 45,000 were reported as killed throughout the North Pacific (NMFS 2006a).

Fin whales are still hunted in subsistence fisheries off West Greenland. In 2004, five males and six females were killed and landed, and two other fin whales were struck and lost. In 2003, two males and four were landed and two others were struck and lost (IWC 2005). Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in this subsistence fishery, however, the scientific recommendation was to limit the number killed up to four individuals until accurate populations could be produced (IWC 2005). In the Antarctic Ocean, fin whales are hunted by Japanese whalers who have been allowed to kill up to 10 fin whales each ear for the 2005-2006 and 2006-2007 seasons under an Antarctic Special Permit (NMFS 2006a). The Japanese whalers plan to kill 50 whales per year starting in the 2007 to 2008 season and continuing for the next 12 years.

Fin whales are also injured and killed by fishing gear and ship strikes (Perkins and Beamish 1979; Lien 1994; Caretta et al. 2007; Waring et al. 2007; Douglas et al. 2008). Between 1969 and 1990, 14 fin whales were captured in coastal fisheries off Newfoundland and Labrador of these seven are known to have died as a result of capture (Perkins and Beamish 1979; Lien 1994); and in 1999, one fin whale was reported as killed in the Gulf of Alaska pollock trawl fishery, and one was killed the same year in the off shore drift gillnet fishery off the west coast (Carretta et al. 2004; Angliss and Outlaw 2006). According to Waring et al. (2007) four fin whales in the western North Atlantic died or were seriously injured in fishing gear, while another five were killed or injured as a result of ship strikes between January 2000 and December 2004. Jensen and Silber's (2004) review of NMFS' ship strike database records from 1975 to 2002 revealed fin whales as the most often confirmed victims of ship strikes (26% of the recorded ship strikes [n = 75/292 records]), with most collisions (of all whale species) occurring off the east coast, followed by the west coast of the U.S. and Alaska/Hawaii. Between 1999 and 2005, there were 15 reports of fin whales being struck by vessels along the U.S. and Canadian Atlantic coasts (Cole et al. 2005; Nelson et al. 2007). Of these, 13 were confirmed, resulting in the deaths of 11 individuals. Five of seven fin whales stranded along Washington State and Oregon showed evidence of ship strike with incidence increasing since 2002 (Douglas et al. 2008). Similarly, 2.4% of living fin whales from the Mediterranean show ship strike injury and 16% of stranded individuals were killed by vessel collision (Panigada et al. 2006). There are also numerous reports of ship strikes off the Atlantic coasts of France and the United Kingdom (Jensen and Silber 2003).

Management measures aimed at reducing the risk of ships hitting right whales should also reduce the risk of collisions with fin whales. In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, proposed rules for seasonal (June through December) slowing of vessel traffic to 10 knots or changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are predicted to be capable of reducing ship strike mortality by 62% in the Bay of Fundy region for right whales and reduced the chance of collisions with fin whales by 27%.

The organochlorines DDE, DDT, and PCBs have been identified from fin whale blubber, but levels are lower than in toothed whales due to the lower level in the food chain that fin whales feed at (Aguilar and Borrell 1987, 1988; Borrell 1993; Henry and Best 1983; Marsili and Focardi 1996). Females contained lower burdens than males, likely due to mobilization of contaminants

during pregnancy and lactation (Aguilar and Borrell 1988; Borrell 1993; Gauthier et al. 1997b). Contaminant levels increase steadily with age until sexual maturity, at which time levels begin to drop in females and slowly increase in males (Aguilar and Borrell 1988; Aquilar and Borrell 1994). Nevertheless, based on the evidence available, the number of fin whales that are recorded to have been killed or injured in the past 20 years by human activities or natural phenomena, does not appear to be increasing the extinction probability of fin whales, although it may slow the rate at which they recovery from population declines that were caused by commercial whaling.

Critical Habitat

NMFS has not designated critical habitat for fin whales.

Humpback Whale

Humpback whales are a cosmopolitan species that occur in the Atlantic, Indian, Pacific, and Southern oceans. Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they breed and give birth to calves, although feeding occasionally occurs) and cooler, temperate or sub-Arctic waters in summer months (where they feed; Gendron and Urban 1993). In both regions, humpback whales tend to occupy shallower, coastal waters. However, migrations are undertaken through deep, pelagic waters (Winn and Reichley 1985).

In the North Pacific, humpback whales summer in coastal and inland waters from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Nemoto 1957; Tomlin 1967; Johnson and Wolman 1984 in NMFS 1991b). These whales migrate to Hawaii, southern Japan, the Mariana Islands, and Mexico during winter. Based on genetic and photo-identification studies, the NMFS currently recognizes four stocks of humpback whales in the North Pacific Ocean: two Eastern North Pacific stocks, one Central North Pacific stock, and one Western Pacific stock (Hill and DeMaster 1998). The central North Pacific stock winters in the waters around Hawaii while the eastern North Pacific stock (also called the California-Oregon-Washington-Mexico stock) winters along coasts of Central America and Mexico. However, Calambokidis et al. (1997) identified individuals from several stocks wintering in the areas of other stocks, highlighting the paucity of knowledge on stock structure. Further, the potential fluidity of stock structure, Herman (1979) presented extensive evidence that humpback whales associated with the main Hawaiian Islands immigrated there only in the past 200 years. Winn and Reichley (1985) identified genetic exchange between the humpback whales that winter off Hawaii and those that winter off Mexico (with further mixing on feeding areas in Alaska) and suggested that humpback whales that winter in Hawaii may have emigrated from Mexican wintering areas.

A “population” of humpback whales winters in the South China Sea east through the Philippines, Ryukyu Retto, Ogasawara Gunto, Mariana Islands, and Marshall Islands, with occurrence in the Mariana Islands, at Guam, Rota, and Saipan from January through March (Darling and Mori 1993; Eldredge 1991, 2003; Rice 1998). During summer, whales from this population migrate to

the Kuril Islands, Bering Sea, Aleutian Islands, Kodiak, Southeast Alaska, and British Columbia to feed (Calambokidis 1997, 2001; Angliss and Outlaw 2007).

In the Southern Ocean, eight proposed stocks of humpback whales occur in waters off Antarctica (IWC 2006a). These hypothesized stocks correspond to proposed breeding areas and include Brazil (A), West Africa (B), East Africa (C), Indian Ocean (X), western Australia (D), eastern Australia (E), Oceania (F), and an eighth off of western South America (G). These whales migrate to Central America, Venezuela, Brazil, southern Africa, western and eastern Australia, New Zealand, and islands in the southwest Pacific during the austral winter. Based upon recent satellite telemetry, a revision of stocks A and G may be warranted to reflect stock movements within and between feeding areas separated east of 50º W (Dalla Rosa et al. 2008). A separate population of humpback whales appears to reside in the Arabian Sea in the Indian Ocean off the coasts of Oman, Pakistan, and India (Mikhalev 1997; Rasmussen et al. 2007) and movements of this group are poorly known.

In the Atlantic Ocean, humpback whales range from the mid-Atlantic bight, the Gulf of Maine, across the southern coast of Greenland and Iceland, and along the coast of Norway in the Barents Sea. These humpback whales migrate to the western coast of Africa and the Caribbean Sea during the winter. Humpback whales aggregate in four summer feeding areas: (1) Gulf of Maine, eastern Canada, (2) west Greenland, (3) Iceland, and (4) Norway (Katona and Beard 1990; Smith et al. 1999). Increasing occurrence in the Mediterranean Sea coincides with population growth and may represent reclaimed habitat from pre-commercial whaling (Frantzis et al. 2004). The principal breeding range forAtlantic humpback whales lies from the Antilles and northern Venezuela to Cuba (Winn et al. 1975; Balcomb and Nichols 1982; Whitehead and Moore 1982), but the largest breeding aggregations occur off the Greater Antilles where humpback whales from all of the North Atlantic feeding areas have been photo-identified (Katona and Beard 1990; Clapham et al. 1993b; Mattila et al. 1994; Palsbøll et al. 1997; Smith et al. 1999; Stevick et al. 2003a). Winter aggregations also occur at the Cape Verde Islands in the Eastern North Atlantic (Reiner et al. 1996; Reeves et al. 2002). Accessory and historical aggregations have been found in the eastern Caribbean (Winn et al. 1975; Levenson and Leapley 1978; Mitchell and Reeves 1983; Reeves et al. 2001; Smith and Reeves 2003; Swartz et al. 2003). To further highlight the “open” structure of humpback whales, a humpback whale migrated from the Indian Ocean to the South Atlantic Ocean, demonstrating interoceanic movements can occur (Pomilla and Rosenbaum 2005).

Because of the extensive rate of immigration and emigration that likely occurs between North Pacific stocks, these groups are unlikely to represent separate populations. Although significant life history differences exist, until further information is available to differentiate groups, North Pacific humpback whales herein represent a single population, along with a separate Arabian Sea population (along Oman, Pakistan, and India), North Atlantic, and ill-defined Southern Ocean/Indian Ocean/South Atlantic group that seems to undergo migration between ocean basins (additional data is necessary to define populations herein; Mikhalev 1997).

Humpback whale calving and breeding generally occurs during winter at lower latitudes. Gestation takes about 11 months, followed by a nursing period of up to 1 year (Winn and Reichley 1985; Baraff and Weinrich 1993). Sexual maturity is reached at between 5 and 7 years

of age in the western North Atlantic, but may take as long as 11 years in the North Pacific, and perhaps over 11 years of age in the North Pacific (Clapham 1992; Gabriele et al. 2007). Females usually breed every 2 to 3 years, although consecutive calving is not unheard of (Clapham and Mayo 1987, 1990; Weinrich et al. 1993). Calving occurs in the shallow coastal waters of continental shelves and oceanic islands worldwide (Perry et al. 1999).

In Hawaiian waters, humpback whales remain almost exclusively within the 6,000 foot isobath and usually within waters depths of less than 600 feet. Maximum diving depths are approximately 555 feet (but usually <200 feet), with a very deep dive (787 feet) recorded off Bermuda (Hamilton et al. 1997). Dives can last for up to 21 minutes, although feeding dives ranged from 2.1 to 5.1 minutes in the north Atlantic (Dolphin 1987; Goodyear unpublished manuscript). In southeast Alaska, average dive times were 2.8 minutes for feeding whales, 3.0 minutes for non-feeding whales, and 4.3 minutes for resting whales (Dolphin 1987). In the Gulf of California, humpback whale dive durations averaged 3.5 minutes (Strong 1989). Because most humpback prey is likely found within 1,000 feet of the surface, most humpback dives are probably relatively shallow.

During the feeding season, humpback whales form small groups that occasionally aggregate on concentrations of food that may be stable for long-periods of times. Humpbacks use a wide variety of behaviors to feed on various small, schooling prey including krill and fish (Jurasz and Jurasz 1979; Hain et al. 1982, 1995; Weinrich et al. 1992). The principal fish prey in the western North Atlantic are sand lance, herring, and capelin (Kenney et al. 1985). There is good evidence of some territoriality on feeding and calving areas (Tyack 1981; Clapham 1994, 1996). In calving areas, males sing long complex songs directed towards females, other males, or both. The breeding season can best be described as a floating lek or male dominance polygamy (Clapham 1996).

Status and Trends

Humpback whales were originally listed as endangered in 1970 (35 FR 18319), and this status presently remains under the ESA. Winn and Reichley (1985) argued that the global population of humpback whales consisted of at least 150,000 whales in the early 1900s, mostly in the Southern Ocean. Based on analyses of mutation rates and estimates of genetic diversity, Palumbi and Roman (2006) concluded that there may have been as many as 240,000 (95% confidence interval = 156,000 to 401,000) humpbacks in the North Atlantic before whaling began. Historical estimates put the number of humpback whales in the North Atlantic at a minimum of 4,700 individuals in 1865 (Mitchell and Reeves 1983). In 1987, the global population of humpback whales was estimated at about 10,000 (NMFS 1987). Although this estimate is outdated, it appears that humpback whale numbers are likely increasing. The best available estimate of abundance in the North Atlantic comes from the 2001 analyses of photographic mark-recapture data from 1992 to 1993, which generated an estimate of 11,570 humpback whales (Stevick et al. 2003). Estimates of animals in Caribbean breeding grounds exceed 2,000 individuals (Balcomb and Nichols 1982). Several researchers report an increasing trend in abundance for the North Atlantic population, which is supported by an increase in individuals sighted within the Gulf of Maine feeding aggregation (Katona and Beard 1990; Barlow and Clapham 1997; Smith et al. 1999; Waring et al. 2001). The rate of increase for this stock varies

from 3.2% to 9.4%, with estimates of the rate of increase slowing over the past two decades (Katona and Beard 1990, Barlow and Clapham 1997; Stevick et al. 2003). If the North Atlantic population has grown according to the estimated instantaneous rate of increase (r = 0.0311), this would lead to an estimated 18,400 individual whales in 2008 (Stevick et al. 2003).

In the North Pacific, the pre-exploitation population size may have been as many as 15,000 humpback whales, and current estimates place North Pacific numbers at between 6,000 to 8,000 whales (Rice 1978a *in* Perry et al. 1999; Calambokidis et al. 1997). Estimates of humpback numbers occurring in the different populations that inhabit the northern Pacific population have risen over time. In the 1980s, estimates ranged from 1,407 to 2,100 (Baker 1985; Darling and Morowitz 1986; Baker and Herman 1987). More recently, Calambokidis et al. (1997) relied on resightings estimated from photographic records of individuals to produce an estimate of 6,010 humpback whales in the North Pacific. Because the estimates produced by the different methodologies are not directly comparable, it is not clear which of these estimates is more accurate or if the change from 1,407 to 6,000 individuals results from a real increase in the size of the humpback whale population, sampling bias in one or both studies, or assumptions in the methods used to produce estimates from the individuals that were sampled. There are currently an estimated 394 humpback whales in the western North Pacific stock, 4,005 in the central North Pacific stock, and 1,396 in the eastern North Pacific stock (Angliss and Outlaw 2005; Carretta et al. 2007). Tentative estimates of the eastern North Pacific stock suggest population increase in the realm of 6% to 7% annually, but fluctuations in census data include negative growth in the recent past (Angliss and Outlaw 2005). However, based upon surveys between 2004 and 2006, Calambokidis et al. (2008) estimated that the current population of humpback whales in the North Pacific consisted of about 18,300 whales, not counting calves. Almost half of these whales were estimated to occur in wintering areas around the Hawaiian Islands.

Threats

Natural sources and rates of mortality of humpback whales are not well known. Based upon prevalence of tooth marks, attacks by killer whales appear to be highest among humpback whales migrating between Mexico and California, although populations throughout the Pacific Ocean appear to be targeted to some degree (Steiger et al. 2008). Juveniles appear to be the primary age group targeted. Humpback whales engage in grouping behavior, flailing tails and rolling extensively to fight off attacks. Calves remain protected near mothers or within a group and lone calves have been known to be protected by presumably unrelated adults when confronted with attack (Ford and Reeves 2008).

Parasites and biotoxins from red-tide blooms are other potential causes of mortality (see Perry et al. 1999). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering from whaling (Lambertsen 1992). Studies of 14 humpback whales that stranded along Cape Cod between November 1987 and January 1988 indicate they apparently died from a toxin produced by dinoflagellates during this period. Both adult and juvenile humpback whales can succumb to such naturally-produced biotoxins (Geraci et al. 1989).

Three human activities are known to threaten humpback whales: whaling, commercial fishing, and shipping. Historically, whaling represented the greatest threat to every population of whales and was ultimately responsible for listing several species as endangered. It is estimated that 15,000 humpback whales resided in the North Pacific in 1905 (Rice 1978a). However, from 1905 to 1965, nearly 28,000 humpback whales were taken in whaling operations, reducing the number of all North Pacific humpback whale to roughly 1,000 (Perry et al. 1999). Prior to 1905, an unknown number of humpback whales were taken (Perry et al. 1999). In 1965, the IWC banned commercial hunting of humpback whales. However, populations have not recovered from whaling harvest, and their small numbers make them more susceptible to other risks.

Humpback whales are also killed or injured during interactions with commercial fishing gear. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada. A total of 595 humpback whales were reported captured in coastal fisheries in those two provinces between 1969 and 1990, of which 94 died (Perkins and Beamish 1979; Lien 1994). Along the Atlantic coast of the U.S. and the Maritime Provinces of Canada, there were 160 reports of humpback whales being entangled in fishing gear between 1999 and 2005 (Cole et al. 2005; Nelson et al. 2007). Of these, 95 entangled humpback whales were confirmed, with 11 whales sustaining injuries and nine dieing of their wounds. Several humpback whales are also known to have become entangled in the North Pacific (Hill et al. 1997; Angliss and Outlaw 2007)

More humpback whales are killed in collisions with ships than any other whale species except fin whales (Jensen and Silber 2003). Along the Pacific coast, a humpback whale is killed about every other year by ship strikes (Barlow et al. 1997). Of 123 humpback whales that stranded along the Atlantic coast of the U.S. between 1975 and 1996, 10 (8.1%) showed evidence of collisions with ships (Laist et al. 2001). Between 1999 and 2005, there were 18 reports of humpback whales being struck by vessels along the Atlantic coast of the U.S. and the Maritime Provinces of Canada (Cole et al. 2005; Nelson et al. 2007). Of these reports, 13 were confirmed as ship strikes and in 7 cases, ship strike was determined to be the cause of death. In the Bay of Fundy, recommendations for slower vessel speeds to avoid right whale ship strike appear to be largely ignored (Vanderlaan et al. 2008). However, new rules for seasonal (June through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than 1 nautical mile to avoid the greatest concentrations of right whales are expected to reduce the chance of humpback whales being hit by ships by 9%.

Organochlorines, including PCB and DDT, have been identified from humpback whale blubber (Gauthier et al. 1997b). As with blue whales, these contaminants are transferred to young through the placenta, leaving newborns with contaminant loads equal to the mothers before bioaccumulating additional contaminants during life and passing the additional burden onto the next generation (Metcalfe et al. 2004). Contaminant levels are relatively high in humpback whales as compared to blue whales. Humpback whales feed higher on the food chain, where prey carry higher contaminant loads than the krill that blue whales feed on.

Critical Habitat

NMFS has not designated critical habitat for humpback whales.

Southern Resident Killer Whale

Southern Resident killer whales compose a single population that occurs primarily along Washington State and British Columbia. The listed entity consists of three groups, identified as J, K, and L pods. They are found throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as the Queen Charlotte Islands, British Columbia. However, there is limited information on the range of Southern Residents along the outer Pacific Coast, with only 25 confirmed sightings of J, K, and L pods between 1982 and 2006 (Krahn et al. 2004). Southern Resident killer whales spend a significant portion of the year in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound, particularly during the spring, summer, and fall, when all three pods are regularly present in the Georgia Basin (defined as the Georgia Strait, San Juan Islands, and Strait of Juan de Fuca) (Heimlich-Boran 1988; Felleman et al. 1991; Olson 1998; Osborne 1999). Typically, K and L pods arrive in May or June and primarily occur in this core area until October or November. During this stay, both pods also make frequent trips lasting a few days to the outer coasts of Washington and southern Vancouver Island (Ford et al. 2000); however, J pod's movements differ considerably and are present only intermittently in the Georgia Basin and Puget Sound. Late spring and early fall movements of Southern Residents in the Georgia Basin have remained fairly consistent since the early 1970s, with strong site fidelity shown to the region as a whole (NMFS 2005a). During late fall, winter, and early spring, the ranges and movements of the Southern Residents are less well known. Offshore movements and distribution are largely unknown for the Southern Resident population.

While the Southern Residents are in inland waters during the warmer months, all of the pods concentrate their activities in Haro Strait, Boundary Passage, the southern Gulf Islands, the eastern end of the Strait of Juan de Fuca, and several localities in the southern Georgia Strait (Heimlich-Boran 1988; Felleman et al. 1991; Olson 1998; Ford et al. 2000). Individual pods are similar in their preferred areas of use, although there are some seasonal and temporal differences in certain areas visited (Olson 1998). For example, J pod is the only group to venture regularly inside the San Juan Islands. The movements of Southern Resident killer whales relate to those of their preferred prey, salmon. Pods commonly seek out and forage in areas where salmon occur, especially those associated with migrating salmon (Heimlich-Boran 1986a; Heimlich-Boran 1988; Nichol and Shackleton 1996).

Southern resident killer whales are significant predators of regional salmon stocks. Killer whales show a strong preference for Chinook salmon (78% of identified prey) during late spring to fall (Hanson et al. 2005; Ford and Ellis 2006). Chum salmon are also taken in significant amounts (11%), especially in autumn. Chinook are preferred despite much lower abundance in comparison to other salmonids (such as sockeye) presumably because of the species' large size, high fat and energy content, and year-round occurrence in the area. Killer whales also captured older (i.e., larger) than average Chinook (Ford and Ellis 2006). Throughout inland waters from May to September, Southern resident killer whale diet is approximately 88% Chinook (Hanson et al. 2007a), with a shift to chum salmon in fall. Little is known about the winter and early spring diet of Southern Residents. Early results from genetic analysis of fecal and prey samples indicate that Southern Residents consume Fraser River-origin Chinook, as well as salmon from

Puget Sound, Washington and Oregon coasts, the Columbia River, and Central Valley of California (Hanson et al. 2007b).

Southern Residents are highly mobile and can travel up to 100 miles per day (Erickson 1978; Baird 2000). Members of K and L pods once traveled a straight line distance of 584 miles from the northern Queen Charlotte Islands to Victoria, Vancouver Island, in seven days. Movements may be related to food availability. Southern Resident killer whales are fish eaters, and predominantly prey upon salmonids, particularly Chinook salmon but are also known to consume more than 20 other species of fish and squid (Scheffer and Slipp 1948; Ford et al. 1998, 2000; Saulitis et al. 2000; Ford and Ellis 2005).

Female Southern Resident killer whales give birth to their first surviving calf between the ages of 12 and 16 years (mean ~14.9 years) and produce an average of 5.4 surviving calves during a reproductive life span lasting about 25 years (Olesiuk et al. 1990a; Matkin et al. 2003). The mean interval between viable calves is four years (Bain 1990). Males become sexually mature at body lengths ranging from 17 to 21 feet, which corresponds to between the ages of 10 to 17.5 years (mean ~15 years), and are presumed to remain sexually active throughout their adult lives (Christensen 1984; Perrin and Reilly 1984; Duffield and Miller 1988; Olesiuk et al. 1990a). Most mating is believed to occur from May to October (Nishiwaki 1972; Olesiuk et al. 1990a; Matkin et al. 1997). However, conception apparently occurs year-round because births of calves are reported in all months. Newborns measure seven to 9 feet long and weigh about 440 lbs (Nishiwaki and Handa 1958; Olesiuk et al. 1990a; Clark et al. 2000; Ford 2002). Mothers and offspring maintain highly-stable, life-long social bonds and this natal relationship is the basis for a matrilineal social structure (Bigg et al. 1990; Baird 2000; Ford et al. 2000).

Killer whales tend to make relatively shallow dives. Of 87 tagged individuals in the Pacific Northwest, 31% of dives were less than 100 feet deep (Baird et al. 2003). However, a free-ranging killer whale was recorded to dive to 264 m off British Columbia (Baird et al. 2005). The longest duration of a recorded dive was 17 minutes (Dahlheim and Heyning 1999).

Status and Trends

Southern Resident killer whales have been listed as endangered since 2005 (70 FR 69903). In general, there is little information available regarding the historical abundance of Southern Resident killer whales. Some evidence suggests that, until the mid- to late-1800s, the Southern Resident killer whale population may have numbered more than 200 animals (Krahn et al. 2002). This estimate was based, in part, on a recent genetic study that found that the genetic diversity of the Southern Resident population resembles that of the Northern Residents (Barrett-Lennard 2000; Barrett-Lennard and Ellis 2001), and concluded that the two populations were possibly once similar in size. Unfortunately, lack of data prior to 1974 hinders long-term population analysis (NMFS 2005a). The only pre- 1974 account of Southern Resident abundance is from Sheffer and Slipp (1948) and merely notes that the species was “frequently seen” during the 1940s in the Strait of Juan de Fuca, northern Puget Sound, and off the coast of the Olympic Peninsula, with smaller numbers along Washington’s outer coast. Olesiuk et al. (1990) estimated the Southern Resident population size in 1967 to be 96 animals. Due to demand for marine mammals in zoos and marine parks, it is estimated that 47 killer whales, mostly immature, were

taken from the Southern Resident population for public display between 1967 and 1973. By 1971, the level of removal decreased the population by about 30% to approximately 67 individuals (Olesiuk et al. 1990a). The population went then went through periods of decline and expansion for more than two decades. At the end of an 11-year growth cycle in 1995, the three Southern Resident pods – J, K, and L, reached a peak of 98 animals (NMFS 2008a).

More recently, the Southern Resident population has continued to fluctuate in numbers. After growing to 98 whales in 1995, the population declined by 17% to 81 whales in 2001 (-2.9% per year) before another slight increase to 84 whales in 2003 (Ford et al. 2000; Carretta et al. 2005). The population grew to 90 whales in 2006, although it declined to 87 in 2007 (NMFS 2008a). The most recent population abundance estimate of 87 Southern Residents consists of 25 whales in J pod, 19 whales in K pod, and 43 whales in L pod (NMFS 2008a).

Threats

The recent decline, unstable population status, and population structure (e.g., few reproductive age males and non-calving adult females) continue to be causes for concern. Moreover, it is unclear whether the recent increasing trend will continue. The relatively low number of individuals in this population makes it difficult to resist/recover from natural spikes in mortality, including disease and fluctuations in prey availability (NMFS 2008a). Although disease outbreaks have not been identified in this population, increased contaminant load (see below) may increase the susceptibility of individuals to disease.

Numerous threats to the continued survival of Southern Resident killer whales have been identified (see NMFS 2008a for a review). Many of these are human in origin. The primary prey of killer whales, salmon, has been severely reduced due to habitat loss and overfishing of salmon along the West Coast (NRC 1995; Slaney et al. 1996; Gregory and Bisson 1997; Lichatowich 1999; Lackey 2003; Pess et al. 2003; Schoonmaker et al. 2003). Several salmon species are currently protected under the ESA, and are generally well below their former numbers.

Puget Sound also serves as a major port and drainage for thousands of square miles of land. Contaminants entering Puget Sound and its surrounding waters accumulate in water, benthic sediments, and the organisms that live and eat here. As the top marine predator, Southern Resident killer whales bioaccumulate these toxins in their tissues, potentially leading to numerous physiological changes such as skeletal deformity, lowered disease resistance, and enzyme disruption. Presently, the greatest contaminant threats are organochlorines, which include PCBs, pesticides, dioxins, furans, other industrial products, and the popularized chemical DDT (Ross et al. 2000; CBD 2001; Krahn et al. 2002). These chemicals tend to bioaccumulate in fatty tissues, such as whale blubber, persist over long periods in the environment, and can be transmitted from mother to offspring. A similar, but separate concern is the growth of the petroleum industry in Puget Sound, which has the low potential to create a catastrophic oil spill, or more likely, small but chronic releases of petrochemicals.

Vessel activity also has been identified as a threat. This includes physical harm or behavioral modifications as well as habitat degradation/loss from U.S. naval vessel sonar activities, ship

strike, and heavy and continuous presence by whale-watching vessels. In 2005, a U.S. vessel participating in sonar exercises apparently caused significant behavior changes in killer whale activity in the area, such that the whales vacated the area (NMFS 2005a). Although such activities are now receiving close scrutiny, the potential remains for these disruptions to occur, or as in other areas, the potential for auditory trauma, stranding, and death. The increase in "background noise" resulting from vessel traffic and coastal development activities, although not directly traumatic, has the potential to influence or disrupt the acoustic system that Southern Resident killer whales use to navigate, communicate, and forage (Bain and Dahlheim 1994; Gordon and Moscrop 1996; Erbe 2002; Williams et al. 2002a, b; NMFS 2008a). Commercial whale-watching in the region focuses primarily on Southern Resident killer whales and has increased dramatically in the recent years (Osborne et al.1999; Baird 2001; Erbe 2002; MMMP2002; Koski 2004, 2006, 2007). Although mechanisms are in place to regulate the industry, concerns remain over persistent exposure to vessel noise, proximity to whales, which can cause behavioral changes, stress, or potentially the loss of habitat (Kruse 1991; Kriete 2002; Williams et al. 2002a, b; Foote et al. 2004; Bain et al. 2006; Wiley et al. 2008; NMFS 2008a).

Critical Habitat

Critical habitat for the DPS of Southern Resident killer whales was designated on November 29, 2006 (71 FR 69054). Three specific areas were designated; (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca, which comprise approximately 2,560 square miles of marine habitat. Three essential factors exist in these areas: water quality to support growth and development, prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth, and passage conditions to allow for migration, resting, and foraging. Water quality has declined in recent years due to agricultural run-off, urban development resulting in additional treated water discharge, industrial development, oil spills. The primary prey of southern residents, salmon, has also declined due to overfishing and reproductive impairment associated with loss of spawning habitat. The constant presence of whale-watching vessels and growing anthropogenic noise has raised concerns about the health of areas of growth and reproduction as well.

Sei Whale

The sei whale occurs in all oceans of the world except the Artic Ocean and is listed as endangered throughout its range. The migratory pattern of this species is thought to encompass long distances from high-latitude feeding areas in summer to low-latitude breeding areas in winter; however, the location of winter areas remains largely unknown (Perry et al. 1999). Sei whales are often associated with deeper waters and areas along the continental shelf edge (Hain et al. 1985). This general offshore pattern of sei whale distribution is disrupted during occasional incursions into more shallow and inshore waters (Waring et al. 2004). The species appears to lack a well-defined social structure and individuals are usually found alone or in small groups of up to six whales (Perry et al. 1999). When on feeding grounds, larger groupings have been observed (Gambell 1985b).

The population structure of sei whales remains unknown and populations herein follow IWC recommendations. In the North Atlantic, the IWC groups sei whales into three stocks for

management purposes: the Nova Scotia, Iceland-Denmark Strait, and Northeast Atlantic stocks, noting that identification of sei whale population structure is difficult and remains a major research problem (Donovan 1991; Perry et al. 1999). The official IWC boundaries of the Nova Scotia stock extend from the U.S. East Coast to Cape Breton, Nova Scotia, and from there east to longitude 42° W (Waring et al. 2004).

In the North Pacific, the IWC groups all sei whales into one management stock (Donovan 1991). However, some mark-recapture, catch distribution, and morphological research indicate more than one population may exist – one between 175° W and 155° W longitude, and another east of 155° W longitude (Masaki 1976 *in* Perry et al. 1999; Masaki 1977). In the Southern Hemisphere, the IWC has divided the Southern Ocean into six baleen whale feeding areas – designated at 60° S latitude and longitude as follows: 120° W to 60° W (Area I), 60° W to 0° (Area II), 0° to 70° E (Area III), 70° E to 130° E (Area IV), 130° E to 170° W (Area V) and 170°W to 120°W (Area VI). There is little information on the population structure of sei whales in the Antarctic, although some degree of isolation appears to exist between IWC Areas I through VI (IWC 1980; Donovan 1991). Insufficient information exists to validate these management stock designations; however, links between some regions were found using tag data – for example, between (1) the Brazilian coast and the western half of Area II, (2) the Natal Coast of South Africa with the eastern half of Area III and the western half of Area IV, and (3) western and southeastern Australia with Area IV (Perry et al. 1999). This information suggests that sei whale stocks are dynamic and that individuals are immigrating and emigrating be between stocks. Consequently, until further information is available to suggest otherwise, we consider sei whales as forming "open" populations that are connected through the movement of individuals.

In the western North Atlantic, a major portion of the sei whale population occurs from northern waters, potentially including the Scotian Shelf, along Labrador and Nova Scotia, south into the U.S. EEZ, including the Gulf of Maine and Georges Bank (Mitchell and Chapman 1977, Waring et al. 2004). These whales summer in northern areas before migrating south to waters along Florida, in the Gulf of Mexico, and the northern Caribbean Sea (Mead 1977; Gambell 1985b). Sei whales may range as far south as North Carolina. In the U.S. EEZ, the greatest abundance of this species occurs during spring, with most sightings on the eastern edge of Georges Bank, in the Northeast Channel, and along the southwestern edge of Georges Bank in Hydrographer Canyon (CeTAP 1982). In 1999, 2000, and 2001, NMFS aerial surveys found sei whales concentrated along the northern edge of Georges Bank during spring; and surveys in 2001 found sei whales south of Nantucket along the continental shelf edge (Waring et al. 2004). During years of greater prey abundance (e.g., copepods), sei whales are found in more inshore waters, such as the Great South Channel (in 1987 and 1989), Stellwagen Bank (in 1986), and the Gulf of Maine (Payne et al. 1990; Schilling et al. 1992). In the eastern Atlantic, sei whales occur in the Norwegian Sea, occasionally occurring as far north as Spitsbergen Island, and migrate south to Spain, Portugal, and northwest Africa (Jonsgård and Darling 1977; Gambell 1985b).

In the North Pacific Ocean, sei whales have been reported primarily south of the Aleutian Islands, in Shelikof Strait and waters surrounding Kodiak Island, in the Gulf of Alaska, and inside waters of southeast Alaska and south to California to the east and Japan and Korea to the west (Nasu 1974; Leatherwood et al. 1982). Sei whales have been occasionally reported from

the Bering Sea and in low numbers on the central Bering Sea shelf (Hill and DeMaster 1998). Masaki (1977) reported sei whales concentrating in the northern and western Bering Sea from July through September, although other researchers question these observations because no other surveys have ever reported sei whales in the northern and western Bering Sea. Horwood (1987) evaluated the Japanese sighting data and concluded that sei whales rarely occur in the Bering Sea. Horwood (1987) reported that 75 to 85% of the total North Pacific population of sei whales resides east of 180° longitude. During winter, sei whales are found from 20° 23° N (Masaki 1977; Gambell 1985b). Horwood (1987) reported that 75% to 85% of the North Pacific population of sei whales resides east of 180° longitude. Sei whales occur throughout the Southern Ocean during austral summer, although they do not migrate as far south to feed as blue or fin whales. During the austral winter, sei whales occur off Brazil and the western and eastern coasts of southern Africa and Australia.

The age structure of sei whale populations is unknown, and little information is available on natural mortality. Reproductive activities for sei whales occur primarily in winter. Gestation is about 12.7 months, calves are weaned at six to nine months of age, and the calving interval is about 3 years (Rice 1977). Sei whales become sexually mature at about age 10 (Rice 1977). Sei whales are primarily planktivorous, feeding mainly on euphausiids and copepods, although the species is also known to consume fish (Waring et al. 2006). In the Northern Hemisphere, sei whales consume small schooling fish such as anchovies, sardines, and mackerel when locally abundant (Mizroch et al 1984; Gambell 1985b). Sei whales in the North Pacific feed on euphausiids and copepods, which make up about 95% of their diets (Calkins 1986a). The balance of their diet consists of squid and schooling fish, including smelt, sand lance, Arctic cod, rockfish, pollack, capelin, and Atka mackerel (Nemoto and Kawamura 1977). In the Southern Ocean, analysis of stomach contents indicates sei whales consume *Calanus* spp. and small-sized euphasiids with prey composition showing latitudinal trends (Kawamura 1974). Evidence indicates that sei whales in the Southern Hemisphere reduce direct interspecific competition with blue and fin whales by consuming a wider variety of prey and by arriving later to the feeding grounds (Kirkwood 1992). Rice (1977) suggested that the diverse diet of sei whales may allow them greater opportunity to take advantage of variable prey resources, but may also increase their potential for competition with commercial fisheries.

Status and Trends

The sei whale was originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973. Globally, Braham (1991) compiled available regional estimates and reported a pre-exploitation abundance for sei whales of more than 105,000 individuals worldwide; the estimate for 1991 indicated a global sei whale abundance of 25,000 (Braham 1991). In the North Atlantic, there is no information on sei whale abundance prior to commercial whaling (Perry et al. 1999). In 1974, the North Atlantic population was estimated to number about 2,078 individuals, including 965 whales in the Labrador Sea group and 870 whales in the Nova Scotia group (Mitchell and Chapman 1977). The most current estimate for the North Atlantic is a low-precision estimate of over 4,000 sei whales (Braham 1991). Estimates do exist for portions of the North Atlantic, however. In the northwest Atlantic, Mitchell and Chapman (1977) estimated the Nova Scotia, Canada, stock of sei whales to contain between 1,393 and 2,248 whales; and an aerial survey program conducted from 1978 to 1982 on

the continental shelf and edge between Cape Hatteras, North Carolina, and Nova Scotia generated an estimate of 280 sei whales (CeTAP 1982). These two estimates are more than 20 years out of date and likely do not reflect the current true abundance; in addition, the Cetacean and Turtle Assessment Program (CeTAP) estimate has a high degree of uncertainty and is considered statistically unreliable (Perry et al. 1999; Waring et al. 1999, 2004). Based on an aerial survey conducted in August 2006, NMFS estimated the current abundance of the Nova Scotia stock at 207 individuals, with a minimum population estimate of 128 (Waring et al. 2008). The total number of sei whales in the U.S. Atlantic EEZ remains unknown (Waring et al. 2006). In the eastern North Atlantic, the most recent abundance estimates for the Iceland/Denmark Strait stock are 1,290 and 1,590 whales, based on sighting data from surveys in 1987 and 1989, respectively (Cattanach et al. 1993).

Prior to commercial whaling, sei whales in the North Pacific are estimated to have numbered 42,000 individuals (Tillman 1977), although Ohsumi and Fukuda (1975) estimated that sei whales in the north Pacific numbered about 49,000 whales in 1963, had been reduced to 37,000 or 38,000 whales by 1967, and reduced again to 20,600 to 23,700 whales by 1973. Japanese and Soviet catches of sei whales in the North Pacific and Bering Sea increased from 260 whales in 1962 to over 4,500 in 1968 and 1969, after which the sei whale population declined rapidly (Mizroch et al. 1984). When commercial whaling for sei whales ended in 1974, the population of sei whales in the North Pacific had been reduced to between 7,260 and 12,620 animals (Tillman 1977). There have been no direct estimates of sei whale populations for the eastern Pacific Ocean (or the entire Pacific). Between 1991 and 2001, during aerial surveys, there were two confirmed sightings of sei whales along the U.S. Pacific Coast. The minimum population estimate based on transect surveys of 300 nautical miles between 1996 and 2001 was 35, although the actual population along the U.S. Pacific Coast was estimated to be 56 (Carretta et al. 2006). About 50 sei whales are estimated to occur in the North Pacific stock with another 77 sei whales in the Hawaiian stock (Lowry et al. 2007).

Threats

Sei whales appear to compete with blue, fin, and right whales for prey and that competition may limit the total abundance of each of the species (Rice 1974; Scarff 1986). As discussed previously in the narratives for fin and right whales, the foraging areas of right and sei whales in the western North Atlantic Ocean overlap and both whales feed preferentially on copepods (Mitchell 1975).

Andrews (1916) suggested that killer whales attacked sei whales less frequently than fin and blue whales in the same areas. Sei whales engage in a flight responses to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Endoparasitic helminths (worms) are commonly found in sei whales and can result in pathogenic effects when infestations occur in the liver and kidneys (Rice 1977). Rice (1977) estimated total annual mortality for adult females as 0.088 and adult males as 0.103.

Human activities known to threaten sei whales include whaling, commercial fishing, and maritime vessel traffic. Historically, whaling represented the greatest threat to every population of sei whales and was ultimately responsible for listing sei whales as an endangered species.

From 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean (Horwood 1987; Perry et al. 1999). From the early 1900s, Japanese whaling operations consisted of a large proportion of sei whales: 300 to 600 sei whales were killed per year from 1911 to 1955. The sei whale catch peaked in 1959, when 1,340 sei whales were killed. In 1971, after a decade of high sei whale catch numbers, sei whales were scarce in Japanese waters. Sei whales are thought to not be widely hunted, although harvest for scientific whaling or illegal harvesting may occur in some areas.

In the North Atlantic Ocean, sei whales were hunted from land stations in Norway and Iceland in the early- to mid-1880s, when blue whales started to become scarcer. In the late 1890s, whalers began hunting sei whales in Davis Strait and off the coasts of Newfoundland. In the early 1900s, whalers from land stations on the Outer Hebrides and Shetland Islands started to hunt sei whales. Between 1966 and 1972, whalers from land stations on the east coast of Nova Scotia engaged in extensive hunts of sei whales on the Nova Scotia shelf, killing about 825 sei whales (Mitchell and Chapman 1977).

Sei whales are occasionally killed in collisions with vessels. Of three sei whales that stranded along the Atlantic Coast of the U.S. between 1975 and 1996, two showed evidence of collisions with ships (Laist et al. 2001). Between 1999 and 2005, there were three reports of sei whales being struck by vessels along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada (Cole et al. 2005; Nelson et al. 2007). Two of these ship strikes were reported as having resulted in the death of the sei whale. One sei whale was killed in a collision with a vessel off the coast of Washington in 2003 (Waring et al. 2008). Proposed rules for seasonal (June through December) slowing of vessel traffic in the Bay of Fundy to 10 knots or changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are predicted to be capable of reducing ship strike mortality by 17% for sei whales.

Sei whales are known to carry body burdens of DDT, DDE, and PCBs (Henry and Best 1983; Borrell and Aquilar 1987; Borrell 1993). Males carry larger burdens than females, as gestation and lactation transfer these toxins from mother to offspring.

Critical Habitat

NMFS has not designated critical habitat for sei whales.

Sperm Whale

Sperm whales are distributed in all of the world's oceans, from equatorial to polar waters, and are highly migratory (furthest from the equator in summer, closest in winter). Mature males range as widely as latitude 70ºN in the North Atlantic and latitude 70ºS in the Southern Ocean, whereas mature females and immature individuals of both sexes are seldom found higher than latitudes 50ºN and 50ºS (Reeves and Whitehead 1997; Perry et al. 1999). Sperm whales inhabit deep pelagic waters along continental shelf edges and further offshore and are rarely found in waters less than 1,000 feet deep. They are often concentrated around oceanic islands in areas of upwelling, and along the outer continental shelf and mid-ocean waters. However, significant numbers of sightings have occurred in shallow continental shelf waters south of New England and over the Nova Scotian shelf (CeTAP 1982; Scott and Sadove 1997).

There is no clear understanding of the global population structure of sperm whales (Dufault et al. 1999). One study found moderate, but statistically significant, differences in sperm whale mitochondrial DNA (mtDNA) between oceans, but it is generally accepted that sperm whales worldwide are genetically homogeneous (Lyrholm and Gyllensten 1998; Whitehead 2003). For management purposes, the IWC recognizes one population in the North Atlantic (Donovan 1991), while NMFS recognizes six stocks under the MMPA: three in the Atlantic/Gulf of Mexico and three in the Pacific (Alaska, California-Oregon-Washington, and Hawaii; Perry et al. 1999; Waring et al. 2004). Nevertheless, genetic studies indicate that movements of both sexes through expanses of ocean basins are common, and that males, but not females, often breed in different ocean basins than the one in which they were born (Whitehead 2003). Sperm whale populations appear to be structured socially, at the level of the social unit or clan, rather than geographically (Whitehead 2003; Whitehead et al. 2008).

Sperm whales primarily occur in waters off the east coast of the U.S. from New England south to North Carolina (Perry et al. 1999). The northern distributional limit of female/immature pods is probably around Georges Bank or the Nova Scotian shelf (Whitehead et al. 1991). Seasonal aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons (Mullin et al. 1994; Hansen et al. 1996). Sperm whales are distributed in a distinct seasonal cycle, concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight. In the eastern Atlantic, mature male sperm whales have been recorded as far north as Spitsbergen (Øien 1990). Recent observations of sperm whales and stranding events involving sperm whales from the eastern North Atlantic suggest that solitary and paired mature male sperm whales predominantly occur in waters off Iceland, the Faroe Islands, and the Norwegian Sea (Gunnlaugsson and Sigurjónsson 1990; Øien 1990; Christensen et al. 1992a).

Sperm whales are found throughout the North Pacific and are distributed broadly in tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Sperm whales are found year-round in Californian and Hawaiian waters, but they reach peak abundance from April through mid-June and from the end of August through mid-November (Rice 1960a; Rice 1974; Shallenberger 1981; Dohl et al. 1983; Lee 1993; Barlow 1995; Forney et al. 1995; Mobley et al. 2000). They are seen in every season except winter (December-February) in Washington and Oregon (Green et al. 1992). Summer/fall surveys in the eastern tropical Pacific (Wade and Gerrodette 1993) show that although sperm whales are widely distributed in the tropics, their relative abundance tapers off markedly towards the middle of the tropical Pacific and northward towards the tip of Baja California (Caretta et al. 2006).

In the Mediterranean, sperm whales are found from the Alboran Sea to the Levant Basin, primarily over steep slope and deep offshore waters. Sperm whales are rarely sighted in the Sicilian Channel, and are vagrants to the northern Adriatic and Aegean Seas (Notarbartolo di Sciara and Demma 1997). In Italian seas, sperm whales are more frequently associated with the continental slope off western Liguria, western Sardinia, northern and eastern Sicily, and both coasts of Calabria. All sperm whales of the southern hemisphere are treated as a single

population with nine divisions, although this designation has little biological basis and is more in line with whaling records (Donovan 1991). However, sperm whales that occur off the Galapagos Islands, mainland Ecuador, and northern Peru may be distinct from other sperm whales in the Southern Hemisphere (Rice 1977; Wade and Gerrodette 1993; Dufault and Whitehead 1995).

Movement patterns of Pacific female and immature male groups appear to follow prey distribution and, although not random, movements are difficult to anticipate and are likely associated with feeding success, perception of the environment, and memory of optimal foraging areas (Whitehead et al. 2008). However, no sperm whale in the Pacific has been known to travel to points over 3,100 miles apart and only rarely have been known to move over 2,500 miles within a time frame of several years. This means that although sperm whales do not appear to cross from eastern to western sides of the Pacific (or vice-versa), significant mixing occurs that can maintain genetic exchange. Movements of several hundred miles are common, though (i.e. between the Galapagos Islands and the Pacific coastal Americas). Movements appear to be group or clan specific, with some groups traveling straighter courses than others over the course of several days. However, general transit speed averages about 2.5 miles per hour. Sperm whales in the Caribbean region appear to be much more restricted in their movements, with individuals repeatedly sighted within less than 100 miles of previous sightings.

Sperm whales have a strong preference for the 3,280-foot depth contour and seaward. Berzin (1971) reported that they are restricted to waters deeper than 1,000 feet, while others have reported that they are usually not found in waters less than 3,300 feet deep (Watkins 1977; Reeves and Whitehead 1997). While deep water is their typical habitat, sperm whales have been observed near Long Island, New York, in water between 135 and 180 feet (Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956).

The age distributions of sperm whale populations are unknown, but sperm whales are believed to live at least 60 years (Rice 1978b). Female sperm whales become sexually mature at an average of 9 years of age when they reach a length of 27 to 29 feet (Kasuya 1991). Males reach a length of 33 to 39 feet at sexual maturity. Male sperm whales take between nine and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully breed (Kasuya 1991). Adult females give birth after roughly 15 months of gestation and nurse their calves for 2 to 3 years. The calving interval is estimated to be about 4 to 6 years between the ages of 12 and 40 (Kasuya 1991; Whitehead et al. 2008). The peak breeding season for sperm whales in the North Atlantic occurs during spring (March and April to May), with some mating activity taking place earlier or later, from December to August. In the North Pacific, female sperm whales and their calves are usually found in tropical and temperate waters year-round, while it is generally understood that males move north in the summer to feed in the Gulf of Alaska, Bering Sea, and waters off of the Aleutian Islands (Kasuya and Miyashita 1988). It has been suggested that some mature males may not migrate to breeding grounds annually during winter, and instead may remain in higher latitude feeding grounds for more than 1 year at a time (Whitehead and Arnbom 1987).

Sperm whales are deep and prolonged divers and therefore, can use the entire water column, even in very deep areas. However, they seem to forage mainly on or near the bottom, often ingesting stones, sand, sponges, and other non-food items (Rice 1989). As far as is known, sperm whales feed regularly throughout the year. Lockyer (1981) estimated that they consumed about 3.0 to 3.5% of their body weight per day.

A large proportion of the sperm whale's diet consists of low-fat, ammoniacal, luminescent squids (Clarke 1980, 1996; Martin and Clarke 1986). While sperm whales feed primarily on large and medium-sized squids, the list of documented food items is fairly long and diverse. Prey items include other cephalopods, such as octopuses, and medium- and large-sized demersal fishes, such as rays, sharks, and many teleosts (Berzin 1972; Clarke 1977, 1980; Rice 1989). The diet of large males in some areas, especially in high northern latitudes, is dominated by fish (Rice 1989). In some areas of the North Atlantic, however, males prey heavily on the oil-rich squid *Gonatus fabricii*, a species also frequently eaten by northern bottlenose whales (*Hyperoodon ampullatus*; Clarke 1997 *in* NMFS 2006b).

Sperm whales are probably the deepest and longest diving mammalian species, with dives to nearly two miles down and durations in excess of two hours (Clarke 1976; Watkins et al. 1985; Watkins et al. 1993). However, foraging dives normally last about 40 minutes and one-quarter mile (Gordon 1987; Papastavrou et al. 1989). Differences in night and day diving patterns are not known for this species, but, like most diving air-breathers for which there are data (e.g. rorqual whales, fur seals, chinstrap penguins), sperm whales probably make relatively shallow dives at night when prey are closer to the surface.

Status and Trends

Sperm whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained with the inception of the ESA in 1973. Past abundance estimates have largely relied on historic whaling data, which the IWC considers unreliable (Perry et al. 1999). Using modern visual survey research, Whitehead (2002) estimated that prior to whaling, sperm whales numbered around 1.1 million individuals and that the current global abundance of sperm whales is around 360,000 whales.

The total number of sperm whales in the western North Atlantic is unknown (Waring et al. 2008). The best available current abundance estimate for western North Atlantic sperm whales is 4,804 based on data from 2004. The best available current abundance estimate for Northern Gulf of Mexico sperm whales is 1,665, based on data from 2003 and 2004. There is insufficient data to determine population trends (Waring et al. 2008).

There are approximately 76,803 sperm whales in the eastern tropical Pacific, eastern North Pacific, Hawaii, and western North Pacific (Whitehead 2002). Minimum population estimates in the eastern North Pacific are 1,719 individuals and 5,531 in the Hawaiian Islands (Carretta et al. 2007). Caretta et al. (2005) concluded that the most precise estimate of sperm whale abundance off the coasts of California, Oregon, and Washington was 1,233 and their best estimate of sperm whale abundance in Hawaii was 7,082 sperm whales. The tropical Pacific is home to approximately 26,053 sperm whales and the western North Pacific has a population of

approximately 29,674 (Whitehead 2002). There are only two estimates for local population trends, one in the Antarctic Ocean and one near the Galapagos Islands. There was no change in Antarctic population size between 1978 and 1992 but a dramatic decline in females around the Galapagos Islands between 1985 and 1999, likely due to migration to nearshore waters of South and Central America (Whitehead 2003).

The information available on the status and trend of sperm whales do not allow us to make definitive statement about the extinction risks facing sperm whales as a species or as populations. However, sperm whale populations probably are undergoing the dynamics of small population sizes, which is a threat in and of itself. In particular, the loss of sperm whales to directed Soviet takes likely inhibits recovery due to the loss of adult females and their calves, leaving sizeable gaps to demographic and age structuring of the remaining population (Whitehead 2003).

Threats

Sperm whales are known to be at least occasionally predated upon by killer whales and harassed by pilot whales (Arnbom et al. 1987; Rice 1989; Jefferson et al. 1991; Whitehead 1995; Palacios and Mate 1996; Weller et al. 1996; Pitman et al. 2001). Strandings are also relatively common events, with one to dozens of individuals generally beaching themselves and dying during any single event. Although several hypotheses have been proposed, direct widespread causes remain unclear (Goold et al. 2002; Wright 2005). Calcivirus and papillomavirus are known pathogens of this species (Smith and Latham 1978; Lambertsen et al. 1987).

Sperm whales historically faced severe depletion from commercial whaling operations. From 1800 to 1900, the IWC estimated that nearly 250,000 sperm whales were killed by whalers, with another 700,000 from 1910 to 1982 (IWC Statistics 1959-1983). However, other estimates have included 436,000 individuals taken between 1800 and 1987 (Caretta et al. 2005). Hill and DeMaster (1999) concluded that about 258,000 sperm whales were harvested in the North Pacific between 1947 and 1987. Takes in the Southern Hemisphere averaged roughly 20,000 whales between 1956 and 1976 (Perry et al. 1999). However, all of these estimates likely underestimated due to illegal and inaccurate takes by Soviet whaling fleets between 1947 and 1973. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the IWC, with smaller takes in the Northern Hemisphere, primarily the North Pacific that extirpated sperm whales from large areas (Yablokov et al. 1998; Yablokov and Zemsky 2000). Additionally, Soviet whalers disproportionately killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender.

Although the IWC instituted an international ban on the harvesting of sperm whales in 1981, Japanese whalers continued to hunt sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). In 2000, the Japanese Whaling Association announced plans to kill 10 sperm whales in the Pacific Ocean for research, which was the first time sperm whales have been hunted since the international ban on commercial whaling. Although consequences of these deaths are unclear, the paucity of population data, uncertainly regarding recovery from whaling, and re-establishment of active programs for whale harvesting pose risks for the recovery and survival of this species. Sperm whales are also hunted for subsistence purposes by whalers from

Lamalera, Indonesia, where a traditional whaling industry has been reported to take up to 56 sperm whales per year.

Following the moratorium on whaling by the IWC, significant whaling pressures on sperm whales were eliminated. However, sperm whales are known to become entangled in commercial fishing gear with 17 individuals known to have been struck by vessels (Jensen and Silber 2004). Whale-watching vessels also influence sperm whale behavior (Richter et al. 2006). Sperm whales are taken incidentally by gill nets at a rate of roughly nine per year (data from 1991 to 1995) in U.S. waters in the Pacific Ocean (Barlow et al. 1997). While sperm whales are known to remove fish from longline fishing gear in the Gulf of Alaska, and entanglement has rarely been recorded (Rice 1989; Hill and DeMaster 1999, Sigler et al. 2008).

Contaminants have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location, with northern hemisphere individuals generally carrying higher burdens (Evans et al. 2003). Contaminants include dieldrin, chlordane, DDT, DDE, PCBs, HCB and HCHs in a variety of body tissues (Aguilar 1983; Evans et al. 2004), as well as several heavy metals (Law et al. 1996). However, unlike other marine mammals, females appear to bioaccumulate these toxins at greater levels than males, which may be related to possible dietary differences between females who remain at relatively low latitudes compared to more migratory males (Aguilar 1983).

Critical Habitat

NMFS has not designated critical habitat for sperm whales.

Steller Sea Lion

Steller sea lions are distributed along the rim of the North Pacific Ocean from San Miguel Island (Channel Islands) off Southern California to northern Hokkaido, Japan (Loughlin et al. 1984; Nowak 2003). Their centers of abundance and distribution are in Gulf of Alaska and the Aleutian Islands, respectively (NMFS 1992). In the Bering Sea, the northernmost major rookery is on Walrus Island in the Pribilof Island group. The northernmost major haul-out is on Hall Island off the northwestern tip of St. Matthew Island. Their distribution also extends northward from the western end of the Aleutian chain to sites along the eastern shore of the Kamchatka Peninsula. For management purposes, two stocks have been designated, but which represent a single population.

Female Steller sea lions reach sexual maturity and first breed between 3 and 8 years of age and the average age of reproducing females (generation time) is about 10 years (Pitcher and Calkins 1981; Calkins and Pitcher 1982; York 1994). They give birth to a single pup from May through July and then breed about 11 days after giving birth. Females normally ovulate and breed annually after maturity although there is a high rate of reproductive failures. The gestation period is believed to be about 50 to 51 weeks (Pitcher and Calkins 1981). The available literature indicates an overall reproductive (birth) rate on the order of 55% to 70% or greater (Pike and Maxwell 1958; Gentry 1970; Pitcher and Calkins 1981).

Males reach sexual maturity at about the same time as females (3 to 7 years of age, reported in Loughlin et al. 1987), but generally do not reach physical maturity and participate in breeding until about 8 to 10 years of age (Pitcher and Calkins 1981). The sex ratio of pups at birth is assumed to be about 1:1 or biased toward slightly greater production of males, but non-pups are biased towards females (Pike and Maxwell 1958; Calkins and Pitcher 1982; Trites and Larkin 1992; NMFS 1992; York 1994).

Mothers with newborn pups will make their first foraging trip about a week after giving birth, but trips are short in duration and distance at first, then increase as the pup gets older (Merrick and Loughlin 1997; Milette 1999; Pitcher et al. 2001; Milette and Trites 2003; Maniscalco et al. 2006). Females attending pups tend to stay within 20 nm of the rookery (Calkins 1996; Merrick and Loughlin 1997). Newborn pups are wholly dependent upon their mother for milk during at least their first 3 months of life, and observations suggest they continue to be highly dependent upon their mother through their first winter (Scheffer 1946; Porter 1997; Trites et al. 2006). Generally, female Steller sea lion will nurse their offspring until they are 1 to 2 years old (Gentry 1970; Sandegren 1970; Pitcher and Calkins 1981; Calkins and Pitcher 1982; Trites et al. 2006).

Estimated annual mortality is 0.22 for ages 0 to 2, dropping to 0.07 at age 3, then increasing gradually to 0.15 by age 10 and 0.20 by age 20 (York 1994). Population modeling suggested that decreased juvenile survival likely played a major role in the decline of sea lions in the central Gulf of Alaska during 1975-1985 (Pascual and Adkison 1994; York 1994; Holmes and York 2003).

Most adult Steller sea lions occupy rookeries during the pupping and breeding season and exhibit a high level of site fidelity. During the breeding season, some juveniles and non-breeding adults occur at or near the rookeries, but most are on haulouts (sites that provide regular retreat from the water on exposed rocky shoreline, gravel beaches, and wave-cut platforms or ice; Rice 1998; Ban 2005; Call and Loughlin 2005). Adult males may disperse widely after the breeding season. Males that breed in California move north after the breeding season and are rarely seen in California or Oregon except from May through August (Mate 1973). During fall and winter many sea lions disperse from rookeries and increase use of haulouts, particularly on terrestrial sites but also on sea ice in the Bering Sea.

Steller sea lions are not known to make regular migrations but do move considerable distances. Adult males may disperse hundreds of miles after the breeding season (Calkins and Pitcher 1982; Calkins 1986; Loughlin 1997). Adult females may travel far out to sea into water greater than 3,300 feet deep (Merrick and Loughlin 1997). Studies on immature Steller sea lions indicate three types of movements: long-range trips (greater than 9.3 miles and greater than 20 hours), short-range trips (less than 9.3 miles and less than 20 hours), and transits to other sites (NMFS 2007a). Long-range trips started around 9 months of age and likely occur most frequently around the time of weaning, while short-range trips happen almost daily. Young individuals generally remain within 300 miles of rookeries their first year before moving further away in subsequent years (Raum-Suryan et al. 2002). Many animals also use traditional rafting sites, which are places where they rest on the ocean surface in a tightly packed group (Bigg 1985; NMFS unpublished data).

Steller sea lions are generalist predators that eat various fish (arrowtooth flounder, rockfish, hake, flatfish, Pacific salmon, Pacific herring, Pacific cod, sand lance, skates, cusk eel, lamprey, walleye, Atka mackerel), squids, and octopus and occasionally birds and marine mammals (Jones 1981; Pitcher and Fay 1982; Calkins and Goodwin 1988; Olesiuk et al. 1990b; Daniel and Schneeweis 1992; NMFS 2000a; Brown et al. 2002; Sinclair and Zeppelin 2002; McKenzie and Wynne 2008). Diet is likely strongly influenced by local and temporal changes in prey distribution and abundance (McKenzie and Wynne 2008).

Diving activity is highly variable by sex and season. During the breeding season, when both males and females occupy rookeries, adult breeding males rarely, if ever, leave the beach (Loughlin 2002). However, females tend to feed at night on 1-2 day trips and return to nurse pups (NRC 2003). Female foraging trips during winter are longer (80 miles) and dives are deeper (frequently greater than 820 feet). Summer foraging dives, however, are closer to shore (about 10 miles) and shallower (330 to 820 feet; Merrick and Loughlin 1997; Loughlin 2002). As pups mature and start foraging for themselves, they develop greater diving ability until roughly 10 years of age (Pitcher et al. 2005). Juveniles usually make shallow dives to just over 50 feet, but much deeper dives in excess of 1,000 feet are known (Loughlin et al. 2003). Young animals also tend to stay in shallower water less than 330 feet deep and within a dozen miles from shore (Fadely et al. 2005).

Status and Trends

Steller sea lions were originally listed as threatened under the ESA on November 26, 1990 (55 FR 49204), following a decline in the U.S. of about 64% over previous three decades. In 1997, the species was split into two separate populations based on demographic and genetic differences (Bickham et al. 1996; Loughlin 1997), and the western population was reclassified to endangered (62 FR 24345) while the eastern population remained threatened (62 FR 30772). The Steller sea lion is also listed as endangered on the 2007 IUCN Red List (Seal Specialist Group 1996).

Loughlin et al. (1984) estimated the worldwide population of Steller sea lions was between 245,000 and 290,000 animals (including pups) in the late 1970s. Though the genetic differences between the eastern and western DPSs were not known at the time, Loughlin et al. (1984) noted that 90% of the worldwide population of Steller sea lions was in the western DPS in the early 1980s (75% in the U.S. and 15% in Russia) and 10% in the eastern DPS. Loughlin et al. (1984) concluded that the total worldwide population size (both DPSs) was not significantly different from that estimated by Kenyon and Rice (1961) for the years 1959 and 1960, though the distribution of animals had changed. Steller sea lions collected in the Gulf of Alaska during the early 1980s showed evidence of reproductive failure and reduced rates of body growth that were consistent with nutritional limitation (Calkins and Goodwin 1988; Pitcher et al. 1998; Calkins et al. 1998). After conducting a range-wide survey in 1989, Loughlin et al. (1992) noted that the worldwide Steller sea lion population had declined by over 50% in the 1980s, to approximately 116,000 animals, with the entire decline occurring in the range of the western DPS.

Eastern Steller Sea Lion

The eastern DPS of Steller sea lions includes animals east of Cape Suckling, Alaska (144°W) south to California waters (55 FR 49204).

Status and Trends

Trend counts in Oregon were relatively stable in the 1980s, showing a gradual increase in numbers since 1976 (NMFS 2005b). Numbers in California, however, have declined to less than 2,000 non-pups, from counts between 1927 and 1947 that were as high as 7,000 non-pups (NMFS 2005b). The count from Central California in 2000, reached the second lowest count of 349 non-pups (in 1992 the count was as low as 276 non-pups). In Southeast Alaska, counts of non-pups at trend sites increased by 56% from 1979 to 2002 from 6,376 animals to 9,951 (Merrick et al. 1992; Sease et al. 2001; NMFS 2005b). Counts of non-pups at British Columbia trend sites increased nearly 260% between 1982 and 2002 (NMFS 2005b).

NMFS considers this population stable, and multiplies pup counts by a factor of 4.5 (based on Calkins and Pitcher 1982) or 5.1 (Trites and Larkin 1996) to estimate the total population size (Angliss and Outlaw 2008). Pup count data from 2002 through 2005 from across the range of the eastern population, multiplied by a factor of 4.5 or 5.1 results in a population estimate of 48,519 or 54,989 animals. In 2005, 5,510 pups were counted in Alaska, 3,318 pups were counted in British Columbia in 2002, 1,136 pups were counted in Oregon in 2002, and 818 counted in California in 2004. The current minimum population estimate is 44,584 animals. NMFS calculates this estimate by adding non-pup counts taken in 2002 in Southeast Alaska, to counts of animals in Washington in 2002 as well as counts of pups and non-pups in Canada in 1998, Oregon in 2002, California in 2004, and southeastern Alaska in 2005 (Angliss and Outlaw 2008).

Threats

Killer whale predation, particularly on the western DPS under reduced population size, may cause significant reductions in the stock (NMFS 2008b). Steller sea lions have tested positive for several pathogens, but disease levels are unknown (FOC 2008). Similarly, parasites in this species are common, but mortality resulting from infestation is unknown. However, significant negative effects of these factors may occur in combination with stress, which reduces immune capability to resist infections and infestations. If other factors, such as disturbance, injury, or difficulty feeding occur, it is more likely that disease and parasitism can play a greater role in population reduction.

Steller sea lions were historically and recently subjected to substantial mortality by humans, primarily due to commercial exploitation and both sanctioned and unsanctioned predator control, (Bonnot 1928; Rowley 1929; Scheffer 1945; Bonnot and Ripley 1948; Scheffer 1950; Pearson and Verts 1970; Bigg 1988; Atkinson et al. 2008; NMFS 2008b). Several dozen individuals may become entangled and drown in commercial fishing gear (Atkinson et al. 2008; NMFS 2008b). Several hundred individuals are removed by subsistence hunters annually in controlled and authorized takes. Occasional takes occur in Canada (FOC 2008). Additional mortality (362 from 1990 to 2003) has occurred from shooting of sea lions interfering in aquaculture operations along British Columbia (FOC 2008). Marine debris is also concerning for the health of Steller sea lion populations. It is estimated that 0.2% of Steller sea lions have marine debris around their necks (0.07%), or are hooked by fishing gear (FOC 2008).

Significant concern also exists regarding competition between commercial fisheries and Steller sea lions for the same resource: stocks of pollock, Pacific cod, and Atka mackerel. Significant evidence exists that supports the western DPS declining as a result of change in diet and resulting declines in growth, birth rates, and survival (Calkins and Goodwin 1988; Calkins et al. 1998; Pitcher et al. 1998; Trites and Donnelly 2003; Atkinson et al. 2008). As a result, limitations on fishing grounds, duration of fishing season, and monitoring have been established to prevent Steller sea lion nutritional deficiencies as a result of inadequate prey availability.

Behavioral disruption occurs as a result of human disturbance (FOC 2008). Research efforts to collect scats, count and weigh pups, and other human activities on or near rookeries can lead to stampedes into the water. Mortality can occur directly due to pup trampling, separating from mothers, or drowning. If disturbance is too frequent, haulouts may be completely abandoned. Although habituation to some activities, such as boating, can occur, unusual activities and sounds, such as blasting or demolition, can remotely trigger stampedes.

Contaminants are a considerable issue for Steller sea lions. Roughly 30 individuals died as a result of the Exxon *Valdez* oil spill and contained particularly high levels of PAH contaminants, presumable as a result of the spill. Blood testing confirmed hydrocarbon exposure. Subsequently, premature birth rates increased and pup survival decreased (Calkins et al. 1994b; Loughlin et al. 1996). Organochlorines, including PCBs and DDT (including its metabolites), have been identified in Steller sea lions in greater concentrations than any other pinniped during the 1980s, although levels appear to be declining (Barron et al. 2003; Hoshino et al. 2006). The levels of PCBs have been found to have twice the burden in individuals from Russia than from western Alaska (4.3 ng/g wet weight versus 2.1 ng/g wet weight; Myers et al. 2008). Levels of DDT in Russian pups were also on average twice that in western Alaska pups (3.3 ng/g wet weight blood versus 1.6 ng/g wet weight). The source of contamination is likely from pollack, which have been found to contain organochlorines throughout the Gulf of Alaska, but higher in regions occupied by the eastern DPS of Steller sea lions (Heinz et al. 2006; NMFS 2008b). Heavy metals, including mercury, zinc, copper, metallothionien, and butyltin have been identified in Steller sea lion tissues, but are in concentrations lower than other pinnipeds (Noda et al. 1995; Kim et al. 1996; Castellini 1999; Beckmen et al. 2002; NMFS 2008b). However, contaminants leading to mortality in Steller sea lions have not been identified (NMFS 2008b). Contaminant burdens are lower in females than males, because contaminants are transferred to the fetus *in utero* as well as through lactation (Lee et al. 1996; Myers et al. 2008). However, this means that new generations tend to start with higher levels of contaminants than their parents originally had. Concerns over Steller sea lion contaminants are of additional concerns because contaminants in the body tend to be mobilized as fat reserves are used, such as when prey availability is low.

Critical Habitat

Critical habitat was designated on August 27, 1993 for both eastern and western DPS Steller sea lions in California, Oregon, and Alaska (58 FR 45269). Steller sea lion critical habitat includes all major rookeries in California, Oregon, and Alaska and major haulouts in Alaska. Essential features of Steller sea lion critical habitat include the physical and biological habitat features that

support reproduction, foraging, rest, and refuge, and include terrestrial, air and aquatic areas. Specific terrestrial areas include rookeries and haul-outs where breading, pupping, refuge and resting occurs. More than 100 major haulouts are documented. The principal, essential aquatic areas are the nearshore waters around rookeries and haulouts, their forage resources and habitats, and traditional rafting sites. Air zones around terrestrial and aquatic habitats are also designated as critical habitat to reduce disturbance in these essential areas. Specific activities that occur within the habitat that may disrupt the essential life functions that occur there include: (1) wildlife viewing, (2) boat and airplane traffic, (3) research activities, (4) timber harvest, (5) hard mineral extraction, (6) oil and gas exploration, (7) coastal development and pollutant discharge, and others.

In addition, British Columbia has established protective areas in which Steller sea lion rookeries occur at Triangle Island and Cape St. James (FOC 2008). Several other haul-out sites occur within Canadian national and provincial parks. Further, the Canadian government is moving to establish a marine wildlife area for the Scott Islands, where Steller sea lions haul-out and breed.

Marine Turtles

Green Sea Turtle

Green sea turtles, although designated as endangered or threatened based upon their nesting populations, are physically indistinguishable from one another and generally share many life history characteristics. Threatened green sea turtles have a circumglobal distribution, occurring throughout tropical, subtropical waters, and, to a lesser extent, temperate waters. Endangered green sea turtles nest in Florida in all coastal counties except those in the Big Bend area. The highest nesting densities are located along the southeast coast from Brevard to Palm Beach Counties (FFWCC 2007a). Green sea turtles nesting in Florida move to foraging areas located throughout the Florida Keys and include the Bahamas, Barbados, Cuba, Puerto Rico, southeastern U.S., and Venezuela (Lahanas et al. 1998; Luke et al. 2004; Bass et al. 2006; Moncada et al. 2006; Bolker et al. 2007; Diez and van Dam 2007). Several protected neritic habitats along the east coast of Florida have been identified as important areas for green sea turtles, including Mosquito and Indian River Lagoons, Port Canaveral, St. Lucie Inlet, and Biscayne Bay (Schmid 1995; Redfoot and Ehrhart 2000; Cantillo et al. 2000; Bresette et al. 2002; Bagley 2003; Kubis et al. 2003).

Green turtle nesting occurs sporadically along much of the Pacific coast of Mexico from the state of Sinaloa south to Chiapas, and near the tip of the Baja California Peninsula (Seminoff 1994; Tiburcios-Pintos in press). The primary nesting sites include the beaches of Colola and Maruata in Michoacán as well as Clarion and Socorro Islands in the Revillagigedos Archipelago). The primary foraging areas for these green sea turtles stretch from the U.S.-Mexico border to the Guatemala-Mexico border, although some turtles from Michoacán have been found as far south as Colombia (Alvarado and Figueroa 1992).

Through examining green sea turtle nesting in the context of oceanography, it is clear that environmental periodicity is a major determinant in the timing of green sea turtle reproduction (Limpus and Nichols 1988; Chaloupka 2001; Solow et al. 2002). It is also apparent that during years of heavy nesting activity, density dependent factors (e.g. beach crowding, digging up of

eggs by nesting females) may impact nesting activity and hatchling production (Tiwari et al. 2005, 2006). Green sea turtles often return to the same foraging areas following nesting migrations, and once there, they move within specific areas, or home ranges, where they routinely visit specific localities to forage and rest (Seminoff et al. 2002a; Godley et al. 2002, 2003; Broderick et al. 2006; Makowski et al. 2006; Seminoff and Jones 2006; Taquet et al. 2006). However, it is also apparent that some green sea turtles remain in pelagic habitats for extended periods; perhaps never recruiting to coastal foraging sites (Pelletier et al. 2003).

Green sea turtles exhibit variable growth rates that largely depend upon diet quality and foraging season duration (Green 1993; McDonald-Dutton and Dutton 1998; Bjorndal et al. 2000; Seminoff et al. 2002b; Balazs and Chaloupka 2004b; Chaloupka et al. 2004b). In general, there is a tendency for green sea turtles to exhibit monotonic growth (declining growth rate with size) in the Atlantic and non-monotonic growth (growth spurt in mid size classes) in the Pacific, although this is not always the case (Chaloupka and Musick 1997; Seminoff et al. 2002b; Balazs and Chaloupka 2004b). Growth ranges from 0.55 inches in length per year to 3.14 inches per year (Zug and Glor 1998; Bresette and Gorham 2001; McMichael et al. 2006). Consistent with slow growth, age-to-maturity for green sea turtles appears to be the longest of any sea turtle species (Chaloupka and Musick 1997; Hirth 1997). Estimates indicate that age-to-maturity ranges from perhaps less than 20 years to 40 years or more (Limpus and Chaloupka 1997; Zug and Glor 1998; Seminoff et al. 2002b; Zug et al. 2002, Chaloupka et al. 2004b). Estimates of reproductive longevity range from 17 to 23 years (Carr et al. 1978; Fitzsimmons et al. 1995; Chaloupka et al. 2004b; Vera 2007). Considering that the mean interval between nesting seasons for Florida turtles is 2 years, a reproductive life span of this duration would result in a female nesting during 11 to 12 seasons over the course of her life (Bjorndal et al. 1983; Witherington and Ehrhart 1989). Florida green sea turtles nest three to four times per season and deposit a mean of 136 eggs per nest (Witherington and Ehrhart 1989; Johnson 1994). Thus, a female may produce 33 to 48 nests, or about 4,500 to 6,500 eggs, during her lifetime. For endangered green sea turtles, the mean duration between females returning to nest ranges from 2 to 5 years, these reproductive longevity estimates suggest that a female may nest three to 11 seasons over the course of her life (Hirth 1997). Based on the reasonable means of three nests per season and 100 eggs per nest, a female may deposit nine to 33 clutches, or about 900 to 3,300 eggs, during her lifetime (Hirth 1997).

Based on growth data from the Gulf of California, green sea turtles require from 9 to 21 years to reach sexual maturity after settling into this neritic foraging area (Seminoff et al. 2002b). Females nesting in Michoacán are substantially smaller than those nesting in the Revillagigedos (Alvarado and Figueroa 1990; Juarez-Ceron et al. 2003). The nesting season in Michoacán runs from September through January, with females nesting every 3 years and depositing a mean of 3.1 nests per season with roughly 65.1 eggs per nest (Alvarado and Figueroa 1990; Alvarado-Diaz et al. 2003). In the Revillagigedos Islands, nesting occurs from March through November with a peak in April/May, and although mean clutch frequency is unknown, there are substantially more eggs per nest (mean = 95 eggs; Brattstrom 1982; Awbrey et al. 1984; Juarez-Ceron et al. 2003).

In general, survivorship tends to be lower for juveniles and subadults than for adults. Adult survivorship has been calculated to range from 0.82 to 0.97 versus 0.58 to 0.89 for juveniles

(Seminoff et al. 2003; Chaloupka and Limpus 2005; Troëng and Chaloupka 2007), with lower values coinciding with areas of human impact on green sea turtles and their habitat (Bjorndal et al. 2003; Campbell and Lagueux 2005).

Green sea turtles undertake complex movements and migrations through geographically disparate habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). The periodic migration between nesting sites and foraging areas by adults is a prominent feature of their life history. After departing as hatchlings and residing in a variety of marine habitats for up to 40 or more years (Limpus and Chaloupka 1997), green sea turtles make their way back to the same beach from which they hatched (Carr et al. 1978; Meylan et al. 1990). Upon leaving the nesting beach, hatchlings begin an oceanic phase, perhaps floating passively in major current systems (gyres) that serve as open-ocean developmental grounds. This early oceanic phase remains one of the most poorly understood aspects of green turtle life history. However, green sea turtles in the western Atlantic shift from this pelagic phase and recruit to neritic developmental areas at 5 to 6 years of age (Zug and Glor 1998). These new arrivals recruit to protected lagoons and open coastal areas rich in sea grass and marine algae and this first stop in their developmental migration may last for up to 6 years, after which time turtles may shift to other sites as larger juveniles/subadults (Musick and Limpus 1997; Zug and Glor 1998; Seminoff et al. 2002a, 2006; Lopez-Mendilaharsu et al. 2005; Bresette et al. 2006). While in coastal habitats, green sea turtles exhibit site fidelity to specific areas or home ranges, and it is clear that they can home in on these sites if displaced (Bresette et al. 1998; McMichael et al. 2003; Makowski et al. 2006).

Green turtles appear to prefer waters that usually remain around 68º F in the coldest month, but may be found considerably north of these regions during warm-water events, such as El Niño. Stinson (1984) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 64.4º F. Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher prey densities that associate with flotsam. For example, in the western Atlantic Ocean, drift lines commonly containing floating *Sargassum* spp. are capable of providing juveniles with shelter and sufficient buoyancy to raft upon (NMFS and USFWS 1998). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance. Available information indicates that green turtle resting areas are near feeding areas (Bjorndal and Bolten 2000).

Green sea turtles nesting in Michoacán, Mexico follow a coastal migratory corridor, usually within 66 miles of the mainland coast as they depart to the north and south (Nichols 2003a). Green turtles nesting in the Revillagigedos traverse oceanic regions as they move to coastal foraging areas along mainland Mexico and the Baja California Peninsula, and turtles moving north of the border to San Diego Bay, U.S., follow a coastal trajectory as soon as they reach the Baja Peninsula (P. Dutton, unpublished data in NMFS and USFWS 2007). Green sea turtles in the eastern Pacific Ocean, particularly those in foraging habitats of northwestern Mexico, have a more varied diet than green turtles in other areas of the world (Bjorndal 1997). Based on genetic differences, two distinct regional clades of green sea turtles are thought to exist in the Pacific: (1) western Pacific and South Pacific islands, and (2) eastern Pacific and central Pacific, including the rookery at French Frigate Shoals, Hawaii. In the eastern Pacific, green turtles forage from San Diego Bay, California to Mejillones, Chile. Individuals along the southern foraging area

originate from Galapagos Islands nesting beaches, while those in the Gulf of California originate primarily from Michoacán. Green turtles foraging in San Diego Bay and along the Pacific coast of Baja California originate primarily from rookeries of the Islas Revillagigedos (Dutton 2003).

While offshore and sometimes while in coastal habitats, green sea turtles are not obligate plant-eating as widely believed, and instead consume invertebrates such as jellyfish, sponges, sea pens, and pelagic prey (Godley et al. 1998; Heithaus et al. 2002; Seminoff et al. 2002c, Hatase et al. 2006; Parker and Balazs in press). However, green sea turtles spend the majority of their lives in coastal foraging grounds. These areas include both open coastline and protected bays and lagoons. While in these areas, green sea turtles rely on marine algae and seagrass as their primary diet constituents, although some populations also forage heavily on invertebrates.

Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, it is presumed that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed 33 to 100 feet while resting (NMFS and USFWS 1998; Hochscheid et al. 1999; Hays et al. 2000). The maximum recorded dive depth for an adult green turtle is just over 350 feet, while subadults routinely dive to 66 feet for 9 to 23 minutes, with a maximum recorded dive of over one hour (Berkson 1967 in Lutcavage and Lutz 1997; Brill et al. 1995 in Lutcavage and Lutz 1997).

Status and Trends

Federal listing of the green sea turtle occurred on July 28, 1978, with all populations listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are endangered (43 FR 32800). Recently, NMFS and USFWS (2007) reviewed the endangered breeding populations' status and found that the nesting population of Florida appears to be increasing based on 18 years of index nesting data from throughout the state. Data for the largest nesting concentration in Pacific Mexico where nesting beach monitoring has been ongoing every year since the 1981 to 1982 nesting season shows an increase in nesting (Chaloupka et al. 2007).

Nesting data collected from 2000 to 2006 show that a mean of approximately 5,600 nests are laid each year in Florida. During this period, the counties with the greatest level of nesting activity were Brevard County, with a mean of 2,582 nests per year, and Palm Beach County, with a mean of 1,407 nests per year (FFWCC 2007a). There are no reliable estimates of the number of immature green sea turtles that inhabit coastal areas (where they come to forage) of the southeastern U.S. However, information on incidental captures of immature green sea turtles at the St. Lucie Power Plant in St. Lucie County, Florida (on the Atlantic coast of Florida) show that the annual number of immature green sea turtles captured has increased significantly in the past 26 years, with an average 215 green sea turtle captures per year since 1977.

It is likely that immature green sea turtles foraging in the southeastern U.S. come from multiple genetic stocks. Therefore, the status of immature green sea turtles in the southeastern U.S. might also be assessed from trends at all of the main regional nesting beaches, principally Florida, Yucatán, and Tortuguero. Trends in nesting at Yucatán beaches cannot be assessed because of a lack of consistent beach surveys over time. Trends at Tortuguero (20,000 to 50,000 nests/year) showed a significant increase in nesting during 1971-1996, and more recent information

continues to show increasing nest counts (Bjorndal et al. 1999; Troëng and Rankin 2005). Therefore, it seems reasonable that there is an increase in immature green sea turtles inhabiting coastal areas of the southeastern U.S.; however, the magnitude of this increase is unknown.

There is one primary nesting concentration (Colola - Michoacán) and three lesser nesting sites (Maruata, Michoacán; Clarion Island, Revillagigedos Archipelago; and Socorro Island, Revillagigedos Archipelago) in Pacific Mexico. Based on nesting beach monitoring efforts, roughly 6,050 nests are deposited each year in Pacific Mexico. Based on the 25-year trend, green turtle nesting has increased since the population's low point in the mid-1980s to mid-1990s. The initial upward turn in annual nesting was seen in 1996, about 17 years after the initiation of a nesting beach protection program (Cliffton et al. 1982; Alvarado et al. 2001).

Current nesting abundance is known for 43 threatened nesting sites worldwide. These include both large and small rookeries and are believed to be representative of the overall trends for their respective regions. Based on the mean annual reproductive effort, 108,761 to 150,521 females nest each year among the 46 sites. Overall, of the 23 sites for which data enable an assessment of current trends, 10 nesting populations are increasing, 9 are stable, and 4 are decreasing (NMFS and USFWS 2007). Long-term continuous datasets of greater than 20 years are available for 11 sites, all of which are either increasing or stable. Despite the apparent global increase in numbers, the positive overall trend should be viewed cautiously because trend data are available for just over half of all sites examined and very few data sets span a full green sea turtle generation (Seminoff 2004). Nesting populations are doing relatively well in the western Atlantic and central Atlantic Ocean. In contrast, populations are doing relatively poorly in southeast Asia, eastern Indian Ocean, and perhaps the Mediterranean.

No trend data is available for almost half of the important nesting sites, where numbers are based on recent trends and do not span a full green sea turtle generation, and impacts occurring over four decades ago that caused a change in juvenile recruitment rates may have yet to be manifested as a change in nesting abundance. Additionally, these numbers are not compared to larger historical numbers. The numbers also only reflect one segment of the population (nesting females who are the only segment of the population for which reasonably good data are available and are cautiously used as one measure of the possible trend of populations).

Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawaii, from a combination of overexploitation and habitat loss (Eckert 1993; Seminoff et al. 2002a). In the western Pacific, the only major populations (>2,000 nesting females) of green turtles occur in Australia and Malaysia, with smaller colonies throughout the area. Indonesia has a widespread distribution of green turtles, but has experienced large declines over the past 50 years. Hawaii green turtles are genetically distinct and geographically isolated, and the population appears to be increasing in size despite the prevalence of fibropapillomatosis and spirochidiasis (Aguirre et al. 1998).

Threats

Hatchlings are preyed upon by herons, gulls, dogfish, and sharks. Adults face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks

can undergo “cold stunning” if water temperatures drop below a threshold level, which can be lethal.

For unknown reasons, the frequency of a disease called fibropapillomatosis is much higher in green sea turtles than in other species and threatens a large number of existing subpopulations. Extremely high incidence has been reported in Florida, where the affliction rate reaches 62% in some areas (Schroeder et al. 1998). The fact that 22% of the 6,027 green sea turtles stranded in Florida from 1980 to 2005 had external fibropapillomatosis tumors suggests serious consequences for population stability (Singel et al. 2003; FFWCC 2007a). Extremely high incidence has been reported in Hawaii, where affliction rates peaked at 47% to 69% in some foraging areas (Murakawa et al. 2000). However, no incidences of fibropapillomatosis have been reported in Mexico.

Green sea turtles face threats from humans in several ways. Impacts of development that reduce nesting habitat along Florida include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Lutcavage et al. 1997; Bouchard et al. 1998; Mosier 1998; Mosier and Witherington 2002; Leong et al. 2003; Roberts and Ehrhart 2003). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to nesting females, and may evoke a change in the natural behaviors of adults and hatchlings (Ackerman 1997; Witherington et al. 2003, 2007). Mexican coastal development constitutes a major threat in several areas, perhaps none more so than in northwest Mexico where the development of a large marina network (Escallera Nautica) is planned for at least five major foraging areas (Nichols 2003b). Several of the lesser green turtle nesting beaches in Mexico suffer from coastal development, a problem that is especially acute at Maruata, a tourist site with tourist activity and heavy foot traffic during the nesting season (Seminoff 1994). The presence of lights on or adjacent to nesting beaches in Florida and Mexico alters the behavior of nesting adults and is often fatal to emerging hatchlings, as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991; Witherington 1992; Nelson-Sella et al. 2006).

Three of the biggest threats to threatened green sea turtles result from harvest for commercial and subsistence use. These include egg harvest, the harvest of females on nesting beaches, and directed hunting of green sea turtles in foraging areas. These factors have led to the precipitous declines in worldwide green sea turtles previously described. Directed harvests are a major problem in American Samoa, Guam, Palau, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Republic of the Marshall Islands, and the Unincorporated Islands (Wake, Johnston, Kingman, Palmyra, Jarvis, Howland, Baker, and Midway). In the Atlantic, green sea turtles are captured and killed in turtle fisheries in Colombia, Grenada, the Lesser Antilles, Nicaragua, St. Vincent and the Grenadines; the turtle fishery along the Caribbean coast of Nicaragua, by itself, has captured more than 11,000 green turtles annually over the past decade (Bräutigam and Eckert 2006; Lagueux 1998). While these threats have been largely eliminated in Florida due to successful conservation measures, the hunting of juvenile and adult turtles continues both legally and illegally in many foraging areas where turtles originating from Florida are known to occur (Fleming 2001; Chacon 2002). At the largest green sea turtle nesting beach along the Pacific Coast of Mexico, nearly all eggs were harvested for at least several decades prior to 1978 (Cliffton et al. 1982). Ongoing harvest of nesting adults has been

documented in Michoacán (Alvarado-Diaz et al. 2001). Turtles are hunted in many areas of northwest Mexico despite legal protection (Nichols et al. 2002; Seminoff et al. 2003).

Other significant impacts on nesting beach habitat include disturbances from feral and domestic animals (Figueroa et al. 1993; Seminoff 1994). Contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging is also a problem (Francour et al. 1999; Lee Long et al. 2000; Waycott et al. 2005). In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats, particularly areas rich in seagrass and marine algae. Further, the introduction of alien algae species threatens the stability of some coastal ecosystems and may lead to the elimination of preferred dietary species of green sea turtles (De Weede 1996). Sea level rise may have significant impacts upon green turtle nesting on Pacific atolls. These low-lying, isolated locations could likely be inundated by rising water-levels associated with global warming, potentially eliminating nesting habitat (Baker et al. 2006).

Green sea turtles have been found to contain the organochlorines chlordane, lindane, endrin, endosulfan, dieldrin, DDT and PCB in a variety of tissues and may affect susceptibility to fibropapillomas (Miao et al. 2001; Gardner et al. 2003). These contaminants have the potential to cause deficiencies in endocrine, developmental, and reproductive health, and are known to depress immune function in loggerhead sea turtles (Keller et al. 2006; Storelli et al. 2007). However, studies of DDE and embryonic sex determination have not identified correlations (Podreka et al. 1998). PCB concentrations have been measured to be 45ng/g to 58 ng/g dry weight in liver tissue and 73 ng/g to 665 ng/g dry weight in adipose tissue, with hexachlorobiphenyls being dominant (Miao et al. 2001). DDE has not been found to influence sex determination at levels below cytotoxicity (Podreka et al. 1998; Keller and McClellan-Green 2004). To date, no tie has been found between pesticide concentration and susceptibility to fibropapillomatosis, although degraded habitat and pollution have been tied to the incidence of the disease and habitats impacted by agricultural, industrial, and urban development (Aguirre et al. 1994; Herbst and Klein 1995; Foley et al. 2005). Flame retardants have been measured at 3.70 ng/g in whole blood from healthy individuals (Hermanussen et al. 2008). Arthur et al. (2008) suspects that exposure to tumor-promoting compounds produced by the cyanobacteria *Lyngbya majuscule* may promote the development of fibropapillomatosis. Others suspect that dinoflagellates of the genus *Prorocentrum* that produce the tumorogenic compound okadoic acid may influence the development of fibropapillomatosis, although okadoic acid has not been detected in green turtle tissues (Landsberg et al. 1999; Takahashi et al. 2008). Takahashi et al. (2008) estimated that the total daily intake of okadoic acid by an adult turtle consuming 4.4 pounds of seagrass per day would be 920 ng.

Metal concentrations are generally similar to those found in loggerhead sea turtles. Arsenic in the form of arsenobetaine has been identified from green sea turtle tissues and is highest in muscle, followed by kidney and liver (Saeki et al. 2000; Fujihara et al. 2003). Cadmium, zinc, and copper have been measured in liver (4.26 mug/g, 34.5 mug/g, and 32.8 mug/g, respectively) and kidney tissues (5.06 mug/g to 5.89 mug/g, 26.39 mug/g, and 8.2mug/g, respectively; Godley et al. 1999; Storelli et al. 2008). Levels of copper and silver in the liver and cadmium in the kidney are very high (Anan et al. 2001). Zinc has also been measured in adipose tissue at 51.3 mug/g wet weight (Sakai et al. 2000). Mercury in the liver has been found at 0.55 mug/g dry

weight (Godley et al. 1999). Additional metals identified in green sea turtles include chromium, silver, barium, and lead (Anan et al. 2001). Cadmium, selenium, and zinc concentrations in kidney tend to decrease with age, while zinc in liver tends to increase (Gordon et al. 1998; Sakai et al. 2000; Anan et al. 2001). These metals likely originate from plants in the green sea turtle diet and seem to have high transfer coefficients (Anan et al. 2001; Celik et al. 2006; Talavera-Saenz et al. 2007). Metal concentrations in eggs have not been found to be high (Celik et al. 2006). However, concentrations of calcium and magnesium are positively correlated with nesting success (Yalcin-Ozdilek et al. 2006).

Critical Habitat

On September 2, 1998, critical habitat for green sea turtles was designated in coastal waters surrounding Culebra Island, Puerto Rico (63 FR 46693). Aspects of this area that is important for green sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for green sea turtle prey. Although specific issues with habitat degradation have not been noted for the designated critical habitat, concerns exist regarding infrastructure for sewage discharge in Puerto Rico. It is not uncommon for raw sewage to be discharged directly to coastal waters, although the occurrence of this on Culebra Island is unknown. Tourism in the area has also grown, but the effects on critical habitat have not been specifically addressed. NMFS has not designated critical habitat for Florida or Mexico breeding stocks of green sea turtles.

Leatherback Sea Turtle

The leatherback ranges farther than any other sea turtle species, having evolved physiological and anatomical adaptations that allow them to exploit waters far colder than any other sea turtle species (Frair et al. 1972; Greer et al. 1973; NMFS and USFWS 1995). In the Atlantic Ocean, leatherbacks have been recorded as far north as North Sea, Barents Sea, Newfoundland, and Labrador, and as far south as Argentina and the Cape of Good Hope, South Africa (Threlfall 1978; Goff and Lien 1988; Marquez 1990; Hughes et al. 1998; Luschi et al. 2003, 2006; James et al. 2005a). In the Pacific Ocean, they range as far north as Alaska and as far south as Chile and New Zealand (Marquez 1990; Gill 1997; Brito 1998; Hodge and Wing 2000). They also occur throughout the Indian Ocean (Hamann et al. 2006). Although leatherbacks occur in Mediterranean waters, no nesting is known to take place in this region (Casale et al. 2003).

Data suggest that leatherbacks in the western North Atlantic may not reach maturity until 29 years of age, not 2 to 14 years as previously thought (Pritchard and Trebbau 1984; Rhodin 1985; Zug and Parham 1996; Dutton et al. 2005; Avens and Goshe 2007). Survival is extremely low in early life, but greatly increases with age. Spotila et al. (1996) estimated survival in the first year to be 0.0625. For the St. Croix population, the average annual juvenile survival rate was estimated 0.63 (Eguchi et al. 2006a). The annual survival rate for leatherbacks that nested at Playa Grande, Costa Rica, was estimated to be 0.65 (Spotila et al. 2000). Rivalan et al. (2005) estimated the mean annual survival rate of leatherbacks in French Guiana to be 0.91. An examination of available strandings and in-water sighting data from the U.S. Atlantic and Gulf of Mexico coasts indicates that 60% of individuals were female. James et al. (2007) found the size distribution to consist mainly of large sub-adult and adults and a significant female biased sex ratio (1.86:1).

Leatherbacks are currently broken down into four main populations in the Pacific, Atlantic, and Indian Oceans, and the Caribbean Sea. These populations are further divided into nesting aggregations. Leatherback nesting aggregations occur widely in the Pacific, including in Mexico and Costa Rica (eastern Pacific), Malaysia, Indonesia, Australia, the Solomon Islands, Papua New Guinea, Thailand, and Fiji (western Pacific; Limpus 2002; Dutton et al. 2007). Scattered nesting also occurs along the Central American coast (Marquez 1990). In the Atlantic Ocean, leatherback nesting aggregations have been documented in Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida (Marquez 1990; Spotila et al. 1996; Bräutigam and Eckert 2006). Widely dispersed but fairly regular nesting also occurs between Mauritania in the north and Angola in the south (Fretey et al. 2007a). In the U.S., nesting commences in March and continues into July. Females can deposit up to seven nests during a season and return to nest about every 2 to 3 years. They can produce 100 or more eggs, although this varies geographically, and some eggs in each clutch are infertile. Many sizeable populations (perhaps up to 20,000 females annually) of leatherbacks are known to nest in West Africa (Fretey 2001). In the Caribbean, leatherbacks nest in the U.S. Virgin Islands and Puerto Rico as well as St. Croix, Puerto Rico, Costa Rica, Panama, Colombia, Trinidad and Tobago, Guyana, Suriname, and French Guiana (Marquez 1990; Spotila et al. 1996; Bräutigam and Eckert 2006). In the Indian Ocean, leatherback nesting aggregations are reported in South Africa, India, Sri Lanka, and the Andaman and Nicobar islands (Hamann et al. 2006).

Leatherback sea turtles are highly migratory animals that are found throughout convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale et al. 1994; Eckert 1998; Eckert 1999a). In a single year, a leatherback may swim more than 6,000 miles (Eckert 1998). Movements during and following nesting are widespread throughout oceans (Ferraroli et al. 2004; Hays et al. 2004; Eckert 2006b; Eckert et al. 2006; Sale et al. 2006; Benson et al. 2007).

Leatherback sea turtles may select foraging areas based on oceanic structures that tend to concentrate prey, including several types of invertebrates (Ferraroli et al. 2004; Eckert 2006). Leatherbacks are deep divers, with recorded dives to depths in excess of a half mile (Eckert et al. 1989). The North Pacific foraging grounds contain individuals from both the eastern and western Pacific rookeries, although leatherbacks from the eastern Pacific generally forage in the southern hemisphere along Peru and Chile (Dutton et al. 1998, 2000; Dutton 2005-2006). Mean primary productivity in all the foraging areas of western Atlantic females is significantly higher (150% greater) than those of the eastern Pacific females. This is coincident with the reproductive output of western Atlantic females was double that of eastern Pacific females (Saba et al. 2007). Leatherback turtles are pelagic and tend to forage in temperate waters except during the nesting season, when gravid females are nesting. Males do not generally occur near nesting areas. It is thought that leatherback sea turtles probably mate outside of tropical waters (Eckert and Eckert 1988). Distribution in temperate and boreal latitudes may be reflective of the location and abundance of their prey, which includes medusae, siphonophores, and salpae (Plotkin 1995).

Leatherback turtles are typically associated with both continental shelf and pelagic environments, and are sighted regularly in offshore waters in a variety of thermal regimes (45° to 80° F; CeTAP 1982). However, juvenile leatherbacks are generally found in water warmer than 70° F,

indicating that the first part of a leatherback's life is spent in tropical waters (Eckert 2002). There appears to be some fidelity to breeding sites by males and females, who show some degree of natal homing (James et al. 2005b).

Leatherbacks are some of the deepest-diving sea turtles, with maximum recorded depths of 1,500 to 3,000 feet (Lutcavage and Lutz 1997). However, dives are more typically 164 to 275 feet; 75% to 90% of the time the leatherback turtles were at depths less than 260 feet (Standora et al. 1984 in Southwood et al. 1999). Dive durations are also impressive, with a maximum duration of 42 minutes and routine dives of 1 to 14 minutes (Eckert et al. 1989, 1996; Harvey et al. 2006). Most of this time is spent traveling to and from maximum depths (Eckert et al. 1989). Overall, leatherbacks appear to dive continuously (Southwood et al. 1999).

Status and Trends

The leatherback sea turtle was listed as endangered on June 2, 1970 (35 FR 8491). Recent declines have been seen in leatherbacks nesting worldwide. Initial estimates of the worldwide leatherback population between 29,000 and 40,000 breeding females were later refined to approximately 115,000 adult females globally (Pritchard 1971, 1982). An estimate of 34,500 females (26,200 to 42,900) was made by Spotila et al. (1996), along with a claim that the species as a whole was declining and local populations were in danger of extinction (NMFS 2001).

Leatherbacks have experienced major declines at all major Pacific basin rookeries, including Mexico, Costa Rica, Malaysia, India, Sri Lanka, Thailand, Trinidad, Tobago, and Papua New Guinea. At Mexiquillo, Michoacán, Mexico, Sarti et al. (1996) reported an average annual decline in nesting of about 23% from 1984-1996. The total number of females nesting on Mexico's Pacific coast during 1995-1996 was estimated at fewer than 1,000. Less than 700 females are estimated for Central America (Spotila et al. 2000). In the western Pacific, the decline is equally severe. Current nesting at Terengganu, Malaysia represent 1% of the levels recorded in 1950s (Chan and Liew 1996). South China Sea and East Pacific nesting colonies have undergone catastrophic collapse. Pacific populations are in a critical state of decline. Once estimated at 81,000 individuals, they are now estimated at less than 3,000 total adults and subadults (Spotila et al. 2000). This tremendous collapse likely stems from drastic overharvesting of eggs and significant mortality from fishing (Sarti et al. 1996; Eckert 1997).

Recent analysis suggests that seven stocks exist in the Atlantic including Florida, northern Caribbean, western Caribbean, southern Caribbean-Guyana Shield-Trinidad, West Africa, South Africa, and Brazil (TEWG 2007). Except for the Western Caribbean, these stocks appeared to be increasing (TEWG 2007). However, caution should be taken as these trend estimates were based only on information from nesting females (one segment of the population). The largest leatherback nesting aggregation in the western North Atlantic occurs along the northern coast of South America in French Guiana and Suriname. Adult leatherbacks of the North Atlantic are believed to number 34,000 to 94,000 individuals (TEWG 2007). Western Atlantic nesting females are reported to number 18,800, while the Eastern Atlantic population is approximately 4,700. However, these data do not consider the number or origin of leatherbacks in specific foraging areas, nor do they provide an estimate of subadult abundance.

Threats

Sea turtles face predation primarily by sharks and to a lesser extent by killer whales (Pitman and Dutton 2004). Hatchlings are preyed upon by herons, gulls, dogfish, and sharks. Unlike other sea turtles, leatherbacks do not undergo "cold stunning" if water temperatures drop below a threshold level, which can be lethal to other sea turtle species.

There are increasing impacts to the nesting and marine environments of leatherbacks. Leatherback nesting beaches are affected by development and tourism in several countries (e.g., Maison 2006; Hamann et al. 2006a; Santidrian-Tomillo et al. 2007; Hernandez et al. 2007). Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Lutcavage et al. 1997; Bouchard et al. 1998). In addition, accumulation of timber and marine debris on the beach, as well as sand mining, can have a negative impact on available nesting habitat in some areas (Chacón-Chaverri 1999; Formia et al. 2003; Laurance et al. 2008). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991; Witherington 1992; Cowan et al. 2002; Deem et al. 2007). Global warming is expected to expand foraging habitats into higher latitude waters (James et al. 2006; McMahon and Hays 2006), and there is some concern that increasing temperatures may increase feminization of nests (Mrosovsky et al. 1984; Hawkes et al. 2007). Egg collection occurs in many countries around the world and has been attributed to catastrophic declines such as in Malaysia. Harvest of females still remains a matter of concern on many beaches.

Commercial and artisanal fishing may severely inhibit leatherback recovery. Lewison et al. (2004) estimated that more than 50,000 leatherbacks were likely taken as pelagic longline bycatch in 2000. Lee Lum (2006) estimated that more than 3,000 leatherbacks were entangled by coastal gillnets off Trinidad in the Southern Caribbean annually, with a 30% mortality. Gillnets are probably a major source of leatherback decline along French Guiana (Chevalier et al. 1999). Elsewhere in the Atlantic, leatherback entanglements are also common. In Canadian waters, 70% of leatherbacks had entanglements in some form, including salmon net, herring net, gillnet, trawl line, and crab pot line (Goff and Lien 1988). Shrimp trawling in the Gulf of Mexico capture the largest number of leatherback sea turtles, with roughly 3,000 individuals captured, but only about 80 of those dying. Along the eastern seaboard, the NMFS estimates about 800 leatherbacks are captured in pelagic longline fisheries, bottom longline and drift gillnet fisheries as well as lobster, deep-sea red crab, Jonah crab, mahi mahi, wahoo, and Pamlico Sound gillnet fisheries. Of these, about 40% are estimated to be killed.

Little is known about the effects contaminants have on leatherback sea turtles. Amongst heavy metals, arsenic, cadmium, copper, mercury, selenium, and zinc are known to bioaccumulate, with cadmium being higher in concentration (30.3 mu g/kg dry weight) in leatherbacks than in any other marine vertebrate (Gordon et al. 1998; Caurant et al. 1999). This is likely due to a diet of primarily jellyfish, which have high cadmium concentrations (Caurant et al. 1999). The pancreas of leatherbacks seems to accumulate metals in greater concentrations than any other tissue (Caurant et al. 1999). Arsenobetaine, arsenate, and arsenocholine are major bioaccumulative congeners of arsenic (Gordon et al. 1998). Chlorobiphenyls have been

identified in the range of 47 mu g/kg to 178 mu g/kg wet weight, with the highest levels in adipose tissues (McKenzie et al. 1999). Organochlorine pesticides have also been measured in this species (McKenzie et al. 1999). Baseline blood values have been established for leatherbacks (Deem et al. 2006). Concentrations of PCBs are reportedly equivalent to those in some marine mammals (Davenport et al. 1990).

Critical Habitat

On March 23, 1979, critical habitat for the leatherback was identified in waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands, up to and inclusive of the waters from 600 feet water depth shoreward to the level of the mean high tide with boundaries at 17° 42'12" N and 65°50'00" W (44 FR 17710). This habitat is critical for leatherback sea turtle nesting and reproduction. Since 1979, tourism to St. Croix has increased significantly and could bring nesting habitat for sea turtles and people into close proximity more often. However, specific studies do not currently support significant deterioration of critical habitat. In January 2010, there was a proposed rule to revise critical habitat designations for the leatherback turtles from Cape Flattery, Washington to the Umpqua River (Winchester Bay), Oregon east of a line approximating the 2,000 meter depth contour (75 FR 319). The PCEs of the proposed revised critical habitats for leatherback turtles include water quality, prey species, and passage conditions.

Loggerhead Sea Turtle

Loggerheads are circumglobal, occurring throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. Loggerheads are the most abundant species of sea turtle found in U.S. coastal waters. Loggerhead sea turtles, are divided into five groupings that represent major oceans or seas: Atlantic, Pacific, and Indian oceans, as well as Caribbean and Mediterranean seas. As with other sea turtles, populations are frequently divided by nesting aggregation (Hutchinson and Dutton 2007). In the eastern Atlantic, five rookeries are known from Cape Verde, Greece, Libya, Turkey, and the western Africa coast. Western Atlantic nesting occurs principally from southern Virginia to Florida, on Dry Tortugas (Florida), along the Gulf Coast from northwestern Florida to Texas, on Cay Sal Bank (Bahamas), at Quintana Roo (Mexico's Yucatan Peninsula), along Brazil's shores, and at additional rookeries in Caribbean Central America, Bahamian Archipelago, Cuba, Colombia, Venezuela, and eastern Caribbean Islands that have not been classified. Loggerheads are known to nest along the Indian Ocean in Oman, Yemen, Sri Lanka, Madagascar, South Africa, and possibly Mozambique. Pacific Ocean rookeries are limited to the western portion of the basin. These sites include Australia, New Caledonia, New Zealand, Indonesia, Japan, and the Solomon islands.

The life cycle of loggerhead sea turtles can be divided into seven stages: eggs and hatchlings, small juveniles, large juveniles, subadults, novice breeders, first year emigrants, and mature breeders (Crouse et al. 1987). Hatchling loggerheads migrate to the ocean where they are generally believed to lead a pelagic existence for as long as seven to 12 years. Loggerheads hatched on U.S. beaches migrate offshore and become associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986). After 14 to 32 years of age, they shift to a benthic habitat, where immature individuals forage in the open ocean and coastal areas along continental shelves, bays, lagoons, and estuaries (NMFS 2001). In the western North Atlantic, loggerheads move into continental shelf waters from Cape Cod Bay south through Florida, The

Bahamas, Cuba, and the Gulf of Mexico. Estuarine waters, including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, and numerous embayments fringing the Gulf of Mexico, comprise important inshore habitat. Along the Atlantic and Gulf of Mexico shoreline, essentially all continental shelf waters are inhabited by loggerheads. Habitat preferences of non-nesting adult loggerheads in the neritic zone differ from the juvenile stage. Areas such as Pamlico Sound and the Indian River Lagoon, regularly used by juveniles, are only rarely frequented by adult loggerheads. Estuarine areas with more open ocean access, such as Chesapeake Bay in the northeast U.S., are more frequently used by adults, primarily during warmer seasons. Offshore, adults primarily inhabit continental shelf waters, from New York south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Continental shelf waters along the west Florida coast, The Bahamas, Cuba, and the Yucatán Peninsula have been identified as important resident areas for South Florida Nesting Subpopulation adult female loggerheads (Foley et al. in press). At 20 to 38 years of age, loggerhead sea turtles become sexually mature, although the age at which they reach maturity varies widely among populations (Frazer and Ehrhart 1985; NMFS 2001). Adult loggerheads are known to make considerable migrations between foraging areas and nesting beaches (TEWG 1998). However, recent studies suggest that not all loggerhead sea turtles completely circumnavigate the North Atlantic Gyre as pelagic immatures. Some of these turtles may either remain in the pelagic habitat in the North Atlantic longer or move between pelagic and coastal habitats (Witzell 2002).

Loggerhead diving behavior varies based upon habitat, with longer surface stays in deeper habitats than in coastal ones. The maximum recorded dive depth for a post-nesting female was over 760 feet, although most dives are far shallower (30 to 70 feet). Routine dive durations for a post-nesting female were between 15 and 30 minutes, with subadults diving somewhat longer (19 to 30 minutes; Sakamoto et al. 1990 *in* Lutcavage and Lutz 1997). Loggerheads tagged in the Pacific over the course of five months showed that about 70% of dives are very shallow (less than 20 feet) and 40% of their time was spent within 3 feet of the surface (Polovina et al. 2003). During these dives, there were also several strong surface temperature fronts individuals were associated with, one of 68° F at 28° N latitude and another of 63° F at 32° N latitude.

Status and Trends

Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800). However, NMFS recently determined that a petition to reclassify loggerhead turtles in the western North Atlantic Ocean as endangered may be warranted due to the substantial scientific and commercial information presented. Consequently, NMFS has initiated a review of the status of the species and is currently soliciting additional information on the species status and ecology, as well as areas that may qualify as critical habitat (73 FR 11849; March 5, 2008).

There is general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size. The nesting trend for the northern subpopulation of loggerheads appears to be stable or declining (TEWG 1998; NMFS 2001). An important caveat for population trends analysis based on nesting beach data is that this may reflect trends in

adult nesting females, but it may not reflect overall population growth rates well. Adult nesting females often account for less than 1% of total population numbers.

Western Atlantic nesting locations include The Bahamas, Brazil, and numerous locations from the Yucatán Peninsula to North Carolina (Addison and Morford 1996; Addison 1997; Marcovaldi and Chaloupka 2007). In this region, it is estimated that between 53,000 and 92,000 nests are laid per year in the southeastern U.S. and the Gulf of Mexico, and estimated the total number of nesting females at 32,000 to 56,000. This group comprises five nesting subpopulations: the Northern Nesting Subpopulation, South Florida Nesting Subpopulation, Dry Tortugas Nesting Subpopulation, Florida Panhandle Nesting Subpopulation, and the Yucatán Nesting Subpopulation. All of these are currently in decline or data are insufficient to access trends. Loggerheads from western North Atlantic nesting aggregations may or may not feed in the same regions from which they hatch. Loggerhead sea turtles from the northern nesting aggregation, which represents about 9% of the loggerhead nests in the western North Atlantic, comprise between 25% and 59% of individuals foraging from Georgia up to the northeast U.S. (Sears 1994; Sears et al. 1995; Norrgard 1995; Rankin-Baransky 1997; Bass et al. 1998). However, loggerheads associated with the South Florida nesting aggregation occur in higher frequencies in the Gulf of Mexico (where they represent about 10% of the loggerhead sea turtles captured) and the Mediterranean Sea (where they represent about 45% of the loggerhead sea turtles captured). It has been estimated that about 4,000 nests per year are laid along the Brazilian coast (Ehrhart et al. 2003).

The South Florida population increased at 5.3% to 5.4% per year from 1978 to 1990, and was initially increasing at 3.9% to 4.2% after 1990. However, an analysis of nesting data from the Index Nesting Beach Survey Program from 1989 to 2005, a period encompassing index surveys that are more consistent and more accurate than surveys in previous years, has shown no detectable trend and, more recently (1998 through 2005), has shown evidence of a declining trend of approximately 22.3% (FFWCC 2007b). Nesting data from the Archie Carr Refuge (one of the most important nesting locations in southeast Florida) over the last 6 years shows a decline in the number of nests from approximately 17,629 in 1998 to 7,599 in 2004. While this is a long period of decline relative to the past observed nesting pattern at this location (a record high followed by a variable period of declines, followed by another record high), aberrant ocean surface temperatures complicate the analysis and interpretation of this data. Although one must be cautious in interpreting the decreasing nesting trend given inherent annual fluctuations in nesting and the short time period over which the decline has been noted, the recent nesting decline at this nesting beach is reason for concern. Based upon the small sizes of almost all nesting aggregations in the Atlantic, the large numbers of individuals killed in fisheries, and the decline of the only large nesting aggregation, we suspect that the extinction probabilities of loggerhead sea turtle populations in the Atlantic are only slightly lower than those of populations in the Pacific.

In the eastern Atlantic, the Cape Verde Islands support the only known loggerhead nesting assemblage, and it is of at least intermediate size (Fretey 2001). Annual data from monitoring projects in Cyprus, Greece, Israel, Tunisia, and Turkey reveal total annual nesting in the Mediterranean ranging from 3,375 to 7,085 nests per season (Margaritoulis et al. 2003). Libya

and the West African coast host genetically-unique breeding populations of loggerhead sea turtles as well (Hutchinson and Dutton 2007).

Pacific nesting is limited to two major locations, Australia and Japan. Eastern Australia supported one of the major global loggerhead nesting assemblages until recently (Limpus 1985). Now, less than 500 females nest annually, an 86% reduction in the size of the annual nesting population in 23 years (Limpus and Limpus 2003). The status of loggerhead nesting colonies in southern Japan and the surrounding region is uncertain, but approximately 1,000 female loggerhead turtles may nest there; a 50% to 90% decline compared to historical estimates (Dodd 1988; Bolton et al. 1996; Sea Turtle Association of Japan 2002; Kamezaki et al. 2003; Kamezaki et al. 2003). In addition, loggerheads are not commonly found in U.S. Pacific waters, and there have been no documented strandings of loggerheads off the Hawaiian Islands in nearly 20 years (1982-1999 stranding data). There are very few records of loggerheads nesting on any of the many islands of the central Pacific, and the species is considered rare or vagrant on islands in this region (NMFS and USFWS 1998).

The largest known nesting aggregation occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani 1982). Extrapolations resulting from partial surveys and tagging in 1977 to 1978 provided broad estimates of 19,000 to 60,000 females nesting annually at Masirah Island, while a more recent partial survey in 1991 provided an estimate of 23,000 nesting females (Ross 1979, 1998; Ross and Barwani 1982; Baldwin 1992). Over 3,000 nests per year have been recorded on the Al-Halaniyat Islands, while along the Oman mainland of the Arabian Sea; about 2,000 nests are deposited per year (Salm 1991; Salm et al. 1993). Based upon genetic analyses, additional populations have been identified as nesting in Yemen, Sri Lanka, and Madagascar (Hutchinson and Dutton 2007). In the southwestern Indian Ocean, the highest concentration of nesting occurs on the coast of Tongaland, South Africa (Baldwin et al. 2003). The total number of females nesting annually in South Africa is estimated to be between 500 and 2,000 (Baldwin et al. 2003). An estimated 800 to 1,500 loggerheads nest annually on Dirk Hartog Island beaches along Western Australia (Baldwin et al. 2003).

Threats

Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo “cold stunning” if water temperatures drop below a threshold level, which can pose lethal effects. Eggs are commonly eaten by raccoons and ghost crabs along the eastern U.S. (Barton and Roth 2008). In the water, hatchlings are hunted by predators like herons, gulls, dogfish, and sharks. Adult loggerhead sea turtles also face predation by sharks and killer whales.

Anthropogenic threats impacting loggerhead nesting habitat are numerous: coastal development and construction, placement of erosion control structures, beachfront lighting, vehicular and pedestrian traffic, sand extraction, beach erosion, beach nourishment, beach pollution, removal of native vegetation, and planting of non-native vegetation (Baldwin 1992, NMFS and FWS 1998, Margaritoulis et al. 2003). Loggerhead sea turtles face numerous threats in the marine environment as well, including oil and gas exploration, marine pollution, trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries; underwater explosions; dredging,

offshore artificial lighting; power plant entrapment; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; and poaching. The major factors inhibiting their recovery include mortalities caused by fishery interactions and degradation of the beaches on which they nest. Shrimp trawl fisheries account for the highest number of loggerhead sea turtles that are captured and killed. Along the Atlantic coast of the U.S., the NMFS estimated that almost 163,000 loggerhead sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, of which 3,948 are killed. Each year, about 2,000 loggerhead sea turtles are captured in various fisheries in Pamlico Sound, of which almost 700 die. Offshore longline tuna and swordfish longline fisheries are also a serious concern for the survival and recovery of loggerhead sea turtles (Bolten et al. 1994; Aguilar et al. 1995; Crouse 1999). Deliberate hunting of loggerheads for their meat, shells, and eggs is reduced from previous exploitation levels, but still exists and hampers recovery efforts.

Climate change may also have significant implications on loggerhead populations worldwide. In addition to potential loss of nesting habitat due to sea level rise, loggerhead sea turtles are very sensitive to temperature as a determinant of sex while incubating. Ambient temperature increase by just 1.8º to 3.6º F can potentially change hatchling sex ratios to all or nearly all female in tropical and subtropical areas (Hawkes et al. 2007). Over time, this can reduce genetic diversity, or even population viability, if males become a small proportion of populations. Increasing ocean temperatures may also lead to reduced primary productivity and eventual food availability. This has been proposed as partial support for reduced nesting abundance for loggerhead sea turtles in Japan; a finding that could have broader implications for other populations in the future if individuals do not shift feeding habitat (Chaloupka et al. 2008).

Loggerhead sea turtles have been found to contain the organochlorines chlordanes, lindane, endrin, endosulfan, dieldrin, PFOS, PFOA, DDT and PCB in a variety of tissues (Rybitski et al. 1995; Corsolini et al. 2000; Gardner et al. 2003; Keller et al. 2004a, b, 2005; Alava et al. 2006; Storelli et al. 2007). PCB concentrations in studied tissue compartments include 52.3 ng/g to 119 ng/g wet weight in liver, 19.0 ng/g in kidney, 12.75 ng/g in lung, and 4.65 ng/g to 15 ng/g in muscle, and 334 ng/g to 459.6 ng/g in fat (Corsolini et al. 2000; Perugini et al. 2006; Storelli et al. 2007). DDT concentrations have been measured at 18.3 ng/g in liver, 5.7 ng/g in kidney, 3.76 ng/g in lung, and 1.45 ng/g in muscle (Storelli et al. 2007). Chlorobiphenyls have been measured in various tissue compartments, but are highest in adipose tissue, ranging from 775 mu g/kg to 893 mu g/kg wet weight (McKenzie et al. 1999). It appears that levels of organochlorines have the potential to suppress the immune system of loggerhead sea turtles and may affect metabolic regulation (Keller et al. 2004b; Keller et al. 2006). These contaminants have the potential to cause deficiencies in endocrine, developmental and reproductive health (Storelli et al. 2007). It is likely that the omnivorous nature of loggerheads makes them more prone to bioaccumulating toxins than other sea turtle species (McKenzie et al. 1999). Blood may be used as a non-lethal sampling mechanism to test for organochlorine concentrations (Keller et al. 2004a, c). Loggerhead eggs have been found to contain DDD, DDE (0.034 ppm to 0.099 ppm), DDT (7.88 ng/g to 1340 ng/g; mean of 67.1), PCBs (7.11 ng/g to 3930 ng/g; mean of 65.0 ng/g), chlordane (4.04 ng/g to 685 ng/g; mean of 37.0 ng/g), dieldrin (1.69 ng/g to 44.0 ng/g; mean of 11.1 ng/g), and polycyclic aromatic hydrocarbons, 1,2,5,6-dibenzanthracene, 1-methyl naphthalene, and naphthalene (Fletemey 1980; Clark and Krynitsky 1985; Alam and Brim 2000; Alava et al. 2006). PCB concentrations have been found to be highest in the chorioallantoic membrane

(Cobb and Wood 1997). Along with Kemp's ridleys, loggerhead sea turtles have higher levels of PCB and DDT than leatherback and green sea turtles. The generally higher level of contaminants found in loggerhead sea turtles is likely due to this species tendency to feed higher on the food chain than other sea turtles (Godley et al. 1999; McKenzie et al. 1999). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

Heavy metals, including cadmium, iron, nickel, copper, zinc, and manganese, have also been found in a variety of tissues in levels that increase with turtle size (Gardner et al. 2006). Arsenic in the form of arsenobetaine has been identified from green sea turtle tissues and is highest in muscle, followed by kidney and liver (Saeki et al. 2000; Fujihara et al. 2003). Cadmium, zinc, and copper have been measured in liver (4.26 mg/kg, 34.5 mg/kg, and 32.8 mg/kg, respectively) and kidney tissues (5.06 mg/kg to 5.89 mg/kg, 26.39 mg/kg, and 8.2mg/kg, respectively) (Godley et al. 1999; Storelli et al. 2008). Levels of copper and silver in the liver and cadmium in the kidney are very high (Anan et al. 2001). Zinc has also been measured in adipose tissue at 51.3 mg/kg wet weight (Sakai et al. 2000). Cadmium, selenium, and zinc concentrations in kidney tend to decrease with age, while zinc in liver tends to increase (Gordon et al. 1998; Sakai et al. 2000; Anan et al. 2001). These metals likely originate from plants in the green sea turtle diet and seem to have high transfer coefficients (Anan et al. 2001; Celik et al. 2006; Talavera-Saenz et al. 2007). Metal concentrations in eggs have not been found to be high (Celik et al. 2006). However, concentrations of calcium and magnesium are positively correlated with nesting success (Yalcin-Ozdilek et al. 2006).

Loggerhead sea turtles have higher mercury levels than any other sea turtle studied, but concentrations are an order of magnitude less than many toothed whales (Pugh and Becker 2001). Mercury in the liver has been found at 0.55 mg/kg dry weight (Godley et al. 1999). Additional metals identified in green sea turtles include chromium, silver, barium, and lead (Anan et al. 2001). Additionally, loggerhead eggs laid along the Atlantic U.S. coast have an order of magnitude higher level of mercury than what has been measured in the Mediterranean Sea or along Japan. Similarly, arsenic has been found to be several fold more concentrated in loggerhead sea turtles than marine mammals or seabirds.

Critical Habitat

NMFS has not designated critical habitat for loggerhead sea turtles. However, NMFS recently determined that a petition to reclassify loggerhead turtles in the western North Atlantic Ocean may be warranted. Consequently, NMFS has initiated a review of the status of the species and is currently soliciting information on the species status and population demographics, and areas that may qualify as critical habitat (73 FR 11849).

Olive Ridley Sea Turtle

Olive ridleys are globally distributed in tropical regions of the Pacific (southern California to Peru, and rarely in the Gulf of Alaska; Hodge and Wing 2000), Indian (eastern Africa and the Bay of Bengal), and Atlantic oceans (Grand Banks to Uruguay and Mauritania to South Africa; Fretey 1999; Foley et al. 2003; Fretey et al. 2005; Stokes and Epperly 2006). They are not known to move between or among ocean basins.

Olive ridleys are best known for their arribada behavior (Carr 1967; Hughes and Richard 1974). Hundreds to tens of thousands of ridleys may synchronously emerge in just a few days from June through December to nest in close proximity. However, many ridleys nest solitarily. It has been suggested that the smaller clutch sizes observed for solitary nesters might be due to energetic costs associated with undertaking internesting movements among multiple beaches (Plotkin and Bernardo 2003). A third mating system may also exist, where some females switch between solitary nesting and arribada nesting in a nesting season (Kalb 1999; Bernardo and Plotkin 2007).

Arribada nesting occurs in the eastern Pacific from Nicaragua to Panama, in the Indian Ocean in the Indian State of Orissa (Gahirmatha, Robert Island, and Rushikulya, which host the largest olive ridley arribadas worldwide), and in the western Atlantic from Suriname/French Guiana to Brazil (NMFS and USFWS 2007). Solitary nesting occurs from Guatemala to Columbia as well as Indonesia and Malaysia in the Pacific, throughout much of the western and northern Indian Ocean, Guyana, Suriname, and French Guiana in the western Atlantic, and from Gambia south to Angola in the eastern Atlantic (NMFS and USFWS 2007). The endangered stock of olive ridleys nest along much of the western Mexican coastline.

In general, individual olive ridleys may nest one to three times per season, but on average two clutches are produced annually, with approximately 100 to 110 eggs per clutch (Pritchard and Plotkin 1995; NMFS and USFWS 1998). Solitary nesters ovulate on 14-day cycles whereas arribada nesters ovulate approximately every 28 days (Pritchard 1969; Kalb and Owens 1994; Kalb 1999). In the western Pacific, females lay nests every 1.1 years on average. Survivorship is low on high-density arribada nesting beaches (Cornelius et al. 1991). The sheer number of nesting turtles (1,000-500,000) means that nests are frequently disturbed by subsequent nesters in the same or following arribada. On solitary nesting beaches, hatching rates are significantly higher, presumably due to reduced disturbance (Castro 1986; Gaos et al. 2006). It is believed that, like other sea turtles, olive ridleys experience high mortality in early life stages, but details of survivorship are poorly understood. Both juveniles and adults occupy offshore waters, where they forage on gelatinous prey such as jellyfish, salps, and tunicates as well as crustaceans and small fish. Olive ridley sexual maturity is attained at a median age of 13 years with a range of 10 to 18 years (Kopitsky et al. 2005; Zug et al. 2006).

Olive ridleys are highly migratory and may spend most of their non-breeding life cycle in deep ocean waters, but occupy the continental shelf region during the breeding season (Cornelius and Robinson 1986; Pitman 1991, 1993; Arenas and Hall 1991; Plotkin 1994; Plotkin et al. 1994, 1995; Beavers and Cassano 1996). Reproductively active males and females migrate toward the coast and aggregate at nearshore breeding grounds near nesting beaches (Pritchard 1969; Hughes and Richard 1974; Cornelius 1986; Plotkin et al. 1991, 1996, 1997; Kalb et al. 1995). However, some breeding also takes place far from shore (Pitman 1991; Kopitsky et al. 2000), and it is possible that some males and females may not migrate to nearshore breeding aggregations at all. Some males appear to remain in oceanic waters, are non-aggregated, and mate opportunistically as they intercept females *en route* to near shore breeding grounds and nesting beaches (Plotkin 1994; Plotkin et al. 1994, 1996; Kopitsky et al. 2000). Their migratory pathways vary annually (Plotkin 1994), there is no spatial and temporal overlap in migratory pathways among groups or cohorts of turtles (Plotkin et al. 1994, 1995), and no apparent migration corridors exist. Olive

ridleys from different populations may occupy different oceanic habitats (Polovina et al. 2003, 2004). Unlike other marine turtles that migrate from a breeding ground to a single feeding area, where they reside until the next breeding season, olive ridleys are nomadic migrants that swim hundreds to thousands of miles over vast oceanic areas (Plotkin 1994; Plotkin et al. 1994, 1995). Olive ridleys may associate with flotsam, which could provide food, shelter, and/or orientation cues (Hall 1992).

Olive ridley turtle diving behavior remains somewhat of a mystery, but several studies have highlighted general insights. In the eastern tropical Pacific, diving rate is greater during daytime than at night (Beavers and Cassano 1996; Parker et al. 2003). During nighttime however, dives are longer (up to 95 minutes). Most dives are relatively less than 330 feet, but individuals can dive to roughly 1,000 feet (Polovina et al. 2003). The presence of a thermocline appears to influence diving behavior, likely due to its impact on prey availability (Parker et al. 2003).

Status and Trends

Except for the Mexico breeding stock, olive ridley sea turtles were listed as threatened under the ESA on July 28, 1978 (43 FR 32800). Olive ridley population trends vary in trajectory; arribada sites in Nicaragua, Costa Rica (Ostional Beach), and Brazil appear to be increasing. One arribada site in Costa Rica (Nancite Beach) seems to be in decline. All other beaches, including the largest sites along the Indian coastline, require further survey data to access trends. Most recent information regarding solitary nesting sites along Guatemala, El Salvador, Bangladesh, Myanmar, Malaysia, Pakistan, and southwest India indicate declines in these areas. However, solitary nesting in Indonesia may be increasing (Limpus 1995; Asrar 1999; Thorbjarnarson et al. 2000; Islam 2002; Dermawan 2002; Krishna 2005).

The olive ridley is the most abundant sea turtle in the world (Pritchard 1997). The eastern Pacific population is believed to number roughly 1.39 million (Eguchi et al. in preparation). Abundance estimates in recent years indicate that the Mismaloya and Moro Ayuta nesting populations appear to be stable and the nesting population at La Escobilla is increasing, although less than historical levels, which was roughly 10 million adults prior to 1950 (Cliffton et al. 1982; R. Briseño, BITMAR and A. Abreu, pers. comm. in NMFS and USFWS 2007). By 1969, after years of adult harvest, the estimate was just over one million (Cliffton et al. 1982). Olive ridley nesting at La Escobilla rebounded from approximately 50,000 nests in 1988 to over 700,000 nests in 1994, and more than a million nests by 2000 (Márquez-M. et al. 1996, 2005).

High levels of adult mortality due to harvesting are believed to be the reason why rapid and large nesting population declines occurred in Mexico (Cornelius et al. 2007). The nationwide ban on commercial sea turtles harvest in Mexico, enacted in 1990, has greatly aided olive ridley conservation, but the population is still seriously decremented and threatened with extinction (Groombridge 1982). Several solitary and arribada nesting beaches experience (although banned) egg harvesting, which is causing declines (Cornelius et al. 2007). Approximately 300,000-600,000 eggs were seized each year from 1995-1998 (Trinidad and Wilson 2000).

Threats

Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can pose lethal effects. Collection of eggs as well as adult turtles has historically led to species decline (NMFS and USFWS 2007). Harvests remain a concern for olive ridley recovery. In some locations, takes are now regulated or banned (with varying compliance), while harvests remain uncontrolled in other areas. Takes of adult turtles are now largely banned, except along African coasts.

There are additional impacts to the nesting and marine environment that affect olive ridleys. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Lutcavage et al. 1997; Bouchard et al. 1998). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991; Witherington 1992). At sea, there are numerous potential threats including marine pollution, oil and gas exploration, lost and discarded fishing gear, changes in prey abundance and distribution due to commercial fishing, habitat alteration and destruction caused by fishing gear and practices, agricultural runoff, and sewage discharge (Lutcavage et al. 1997; Frazier et al. 2007).

In India, uncontrolled mechanized fishing in areas of high sea turtle concentration, primarily illegally operated trawl fisheries, has resulted in large scale mortality of adult olive ridley turtles during the last two decades. Since 1993, more than 50,000 olive ridleys have stranded along the coast, at least partially because of near-shore shrimp fishing (Shanker and Mohanty 1999). Fishing in coastal waters off Gahirmatha was restricted in 1993 and completely banned in 1997 with the formation of a marine sanctuary around the rookery. However, mortality due to shrimp trawling reached a record high of 13,575 ridleys during the 1997 to 1998 season and none of the approximately 3,000 trawlers operating off the Orissa coast use turtle excluder devices in their nets despite mandatory requirements passed in 1997 (Pandav and Choudhury 1999).

Olive ridley sea turtles have been found to contain the organochlorines chlordanes, lindane, endrin, endosulfan, dieldrin, DDT and PCB in a variety of tissues (Gardner et al. 2003). These contaminants have the potential to cause deficiencies in endocrine, developmental and reproductive health (Storelli et al. 2007), and are known to depress immune function in loggerhead sea turtles (Keller et al. 2006). Heavy metals, including cadmium, iron, nickel, copper, zinc, and manganese, have been found in a variety of tissues in levels that increase with turtle size (Gardner et al. 2006). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation. Eggs have been found to contain iron, zinc, lead, cobalt, chromium, copper, cadmium, and nickel, with the first three metals being of higher concentrations than the rest, but none in particularly high concentrations (Sahoo et al. 1996). Newly emerged hatchlings have higher concentrations than are present when laid, suggesting that metals may be accumulated during incubation from surrounding sands (Sahoo et al. 1996).

Critical Habitat

NMFS has not designated critical habitat for olive ridley sea turtles.

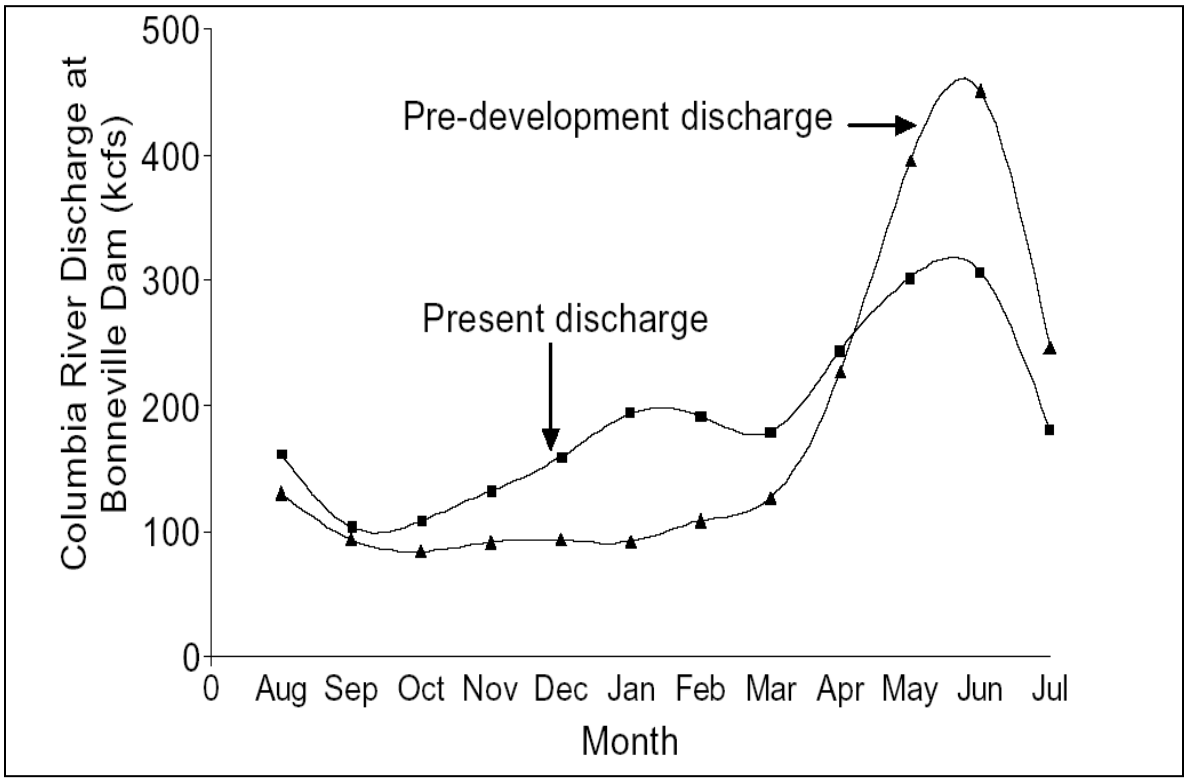
ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Overview

The Columbia River drains an area of 259,000 square miles and flows 1,243 miles from its headwaters in the Canadian Rockies of British Columbia, across the state of Washington, and along the border of Washington and Oregon to its mouth on the Pacific Ocean near Astoria, Oregon. The lower Columbia River extends from Bonneville Dam (RM 146) to the mouth of the Columbia River. Historically, unregulated discharges at the mouth ranged from 79,000 cubic feet per second (cfs) to over 1 million cfs, with average discharges of 273,000 cfs (Figure 39). Currently, discharge at the mouth of the river ranges from 100,000 to 500,000 cfs, with an average of about 260,000 cfs.

Figure 39. Annual Monthly River Discharge at Bonneville Dam under Current Operations as Compared to Historical River Discharge with No Mainstem Dams



Source: Corps Portland District

Highest discharges occur between December and March. Stream discharge in the lower Columbia River is influenced by snowmelt, winter rainstorms, and dam regulation. Stream discharge peaks generally occur during April through June. Local flooding in the lower Columbia River now begins when stream discharge reaches about 450,000 cfs, while the unregulated peak discharge would have been 602,000 cfs. Low stream flow generally occurs between August and October.

Discharge and sediment load have been altered by construction of 31 irrigation and hydropower dams, and 162 smaller dams, in the basin since 1890. Before 1890, the Columbia River estuary had extensive sand beds and variable river discharges. However, the construction of upriver hydroelectric dams has dramatically changed the nature of the estuary, as these dams have translated into different discharge rates and sediment discharges. Moreover, channel deepening, use of jetties and dredging to stabilize channels, development of perennial wetland areas, and isolation of remaining wetlands from the mainstem river have altered the physical character of the estuary; these changes have affected the biological systems supported by the estuary.

Physical Characteristics

The Columbia River estuarine environment extends from the mouth to approximately RM 38. The river varies from 2 to 5 miles wide throughout the estuary and is about 1 mile wide at RM 30. Tidal effect extends almost 150 miles upstream (Corps 1983), but the saltwater wedge is limited to approximately RM 20 (Corps 1999). The North and South jetties and Jetty A were constructed at the mouth to help stabilize the channel, reduce the need for dredging, and provide protection for ships. A series of pile dikes were also historically constructed for similar reasons. The navigation channel is currently maintained at authorized depths of 48-55 feet deep below MLLW and 0.5-mile wide from RM -3 to RM 3. River flows are controlled by upstream storage dams. A dredged material disposal site near the North Jetty was established in 1999 to protect the North Jetty from erosion. About 100,000 to 500,000 cubic yards of sand are placed there annually. The MCR Shallow Water Site (SWS), Deep Water Site (DWS), and Chinook Channel Area D Sites are also active disposal locations within the action area but offshore and upstream of MCR, respectively. Historic disposal sites no longer active within vicinity of the jetties include Site E located within the expanded SWS and sites A, B, and F, which are in deeper water but still shoreward of the active DWS.

The Corps regularly conducts operations and maintenance activities to maintain the jetty system and the authorized navigation channels and facilities. In the action area, there are several turning and mooring basins and federally authorized periodically dredged channels extending to various ports from the navigation channel. The Columbia River Channel Improvements Project was recently completed and deepened the navigation channel 3 feet from approximately RM 3-104.

Waves, Currents, and Morphology

The MCR is a high energy environment. The ocean entrance at the MCR is characterized by large waves and strong currents interacting with spatially variable bathymetry. The MCR is considered one of the world's most dangerous coastal inlets for navigation. Approximately 70% of all waves approaching the MCR are from the west-northwest. During winter storm conditions, the ocean offshore of the jettied river entrance is characterized by high swells

approaching from the northwest to southwest combined with locally generated wind waves from the south to southwest. From October to April, average offshore wave height and period is 9 feet and 12 seconds, respectively. From May to September, average offshore wave height and period is 5 feet and 9 seconds, respectively, and waves approach mostly from the west-northwest. Occasional summer storms produce waves approaching MCR from the south-southwest with wave heights of 6.5 to 13 feet and wave periods of 7 to 12 seconds. Astronomical tides at MCR are mixed semi-diurnal with a diurnal range of 7.5 feet. The instantaneous flow rate of estuarine water through the MCR inlet during ebb tide can reach 1.8 million cfs. Tidally dominated currents within the MCR can exceed 8.2 feet per second. A large, clockwise-rotating eddy current has been observed to form between the North Jetty, the navigation channel, and Jetty A during ebb tide. A less pronounced counter-clockwise eddy forms in response to flood tide. Horizontal circulation in the estuary is generally clockwise (when viewed from above), with incoming ocean waters moving upstream in the northern portion of the estuary and river waters moving downstream in the southern portion. Vertical circulation is variable, reflecting the complex interaction of tides with river flows and bottom topography and roughness (Corps 1983). The North Jetty eddy has varying strength and direction (based on location and timing of tide) ranging from 0.3 to 3.3 feet per second.

As waves propagate shoreward toward the mouth of the Columbia River, the waves are modified (waves begin to shoal and refract) by the asymmetry of the mouth of the Columbia River underwater morphology. Nearshore currents and tidal currents are also modified by the jetties and the mouth of the Columbia River morphology. These modified currents interact with the shoaling waves to produce a complex and agitated wave environment within the mouth of the Columbia River. The asymmetric configuration of the mouth of the Columbia River and its morphology is characterized by the significant offshore extent of Peacock Spit on the north side of the North Jetty, southwesterly alignment of the North/South jetties and channel, and the absence of a large shoal on the south side of the mouth of the Columbia River. The asymmetry of the mouth of the Columbia River causes incoming waves to be focused onto areas which would not otherwise be exposed to direct wave action. An example of this wave-focusing effect is the area along the south side of the North Jetty. Upon initial inspection, it would appear that this area is most susceptible to wave action approaching the mouth of the Columbia River from the southwest. However, this is not the case; the opposite is what occurs. The area located between the North Jetty, the navigation channel, and Jetty A is affected by wave action during conditions when the offshore wave direction is from the west-northwest, because of the refractive nature of Peacock Spit. Waves passing over Peacock Spit (approaching from the northwest) are focused to enter the mouth of the Columbia River along the south side of the North Jetty. Conversely, large waves approaching the mouth of the Columbia River from the southwest are refracted/diffracted around the South Jetty and over Clatsop Spit, protecting the south side of the North Jetty from large southerly waves.

Channel stability at the mouth of the Columbia River is related to the jetties and the morphology of Peacock and Clatsop spits (Moritz et al. 2003). Because of phased jetty construction from 1885 to 1939 and the associated response of morphology, mouth of the Columbia River project features and the resultant morphology are now mutually dependent both in terms of structural integrity and project feature functional performance.

Foundation Conditions

The project has two main shoaling areas. The outer shoal extends from approximately RM -1.6 to RM -1.0. The inner shoal, Clatsop Shoal, extends from approximately RM 0.0 to RM 2.6, beginning on the south side and crossing the channel near RM 1.0. To maintain the channel's depth, dredging is conducted and materials dredged from the project are placed in one of two EPA Section 102 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) Ocean Dredged Material Disposal Sites (ODMDS) -- the Deep Water Site (DWS) or the Shallow Water Site (SWS), or alternately in a Clean Water Act Section 404 North Jetty site (Corps 2008).

The MCR jetties were constructed on these underwater sand shoals which are considered to be crucial project elements. These shoals are currently receding, which could affect the sediment budget supplying the adjacent littoral zones north and south of the MCR. As morphology near the jetties experiences significant erosion, the jetties will be undermined by waves and currents.

Landforms

Near the Oregon shore of the estuary, Clatsop Spit is a coastal plain. On the Washington shore, Cape Disappointment is a narrow, rocky headland. Extensive accretion of land has occurred north of the North Jetty since its construction. This accreted land, however, is now in the process of recession as is evident by erosion at Benson Beach. The Corps is in the process of placing Columbia River sand back into the littoral drift cell north of the North Jetty at Benson Beach. Behind the headland is beach dune and swale. Wetlands occur on accreted land north of the North Jetty and on Clatsop Spit.

Wetlands near the North Jetty

Scouring has occurred on the north side of the North Jetty resulting in the formation of wetlands and a backwater lagoon within the approximately 16-acre wedge of land between the North Jetty and Jetty Road. Lagoons are characterized by shallow water and intermittent ocean connectivity and are often oriented parallel to the shoreline. Because of their interface location between land and sea, their exposure to rapidly changing physical and chemical influences, their short and varied water residence time, and their wind and weather dependent vertical and horizontal stratification, these lagoon features can be very dynamic and productive based on these natural constraints (Troussellier 2007). A recently repaired sand berm separates the western entrance of the North Jetty lagoon from tidal flows along the south end of Benson Beach. Thus, the North Jetty lagoon and wetlands are separated from direct ocean connectivity by the berm and the jetty itself. Fish access to and use of the lagoon is not likely. However, the lagoon is often inundated both by tidal waters that come through the jetty and by freshwater from wetlands that have formed in accreted lands north of Jetty Road and which drain through a culvert into the lagoon and its adjacent wetlands. The lagoon area and three wetland areas were delineated in this wedge of land and total approximately 6.5 acres of wetlands and waters of the United States.

Wetlands within and fringing the lagoon that are proposed to be filled are located between the North Jetty and the beach access road to the north and comprise a total of 1.78 acres. These wetlands were delineated by Tetra Tech (2007a, b) in accordance with the Corps' Wetlands Delineation Manual (Corps 1987). Three distinct wetlands were identified.

Wetland 1 (0.61 acre). These disjunct wetlands are classified as estuarine emergent, persistently regularly flooded. These patches of wetlands fringe the scoured-out tidal channel and are characterized by bighead sedge, American dune grass, Baltic rush, and tufted hairgrass. These fringe wetlands are ephemeral in nature in that they can be affected by moving sand. This was evident during a field visit in fall 2007 when a storm during the previous winter washed sand eastward covering nearly all of a patch of wetland that occurred near Benson Beach.

Wetland 2 (0.97 acre). This wetland is classified as palustrine emergent, persistently seasonally flooded and as palustrine scrub-shrub broad-leaved deciduous seasonally flooded. It occurs adjacent to the beach access road in drainage ditches. Three plant communities characterize this wetland: baltic rush-velvet grass emergent, slough sedge emergent, and willow shrub.

Wetland 3 (0.20 acre). This wetland is classified as palustrine scrub-shrub, broad-leaved deciduous, seasonally flooded. This bowl-shaped wetland occurs toward the west end of the area projected for filling and is characterized by a thick understory of slough sedge and an overstory mainly of alder. Pacific crabapple and Sitka spruce are also present.

Two of the three wetlands described above were rated by the Washington Department of Ecology and the Corps on November 16, 2007 in accordance with the Washington State Wetland Rating System (Hruby 2004). Wetland 1, the tidal fringe wetlands, was not rated by this system because they are considered estuarine wetlands. Because of lack of hydrologic connection, Wetland 2 (consisting of two ditches) was broken out into discrete wetlands for rating purposes (referred to here as Wetland 2a and Wetland 2b). Wetland 2a is between the east parking lot and beach access road and Wetland 2b is just west of Wetland 2a. Categories assigned by the rating system are: Category I (score ≥ 70), Category II (score 51-69), Category III (score 30-50), and Category IV (score < 30). All three wetlands rated are considered depressional wetlands and qualify as Category III wetlands. Scores for the wetlands are shown in Table 34.

Table 34. North Jetty Wetland Scores

Function	Wetland		
	2a	**2b**	**3**
Water Quality Functions	12	20	12
Hydrologic Functions	5	10	12
Habitat Functions	13	13	15
Total Score	30	43	39

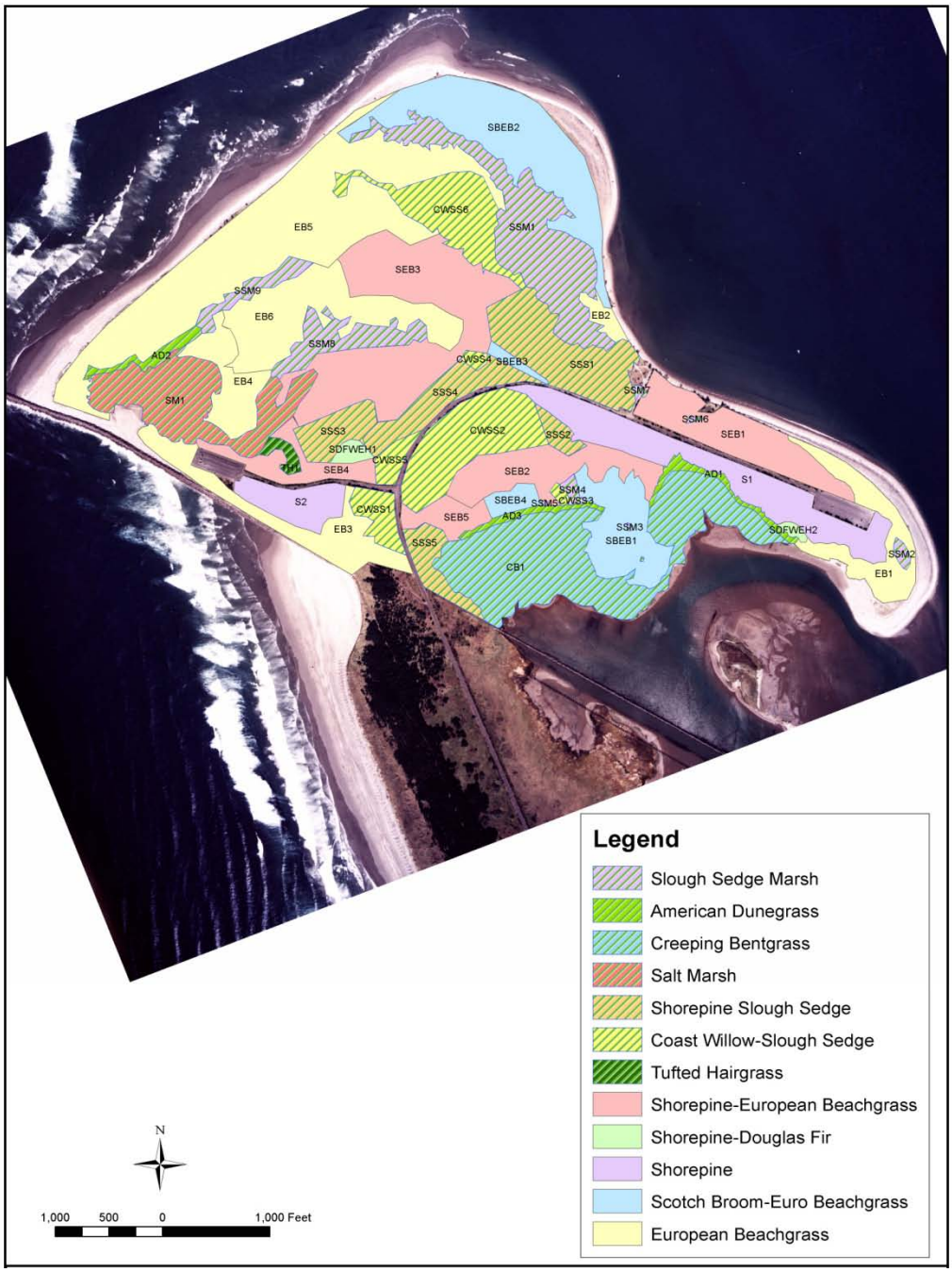
Note: Rating by Washington State Wetland Rating System.

Wetlands near the South Jetty (on Clatsop Spit)

Though official delineations have not yet been completed near the South Jetty, habitat surveys (Tetra Tech, 2007b) suggest that of the 600-acres of Clatsop Spit surveyed, there are likely 193-acres of wetlands. The topography of the area is complex with dunes and intertidal swales forming a mosaic of various vegetation communities, including: shorepine-slough sedge, slough sedge marsh, American dune grass, creeping bent grass, salt marsh, coast willow-slough sedge, tufted hair grass, shorepine-European beach grass, shorepine-Douglas fir, shorepine, Scotch

broom-European beach grass, and European beach grass (Figure 40). At least three of these communities (shorepine-slough sedge, shorepine-Douglas fir, and coast willow-slough sedge) have been ranked globally and by the state for their rarity and vulnerability to extinction.

Figure 40. Clatsop Spit Vegetative Communities (Tetra Tech 2007b)



It is anticipated that the proposed actions will avoid most impacts to wetlands and waters of the United States in this area to the maximum degree feasible. The marsh wetlands at the South Jetty are also mostly isolated and separated from active direct ocean access by an existing dune

that precludes regular connectivity, therefore regular anadromous fish use is not expected. However, fish monitoring surveys from the 2007 repairs did observe some stranding of threespine stickleback (*Gasterosteus aculeatus*), which was reported to NMFS. As mentioned, at the South Jetty fish salvage and exclusion have been proposed to avoid stranding listed species.

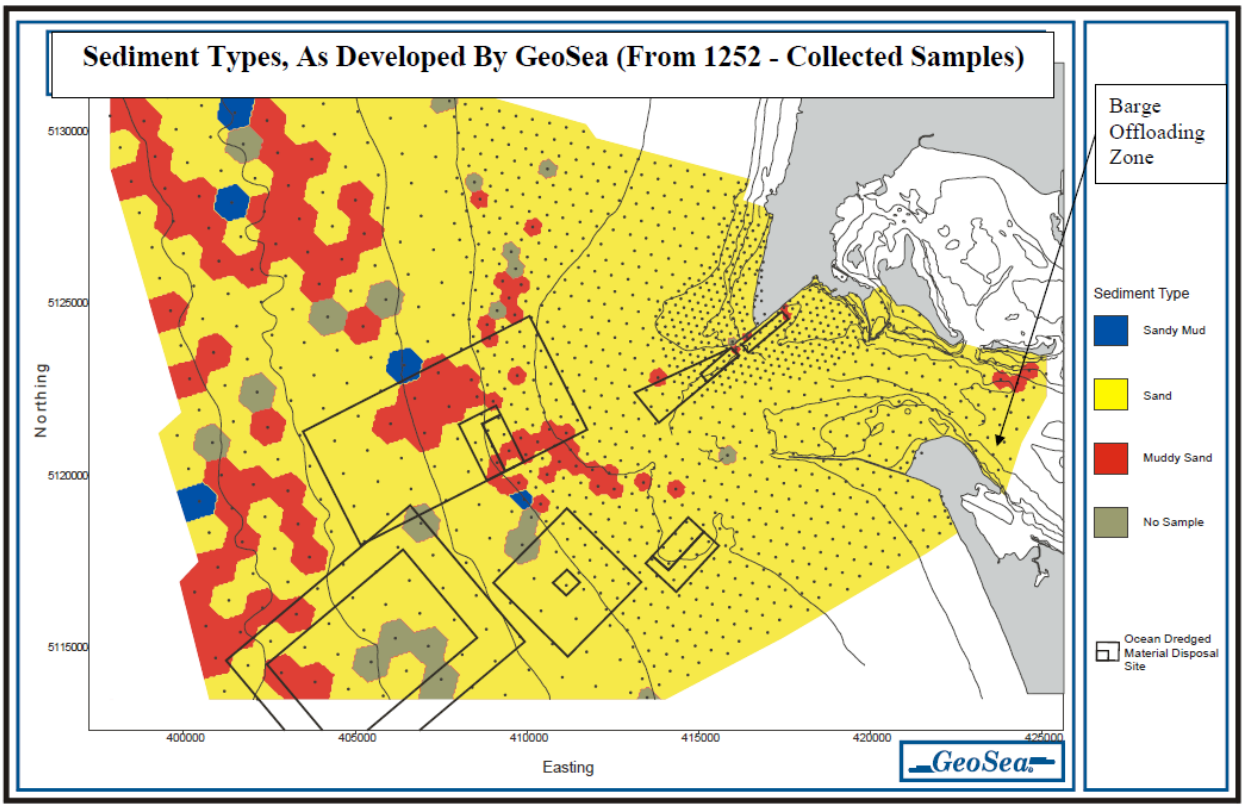
Wetlands near Jetty A

Land around the base of Jetty A received a cursory inspection on January 22, 2007 and on September 13, 2010. It is possible that sparse, perched wetlands composed of sedge and grassy fringe estuarine wetlands were present; no official wetland delineation was completed.

Sediment Quality

In 2000 a Sediment Trend Analysis (STA) was conducted by GeoSea Consulting, under contract to the Corps. Over twelve hundred (1,252) samples were collected in the MCR and surrounding off-shore locations (Figure 41). Physical analyses, of the samples surrounding the study area (6 samples selected), indicate the project area consists of >99 % sand. Select samples (10) from the GeoSea study in the MCR project were analyzed for physical and chemical contamination. These samples indicated no contaminates were detected at or near the DMEF screening levels. See http://www.nwp.usace.army.mil/ec/h/hr/Reports/Mcr/mouth00.pdf for the complete report on chemical results (Corps 2008).

Figure 41. Sediment Trend Analysis in MCR Area



In 2005 a Tier I evaluation was conducted near the proposed the South Jetty barge offloading site following procedures set forth in the Inland Testing Manual (ITM) and the Upland Testing Manual (UTM). The methodologies used were those adopted for use in the Dredge Material Evaluation Framework (DMEF) for the Lower Columbia River Management Area, November 1998, and its updated draft 2005 version, the Sediment Evaluation Framework (SEF). This Tier I evaluation of the proposed dredge material indicated that the material was acceptable for both unconfined in-water and upland placement. No significant, adverse ecological impacts in terms of sediment toxicity were expected from disposal (Corps 2005a).

In 2008 using USEPA's OSV Bold, ten Van Veen surface grab samples were collected from sites previously sampled during the September 2000 sediment evaluation study. Percent sand averaged 98.45% with a range of 99.3% to 97.0%. Percent silt and clay averaged 1.59% ranging from 3.0% to 0.7%. Per the Project Review Group approved SAP, no chemical analyses were conducted. Physical results for the 2000 and 2008 sampling events were compared. The mean percent sand for all samples in September 2000 was 98.11% for June 2008 it was 98.45%. Within both data sets, sediment towards the outer portion of the mouth is finer than sediments towards the center of the mouth (Corps 2008).

Other Activities and Conditions

Commercial and recreational fishing activities also have some influence on listed species and their prey items in the action area. The major fisheries are for bottom fish, salmon, crab, and other species of shellfish. Crab fishing occurs from December to September with the majority of the catch occurring early in the season. Most crab fishing occurs north of the Columbia River mouth at depths ranging from 25 to 250 feet mean sea level (MSL). Dungeness crab population numbers are subject to large cyclic fluctuations in abundance. Catch records for fishery are generally believed to represent actual population fluctuations. Modeling studies by Higgins and others (1997) show that small scale environmental changes, such as a short delay in the onshore currents in spring, can dramatically impact survival of young-of-the-year crab but have no effect on adults and older juveniles inshore. Bottom fishing by trawl for flatfish, rockfish, and pink shrimp occurs year-round throughout the entire offshore area, primarily at depths offshore from the jetties. Many of these species interact with listed species in a predator-prey relationship that, in some cases, can change over the course of each species' life history. Fisheries could have some effect on prey availability and species numbers in the action area.

EFFECTS OF THE ACTION

Effects of the action refers to 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). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. The Corps has determined that the effects of the proposed action could occur from:

- Rock Transport
- Construction Access, Staging, Storage, And Rock Stockpiling
- Rock Placement
- Dredging
- Disposal
- Barge Offloading Facilities
- Pile Installation and Removal
- Lagoon And Wetland Fill And Culvert Replacement
- Dune Augmentation
- Water Quality
    - Suspended sediment
        - Dredging
        - Disposal
        - Pile Installation and Removal
    - Spills Leaks
    - Contamination
- Hydraulic and Hydrological Processes
    - Water Velocity
    - Salinity and Plume Dynamics
    - Bed Morphology
- Wetland Mitigation and Habitat Improvements

Rock Transport

As discussed, barge transport of stone from quarry sites is likely and would occur mostly during daylight hours along major navigation routes in existing harbors and navigation channels. The number of additional barge trips per year attributable to the proposed action is expected to be somewhere between 8 and 22 ships. This is small annual percentage increase relative to the current number of other commercial and recreational vessels already using any of these potential routes. MCR is the gateway to the Columbia-Snake River system, accommodating commercial traffic with an approximate annual value of $16 billion dollars a year. Loaded water-borne

container traffic identified as foreign in- and outbound to/from Portland that would likely have crossed the MCR in 2008 totaled approximately 195,489 ships (Corps 2010). Traffic from the proposed action will also be limited mostly to summer months when fair weather allows safe passage. Though transport will occur on an annual basis, stone may or may not be delivered to one or more jetties seasonally. Due to the infrequency of these vessel trips, their geographic limitation to existing navigation channels, and their minimal duration in any particular area, the disturbance effects are expected to be discountable. The proposed action will not cause any meaningful increase (less than 1%) in annual vessel traffic along the routes or around the MCR jetty system.

Construction Access, Staging, Storage, and Rock Stockpiling

Construction activities will occur on an annual basis, could happen through-out the year, and may occur at one or more jetties simultaneously. Upland effects could include: repetitive disturbance; de-vegetation; residual rock side-cast; and soil compaction. Changes in soil structure and composition could also result in localized habitat conversion of the vegetative and biological communities. Invasive species are located in the vicinity of all three jetties, and chronic disturbance can increase the spread and establishment of such species. Changes in the plant communities can also cause trophic effects on the faunal communities that rely on these ecosystems for forage and habitat. However, the Corps expects effects to listed species from associated construction activities for staging, roadways, and stockpiles to be localized at all jetties, as the majority of these construction features are located in upland areas above mean high tide elevation. Species exposure is therefore highly unlikely. Avoidance and minimization measures have reduced the construction footprint where possible, and higher value habits like marsh wetlands and slough sedge communities have been preserved such that activities are limited to areas where previous disturbance and development have already occurred. Wetland fill effects from these activities are discussed in the wetland fill section. Whenever feasible, stabilizing dune vegetation is being preserved and little if any riparian or vegetative cover will be removed or disturbed. Furthermore, protective fencing, set-backs, and an Erosion and Sediment Control Plan or Stormwater Protection Plan will be implemented so that best management practices (BMPs) avoid stormwater erosion and run-off from disturbed areas. The topography in this area is flat, and proposed impact minimization measures for construction will reduce the likelihood for sediment to enter the Columbia River. When construction activities are suspended for the season, appropriate demobilization and site stabilization plans will limit the distribution and duration of any effects. No pollutants are expected to enter waterways. There may be some disturbance from equipment sounds and human presence, but these will be indirect and of low intensity, mostly during daylight hours and summer months. Therefore, disturbance effects from these activities are expected to be minimal and discountable.

Rock Placement

Rock placement will occur on an annual basis starting in the late spring through the late to early fall seasons. Placement may occur at more than one jetty per season and will occur regularly throughout the duration of the construction schedule. Some permanent habitat conversion and modification will occur as a result of stone placement for repair and rehabilitation of jetty features. Along specific portions of North and South jetties and along the entire length of Jetty A, substrate will be converted to rocky sub and intertidal habitat, and associated benthic

communities will be covered. In addition, crane set-up pads and turnouts will require placement of rock that could extend slightly off the current centerline of the jetty trunk. However, this total area is a relatively small percentage of the existing jetty structures, and conversion is mostly limited to the spur groin locations. Generally, effects to in-water habitat could include the following sub-tidal and intertidal habitat conversion from sandy to rocky substrate and potential unforeseen indirect far-field effects from hydraulic influence (slight, localized changes to accretion, currents, velocities, etc). However, relatively little habitat conversion and footprint expansion will occur because a majority of the stone placement for construction of the jetty head, trunk, and root features will occur on existing relic jetty stone and within the existing structural prism. Moreover, species will experience limited exposure, since stone placement for cross-section repair and rehabilitation actions occurs mostly above the MHHW elevation. This is summarized below.

North Jetty

- About 58% of the overall stone placement on these portions of the jetty will be placed above mean higher high water (MHHW); about 25% of the volume will be placed between MHHW and MLLW; and about 18% of the volume placed will be below MLLW. Therefore, approximately 83% of the volume placed for trunk and root cross section repairs is above MLLW. There is no expected expansion of the footprint beyond the relic jetty stone or structure.
- A small percentage (about 0.1%) of the overall stone placement for spur groins will be above MHHW; about 4% will be placed between MHHW and MLLW; and about 95.9% will be placed below MLLW. Therefore, approximately 96% of the spur groin construction will be below MLLW, and this will cause 1.55 acres of habitat conversion from sandy to rocky substrate. Bottom topography and shallow water habitat will be altered in a limited geographical area, and benthic organisms will be covered. This is a small percentage relative to the existing acreage of the jetty structure and the available adjacent remaining shallow-water sand habitat in the vicinity of the action area. These structures are also relatively short, remaining close to the jetty trunk and root. Channel-side groins are submerged a minimum of 5 to 35 ft below MLLW.
- About 49% of the overall stone placement on the capping portions of the jetty will be placed above MHHW; about 24% of the volume will be placed between MHHW and MLLW; and about 27% of the volume placed will be below MLLW. Therefore, approximately 73% of the volume placed for head capping will remain above MLLW. This feature is not expected to expand beyond the footprint of the relic jetty stone.
- Stone placement for barge offloading facilities (additional effects discussed further elsewhere), turn-outs, and set-up pad facilities will cover and convert about 0.63 acres and will be confined within the same location as the stone placed for repairs. This is a small percentage relative to the existing acreage of the jetty structure and the available adjacent remaining shallow-water sand habitat in the vicinity of the action.

South Jetty

- About 68% of the overall stone placement on these portions of the jetty will be placed above mean higher high water (MHHW); about 19% of the volume will be placed

between MHHW and MLLW; and about 13% of the volume placed will be below MLLW. Therefore, approximately 87% of the volume placed for trunk and root cross section repairs is above MLLW. There is no expected expansion of the footprint beyond the relic jetty stone or structure.

- A small percentage (about 0.1%) of the overall stone placement for spur groins will be above MHHW; about 12.3% will be placed between MHHW and MLLW; and about 87.6% will be placed below MLLW. Therefore, approximately 88% of the spur groin construction will be below MLLW, and this will cause 1.10 acres of habitat conversion from sandy to rocky substrate. This is a small percentage relative to the existing acreage of the jetty structure and the available adjacent remaining shallow-water sand habitat in the vicinity of the action area. These structures are also relatively short, remaining close to the jetty trunk and root.
- About 52% of the overall stone placement on the capping portions of the jetty will be placed above MHHW; about 25% of the volume will be placed between MHHW and MLLW; and about 23% of the volume placed will be below MLLW. Therefore, approximately 77% of the volume placed for head capping will remain above MLLW. This feature is not expected to expand beyond the footprint of the relic jetty stone or structure.
- Stone placement for barge offloading facilities, causeways, turn-out, and set-up pad facilities will cover and convert about 1.96 acres. This is a small percentage relative to the existing acreage of the jetty structure and the available adjacent remaining shallow-water sand habitat in the vicinity of the action.

Jetty A

- About 63% of the overall stone placement on these portions of the jetty will be placed above mean higher high water (MHHW); about 29% of the volume will be placed between MHHW and MLLW; and about 8% of the volume placed will be below MLLW. Therefore, approximately 92% of the volume placed for trunk and root cross section rehabilitation will remain above MLLW. There may be some expansion of the footprint beyond the relic jetty stone or structure. This is not expected to extend beyond 10-ft off the existing prism, which is a possible conversion of 1.2 acres from sandy to rocky substrate. This is a small percentage relative to the existing acreage of the jetty structure and the available adjacent remaining shallow-water sand habitat in the vicinity of the action.
- 100% of the spur groin construction will be below MLLW, and this will cause 0.61 acres of habitat conversion from sandy to rocky substrate. This is a small percentage relative to the existing acreage of the jetty structure and the available adjacent remaining shallow-water sand habitat in the vicinity of the action area. These structures are also relatively short, remaining close to the jetty trunk and root. Both groins are submerged a minimum of 5 below MLLW.
- About 44% of the overall stone placement on the capping portions of the jetty will be placed above MHHW; about 26% of the volume will be placed between MHHW and MLLW; and about 30% of the volume placed will be below MLLW. Therefore, approximately 70% of the volume placed for head capping will remain above MLLW.

This feature is not expected to expand beyond the footprint of the relic jetty stone or structure.

- Stone placement for barge offloading facilities, causeways, turn-out, and set-up pad facilities will cover and convert about 2.89 acres. This is a small percentage relative to the existing acreage of the jetty structure and the available adjacent remaining shallow-water sand habitat in the vicinity of the action.

Indirect disturbance effects due to placement activities will be localized and occur mostly during daylight hours in the summer months. Disturbance effects are expected to be of limited duration and minimal, since a majority of the placement is above MHHW and on existing relic stone. The Corps does not expect long-term negative effects from these actions.

Dredging

As previously described, dredging will for construction and maintenance of barge offloading facilities and is likely during early summer prior to rock delivery, but may not occur at all facilities annually. If all facilities were dredged, this would total about 16 acres near the jetties. However, it is likely only one or two facilities would be used seasonally for short durations and would be dredged on a periodic basis as needed.

The effects of dredging on physical habitat features include modification of bottom topography, which in the vicinity of the jetties is by nature extremely dynamic. Dredging may convert intertidal habitats to subtidal, or shallow subtidal habitats to deeper subtidal. Such conversions may affect plant and animal assemblages uniquely adapted to the particular site conditions these habitats offer. However, the dredged prisms are very small as a relative percentage of the ~19,575 acres of shallow-water habitat available within a 3-mile proximity to the MCR. The proposed dredging of the offloading facilities will affect bottom topography, but is unlikely to cause large-scale or long-term effects to habitat features. Dredging activities will also have some contribution to increased acoustic disturbance that could occur for a limited duration while dredging is underway. These effects are expected to attenuate rapidly such that they return to background levels within a short distance from the source.

The effects on water quality and suspended sediment are discussed further under the Water Quality section.

Disposal

Disposal is likely to occur on an annual basis originating from one or more of the offloading facilities. The duration of disposal will be limited and will likely occur earlier in the construction season prior to use of offloading facilities. As mentioned previously, all disposal of dredged material will be placed at previously evaluated and EPA-approved in-water ODMDS or Clean Water Act disposal sites. No new or different impacts to species or habitats than those previously evaluated by EPA for disposal approval are expected from these actions. Per EPA guidelines, all ocean dumping sites are required to have a site management and monitoring plan (SMMP) which is aimed at assuring that disposal activities will not unreasonably degrade or endanger the marine environment. This involves regulating the times, the quantity, and the

physical/chemical characteristics of dredged material that is dumped at the site, establishing disposal controls, and monitoring the site environs to verify that unanticipated or significant adverse effects are not occurring from past or continued use of the disposal site and that permit terms are met. The relative quantities, characteristics, and effects of the proposed action area not expected to have different or significant negative impacts to these sites.

The effects of disposal on physical habitat features include modification of bottom topography. In some cases, disposal may result in the mounding of sediments on the bed of the disposal site. Such conversions may affect plant and animal assemblages uniquely adapted to the particular site conditions these habitats offer. However, the area impacted by disposal is relatively small and will likely occur in deeper habitat offshore, in the littoral cell or near the North Jetty vicinity. The proposed disposal is unlikely to cause large-scale or long-term effects to habitat features. The effects on suspended sediment are discussed further under the Water Quality section.

Barge Offloading Facilities

Installation of offloading facilities is likely to occur once, likely in the late spring or early summer prior to or during the first season of construction on the associated jetty. Subsequently, periodic maintenance may be required as facilities weather wave and current conditions at the MCR. Facilities may also occasionally be partially removed and reconstructed, which could slightly increase the frequency of disturbance. Depending on the specific facility and contemporary conditions at the time, removal would then occur at the end of the scheduled construction duration. Temporally, this limits the repetition of disturbance activities associated with the construction of these facilities. Use of the facilities may be annual with periodic breaks in between, depending on the construction schedule and conditions at the jetties. Annual use is likely at least one of the facilities and will be seasonally concentrated in the spring, summer, and fall. Though unlikely, occasional breaks in weather could allow offloading at other times of the year.

Stone placement for barge offloading facilities could have the same minimal effects and were described previously under rock placement. However, - with the exception of the facility at Parking Lot D on the Clatsop Spit - construction and maintenance of the facility and associated and piles would be equivalent to actions already occurring from jetty repair and stone placement, and would not cause a separate or cumulative increase in disturbance. Also as mentioned previously, chemically treated wood will not be used for decking material, as treated decking could leach toxic substances into the water. Therefore water quality is not expected to be negatively impacted by these facilities. Possible effects of the action to water quality are discussed under Water Quality. Offloading facilities will be areas of slightly increased activity and vessel traffic, but the intensity of use is expected to be low and seasonal in nature. Additional noise from vessel activities may increase disturbance, but acoustic effects are not expected to reach harmful levels and will be geographically and temporally limited. A return to background noise levels is likely near the source.

The effects from dredging and pile installation and removal for these facilities are discussed under their respective sections.

Pile Installation and Removal

Pile Installation and subsequent removal is likely to occur once, likely in the late spring or early summer prior to or during the first season of construction on the associated jetty. Subsequently, periodic maintenance may be required as piles weather barge use and wave and current conditions at the MCR. Pile may also occasionally be partially removed and installed, which could slightly increase the frequency of disturbance. Depending on the specific associated offloading facility and contemporary conditions at the time, removal would then occur at the end of the scheduled construction duration. Temporally, this limits the repetition of disturbance activities associated with the installation and removal of these structures.

As mentioned previously, for initial construction of all four facilities combined, up to approximately up to 96 Z- or H-piles could be installed as dolphins, and up to approximately 373 sections of Z or H piles installed to retain rock fill. However, it is unlikely that all facilities would be installed at the same time. Installation is likely to happen early in the construction season sometime between April and June, and is weather dependent. Piles will be located within 200-ft of the jetty and offloading structures. Vibratory drivers will be used and will dampen any acoustic effects to fish and other species. Because of the soft substrates in the lower Columbia River, vibratory drivers can be used effectively to install and remove piles. Sound wave form and intensity is not expected to reach harmful levels and are expected to return to background levels within a short distance from the source. Any acoustic impacts would be short duration and intermittent in frequency. Therefore, this action is not expected to have any significant direct effects.

The presence of piles at the offloading facilities could increase perching opportunities for piscivorous birds, especially cormorants and brown pelicans. However, piling caps will avoid any significant increase in new perch sites so that the effects are expected to be minimal and discountable. Furthermore, perching opportunities for these birds are abundant in the lower Columbia River and are not expected to increase cormorant and pelican use of this area.

Wetland and Lagoon Fill and Culvert Replacement

Wetland fills and culvert installations at all jetties will occur once, and could happen during anytime in the construction season depending on weather. Sequentially, these actions will be required prior to several of the other proposed action. Subsequent removal of construction related culverts is likely to occur once, and could also happen during anytime in the construction season depending on weather and construction need. Periodic culvert maintenance may be required during construction. Temporally, this limits the repetition of disturbance activities to single event and season on separate jetties.

Where possible, the Corps has planned the construction, access, and staging areas at all jetties so that the footprint minimizes impacts to wetlands and higher value habitat features. Protections will be implemented for the identified rare and ranked vegetative communities within this area. Strategic use of uplands and lower quality wetlands for rock storage will be done to the most practical extent in order to avoid and minimize these impacts. However, permanent and temporary wetland fill will occur as a result of construction staging, storage, and rock stockpiles at all three jetties. Fill to protect the North Jetty root will also affect wetlands. Long-term direct

and indirect impacts to wetlands could include: permanent wetland fill; potential fragmentation of and between existing wetlands; soil compaction; loss of vegetation; altered hydrology; conversion to upland; and loss of ecosystem functions (water quality, flood storage, nitrogen cycling, habitat, etc.). However, the Corps further expects effects from wetland impacts and lagoon fill to be insignificant on river functions, as the wetlands are not within the channel prism of the Columbia River. Although these wetlands are connected hydrologically to the Columbia River, wetland fill impacts are not likely to negatively alter groundwater-stream exchange or hyporheic flow because wetlands are on accreted land that has formed on stabilized sand shoals behind the jetties. Wetland hydrology is mostly elevation and rainfall dependent, and fill impacts will be relatively insignificant to the Columbia channel. Culverts will be installed to maintain wetland hydrology and connectivity with permanent replacement at the North Jetty and when temporary construction roadways cross wetlands. See the Wetland Mitigation and Habitat Improvements sections for further information about actions that will offset any habitat and functional losses from wetland fill.

Dune Augmentation

Dune augmentation will occur once during a single season, and could happen likely in the late spring or early summer depending on weather. Sequentially, this actions will be required prior to several of the other proposed action. Periodic maintenance may be required, likely on a decadal scale. This is only proposed at the South Jetty. Therefore, temporally and geographically this limits the repetition of disturbance activities to single event and season on a single jetty.

Dune augmentation at the South Jetty will occur above mean high tide; therefore, actions will cause limited exposure to aquatic species. Though substrate modification will occur along the shoreline, the Corps does not expect any measurable changes from in-water habitat conversion below MHHW. This action is likely to be completed in a single season, and cobble replenishment would likely be on a decadal scale. Clean cobble material will be placed from an existing roadway, and delivery via beach access will be prohibited. Some equipment will be required to move materials around on the dry sand. There is little likelihood of having any direct or indirect negative impacts to water quality or intertidal species, and the amount of dry sand conversion is relatively small compared to the amount of similar adjacent habitat that is available. The effects of this conversion are discountable and species exposure is unlikely.

Water Quality

Effects of the proposed action to water quality could occur by: increasing suspended sediments; increasing the potential occurrence of spills and leaks, and; increasing the potential for contamination. However, the Corps does not expect these effects to be significant.

Placement of rock by heavy equipment, jetty access road construction, dredging, disposal, and pile installation and removal could all cause temporary and local increases in suspended sediment. This is expected to have minimal and limited effects on the environment. Previous tests have confirmed that material to be dredged will be primarily sand with little or no fines, which does not stay suspended in the water column for a significant length of time. During infrequent and limited duration dredging and disposal, suspended sediments may increase locally for a short time. However, light attenuation and water quality effects from increased suspended

sediments are expected to be minimal and fleeting. Pile driving is also expected to occur in sand and therefore have similar transient and minimal effects to water quality. Jetty roads could also contribute suspended sediments that would create turbidity, but since they are above MHHW this will likely be an infrequent occurrence. Increases in turbidity from construction activities on the jetties will likely occur on a nearly daily basis but will be of limited extent and duration, as rock placement will involve clean fill. Wave and current conditions in the action area naturally contribute to higher background turbidity levels; and such conditions also preclude the effective use of isolating measures to minimize turbidity. However, other BMPs described in the proposed action will further reduce effects of turbidity from the proposed action. Effects from potential stormwater runoff were addressed in the Construction Staging and Stockpile section. Therefore, impact from suspended sediments should be insignificant.

The Corps will require the contractor to provide a spill prevention and management plan that will include measures to avoid and minimize the potential for spills and leaks and to respond quickly to minimize damages should spills occur. Good construction practices, proper equipment maintenance, appropriate staging set-backs, and use of a Wiggins fueling system would further reduce the likelihood of leak and spill potential and exposure extent and its associated effects.

Test results on dredge material described earlier further indicated that materials in the area are approved for unconfined in-water disposal and do not contain contaminants in concentrations harmful to organisms occupying the action area. The prohibition of treated wood will also avoid contamination from the migration of creosote and its components [e.g., copper and polynuclear aromatic hydrocarbons (PAHs)] from treated wood in the lotic environments.

Temporally, effects to water quality from suspended sediment and turbidity could occur on a daily basis, but are not expected to be continuous throughout the day. Turbidity levels and durations will be limited to conditions required in the State Water Quality Certifications which include exceedence windows that are protective of beneficial uses like salmonids and other aquatic life. Contamination, spill, or leaks are expected to be infrequent and unlikely. Though, temporally the repetition of disturbance could be greater, this is still expected to remain within safe ranges that do not have long-term or significant effects. Furthermore, effects are expected to be geographically limited, short term and minor.

Hydraulic and Hydrological Processes

As mentioned previously, over the years of project development, USGS and ERDC have conducted numerical modeling to evaluate changes in circulation and velocity, salinity, and sediment transport at the MCR for various rehabilitation design scenarios of the MCR jetty system. The purpose of the 2007 USGS evaluation was to assess the functional performance of the extended jetty system and to aid in the assessment of potential impacts to fish from the rebuilt lengths and spur groins. Except for the spur groins, modeling components including rebuilding jetty lengths is not proposed in this action. However, results under the larger build-out scenario are still relevant for comparing and evaluating previously estimated potential changes to the MCR system as a whole. Previous modeling work also remains somewhat valid for consideration because the current proposed action caps the jetties at their present location, which is essentially the same length as the original base conditions used for the previous models.

In 2007, modeling by USGS was done for two time periods, August-September and October-November. The model period of August-September was in existence from the 2005 Mega-Transect experiment (see below). The October-November run was established for engineering purposes as this time period represents extreme conditions at the MCR. A series of plots was produced to show existing and post-rehabilitation conditions for the following parameters: residual (average for all tides) velocity and current direction for bed and near surface, residual bed load transport, residual total load transport (bed load + suspended load), and mean salinity for bed and near surface. Rehabilitation components for USGS modeling included restoring the lengths of the North Jetty and Jetty A, and installing spur groins (Moritz and Moritz 2010; USGS 2007).

Existing conditions were established using August-September 2005 data collected from the Mega-Transect, a data collection system at the MCR. The Mega-Transect experiment was a 6-week field data collection effort to observe currents, suspended sediment, and salinity-temperature across the MCR. Data was collected concurrently at five fixed locations spanning 2 miles across the MCR during August-September of 2005. Instrumented tripods were placed at these five critical hydraulic-morphologic locations. Acquisition of prototype data describing the three-dimensional circulation within the MCR was intended to improve the hydrodynamic understanding and improve the ability to manage the sediment resources within the inlet/estuary (Moritz et al., undated).

The ERDC analyzed the impacts of the presence of spur groins at the MCR. This analysis was done independently of the modeling conducted by USGS and was conducted with the coastal modeling system (CMS) and other models that operate within the surface water modeling system (SMS). A regional circulation model (ADCIRC) provided the tidal and wind forcing for the boundaries of project-and local-scale wave, current, sediment transport, and morphology change calculated by the CMS. The half-plane version of the wave transformation model, STWAVE, was coupled with two-dimensional and three-dimensional versions of the CMS, which calculates current, sediment transport, and morphology change. These models were coupled to provide wave forcing and update calculated bathymetry used in both models at regular intervals (Connell and Rosati 2007).

Water Circulation and Velocity

The Columbia River estuary has a greater range between high and low tides and receives a larger river discharge than most other estuaries in the U.S. resulting in rapid and turbulent currents. The primary factors controlling circulation in the Columbia River estuary are river flow, tides, and currents resulting from the pressure gradient force. The variability in the above mentioned parameters result in large variability in velocity (see charts presented in Fox et al. 1984). Quinn (2005) notes that there is great spatial variation in estuaries and that and that physiochemical attributes of the water such as depth, salinity, temperature, turbidity, and velocity vary over complex temporal scales including seasonal, lunar, and tidal periods. The USGS modeling results, for example, showed that in near surface waters near the landward portions of the North Jetty, velocity naturally varies with tides to over 1 meter/second during August-September. Under the rebuild scenario, changes to bed and surface velocities and current directions predicted by the models were negligible, particularly with respect to fluctuations that already occur. Though spur groins remain a component, no length rebuild is proposed under the current action.

Therefore, any previously predicted effects to water circulation and velocity are even less likely under the current proposed action.

To further illustrate for the sake of comparison, previous model results quantified changes for the length rebuilds, which were negligible despite the larger scale action than what is currently proposed. When viewing the figures below, it is important to keep in mind they represent a previous action of a larger scope and scale. The representative original condition along with the spur groins is now more reflective of what the likely post-project conditions could entail.

For the August-September timeframe, an increase to residual bed layer velocity was predicted on the west side of the south portion of Jetty A to currents oriented in a south-southeast direction (Figure 42) but mean differences (existing to predicted) were less than 0.1 meter/second in this area. Smaller changes in residual velocities were predicted for near surface waters in the vicinity of Jetty A (Figure 43) (Moritz 2010, USGS 2007). These changes are small (10% or less) relative to the natural variation in this high energy environment. In these velocity charts, length of arrows indicates magnitude of velocity; red arrows indicate existing conditions and black arrows indicate predicted conditions resulting from implementation of the proposed project.

Under the length rebuild scenario, surface current direction for the August-September timeframe was predicted to change slightly toward the north as water flowed around Jetty A forming a more pronounced clockwise eddying effect west of Jetty A and tending to force water more directly toward the North Jetty. Residual velocities toward the North Jetty were predicted to decrease, however, and this effect would have protected the North Jetty. Predicted changes to current direction in the bed layer are less pronounced than in the surface layer (Figures 44 and 45). Changes to current direction and velocities are negligible in the vicinity of the South Jetty (Figure 45) (Moritz 2010, USGS 2007).

Figure 42. Residual Velocity Bed Layer for August/September Time Window

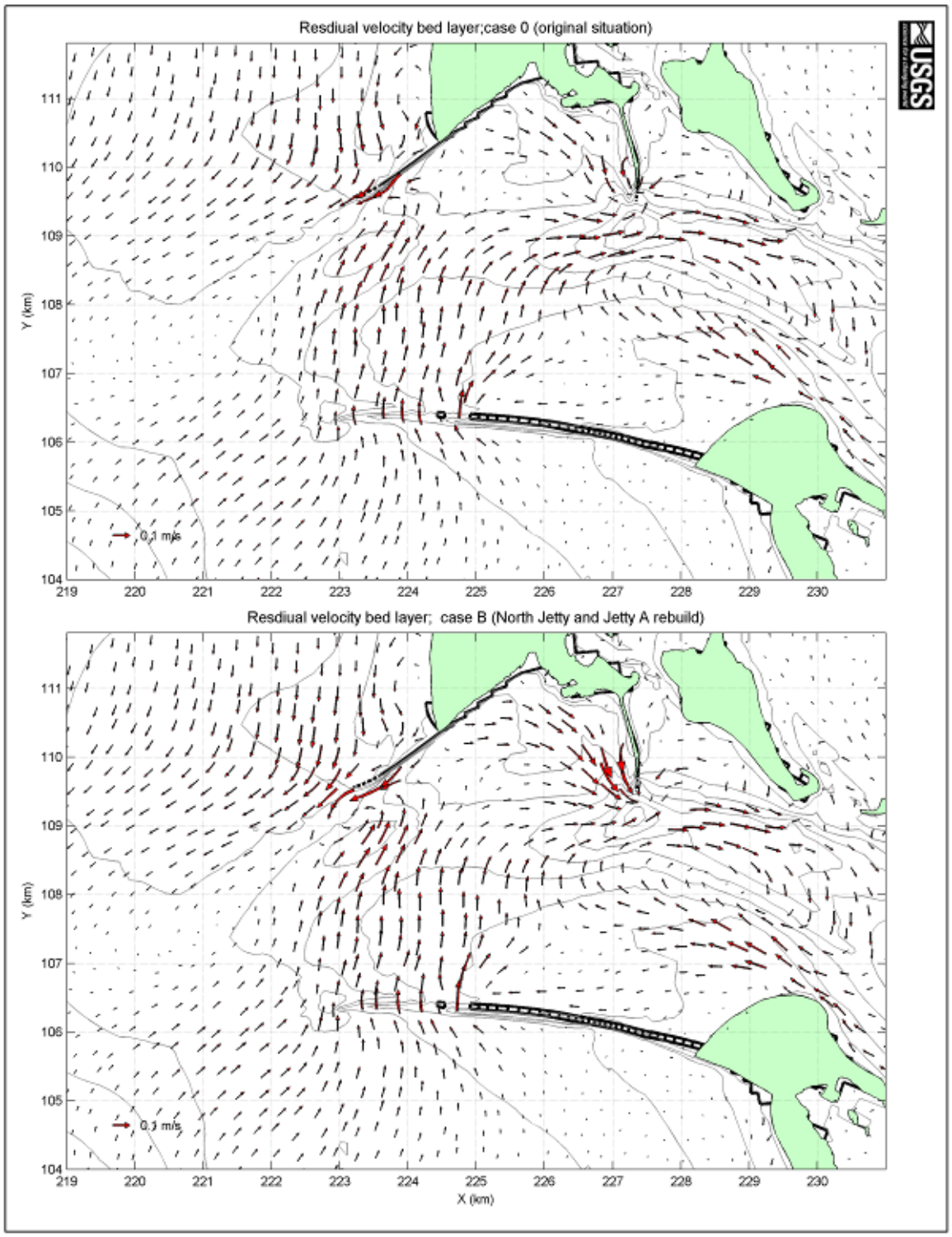


Figure 43. Residual Velocity Surface Layer for August/September Time Window

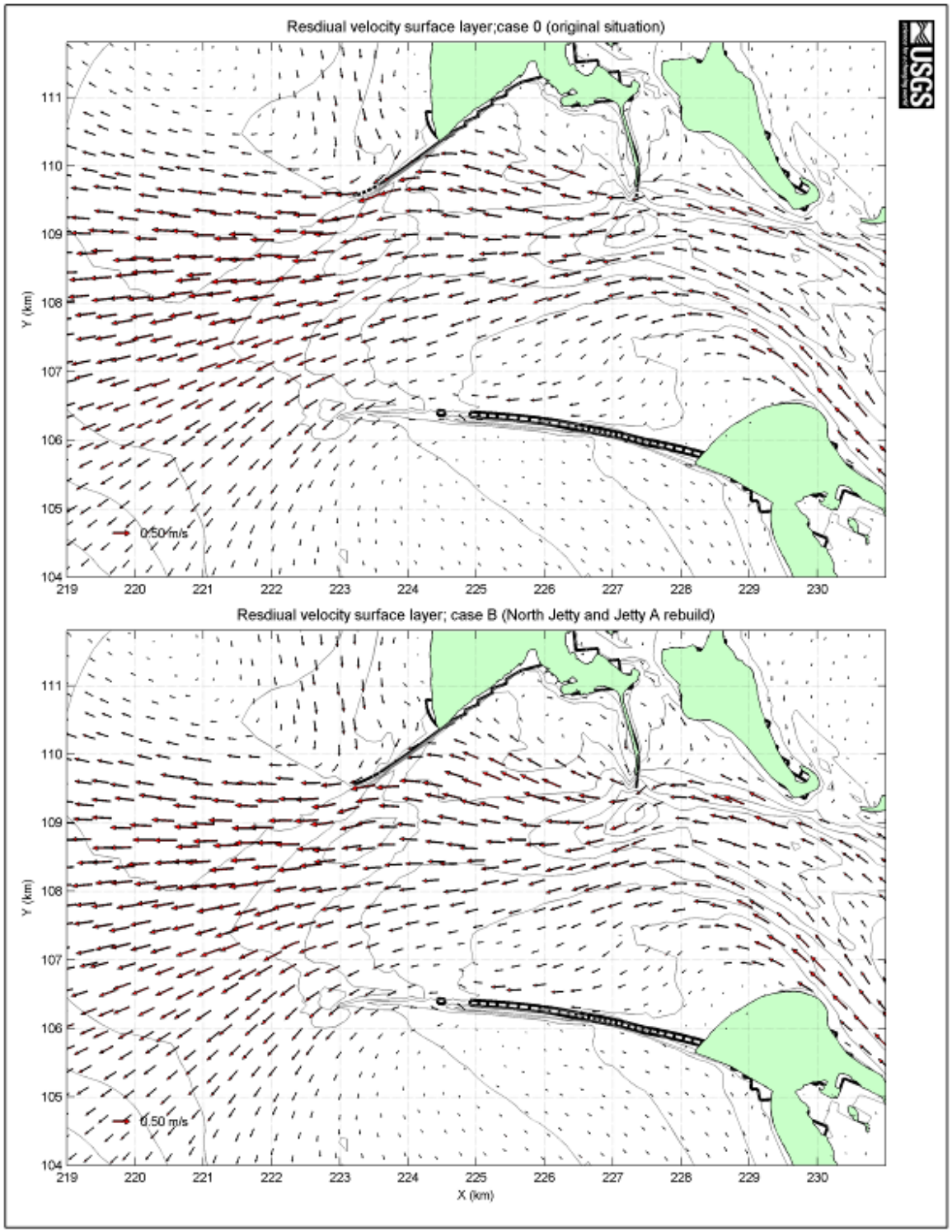


Figure 44. Residual Velocity near North Jetty and Jetty A for August/September Time Window

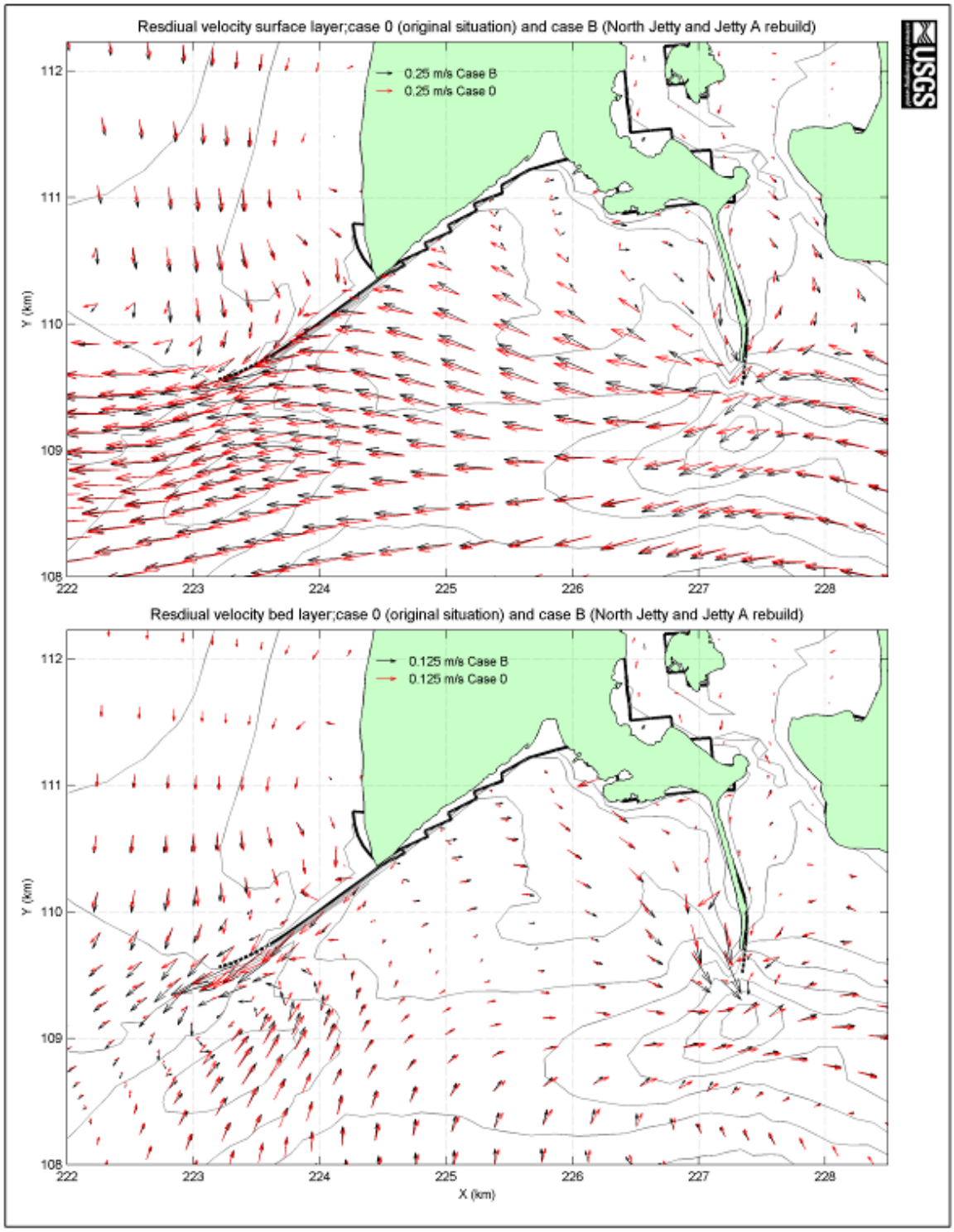
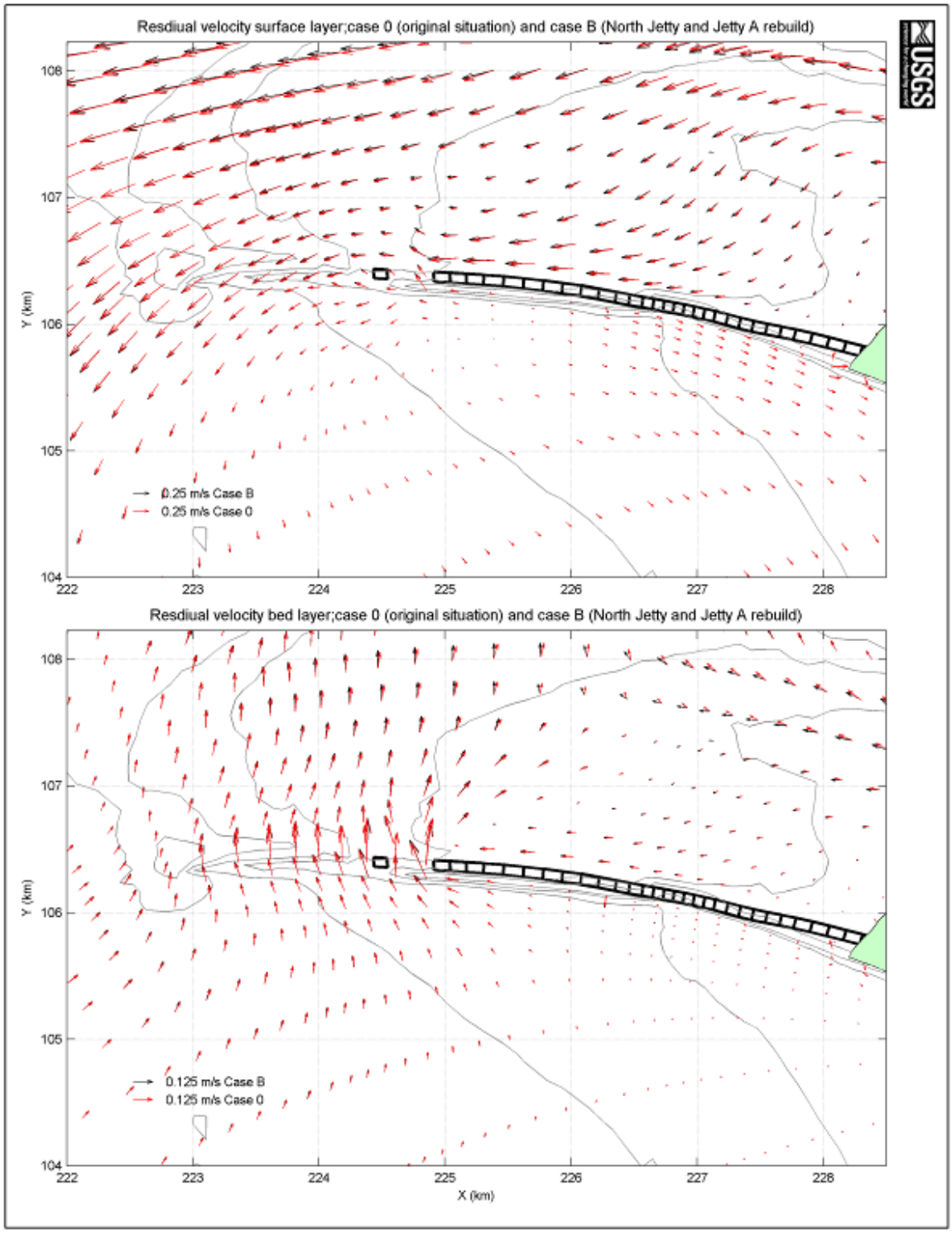


Figure 45. Residual Velocity near South Jetty for August/September Time Window



For the October-November timeframe, the situation was similar to the August-September timeframe in that a relatively large increase to residual bed layer velocity, compared to other areas in the MCR, was predicted on the west side of the south portion of Jetty A to currents oriented in a south-southeast direction (Figure 46) (Moritz 2010, USGS 2007). These changes, however, as with the August-September timeframe, were small as compared to natural variability.

For the October-November timeframe, current direction was predicted to change slightly toward the north as water flows around Jetty A forming a more pronounced clockwise eddying effect west of Jetty A and tending to force water more directly toward the North Jetty (Figure 47). Residual velocities toward the North Jetty are predicted to decrease, however, and this effect would act to protect the North Jetty, as is the case with the August-September timeframe (Moritz 2010, and USGS 2007). Such changes to velocities and currents are even less likely now since the current proposed action does not involve a length rebuild.

For the October-November timeframe, there also were predicted increases in bed layer velocity near the terminus of the North Jetty (Figure 47). Only small changes in residual velocities were predicted for near surface waters near the North Jetty terminus. Changes in surface current direction are similar to those described above for the August-September timeframe. Changes to velocities and current directions were predicted to be minimal for areas near the South Jetty (Figure 48), because these parameters at the South Jetty are essentially unaffected by alterations on the north side of the river (Moritz 2010, USGS 2007). As mentioned above, such changes are unlikely now since the current proposed action does not involve any length rebuild.

Figure 46. Residual Velocity Bed Layer for October/November Time Window

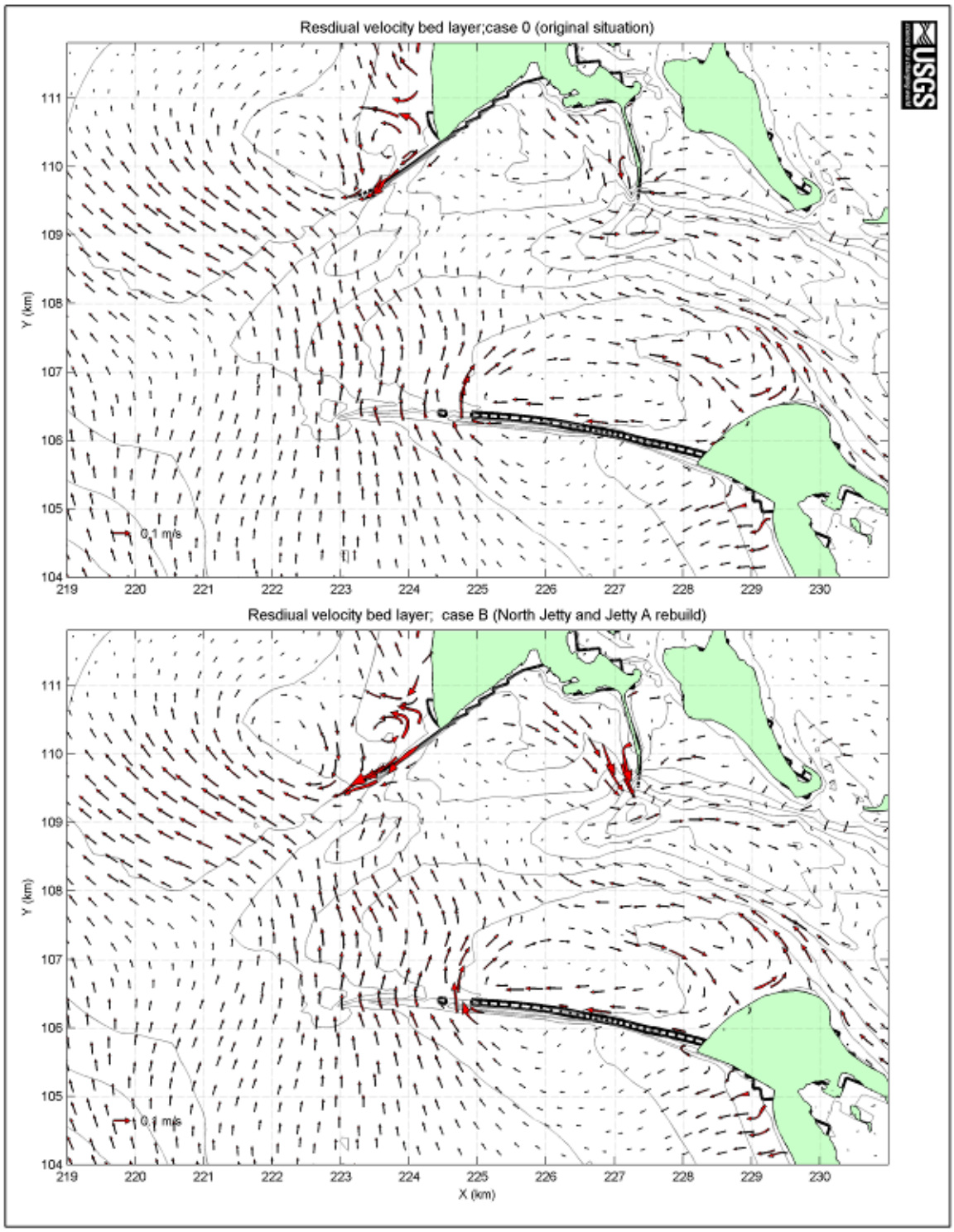


Figure 47. Residual Velocity near North Jetty and Jetty A for October/November Time Window

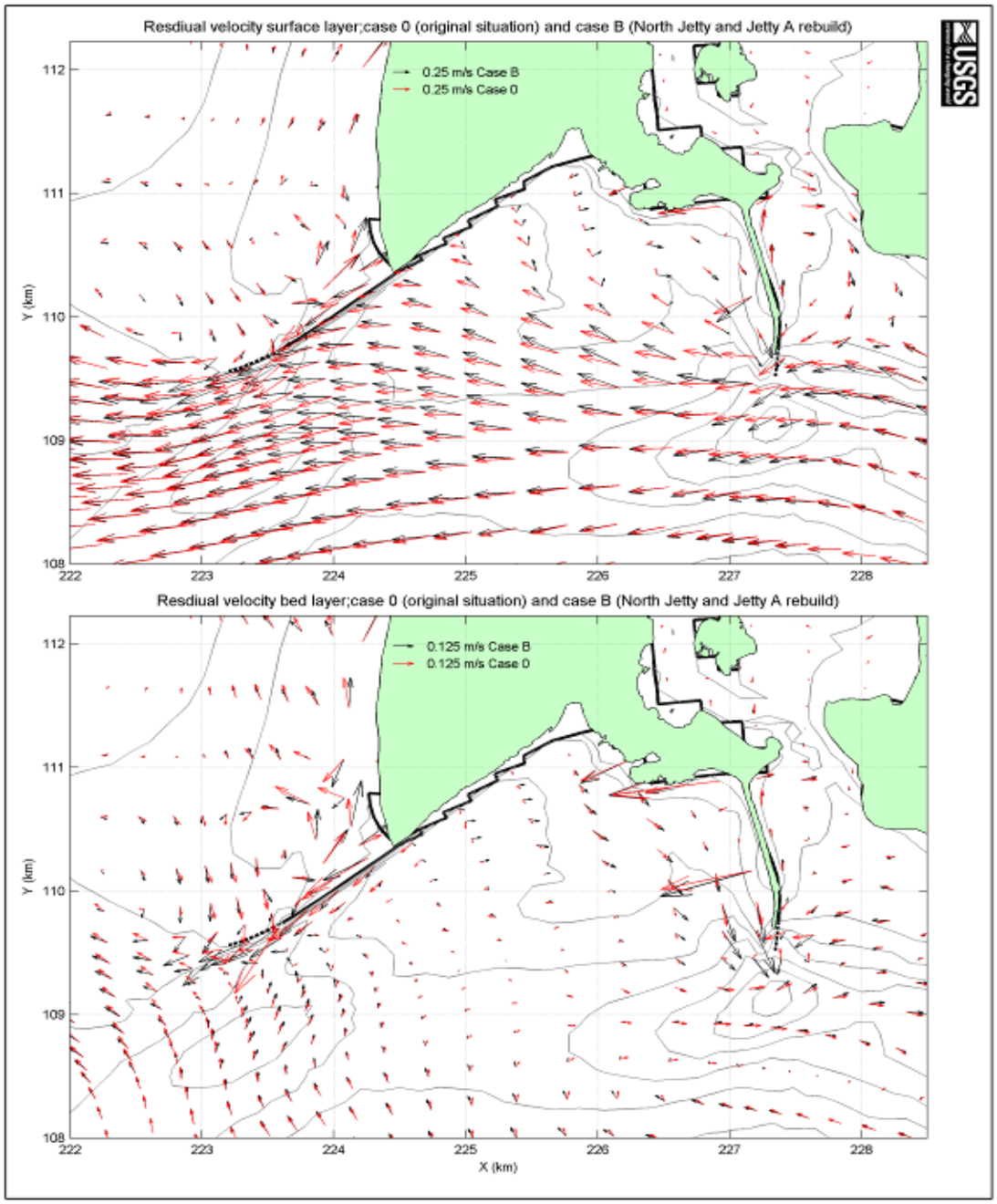
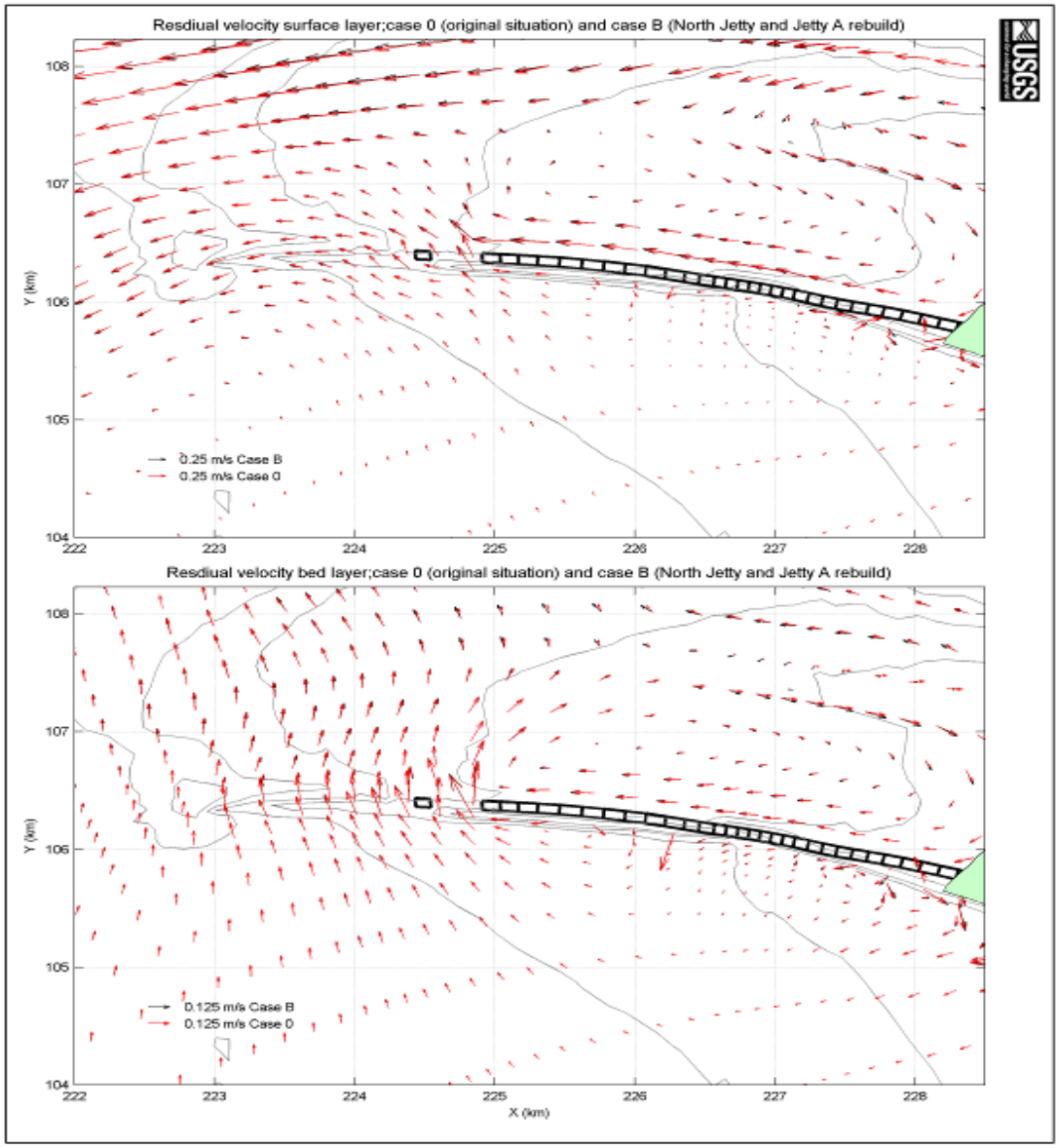


Figure 48. Residual Velocity near South Jetty for October/November Time Window



Salinity

As noted above, the primary factors controlling circulation in the Columbia River estuary are river flow, tides, and currents resulting from the pressure gradient force. Salinity distribution is, in turn, determined by the circulation patterns and the mixing process driven by tidal currents. The variability in the above mentioned parameters also result in large variability in salinity. The USGS modeling results, for example, showed that in near surface waters near the landward portions of the North Jetty, salinity naturally varies with tides to 20 parts per thousand (ppt) during October-November (Moritz 2010, USGS 2007).

As illustrated previously, earlier model results quantified changes to salinity for the length rebuild scenarios. Changes were again negligible despite the larger scale action than what is currently proposed. As before, figures represent changes predicted for action of a larger scope and scale. The representative original condition along with the spur groins is now more reflective of what the likely post-project conditions could entail.

Minor local changes to mean salinity was predicted as a result of implementation of the length rebuild proposed action. For the August-September timeframe, changes to bed layer salinity were predicted in waters between Jetty A and the North Jetty (Figure 49). An increase in mean salinity of 0-4 ppt from 26-28 ppt to 28-30 ppt was predicted to occur over some of this area (Moritz 2010, and USGS 2007) This could be calculated as up to ~ 15% change, but was still well under the 20 ppt (or up to 67%) change range of natural variability. A similar but less extensive salinity pattern was predicted for the near surface layer in waters between Jetty A and the North Jetty, where mean salinity was also predicted to increase 0-4 ppt from 18-20 ppt to 20-22 ppt (Figure 50). For the near surface layer, note that this increase in mean salinity included the area in close proximity to much of the landward portion of the North Jetty. For the near surface layer, a decrease in mean salinity of 0-4 ppt from 12-14 ppt to 14-16 ppt was predicted to occur over a relatively small area south of West Sand Island, which is located just east of Jetty A (Moritz 2010, USGS 2007).

For the October-November timeframe, small patterns of salinity change were also predicted. For the bed layer, a small-scale extrusion of higher salinity water was predicted for the main channel and along the South Jetty as a result of implementation of the proposed action (Figure 51). For example, for the existing condition, salinity in the range of 28-30 ppt occurs just upstream of Jetty A; whereas for the post-project condition, this zone of salinity ended directly south of Jetty A. Only small changes were predicted in the bed layer near the North Jetty. For the surface layer, extrusion of higher salinity water in the main channel was not predicted but was predicted for waters near the South Jetty (Figure 52). For the existing condition, salinity in the range of 24-26 ppt was predicted along the seaward 1/3 of the South Jetty, whereas for the post-project condition this area was predicted to support salinity in the range of 22-24 ppt. A minor reduction of lower salinity waters in the range of 18-20 ppt is predicted for along the landward half of the North Jetty (Moritz 2010, USGS 2007).

In summary, under the rebuild scenario minor local changes to mean salinity were predicted as a result of implementation of jetty build-outs. Even under a larger rebuild, the resulting changes to salinity were also negligible with respect to fluctuations that already occur. No rebuild is proposed under the current action, so any effects to water salinity and plume conditions are even more unlikely.

Figure 49. Mean Salinity for Bed Layer for August/September Time Window

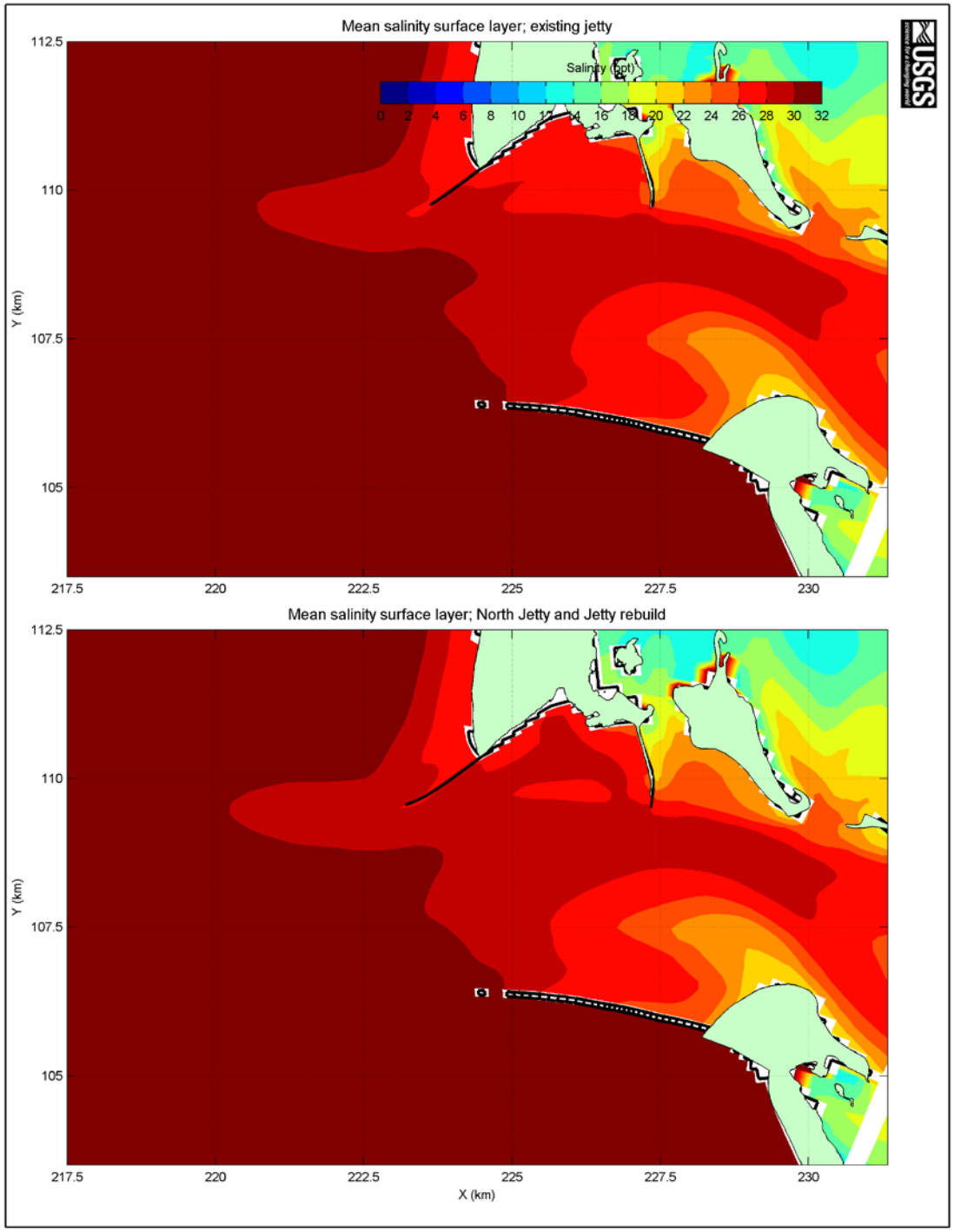


Figure 50. Mean Salinity for Surface Layer for August/September Time Window

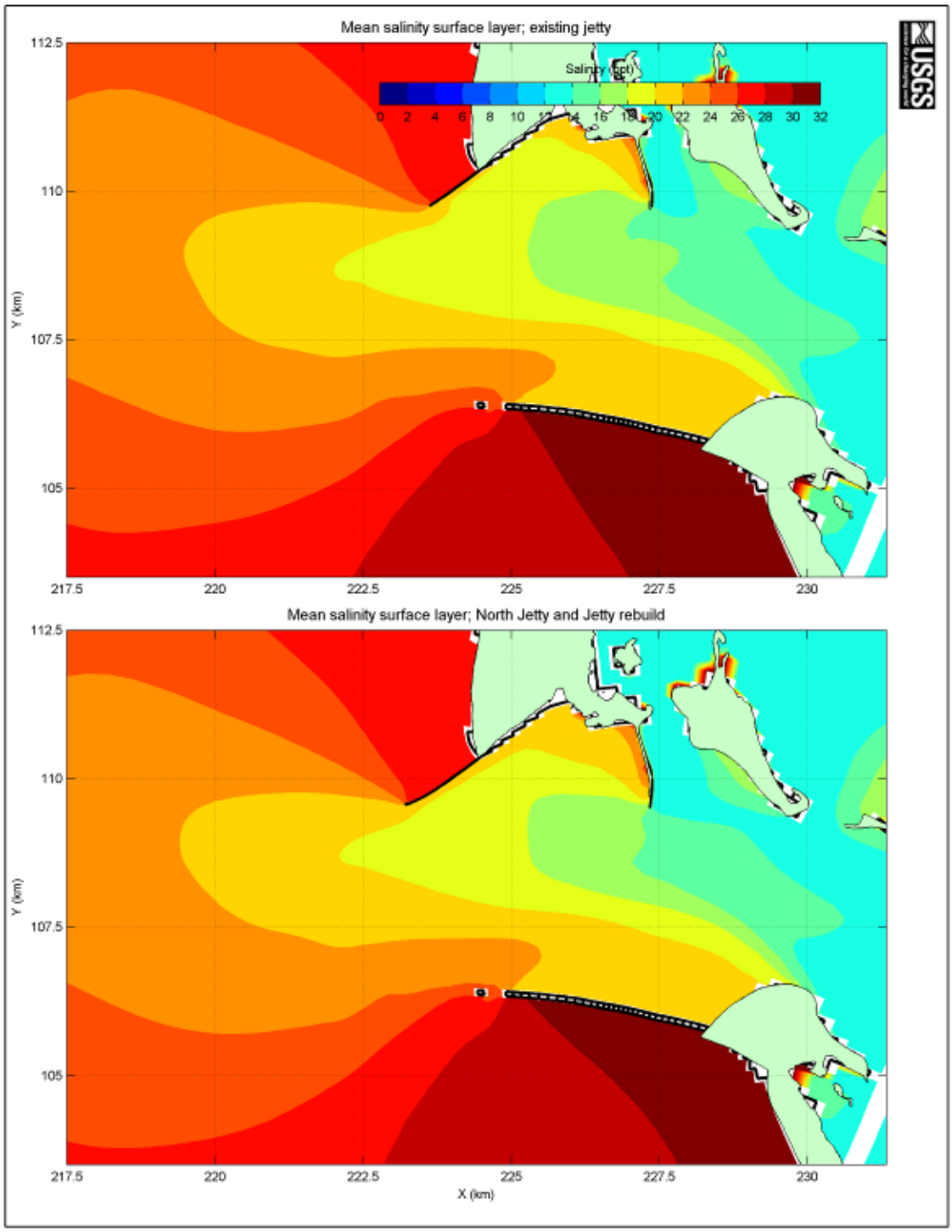


Figure 51. Mean Salinity for Surface Layer for October/November Time Window

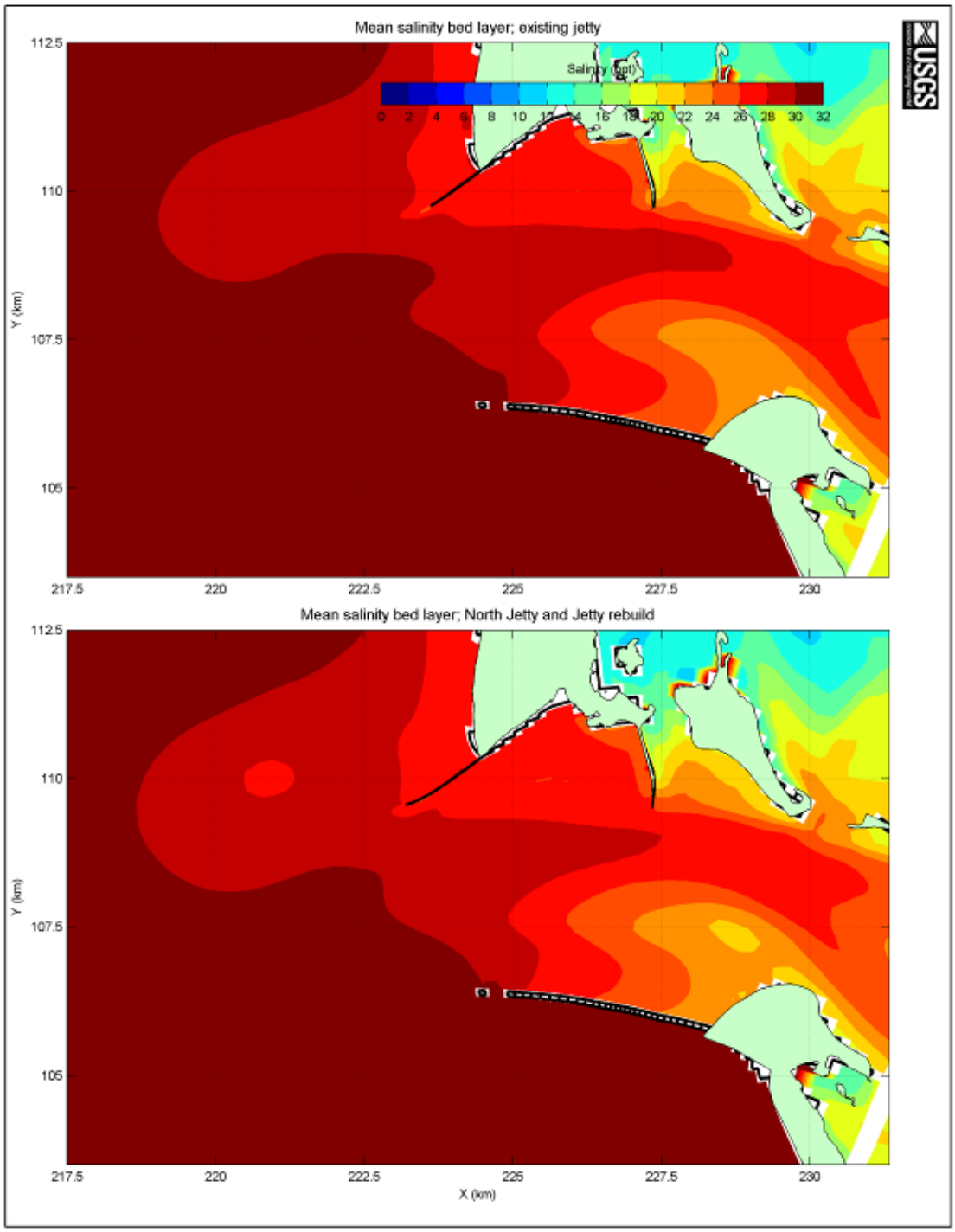
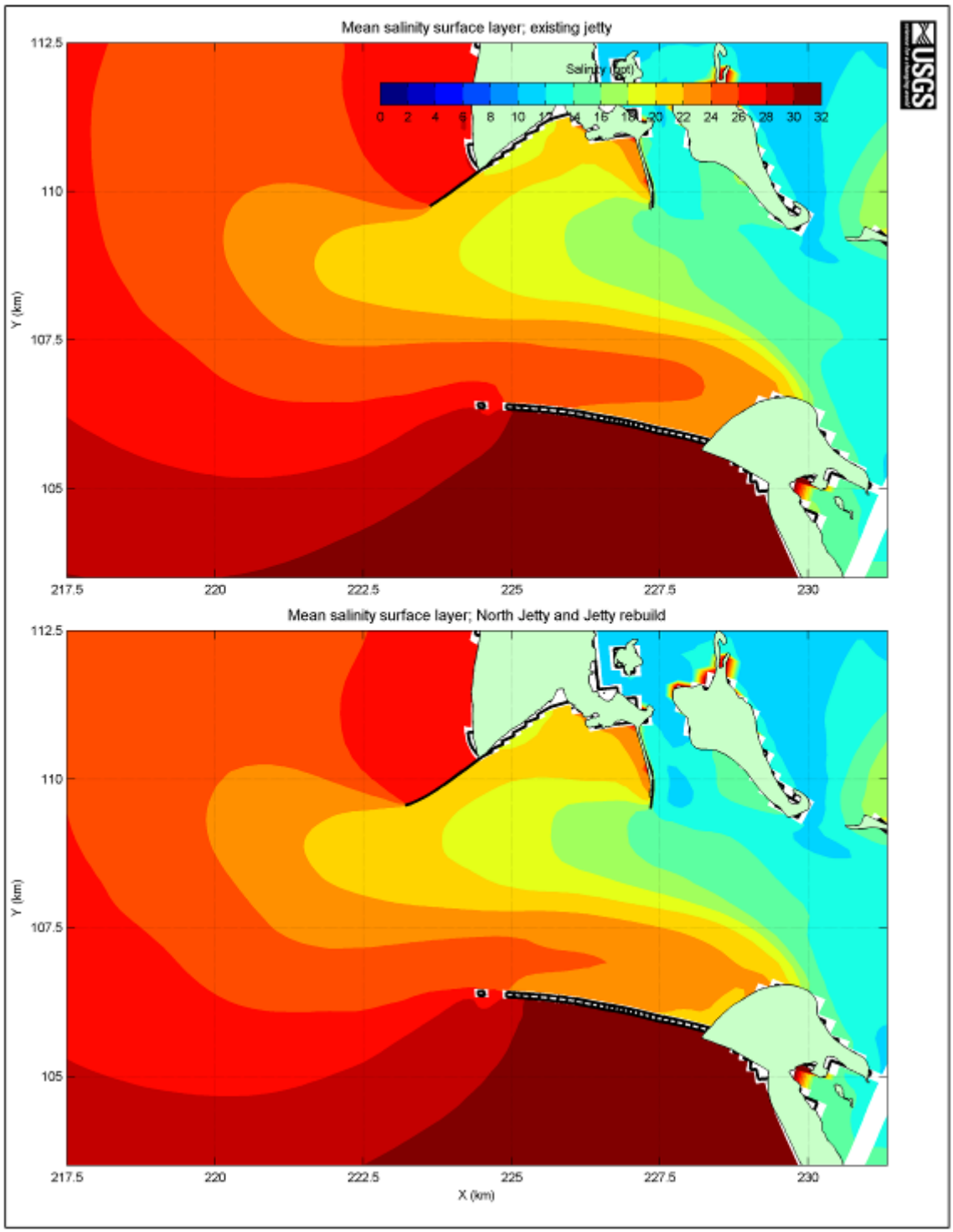


Figure 52. Mean Salinity for Surface Layer for October/November Time Window



Plume Dynamics

The parameters of study in the USGS modeling were predicted to be less affected in the plume than in the entrance itself from construction of the larger rebuild project. It was evident from the above figures that there would be only small predicted changes to residual velocity and current directions for both bed layer and near surface layer for the August-September and October-November timeframes in the plume. A decrease in bed layer salinity of 0-4 ppt (from 28-30 ppt to 26-28 ppt) was predicted in the plume over an oval area west of the terminus of the North Jetty. Only small changes were predicted to residual bed load transport and residual total load transport within the plume for the August-September and October-November timeframes (Moritz 2010, USGS 2007). Under the current proposed action, no length rebuild is included. Because of this smaller scale of action, any minimal changes that were previously predicted under the model comparison would be less likely. The existing conditions of the previous model are somewhat representative of the current proposed action with the addition of spur groins.

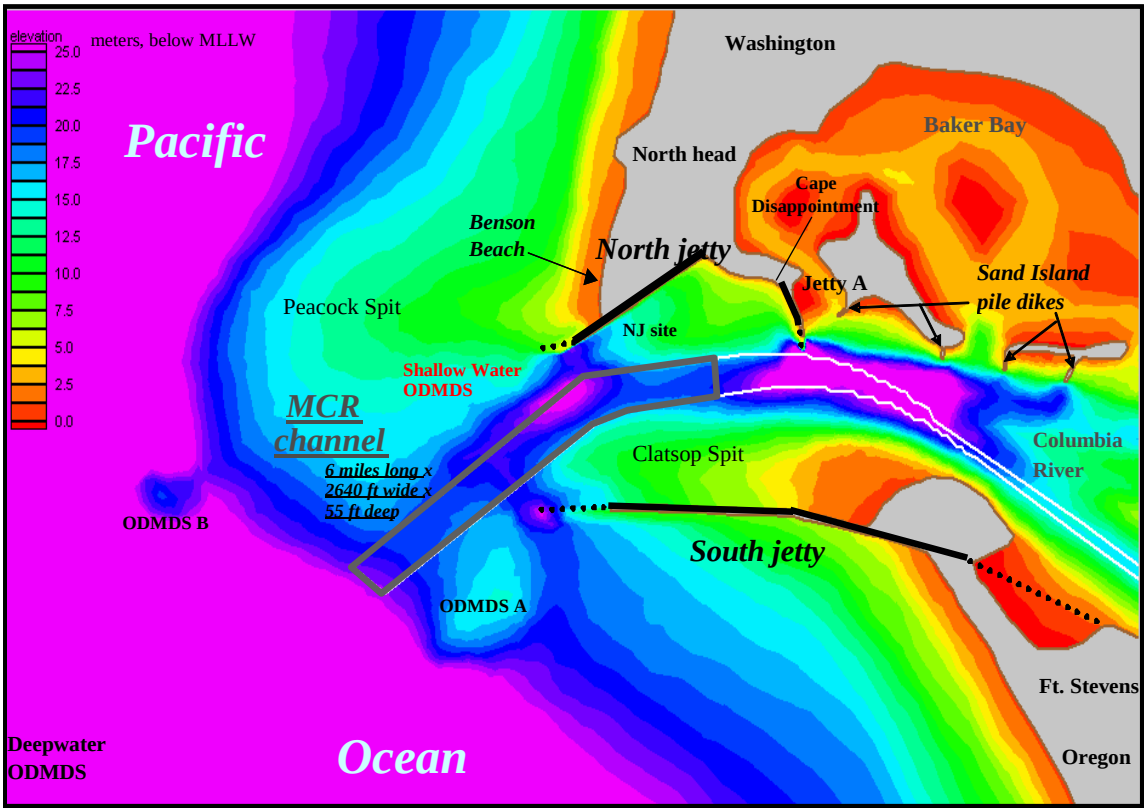
Bed Morphology

Modeling predicted some bed level changes along the seaward channel- side of the North Jetty due to the rebuilt lengths and implementation of spur groins. With longer jetties, change were predicted for both modeled timeframes, but was more pronounced in the winter, with an approximately 8.3% differences in bed elevation of 1.25 to 1.50 meters change from the existing 12 to 24 meters depth. This change is relatively small, however, considering the dynamic environment at the MCR (bathymetry at the MCR is shown in Figure 53). From the ERDC modeling results of the groin structures, it was predicted that a temporary increase in bed level due to sedimentation would occur upstream of the spurs, but that a temporary decrease in bed level due to erosion would occur immediately downstream of the spurs.

There were predicted changes that would occur to bed levels with implementation of the proposed length rebuild project. The most obvious change to bed level would have resulted in deeper water habitat than currently exists along the channel side of the seaward half of the North Jetty. This change was predicted to exist for both the August-September (Figure 54) and October-November (Figure 55) timeframes, but was more pronounced for the latter, with differences in bed elevation of 1.25 to 1.50 meters. This change is relatively small, however, considering that water here is 12 to 24 meters deep (Moritz 2010, Connell and Rosati 2007).

Bed morphology changes were predicted to occur in similar areas during the August-September and October-November timeframes but more scouring and deposition is predicted to occur during the latter. In addition to the result described above for the channel side of the seaward portion of the North Jetty, decreases to bed level with implementation of the proposed action were predicted for a broad area in deep waters of the navigation channel off of Jetty A and deep waters around the seaward portion of Jetty A and for locations north of the North Jetty, which includes shallow nearshore waters. Areas predicted to have an increase in bed level occurred upstream and downstream of Jetty A, downstream of the above-mentioned broad area in the navigation channel, on the ocean side of the North Jetty, and downstream of Clatsop Spit (Moritz 2010, Connell and Rosati 2007). As mentioned before, the scale of the current proposed action is much smaller and precludes a length rebuild. Therefore, any changes previously predicted would be even smaller or unlikely.

Figure 53. Bathymetry at the MCR



From the ERDC modeling results of the groin structures, it is predicted that a temporary increase in bed level due to sedimentation would occur upstream of the spurs, but that a temporary decrease in bed level due to erosion would occur immediately downstream of the spurs (Moritz 2010, Connell and Rosati 2007).

Temporally, effects from hydraulics and hydrologic process would occur as a single event with construction as described under Rock Placement. Any minor subsequent effects would be long-term, but are discountable within the range of natural dynamic conditions and are of limited geographical extent.

In summary, previous modeling results indicated the changes to velocities, currents, salinity, plume dynamics, and bed morphology were minimal under the much larger jetty length rebuild scenario. Also, the existing or "original" conditions of the previous model represented lengths that are retained under the current proposed action. Because of previous results, no significant overall changes to the hydraulics or hydrology of the MCR system are anticipated under the new, smaller proposed action.

Figure 54. Difference in Bed Level (meters) for August/September Time Window

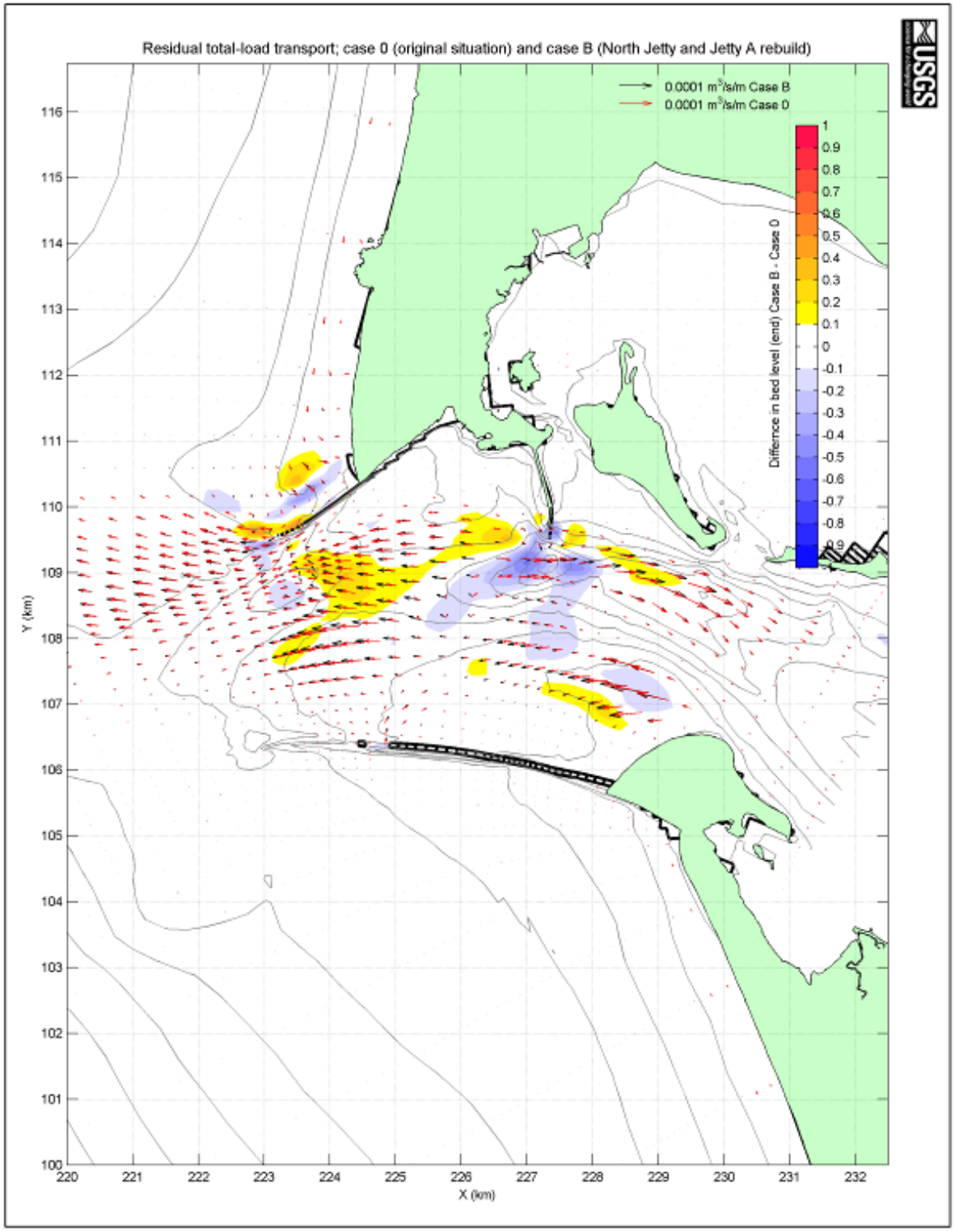
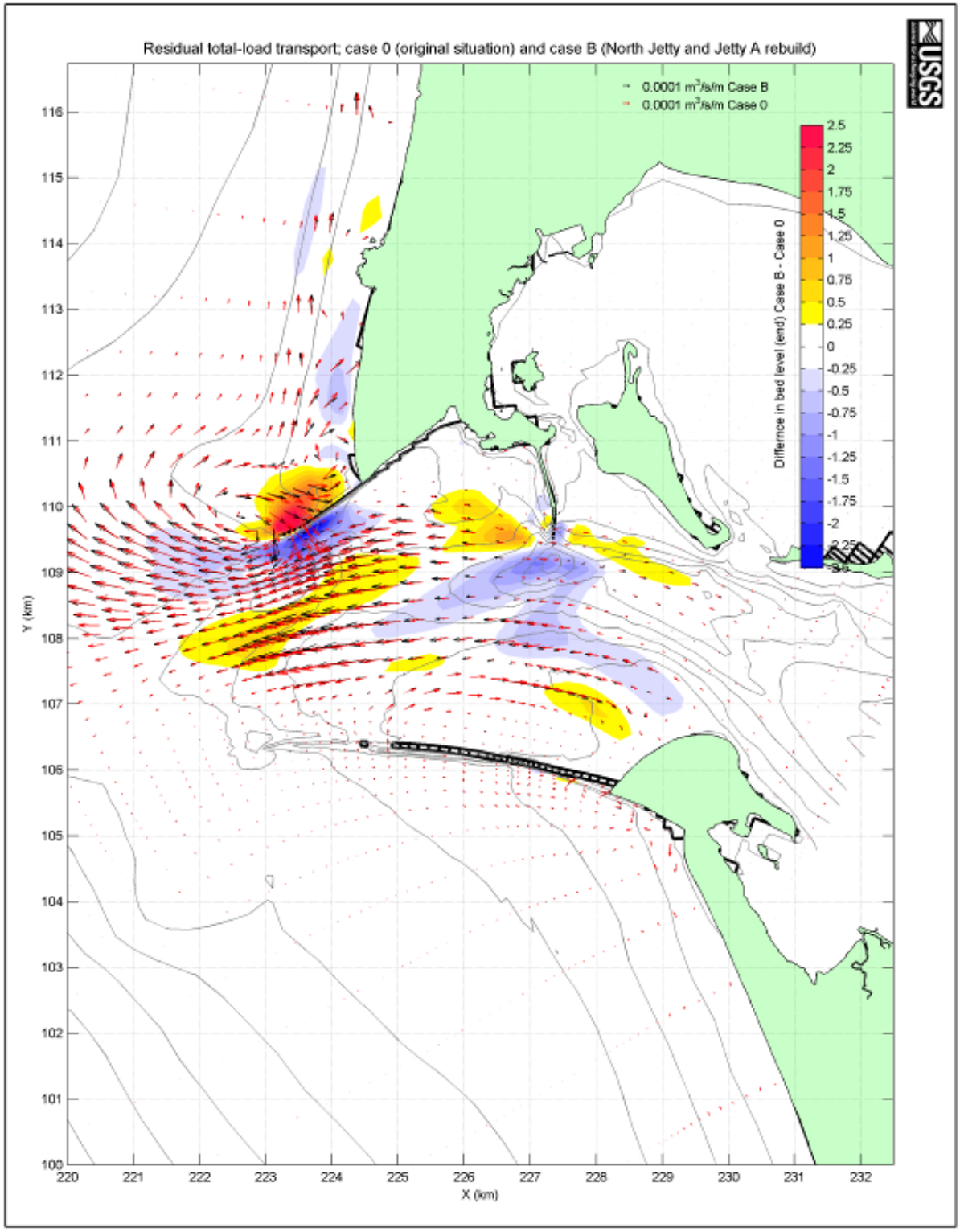


Figure 55. Difference in Bed Level (meters) for October/November Time Window



MITIGATION AND HABITAT IMPROVEMENTS

In this BA, the Corps has proposed ecosystem restoration at its discretion under Section 7(a) (1) of the ESA. These actions will restore and improve the habitat for the benefit of listed and candidate salmonid species as well as other native species found in the lower Columbia River ecosystem. Under the Clean Water Act, the Corps is also required to provide mitigation for wetland impacts. The Corps will develop detailed proposals, which will be coordinated with the Services and State partners, and then work to implement them using the AMT.

As described in the proposed action, the Corps has developed a wetland mitigation and habitat improvement package with a suite of potential actions to offset wetland impacts and to improve shallow-water habitats. In the long term, implementation of wetland mitigation and habitat improvement actions along with upland plantings will increase the overall square footage of wetlands and improve uplands, potentially also improving wetland-stream hydrologic functions in the Columbia River estuary. Restoration of low saltwater marsh habitat will improve resting and rearing habitat access for juvenile fish, as well as improved and increased instream and riparian and estuarine functions; for example, creation of brackish intertidal and mudflat habitat, restoration of hydrologic regimes, and improvement of riparian and canopy cover. These actions will be focused on higher value habitats and functions than those which are being affected in the immediate vicinity of the jetties.

Actions could also increase estuarine productivity lower in the Columbia River system for a wide range of species. Re-establishment of native plant communities and improvement of riparian functions would improve water quality function, habitat complexity, and trophic inputs. Reintroduction of a greater range of flows and more natural tidal regimes to uplands and diked pasturelands would also improve the likelihood of re-establishing native intertidal species. Re-establishing hydrologic and tidal regimes increases the opportunity to develop edge networks, dendritic channels, and mud flat habitats for use by listed species. Increased benthic habitat could also improve food web productivity. Dike breaches and tide and culvert retrofits would also increase adult fish passage and restore access to expanded spawning and rearing areas.

In relationship to the recovery plan in the estuary module (NMFS 2007c), the 7 (a) (1) actions being proposed by the Corps address threats identified in the recovery plan, and specifically relate to Columbia River Estuary (CRE) management actions. Depending on final plan selection, habitat improvements may specifically address the following CRE actions: 1 (riparian protection and restoration); 4 (restoring flow regimes via improved/restored tributary hydrologic connectivity); 5 (replenishment of littoral cell via beneficial use of dredged materials); 8 (removal of pile dikes); 9 (protection of remaining high-quality off-channel habitat from degradation), and; 10 (improvement of off-channel habitat via levee and dike breaches). Several of these CREs were also in the higher rankings for benefits with implementation, and higher percentages for Survival Improvement Targets (NMFS 2007c).

Therefore, the Corps expects these actions to have either direct or indirect long-term beneficial rather than adverse effects to most of the listed species and their designated critical habitat in the action area. In the short-term, temporary disturbance and increased suspended sediment may result in higher turbidity during in-water construction at restoration sites. This is not likely to occur during upland planting. However, these actions will be limited in duration and intensity, as BMPs to reduce and avoid pollutant runoff described in the proposed action would also be applicable to actions at restoration sites. Suspended sediments from in-water work will be monitored per State Certification conditions, and appropriate BMPs to minimize turbidity will also be implemented to ensure levels do not reach a duration or intensity that will harm species.

For invasive species removal, the Corps proposes to use no herbicides within 100 feet of the Columbia River or associated water bodies, and therefore, does not expect increased pollutant loads or effects on instream or riparian function. Short-term noise disturbances are likely to attenuate near the source and project locations are likely to be much further away from habitat used by marine mammals. These acoustic effects will likely be minimal and discountable.

Temporally, implementation of different components of wetland mitigation and habitat improvement projects could occur throughout the year. It would likely be possible to complete associate in-water work during the appropriate in-water work windows that protect listed species. Concurrent with initial impacts to wetlands, construction would likely occur in one or two seasons with subsequent monitoring. Temporally, this limits the repetition of disturbance activities associated with the construction of these projects. Short-term effects to water quality may occur on a daily basis, but would be limited and similar to those describe in the Water Quality effects discussion.

EFFECTS OF THE ACTION ON LISTED SPECIES

Harassment applies to actions that create the potential for injury by significantly disrupting normal behavioral patterns including breeding, spawning, rearing, migrating, feeding or sheltering. To be significant, harassment must be capable of resulting in the death or injury of fish or wildlife. Harm applies to actions that result in actual injury or death, including actions that cause environmental damage leading to injury or death.

Based on migratory and residence time, listed marine and anadromous fish including salmon, steelhead, eulachon, and green sturgeon will be present in the action area during the proposed period of jetty repair, rehabilitation, and maintenance operations. Listed sea turtles, listed marine mammals, including Steller sea lions and whales, may also be present. The following actions and effects have been evaluated for these species.

- Rock Transport
- Construction Access, Staging, Storage, And Rock Stockpiling
- Rock placement
- Dredging
- Disposal
- Barge Offloading Facilities
- Pile Driving
- Lagoon And Wetland Fill And Culvert Replacement
- Dune augmentation
- Water Quality
    - Suspended Sediment
        - Dredging
        - Disposal
        - Pile driving
    - Spills and Leaks
    - Contamination
- Hydraulic & Hydrological Processes
    - Salinity and Plume dynamics
    - Bed Morphology
    - Water Velocity
- Wetland Mitigation and Habitat Improvements

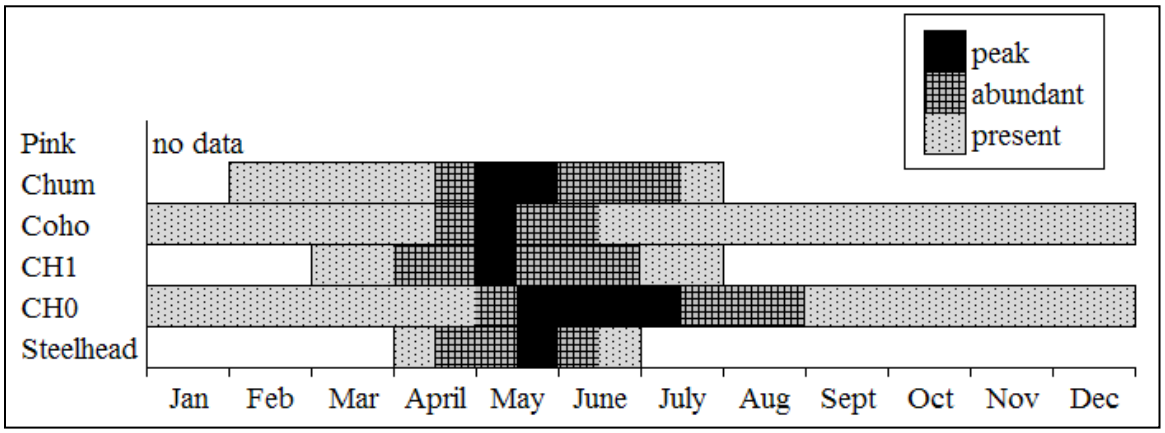
Listed Marine and Anadromous Fish

Salmonids

A variety of anadromous fish occur in the Columbia River near and offshore areas. Occurrence of adult migratory salmon in the offshore area is correlated primarily with their period of upstream migration. Migratory juvenile salmon are present following their migration out of the Columbia River estuary primarily in the spring and fall. Anadromous species occur throughout the year with many using the estuary as a rearing and nursery area (Corps 1999). Adult salmonids may be present and holding in the estuary during upstream migrations on their way to spawning grounds (Figures 56 and 57). Juvenile salmonids occur in the action area during their out-migration to the ocean. Juveniles that have already become smolts are present in the lower river for a short time period. Juveniles that have not become smolts, such as Chinook subyearlings, spend extended periods of time rearing in the lower river. They normally remain in the lower river or estuary until summer or fall or even to the following spring when they smoltify and then migrate to the ocean. Rearing occurs primarily in shallow backwater areas.

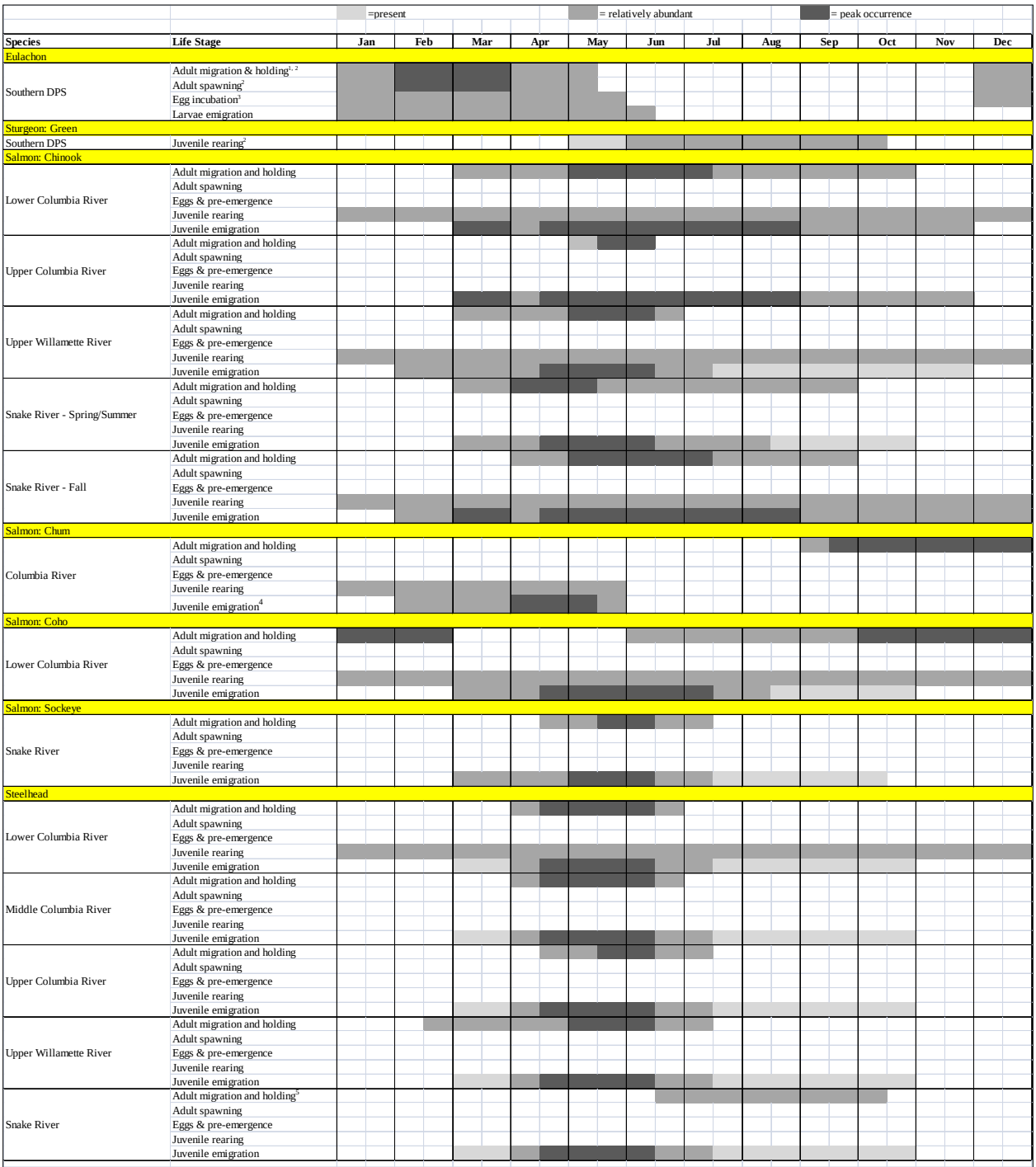
In the estuary, most rearing of juvenile salmonids occurs in the upper part of the water column near the shore and in shallow-water areas (Bottom et al. 2005). Use of deeper areas does occur; it is known that juvenile chum salmon prefer feeding in shallow waters but food limitations may induce movement to deeper waters (NMFS 1991). Also, it is known that subyearling Chinook and chum salmon occupy shallow, nearshore habitats but shift to deeper habitats farther away from the shoreline as they grow to fingerling and smolt stages (Bottom et al. 2005).

Figure 56. Timing of Salmonid Life History Events in the Lower Columbia River



General trends in presence and abundance of juvenile salmonids in the lower Columbia River estuary at and downstream of Jones Beach (RKM 75; Dawley et al. 1986; McCabe et al. 1986; Roegner et al. 2004; Bottom et al. 2008).

Figure 57. Fish Presence in Lower Mainstem Columbia River below Sauvie Island (RM 87)



[1] Eulachon Status Review Update, 20 January 2010. Available at: http://www.nwr.noaa.gov/Other-Marine-Species/upload/eulachon-review-update.pdf

[2] Personal communication. Conversation between WDFW (Brad James, Olaf Langness, and Steve West), ODFW (Tom Rien), and NMFS (Rob Markle, Bridgette Lohrman) regarding green sturgeon and eulachon presence in the Columbia River. June 23, 2009.

[3] Eulachon egg incubation estimated relative to spawning timing and 20 to 40 day incubation period.

[4] Carter et al. 2009 (Seasonal juvenile salmonid presence and migratory behavior in the lower Columbia River).

[5] Good et al. 2005 (Updated status of federally listed ESUs of West Coast salmon and steelhead

Citations:

Carter, J.A., G.A. McMichael, I.D. Welch, R.A. Harnish, and B.J. Bellgraph. **2009**. Seasonal juvenile salmonid presence and migratory behavior in the Lower Columbia River. PNNL-18246, Pacific Northwest National Laboratory, Richland, Washington. Available at: www.pnl.gov/main/publications/external/technical_reports/PNNL-18246.pdf.

FERC (Federal Energy Regulatory Commission). **2009**. Bradwood Landing Project biological assessment and Essential Fish Habitat assessment (Table 7.3.1-1). Available at: www.ferc.gov under accession #20090624-4002). Division of Gas-Environment and Engineering.

In a study in an artificial estuary, juvenile Chinook salmon showed a preference for deep saline habitats to shallow freshwater habitats and were shown to make brief forays into the upper freshwater habitat if food availability was sufficiently high (Webster et al., 2007). Although specific size-depth relationships may vary by species, studies have found juvenile salmon distributed along a depth continuum based on size of the fish: juvenile Chinook and chum salmon less than 50-60 mm fork length (FL) occur primarily in shallow water (less than 1 meter in depth); fish 60-100 mm FL are found in slightly deeper habitats (shoals, tributary channels); and fish greater than 100 mm FL may be found in both deep and shallow-water habitats. This relationship between size and depth tends to be less reliable in hours of darkness when schooling fry or fingerlings often disperse from shore (Bottom et al. 2005).

Juvenile salmon movement toward the ocean is facilitated by ebb tides when current movement in the channel is generally in an east to west direction. Of the Salmonid species, sub-yearling Chinook salmon stay in the estuary for the longest period of time and use the greatest variety of estuarine habitats (Bottom et al. 2005), mainly slower, shallower, backwater areas. Healey (1982) proposed that Chinook salmon is the most estuarine dependent of Salmonid species. These slow water areas are not typically available in close proximity to the jetties, but even in this high energy environment, sub-yearling Chinook still show a tendency to linger and to use nearshore areas. This is further demonstrated by acoustic tagging studies in the lower Columbia.

A 2005 Pacific Northwest National Lab (PNNL) study on acoustically tagged sub-yearling and yearling Chinook salmon and steelhead was conducted in the vicinity of the mouth of the Columbia River North and South jetties (McMichael et. al. 2006). Detection nodes were placed across the channel at RM 5.6 (primary node) and at RM 1.8 (secondary node). The secondary node did not extend all the way to the south side of the channel, however. As a result, fish could pass close to the South Jetty without being detected. A third set of detection nodes were placed near the North Jetty disposal area. Chinook salmon, both sub-yearling and yearling, were run-of-the-river fish tagged and released at the Bonneville Second Powerhouse bypass at the juvenile fish facility. Steelhead were Snake River-origin hatchery fish that were collected from fish transport barges between John Day and Bonneville dams and released mainly at Skamania Landing downstream of Bonneville (some were transported/released at Astoria-Megler Bridge).

In the 2005 study, sub-yearling Chinook salmon were shown to move back and forth past the nodes, remaining longer in the vicinity of the nodes than yearling Chinook salmon and steelhead, and tended to use nearshore areas (closer to the North Jetty) more than yearling Chinook salmon and steelhead. Yearling Chinook salmon and steelhead were concentrated more in deeper waters near the navigation channel than sub-yearling Chinook salmon. Larger fish tended to spend less time (9-24 minutes) within the MCR detection area that smaller subyearling Chinook (mean=160 minutes). Yearling Chinook and steelhead indicated a more directed emigration pattern relative to sub-yearling Chinook. Sub-yearling Chinook salmon residence times within the detection areas were up to 15-20 times longer than yearling Chinook salmon and steelhead, usually passing on two to three ebb tides instead of one. Also, they took longer to reach the MCR from Bonneville Dam (average 4.5 days) than yearling Chinook salmon and steelhead (mean = 3.5 days; McMichael et al. 2006). Though these metrics do not indicate actual time fish spent in the area around the jetties themselves, they can be used to roughly extrapolate the overall range of

residence time in the area. Considering the sampled area was approximately 70 acres out of about 2,600 acres across the river between the tips of the jetties and Cape Disappointment, extrapolating from the data indicated that subyearling Chinook could spend anywhere from a few hours to a maximum of about 4.6 days within the larger MCR area. Steelhead and yearling Chinook spend even less time (usually a few hours to less than 1 day), as they are more directed in their emigration (McMichael et al. 2006). Furthermore, detections at each array were within a spherical range of approximately 200 meters, which means fish detected on arrays closest to the jetties could still be up to 200 meters away from the structure itself (McMichael et al. 2010). Therefore, juvenile residence time within the MCR area and their potential exposure to jetty repair activities is of short and relatively limited duration. Residence time with immediate proximity to the jetties themselves would logically be even smaller.

The PNNL conducted subsequent similar studies that monitored and mapped migration pathway and habitat associations and behaviors relative to these pathways for acoustic-tagged juvenile yearling Chinook salmon, steelhead, and subyearling Chinook salmon downstream of Bonneville Dam as they migrated seaward through the Columbia River and its estuary. In the action area in 2009, receiver arrays were deployed across the entire river channel at two locations near the mouth of the river at East Sand Island (RKM 8.3) and the Columbia River bar (RKM 2.8; Figure 58). Partial arrays were also deployed across the primary channel at the Astoria Bridge (RKM 22.0; McMichael et al. 2010).

The 2009 PNNL study indicated that acoustic-tagged yearling Chinook detected in the Bonneville Dam forebay and at the mouth of the Columbia River had a mean travel time of 3.4 days. Travel times decreased throughout the migration period. Travel rates of both yearling Chinook salmon and steelhead decreased as they moved between Oak Point and the Astoria Bridge and increased and was more variable downstream of RKM 22. Steelhead had a mean travel time of 3.1 days, and travel times decreased throughout the migration period. Subyearling Chinook salmon had a mean travel time of 4.1 days between RKM 236 and RKM 8.3. Travel times increased slightly throughout the migration period. Travel rate of subyearling Chinook salmon decreased as they moved between the array at Cottonwood Island (RKM 113) and RKM 22, and then increased and was more variable downstream of RKM 22. Furthermore, timing of arrival of tagged fish at most arrays in the lower 50 km of the estuary was influenced more by tide than by time of day for all three groups. Most tagged fish passed the lower three arrays on ebb tides, and this relationship was most evident when the difference between high and low tide was greatest (McMichael et al. 2010).

These PNNL studies also evaluated cross-channel distribution at the arrays within the action area, and 2009 results are shown in Figures 59-61. These studies give some indication of distribution near the jetties and offloading facilities, though arrays were not specifically at these locations. Similar to the 2007 and 2008 studies, results obtained from 2009 also indicated that a greater proportion of subyearling Chinook salmon migrated through off-channel areas (outside the primary channel) than yearling Chinook salmon or steelhead which concentrated more towards the navigation channel (McMichael et al. 2010). For 2007 and 2008 (when more arrays were located nearer the South Jetty than in 2005) migration patterns for subyearling Chinook indicated cross-channel distribution that was more skewed towards the Washington shore in the vicinity of the MCR. However, fish distribution did not peak at the nodes in closest proximity to

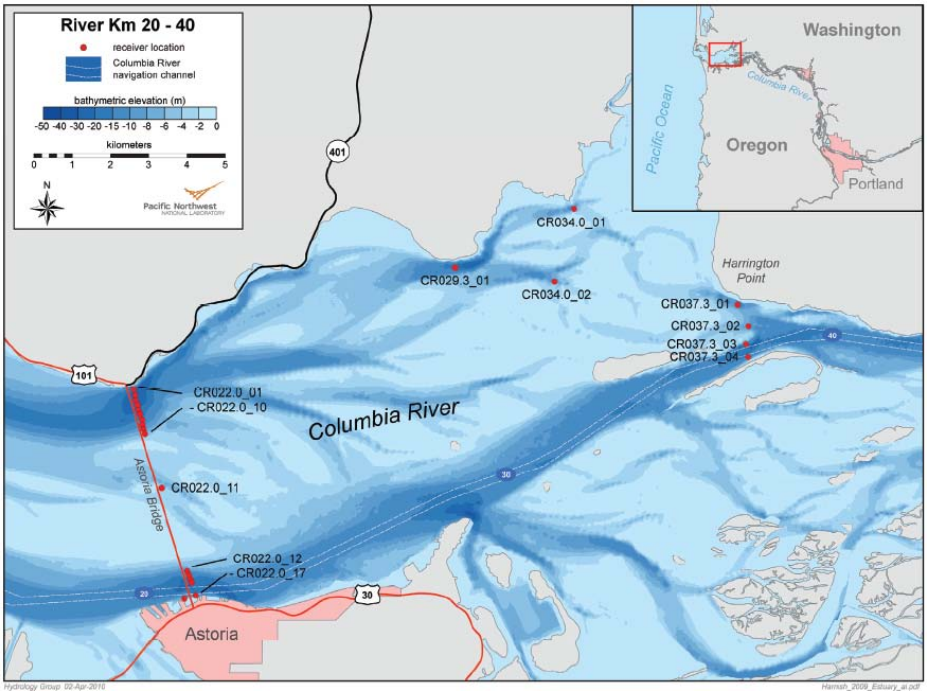
the jetties (Carter et. al. 2009). Furthermore, in 2007, approximately 93% of juvenile yearling Chinook detected passed farther than 200 meters away from the North Jetty (200 m is the approximate spherical detection radii of the arrays), and over 99% detected passed at an even greater distance away from the South Jetty (Carter et. al. 2009). In 2008, approximately 96% of detected juvenile subyearling Chinook passed at a distance greater than 200 meters from the North Jetty, and over 99% passed at an even farther distance away from the South Jetty (Carter et. al. 2009). Results for 2009 showed similar trends for all juveniles, and in particular subyearling Chinook. These are shown in Figures 59-61 (McMichael et al. 2010).

In 2010, nodes were briefly moved for a short time so that one node was placed on the upriver side of Jetty A, one at the tip of Jetty A, and one on the western, oceanside of Jetty A (McMichael et al. 2010). Preliminary results indicated that 378 subyearling Chinook were detected at the upstream node, 385 at the tip, an only 8 at the ocean side node. This seems to indicate that fish move downstream towards Jetty A without moving very close to Jetty A on the ocean side (McMichael et al. 2010). Furthermore, at the array near the mouth, in 2010, 7 out of the 1,144 fish (or 0.6%) detected on the array passed on the node nearest the North Jetty (McMichael et al. 2010). Again, this is within a 200 meter range of detection, so actual immediate proximity to the stone structure may be even less.

Distribution of juveniles and use of and near the jetties may further be considered in light of a 1998 study Pacific County, Washington that was conducted to determine effects on juvenile salmon from the construction of a 1,600 foot long above-water spur groin, known locally as Jacobson's Jetty, and a 930 foot long underwater dike (Miller et al. 2002). The structures were constructed on the north side of Willapa Bay at Washaway Beach to halt erosion adjacent to State Route 105. Large tidal exchange in and out of Willapa Bay results in strong currents around the structures, similar to the jetties at the MCR. Observations on juvenile salmonids and potential predators were made at the Washaway Beach site during May 2002 at the structures and at reference points and beach habitat both east and west of the structures in an attempt to ascertain structure effects. Juvenile salmon, primarily Chinook, were observed during snorkel and dive surveys adjacent to the structures and over the dike in the upper 1 m of the water column and were observed feeding on plankton near the structure and barnacles on the structure. They were in groups of generally five or fewer in the size range of 85-110 mm. It has been shown that juvenile salmonids, especially sub-yearling Chinook salmon, outmigrate in close proximity to the MCR North Jetty. They may outmigrate in close proximity to the South Jetty as well. From knowledge gathered from the Washaway Beach study, it is likely that juvenile salmonids use jetty rock habitat at the MCR for feeding during their outmigration. However, compared to the overall cross-channel distribution of fish detected in the PNNL studies at both jetties, this is likely a relatively small percent of out-migrants (4%-7% of sub yearling Chinook, and an even smaller percentage of yearling Chinook and steelhead). Also as indicated by the PNNL studies, the short juvenile residence time the high energy environment at the jetties means fish use in these areas is likely further limited.

Figure 58. Locations of Acoustic Telemetry Receiver Arrays, 2009

At Harrington Point (CR037.3) and Astoria Bridge (CR022.0) and locations of single receivers in Grays Bay (CR034.0_01, CR034.0_02, and CR029.3_01) in relation to bathymetry (McMichael 2010).



At East Sand Island (CR008.3) and the Columbia River Bar (CR002.8) (McMichael 2010).

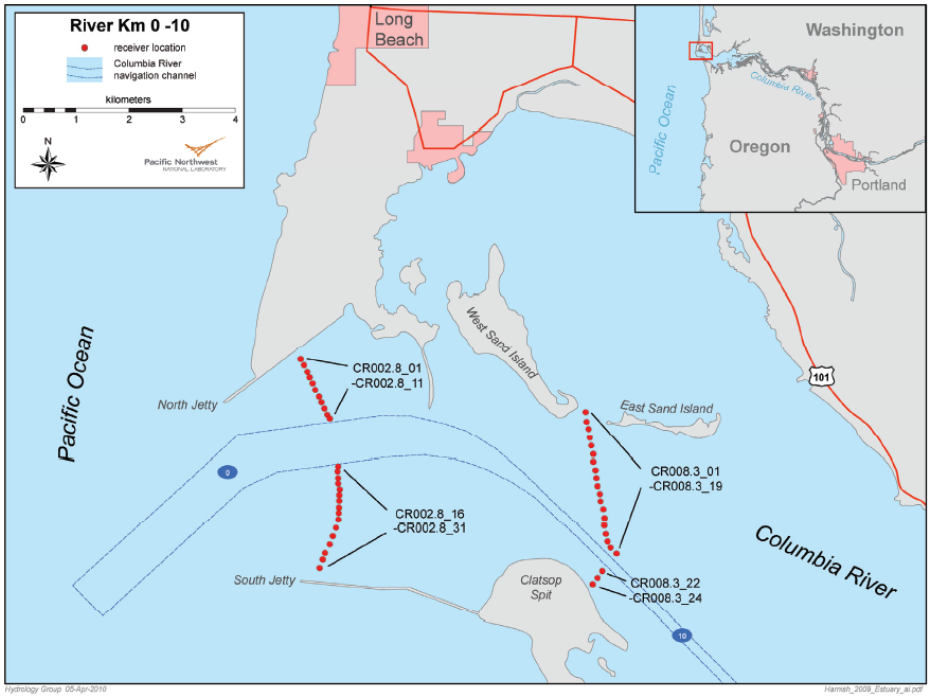


Figure 59. Cross-channel Distribution of Acoustic-tagged Yearling Chinook Salmon

First detections at arrays at Astoria Bridge (CR022.0), East Sand Island (CR008.3), and Columbia River Bar (CR002.8; McMichael et al. 2010).

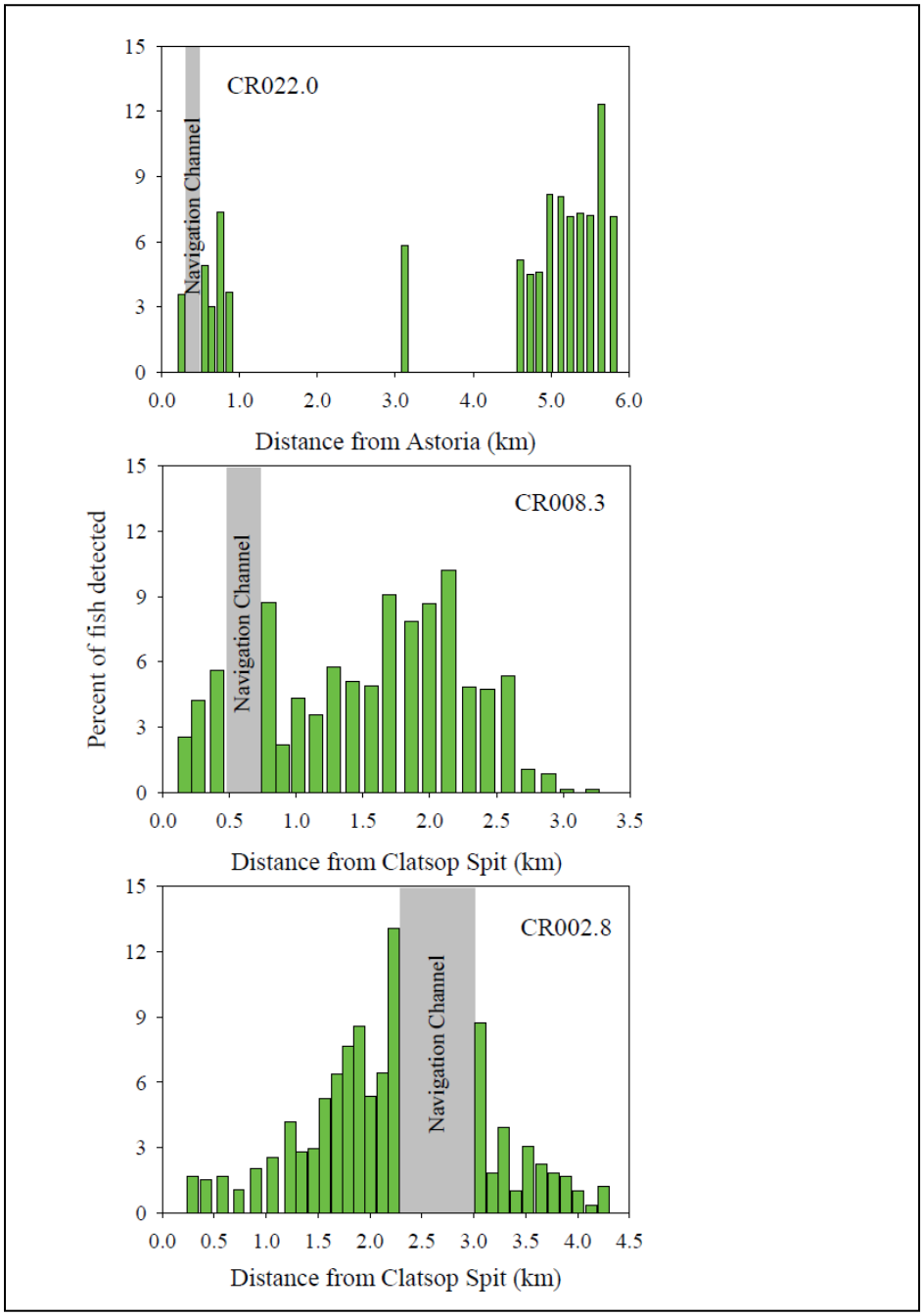


Figure 60. Cross-channel Distribution of Acoustic-tagged Steelhead

First detections at arrays at Astoria Bridge (CR022.0), East Sand Island (CR008.3), and Columbia River Bar (CR002.8; McMichael et al. 2010).

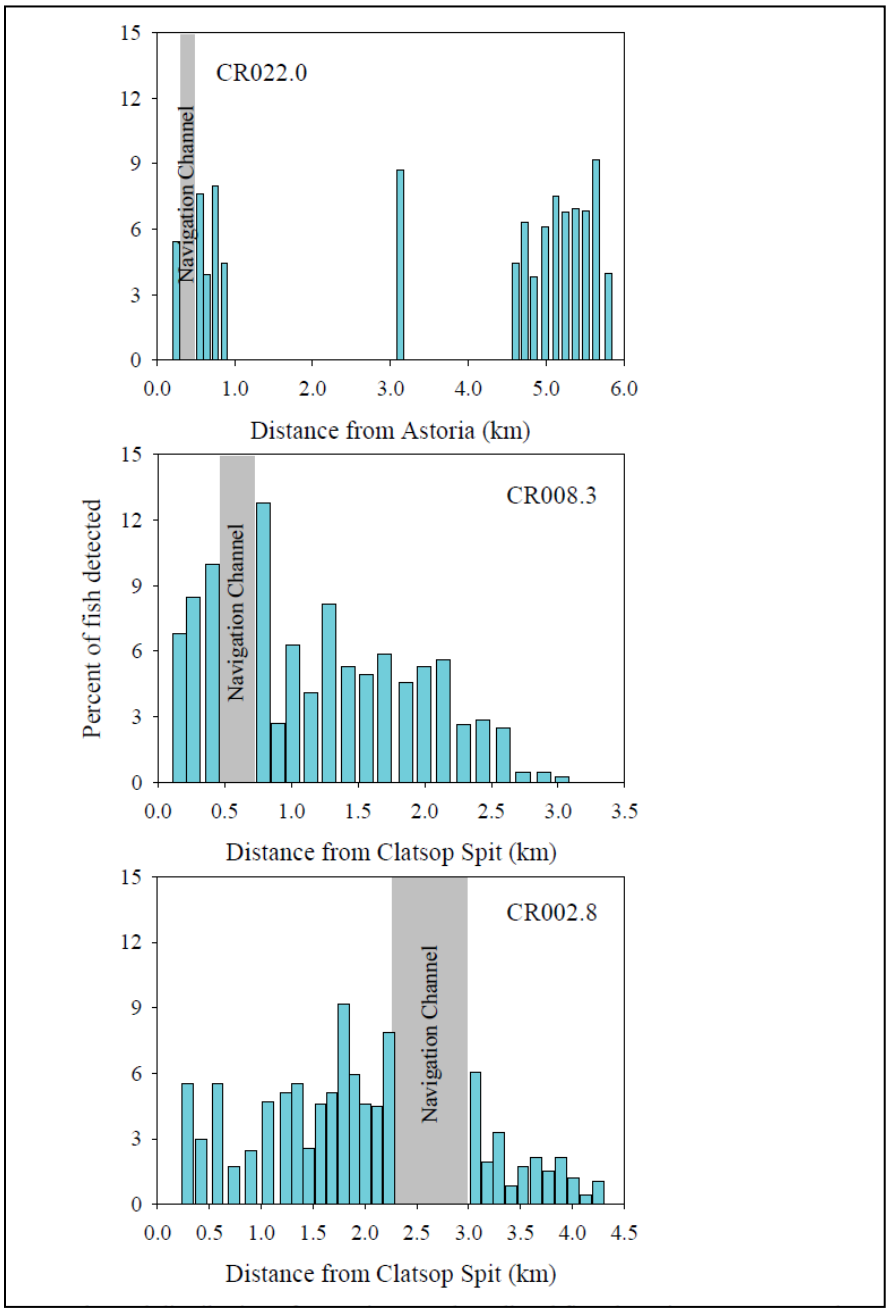
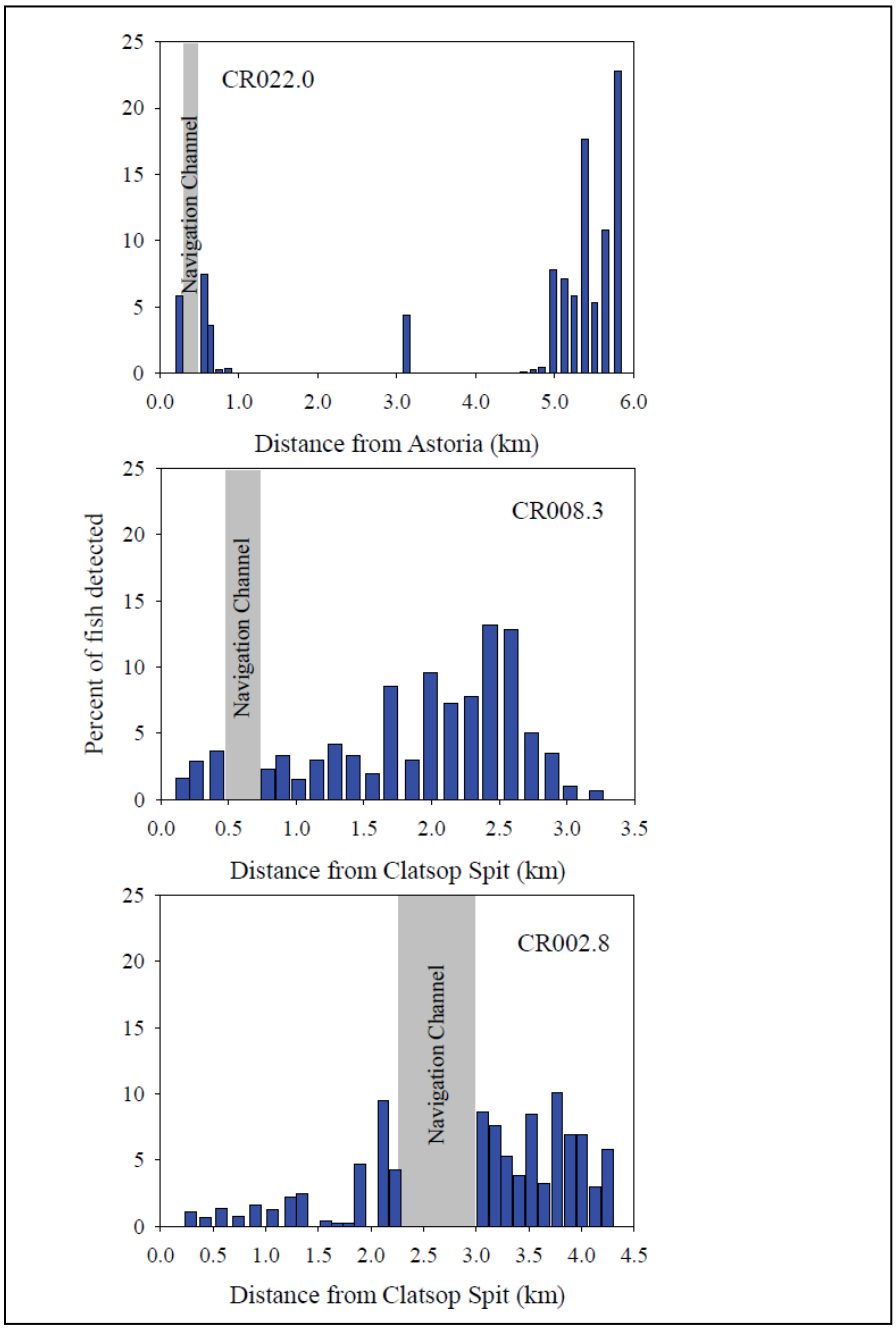


Figure 61. Cross-channel Distribution of Acoustic-tagged Subyearling Chinook Salmon

First detections at arrays at Astoria Bridge (CR022.0), East Sand Island (CR008.3), and Columbia River Bar (CR002.8; McMichael et al. 2010).



The Columbia River plume is the zone of freshwater/saltwater interface where the freshwater exiting the Columbia River meets and rises above the denser saltwater of the Pacific Ocean, just seaward of the MCR. The plume is formed as thin, buoyant lenses of fresher water flowing over denser, oceanic water and is more pronounced when flow from the river is large in comparison to tidal volume. The Columbia River plume is ephemeral and may persist for several hours and is controlled by fluctuating tide. A frontal boundary (front) is formed between the river plume and adjacent marine waters. The front is richer in zooplankton than adjacent marine waters and plume waters, being attributed to increased abundance of surface-oriented organisms (Morgan et al. 2005). The plume front is easily identified by well defined horizontal gradients in salinity and water clarity and by the accumulations of foam and flotsam (De Robertis et al., 2005).

Nutrients were not found to be more abundant in the fronts than adjacent plume and ocean waters and, therefore, it is unlikely that plume fronts are regions of greater production. Greater zooplankton biomass in the plume front was largely due to the concentration of surface-oriented species along the front, particularly Dungeness crab (*Cancer magister*) megalopae and the concentration of the eggs of northern anchovy (*Engraulis mordax*) and sanddab (*Citharichthys* spp.). This increased concentration of surface-oriented zooplankton is caused by convergent water flows at the frontal boundary. Although biomass was greater, density of all zooplankton combined (including non-surface-oriented zooplankton) was not found to be greater at the plume compared to adjacent plume and ocean waters. More bird feeding activity was noted at the front compared to the adjacent plume and ocean waters (Morgan et al. 2005). Increased bird foraging could contribute to limiting salmon use of fronts.

In the study by Morgan and others (2005), there was no significant difference in the mean temperature among the three habitats in 2001 but the plume was significantly warmer than the ocean and front habitats in 2002. The mean salinity of the front was more similar to that of the plume in 2001 and to the ocean habitat in 2002.

This multi-layered mixing zone plays an important role as habitat for juvenile salmonids. The first few weeks of their ocean life, some of which is spent in the plume, are critical for recruitment success of salmonids (Pearcy 1992). The Columbia River plume provides a high turbidity refuge from predation, provides fronts and eddies where prey become concentrated, and provides a stable habitat for northern anchovy spawning (Richardson 1981, Bakun 1996). A strong, quickly moving plume also helps juvenile salmonids move rapidly offshore.

Studies in the Columbia River plume show that juvenile salmonids typically use upper waters, above about 12 meters (Emmett et al. 2004). Many Columbia Basin salmonids enter the ocean when river flow is high and frontal formation is intensified, during spring and early summer. Therefore, there is potential for juveniles to take advantage of high prey biomass at the plume front (Morgan et al. 2005). The surface-oriented organisms found to be concentrated at the plume front are all prey that juvenile salmon have been found to consume (Morgan et al. 2005) but analysis of juvenile salmon stomach contents did not reveal greater amounts of frontal surface-oriented prey from fish occurring at fronts, nor did it identify prey groups indicative of salmon feeding in the frontal areas. Stomach fullness tended to be higher in the more marine shelf waters than either the front or plume areas, which does not support the hypothesis that salmonids consistently ingest more prey at frontal regions (De Robertis et al. 2005).

De Robertis and others (2005) found that juvenile salmonids tended to be abundant in the frontal and plume regions compared to the more marine shelf waters, but this pattern differed among species and was not consistent across two study years. Juvenile chum and yearling coho salmon were more abundant in the front than adjacent plume or ocean, while juvenile steelhead were more abundant in the front and plume than adjacent ocean. No significant differences were observed in Chinook habitat use during 2001. In 2002, both yearling coho and Chinook were more abundant in the plume than adjacent front and ocean, whereas juvenile steelhead were more abundant in the front than adjacent plume and ocean. Small numbers of chum captured in 2002 precluded statistical analysis. There was no significant difference in the fraction of marked (hatchery) fish among ocean, front, and plume habitats (this appears to indicate that hatchery fish did not use habitats differently than wild fish). This study did not support the hypothesis that juvenile salmonids congregate to feed at the plume fronts. De Robertis and others (2005) postulated that the short persistence time of these ephemeral fronts may prevent juvenile salmon from exploiting this food-rich zone. They caution that given that the plume is the first area salmon encounter during ocean entry, changes in plume structure may significantly influence the distribution and survival of salmon.

In 2009 samples and preliminary studies of juvenile Chinook salmon were conducted in the nearshore areas at the beaches immediately adjacent to the North and South Jetties; with additional sampling conducted at the North Jetty in 2010 (Marrin Jarrin and Miller, unpublished data). Sampling methodology (beach seine from approximately 1 meter depth where surf-zone borders with swash zone) was the same as that detailed in a 2009 study near the mouth of Coos Bay, which investigated yearling Chinook migratory patterns and use of nearshore, surf-zone and sandy beach habitat (Marin Jarrin 2009). Between June 23, 2009 and September 2, 2009, a total of 10 juvenile Chinook salmon were caught adjacent to the North Jetty; no Chinook were caught adjacent to the South Jetty during that same period. Additionally, between July 14, 2010 and August 12, 2010, no salmon were caught adjacent to the North Jetty (Marrin Jarrin and Miller, unpublished). Juvenile use of MCR nearshore environment may be similar to other findings from Marin Jarrin (2009) that suggest surf zone environments close to large estuaries provide important habitat for further juvenile development due to significant prey supply, shelter from predators, and proximity to low-salinity water masses, which may further aid in acclimation.

Green Sturgeon

Green sturgeon spend more time in the marine environment than other sturgeon species (Adams et al. 2002 and in press). The southern green sturgeon likely uses the action area as habitat for adult and subadult migration and feeding, as well as growth and development to adulthood by subadults. According to NMFS (NMFS 2010), when not spawning, this anadromous species is broadly distributed in nearshore marine areas from Mexico to the Bering Sea. Although it is commonly observed in bays, estuaries, and sometimes the deep riverine mainstem in lower elevation reaches of non-natal rivers along the west coast of North America, the distribution and timing of estuarine use are poorly understood (NMFS 2010). Green sturgeon in the ocean can be assumed to remain largely inside the 100-meter depth contour (Erickson and Hightower 2004). Southern DPS green sturgeon, radio-tagged in the Sacramento River, have recently been shown to occur seasonally in northern estuaries including the Columbia River estuary during the summer and early fall (Moser and Lindley 2007). Green sturgeons have been commercially

harvested in the Columbia River. In the Columbia River, Israel and May (2006) found the percentage of southern DPS fish to exceed 80% (of total northern and southern DPS fish) during late summer and early fall of some years.

Observations of green sturgeon in the Columbia River are concentrated in the estuary but have been made as far upriver as Bonneville Dam. No evidence exists for spawning in this system (Rien et al. 2002). Information based primarily on fishery-dependent sampling suggests that green sturgeon occupy large estuaries only during the summer and early fall. Southern population DPS green sturgeon are known to occur in the Columbia River estuary from June until October. Tagging studies indicate that green sturgeon from all known spawning populations inhabit the Columbia estuary in summer, including a significant portion of green sturgeon from the southern DPS (Moser and Lindley 2006).

Habitat use and food habits of green sturgeon in northern estuaries have not been investigated in detail. Digestive tract contents from 46 commercially caught Columbia River green sturgeon were found to contain only algae (species unknown) and pebbles. One Rogue River green sturgeon digestive tract sample contained an exoskeleton of one crayfish (*Pacifasticus* spp.) and algae (ODFW 2005). It is possible that the algae and pebbles were incidentally ingested, however. The Rogue River fish was likely from the northern DPS.

The Corps and USGS have recently been working on a green sturgeon study in the Coos and Columbia River estuaries. Though results are preliminary and sample sizes are relatively small, acoustic receivers detected green sturgeon presence several times off the tip of Jetty A, near the North Jetty, and in the area of Social Security beach off the Clatsop Spit (USGS Preliminary 2009-2010 data). Information about specific use in the action area is still under development, but activities at Jetty A and North Jetty could cause some avoidance behavior by green sturgeon present during construction.

Eulachon

Most eulachon production originates in the Columbia River basin with spawning in the mainstem of the Columbia River upstream of the estuary and action area, (Emmett et al. 1991, Musick et al. 2000) in January or February (Beacham et al. 2005). Eulachon spawn in the mainstem Columbia River and usually spawn every year in the Cowlitz River, with inconsistent runs and spawning events occurring in the Gray's, Elochoman, Lewis, Kalama, and Sandy rivers (ODFW and WDFW 2009). Prior to the construction of Bonneville Dam, occasional reports were received of smelt occurring upstream as far as Hood River, Oregon, and possibly farther (Smith and Saalfeld 1955). In times of great abundance, (e.g., 1945, 1953) eulachon have been known to migrate as far upstream as Bonneville Dam (Smith and Saalfeld 1955, Howell et al 2001), and are suspected of passing through the ship locks, having reached the Klickitat River (Smith and Saalfeld 1955). Though eulachon have been observed migrating up the Columbia River, spawning has not been documented in the mainstem above RM 80 (Romano et al. 2002).

Larval forms outmigrate through the estuary and juvenile forms rear in marine waters extending out along the continental shelf (NMFS 2008d). Young eulachon larvae are about 4.0 to 8.0 mm in length and, are rapidly flushed to the ocean, often within days of hatching, and subsist on their yolk sac during this downstream dispersal (ODFW and WDFW 2001).

Information on the distribution and ecology of juvenile eulachon is scanty due to these fish being too small to be detected in fisheries surveys, and too large to occur in ichthyoplankton surveys (Hay and McCarter 2000). It is likely that juvenile eulachon rear in near-shore marine areas at moderate or shallow depth (Barraclough 1964) and feed on pelagic plankton, including euphausiids (krill). As they grow at sea, they tend to utilize waters of greater depths and have been found as deep as 625 meters (Allen and Smith 1988).

Adult eulachon range in size from 14 to 30 cm and are planktivorous in the ocean, but stop feeding when returning to fresh water to spawn (McHugh 1939, Hart and McHugh 1944). The homing instinct of eulachon (returning to birth streams) is not clear, but it is postulated that larvae may spend weeks to months in nearby estuarine environments where they grow significantly in size and may develop the capacity to imprint on large estuaries and eventually home to these areas as adults (McCarter and Hay 1999, Hay and McCarter 2000).

Eulachon return to fresh water to spawn at 2 to 5 years of age. Spawning in the lower Columbia River can occur soon after freshwater entry (ODFW and WDFW 2009). Eulachon typically enter the Columbia River in early to mid-January (though a small 'pilot' run may occur in December), followed by tributary entry in mid- to late January. Peak tributary abundance is usually in February, with variable abundance through March and an occasional showing in April (ODFW and WDFW 2009). Therefore, migrating adults and larvae may be in the vicinity of the jetties, and adults and rearing juveniles may be present in the near and offshore environments of the action area. However, during most of the proposed construction activities, it is unlikely that adult, eulachon will be present, though juvenile or larval life stages may be in the estuary.

Table 35 shows the life stages of marine and anadromous species that could be present in the action area during some part of the year, though not always during the bulk of associated construction actions. Many of the effects from the proposed action will be similar for all of the species. Therefore, effects discussed below are applicable to all species, unless differences or additional effects are otherwise specified.

Table 35. Life Stages of Marine and Anadromous Species

Salmon and steelhead	Sturgeon	Eulachon
1. Juveniles a. Rearing b. Migration c. Smoltification 2. Adults a. Sub-adult growth and development b. Upstream migration and holding c. Seaward migration (steelhead)	1. Adults a. Sub-adult growth and development b. Upstream migration and holding c. Seaward migration d. Seasonal holding e. Estuarine, nearshore and marine movements	1. Juveniles a. Rearing b. Migration c. Metamorphosis 2. Adults a. Sub-adult growth and development b. Upstream migration and holding

As described above, certain aspects of the proposed action are reasonably likely to result in effects to ESA-listed species in the action area. Some juvenile salmon and steelhead will be migrating and rearing in the action area, as well as eulachon, and green sturgeon over the

approximately 20-year construction period. The Corps does not expect adult eulachon, sturgeon, salmon and steelhead to be injured or harmed by the proposed action. Furthermore, during the bulk of construction and vessel activities, it is very unlikely that adult eulachon will be present in the vicinity of the MCR. Most of the adults will already be upstream, and the peak emigration of juvenile and larval forms will have likely been flushed from the estuary after the spring freshets.

Rock Transport

Though within the navigation channels rock transport could increase the possible disturbance of salmon, steelhead, sturgeon or eulachon, this is unlikely to occur. Adult species are likely already attuned to this traffic, and their swimming speeds and mobility would allow perception and avoidance of these vessels. The proposed action will also not cause a significant increase in the intensity of traffic levels. Therefore, vessel traffic is unlikely to affect adult migration or holding patterns in any significant manner. Furthermore, juvenile salmonids tend to use predominantly shallower and nearshore habitat than that used by barges. The seasonality of potential larval, juvenile, or adult eulachon usage has little overlap with the likely timing of most of the barge traffic, and therefore this action is not likely to increase eulachon exposure to vessel traffic in the vicinity of MCR. Green sturgeon adults and juveniles may be present, but would likely be lower in the water column and tend to move at night. Therefore their exposure to traffic would be geographically and temporally limited. Any encounters with barge traffic will be transitory and discountable for all species. Disturbance from vessel traffic could cause movement in salmon, steelhead, eulachon, and sturgeon species that would not otherwise occur. However, proposed actions are not expected to have significant long-term impacts to migration, rearing, or holding behaviors for any of these species.

Construction Access, Staging, Storage, and Rock Stockpiling

Effects to water quality and natural habitat cover are expected to be minimal and therefore are not expected to have impacts to juvenile rearing, migration, or development, nor to adult migration or holding patterns for any of these species. Most actions will occur in the uplands above MHHW and are therefore not expected to cause in-water disturbances that could induce movements or significantly change fish behavior. Species exposure to any of these effects is highly unlikely. Construction BMPs and water quality monitoring will ensure that there are no discharges of pollutants. In the unlikely event of increased turbidity, monitoring will ensure that it does not reach the levels or duration that would have harmful impacts to fish species.

Rock Placement

Eulachon are unlikely to be present during these actions, though juveniles could be in the estuary during early summer operations. There may be some effects to this life stage, but they are not expected to be significant, as the timing does not overlap well with the peak emigration period. As indicated in the multi-year PNNL studies, in comparison to higher peaks in distribution nearer the navigation channel, cross-sectional distribution of migrating juvenile Chinook and steelhead salmon suggested only a small percentage of juveniles (~4-7% of subyearling Chinook, less for yearlings and steelhead) use the areas within a 200m proximity to the jetties. Furthermore, the residence time of juveniles within the larger MCR area ranges from a few hours up to at most a few days for the less-directed subyearling Chinook emigrants. Yearling Chinook

and steelhead are more directed and within the larger MCR area have an even shorter residence times. The Corps expects that actual residence time for all juveniles in the immediate proximity of the jetty structures is likely even smaller than these extrapolations for the larger area indicated. Furthermore, a majority of the stone placement for work on the jetty root, trunk, and head will occur above MHHW, and an even higher percentage (70% or more in most cases) will occur above the MLLW elevation, which further limits the geographical distribution of the effects relative to marine and anadromous fish use in the area. Most fish present will be migrating in the water column at elevations significantly lower than this zone of work, and this is particularly true of green sturgeon. Therefore, juvenile exposure to any effects from rock placement are unlikely and would be of short duration if exposure occurred.

Migration. Some effects to migration from artificial obstruction by rock placement may occur, but they are not expected to be measurable. Besides the expected limitations to exposure, this is also because a majority of the spur groins most likely to be encountered by juveniles and adults are submerged so that fish can easily pass over the tops of them. In Table 36, MLLW represents the average height of the lower low waters over a 19-year period.

Table 36. Depths of Spur Groins with Respect to MLLW

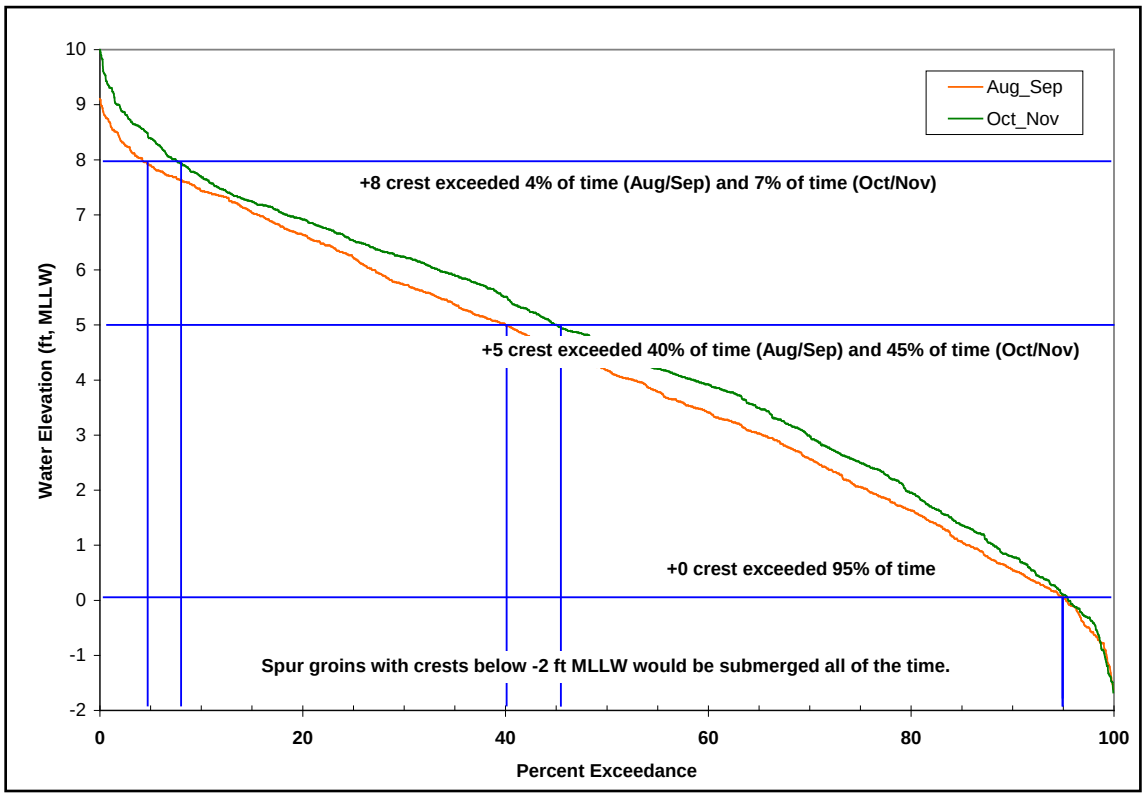
Jetty	Spur Groin	Side	Approximate Dimension (feet; LxWxH)	Acreage (+/-20%)	Depth (feet MLLW)
North	NJ1C	Channel	100x80x10	0.18	-5
North	NJ2C	Channel	170x115x19	0.45	-15
North	NJ3O	Ocean	60x80x10	0.11	+8
North	NJ4C	Channel	170x115x19	0.80	-35
A	J1C	Channel (East)	135x105x18	0.33	-5
A	J2O	Ocean (West)	125x100x15	0.29	-5
South	SJ1O	Ocean	60x80x9	0.11	+8
South	SJ2C	Channel	70x80x10	0.13	+5
South	SJ3C	Channel	70x80x10	0.13	+5
South	SJ4C	Channel	90x90x12	0.19	0
South	SJ5O	Ocean	190x125x22	0.55	-15

As discussed earlier, a limited number of juvenile salmonids could use the North Jetty area for migration. Little data is available regarding juveniles use of the South Jetty area, but it is possible that outmigration occurs in close proximity to the South Jetty as it does the North Jetty. Only spur groins on the channel side with elevations at or above MLLW could be capable of altering outmigration routes of juvenile salmonids by forcing them away from the shallower waters along the jetty proper and into deeper waters as they swim around spur groins. Otherwise, juveniles are assumed to pass over the submerged groins. Spur groins that could interfere with outmigration at times, depending on tidal level, would be located only on the South Jetty and include spur groins SJ2C and SJ3C at +5 MLLW (both 70 feet long) and spur groin SJ4C at 0 MLLW (90 feet long). Use of the jetties by eulachon and green sturgeon is also not well known.

Figure 62 shows percentage of time that the crests of spurs at 0 MLLW, +5 MLLW, and +8 MLLW would be exceeded (i.e., overtopped by water). Both spur groins with elevation +8 MLLW are not relevant to outmigration because they are on the ocean side of the jetties. Spurs

SJ2C and SJ3C on the South Jetty at an elevation of +5 MLLW would be above water 60% of the time for August-September and 55% for October-November. Spur SJ4C would be above water 5% of the time. It is expected that at some point on most ebb tides that spurs SJ2C and SJ3C would be above water, and that fish outmigrating within 70 feet of the South Jetty during that part of the ebb tide when the tops of these spur groins are exposed would have to swim around them. Though sub-yearling Chinook use nearshore areas by the North Jetty more than older juvenile salmonids and typically leave the MCR area over a period of more than one ebb tide, their exposure to these effects is expected to be minimal, and not anticipated to measurably change their migration behaviors.

Figure 62. Tidal Elevations at the MCR for August/September and October/November Time Windows with Respect to Spur Groins Subjected to Periodic Submergence



It is suspected that many, if not most, sub-yearling Chinook salmon swim to shallow, nearshore waters (i.e. just off the surf zone) after being swept out to the ocean by Columbia River flows (Emmett et al., 2004). Purse seine catches in these areas have indicated that shallow nearshore habitats are important for small (<130 mm FL) sub-yearling Chinook salmon (D. Miller, unpublished data cited in Emmett et al., 2004). Demonstration of nearshore habitat use by juvenile Chinook was also supported by studies and preliminary findings at the North and South Jetties (Marin Jarrin 2009, Marin Jarrin and Miller 2010). Fish migrating along the North Jetty could experience some minor artificial obstruction from the ocean-side spurs and be forced farther offshore in the plume before migrating to nearshore waters, although it is uncertain how far out they go with the plume before beginning migration shoreward. Therefore, because of slightly greater required swimming distance they could also conceivably be exposed to some

artificial obstruction effects from rock placement, as well as possible increased risks of predation before reaching preferred shallow water nearshore habitat. However, these effects are not expected to cause measurable changes in migration or foraging behavior. These effects are even less likely at the South Jetty, where juvenile Chinook presence was not established in the initial study samples by Marin Jarrin and Miller (2010).

Rock placement is not expected to cause direct fish mortality. It is much more likely that fish would be temporarily displaced during rock placement from disturbance from rocks entering the water. Furthermore, a majority of the rock would be placed above MLLW water, which greatly reduces the likelihood of any exposure to placement actions. Additionally, as the PNNL study indicated for juvenile salmonids, the short residence time in the immediate vicinity of the jetties suggests minimal potential for significant temporal exposure to jetty constructions and maintenance activities (McMichael et. al. 2006).

Habitat Conversion: Some sandy, shallow-water inter-tidal and lagoon habitat will be converted to fill or rocky inter-tidal habitat. This includes actions from stone placement for lagoon fill at the North Jetty; the construction of spur groins, barge offloading and turn-out facilities at all jetties; and a possible slight expansion of the jetty prism at Jetty A. The conservatively estimated total of this footprint for all placement actions is 15.5 acres (North Jetty ~ 7 acres; South Jetty ~ 3.5 acres; and Jetty A ~ 5 acres). Consequently, these conversions and disturbances could result in disturbance of benthic invertebrates and a possible conversion of biological communities. Within an estimated 3-mile proximity of the MCR jetties, about 19, 575 acres of shallow water habitat (anything -20 ft or shallower) exists, of which 15.5 acres represents a difference of much less than 1 %. Therefore, these effects of habitat conversion are expected to be minimal, and unlikely to significantly impact food resources or foraging behavior of juvenile or adult salmonids or sturgeon. Bottom feeding sturgeon may experience slightly greater effects, but habitat conversion is not expected to be of an extent that would significantly limit food resources. Spawning does not occur in the areas of habitat conversion, so effects from the proposed action will not impact spawning substrate or behavior. Further, eulachon are planktonic feeders, so minimal losses of benthic invertebrates would not affect their foraging behaviors. It is also expected that juvenile salmonids and sturgeon could utilize new ephemeral sand habitat that accretes behind spur groins for migration and rearing. Deposition behind the spur groins (landward side) would provide calmer waters. Deposition of sand upstream of existing spurs has been shown on the channel side of the South Jetty.

Predator Attraction. For the proposed action it is possible that piscivorous fish capable of preying on juveniles could recruit to the spur groins, rebuilt portions of the jetties, causeways, and barge offloading facilities. When juvenile salmonids or eulachon are near these locations they could be susceptible to predation. However, the short residence time of both juvenile salmon and eulachon reduces the likelihood and duration of increased exposure. Along the jetties is also not the preferred route for juveniles as demonstrated by the PNNL studies. Furthermore, the increase in the jetty prism and expansion of the footprint is very small relative to the existing structure, and a majority of stone placement is above MLLW; therefore an increase in piscivorous fish habitat and species interaction is not expected to occur. Green sturgeon are also not likely to be significantly affected by increased predation, since they would

likely remain closer to the bottom with even less exposure to predators further up in the water column and within the jetty rock structure.

At the Washaway Beach site, beach seines were deployed during May 2002 to characterize the occurrence of shallow-water fish. A total of 34,754 fish comprising 24 species were captured, 85.7% of which were surf smelt (*Hypomesus pretiosus*). Species richness (i.e., number of species per sample) was greater at the structures (19.5 species) compared to 11 and 15 at the west reference and east beach reference points, respectively. Potential predators of juvenile salmonids collected by beach seining included sub-adult coho salmon, Pacific staghorn sculpin (*Leptocottus armatus*), and lingcod (*Ophiodon elongates*). Staghorn sculpin and lingcod are both demersal ambush predators that feed on crustaceans and small fish (Emmett et al. 1991). The relatively high abundance of juvenile lingcod at Washaway Beach suggests that lingcod are recruiting to groin-associated habitats. It is clear that the structures provided habitat for predatory fish. From results of the Washaway Beach study, it is expected that piscivorous fish capable of preying on juvenile salmonids would recruit to rock structures (rebuilt jetty, spur groins, and causeways). However, a significant increase in salmonid exposure to predators is also unlikely, since juvenile residence times at the MCR and their proximal use at the jetty interface is minimal. Predators would be more likely to be within the stone structure and juvenile use in the near proximity of the jetties is limited.

Potential avian predator sightings at Washaway Beach during May 2002 in the vicinity of the structures included gulls (*Larus* spp.), Bonaparte's gull (*Larus philadephia*), surf scoter (*Melanitta perspicillata*), common loon (*Gavia immer*), Pacific loon (*Gavia pacifica*), cormorants (*Phalacrocorax* spp.), Northwestern crow (*Corvus caurinus*), tern (*Sterna* spp.), Western grebe (*Aechmophorus occidentalis*), and bald eagle (*Haliaeetus leucocephalus*). The mean number of avian predators observed per survey was less at the structures than at the reference points. At the MCR, the relatively small amount of additional rock from rehabilitation of jetties and construction of spur groins and causeways could increase perching opportunities for piscivorous birds, especially cormorants and brown pelicans. However, these perching opportunities are currently abundant in the lower Columbia River and are not expected to increase cormorant and pelican use of this area such that predatory pressure would be measurably increased. Similarly, the addition of stone is not expected to increase use by pinnipeds preying on adult salmonids, eulachon, or green sturgeon, since availability of jetty rock is not currently a limiting factor for pinniped populations. Effects of increased predation at the jetties are expected to be immeasurable and discountable.

Dredging

The elevation at barge offloading sites will require access to navigable waters and a dredge prism with a finish depth of -25 feet below MLLW, with maximum advance maintenance and disturbance depths not to exceed -32 feet MLLW. Facilities will have an approximate footprint of 400 feet x 400 feet. The depth along the barge unloading sites would be maintained during the active period for which the rock barges will be unloaded. Each facility will require about 4 acres of dredged area, and there are 2 facilities identified for the South Jetty and one each at North Jetty and Jetty A.

If all four offloading facilities were utilized simultaneously, this would result in a dredged area of approximately 16 acres. Within an estimated 3-mile proximately of the MCR jetties, about 19, 575 acres of shallow water habitat (anything -20 ft or shallower) exists. Therefore, as with stone placement, this results in a habitat conversion of less than one percent. Furthermore, it is more likely that only one or two facilities would be needed per year, which makes the relative percent of habitat conversion even smaller. Though there will be loss of benthic invertebrates in areas dredged, only negligible losses to food resources of juvenile salmonids or sturgeon are expected to result. Because eulachon feed on plankton, their foraging habitat will not be affected. Some sandy, shallow-water inter-tidal habitat will be converted to deeper inter- and sub-tidal habitat. Consequently, these conversions and disturbances could result in a possible conversion of biological communities with changes in depth and light penetration. The extent is expected to be minimal and recolonization is expected to be rapid. These effects are unlikely to significantly impact food resources or foraging behavior of juveniles or adults.

Most rearing of juvenile salmonids in the Columbia River estuary occurs in the upper part of the water column near the shore and in shallow-water areas (Bottom et al. 2005 cited in Corps 2004). Also, it is known that subyearling Chinook and chum salmon occupy shallow, nearshore habitats (Healey 1982 and others cited in Bottom et al. 2005). Therefore, it is likely that juvenile salmonids could use areas near the bottom where dredging for barge offloading facilities would be required. However, juvenile salmonid entrainment by clamshell dredges is very unlikely. This is supported by the assessment in the recent Coastal Biological Opinion (NMFS 2010), which evaluated dredging and disposal actions on a much larger scale relative to those proposed in this action. Green sturgeons are more likely to utilize bottom habitats that could be dredged, but they are equally likely to avoid entrainment. Temporary displacement of fish from disturbance could occur for short periods of time. More likely, fish would be forced into moving to other nearby suitable habitat during dredging. Eulachon may be affected during dredging activities, but it is not expected to be significant, and the timing is not likely to overlap with the emigration peak.

Effects on fish from changes in water quality due to dredging are discussed in that section.

Disposal

The effects of these actions are not expected to be different than those previously considered when the ODMDS were under evaluation. Activities from the proposed action are expected to be of significantly smaller scale and frequency than a majority of the disposal actions already occurring at the sites. As with dredging, there will be a temporary loss of benthic invertebrates in disposal areas. Some mounding could occur, resulting in some temporary changes to biological assemblages. However, actions are expected to be confined to the existing ODMDS disposal sites, and rapid invertebrate recruitment is expected. Therefore, only negligible losses to food resources of juvenile salmonids and sturgeon are expected to result.

As mentioned, subyearling Chinook and chum salmon shift to deeper habitats farther away from the shoreline as they grow to fingerling and smolt stages (Healey 1982 and others cited in Bottom et al. 2005). Therefore, they may be present in the disposal area along with adult and juvenile green sturgeon and eulachon. Though some exposure to the disposal plume may occur on an annual basis, fish would likely practice avoidance behaviors and be forced into moving to

other nearby suitable habitat during disposal activities. Direct fish mortality from the disposal plume is not expected. These actions are not expected to significantly affect rearing, holding, or migration patterns of juveniles or adults.

Effects on fish from changes in water quality due to disposal are discussed in that section.

Barge Offloading Facilities

As described, construction of barge offloading facilities, including stone placement, dredging, and pile installation and removal could cause temporary minor disturbance to fish. The coming and going of barges could also induce movement in salmonids and sturgeon that may be present in the vicinity. Though vessel movement may occur several times daily during construction season, it will be temporally limited in duration and geographically isolated to the navigation channel and facility. As with stone placement, fish distribution identified by PNNL studies could also indicate that use in the vicinity of the facilities is expected to be relatively low, and changes in migration or behavior patterns are expected to be immeasurable. Eulachon are not likely to be present during construction or use of barge offloading facilities and will not experience increased exposure to these effects.

Effects to fish from increased piscivory are not expected, as piling caps will avoid any significant increase in new perch sites. The effects to fish from dredging, pile installation and removal, and water quality at these facilities are discussed under their respective sections.

Pile Installation and Removal

As mentioned previously, for initial construction of all four facilities combined, up to approximately up to 96 Z- or H-piles could be installed as dolphins, and up to approximately 373 sections of Z or H piles installed to retain rock fill. However, it is unlikely that all facilities would be installed at the same time. Installation is likely to happen early in the construction season sometime between April and June, and is weather dependent. Piles will be located within 200-ft of the jetty and offloading structures. Vibratory drivers will be used and will dampen any acoustic effects to fish and other species. Further, impacts would be of short duration and intermittent in frequency. It is likely that sound will attenuate to near background levels a short distance from the source. Because of the vibratory methods being used, sound levels are not expected to reach levels that are harmful to fish. Additionally, fish distribution in the immediate vicinity of the jetties is less likely than further towards the navigation channel, so fewer juveniles will be in near proximity of the piles. Minor avoidance behavior may occur as a result of pile installation and removal, but this is not expected to significantly alter juvenile or adult migration or holding patterns. Eulachon are not likely to be present in the vicinity of the action area when installation happens, and will not be exposed to acoustic effects. Therefore, this action is not expected to have any significant or direct negative effects to marine or anadromous fish.

Wetland and Lagoon Fill and Culvert Replacement

As mentioned, the lagoon and wetlands at both the North and South Jetties are thought to be separated from direct regular ocean connectivity. There is little likelihood that listed species are present in these areas or that they would be exposed to any of these actions. The fill is also not

expected to have any significant negative effects on the habitat values or functions in the vicinity of the MCR such that impacts to water quality, natural cover, or forage would occur. Proposed fish salvage and fish exclusion measures that the South Jetty will further preclude the likelihood of impacts or exposure to effects of fill activities.

Dune Augmentation

A majority of the work and the entire amount of proposed fill for this action occurs above MHHW. Therefore, fish exposure to effects is highly unlikely. There is little likelihood of having any direct or indirect negative impacts to water quality or intertidal species, and the amount of dry sand conversion is relatively small compared to the amount of similar adjacent habitat that is available. Effects to marine and anadromous species are expected to be immeasurable.

Water Quality

Water quality effects of the proposed action which could indirectly affect fish include possible exposure to increased suspended sediments. It has been noted (NMFS 2004) that for coho salmon, concentrations of 250 ppm of suspended sediment for 1 hour caused a 95% reduction in feeding rates in juveniles, concentrations of 1,200 ppm for 96 hours killed juveniles, and concentrations of 53.5 ppm for 12 hours caused physiological stress (Noggle 1978) and changes in behavior (Berg 1983). In the high energy environment of the proposed project, however, it is expected that turbidity would dissipate before these sorts of adverse impacts would result. Also, fish are expected to be capable of escaping turbid situations. Background levels in the Columbia River have shown that turbidity readings can fluctuate by over 10% for samples taken at the same time in close proximity to each other (Corps 2005).

Salmon, sturgeon, and eulachon are mobile enough even as juveniles to avoid areas of high turbidity. Further, salmonids may intentionally use the very turbid plume extensively during their outmigration. It has been hypothesized that juvenile salmonids seek out turbid waters in estuaries in order to better conceal themselves from potential predators (Simenstad et al. 1982, Thorpe 1994). Because of rapid dissipation of turbidity in a high energy environment and motility of juvenile and adult salmonids, increases in turbidity will likely not result in reduction in feeding rates and growth, physiological stress, or increased mortality. Movement from turbid areas and behavioral avoidance of turbid areas by salmonids would likely result.

Operation of heavy equipment requires use of fuel, lubricants, etc which if spilled into the water can have direct negative effects and can kill or injure aquatic organisms. Because of preventative and response measures required in a Spill Prevention and Response Plan as well as the low chance of occurrence, it is unlikely that spills would adversely affect fish. Additional BMPs described in the proposed action further reduces the likelihood of spills or leaks occurring.

Furthermore, migration of creosote and its components [e.g., copper and polynuclear aromatic hydrocarbons (PAHs)] from treated wood in lotic environments can adversely affect juvenile salmon (NMFS December 1998). However, this exposure is unlikely because use of treated wood has been prohibited. Increased contamination from the dredge and disposal actions is

equally unlikely to cause direct or indirect harm to water quality or fish, as all test results have indicated safe levels for in-water disposal.

Hydraulic and Hydrological Processes

As mentioned, modeling results were indicative of small changes that were predicted from a larger-scale length rebuild scenario. Results remain informative because the relatively small changes that were expected from a larger action were still not expected to have significant negative effects on juvenile salmonids. The smaller currently proposed action, which only includes spur groins and not additional lengths from the original model, would be expected to have even few effects. The majority of juvenile salmonids outmigrates in late spring and early summer, although fall Chinook salmon typically have a more extended outmigration period than other Columbia Basin salmonids and commonly outmigrate in late summer as well. Therefore, modeling results for the August-September timeframe were more relevant than results for the October-November timeframe since riverine flow and oceanographic/circulation conditions from the August-September timeframe were more similar to the heavy outmigration period of late spring and early summer. Similarly, since juvenile salmonids typically use near surface waters, modeling results for these waters, as opposed to bed zone waters, are of primary interest. Changes to bed zones would be more applicable to green sturgeon.

As discussed previously, most rearing of juvenile salmonids in the Columbia River estuary occurs in the upper part of the water column near the shore and in shallow-water areas (Bottom et al. 2005). Also, it is known that subyearling Chinook and chum salmon occupy shallow, nearshore habitats but shift to deeper habitats farther away from the shoreline as they grow to fingerling and smolt stages (Healey 1982). Changes to bed morphology were not expected to result in extensive or significant deepening of shallow water habitats important to juvenile salmonids and sturgeon for rearing. Negative impacts to juvenile green sturgeon and salmonid rearing habitat will not likely result from the changing environmental conditions at the MCR jetties themselves. The most significant scouring effects that were predicted at the seaward half of the North Jetty and near the tip of Jetty A are no longer as likely under the current scenario, as no changes in lengths are proposed. Maximum change to bed level was predicted to be 1.25 to 1.50 meters in these areas, which was a small percentage (8%) of the existing 12-24m depth. This scouring was also predicted to occur in deep areas, much too deep for juvenile salmonids to be using near bottom habitat. As discussed earlier, juvenile salmonids typically seek out shallower waters while rearing in the estuary. For green sturgeon, bed load effects may be more relevant, but were not expected to be significant enough to alter habitat use or foraging opportunities.

Juvenile salmonids gradually acclimate to increased salinity as they move downstream through the Columbia River estuary. Juvenile salmonids can regulate the salinity around them by moving up or down in the water column, since heavier, more saline waters are found at greater depths. Ocean-type salmonids (e.g., sub-yearling Chinook) tend to occupy less saline waters in estuaries than stream-type salmonids (e.g., coho). Previously predicted local mean salinity changes of 0-4 ppt compared to the natural 20 ppt variation was and is not thought to represent a change at the MCR that would adversely affect juvenile salmonids, since it is a small change relative to natural variation that occurs in the area. Without a length rebuild, changes to salinity are highly unlikely and discountable.

Changes to water velocities are not thought to adversely alter how juvenile salmonids use the MCR. Surface current direction for the August-September timeframe is predicted to change slightly toward the north as water flows around Jetty A, forming a more pronounced clockwise eddying effect west of Jetty A and tending to force water more directly toward the North Jetty. It is possible that creation of a more pronounced eddying effect west of Jetty A may induce some juvenile salmonids, especially those that tend to spend more time in the estuary (e.g., sub-yearling Chinook salmon), to use habitat just downstream of Jetty A to a greater degree with the proposed action.

Wetland Mitigation and Habitat Improvements

In the long term, implementation of wetland mitigation and habitat improvement actions along with upland plantings will increase the overall square footage of higher-value wetlands, thus potentially improving wetland-stream hydrologic functions in the Columbia River estuary. This could also help improve water quality, natural cover, and forage opportunities that could benefit adults and juveniles. Improvement and restoration of low saltwater marsh habitat and shallow-water, intertidal sand and mudflat habitat in the estuary and within the vicinity of MCR will increase and improve habitat access for juveniles and adults near the area where the majority of the proposed actions will occur. This will also help improve and increase instream, riparian, and estuarine functions (e.g., creation of brackish intertidal and mudflat habitat, streambank stability, and improved canopy cover). Project goals and actions would result in benefits to listed species including increased juvenile habitat for resting, rearing, and refuge. Restoring tributary connectivity to the estuary would also reduce artificial obstructions and improve adult fish passage and access to headwaters and expanded potential spawning habitat. Wetland mitigation will restore any short functional losses associated with fill activities, which are expected to be minimal and short-term in nature.

Proposed actions that convert uplands and pasturelands to interdunal and saltwater marsh wetlands and high-quality, shallow-water, lower-velocity habitats available to juvenile fish would provide improvements that are beneficial to several species including sturgeon and salmon. Adult salmonids would also benefit by improved access and connectivity to additional tributary habitat. As previously discussed, several of the potential 7 (a) (1) projects contain management actions that have been included in Estuary Module of the Recovery Plan (NMFS 2007c). These management actions also received higher rankings for potential benefits, and higher percentages for increased survival of salmonids. The Corps expects long-term benefits and improvements to have a positive effect on the species.

Temporary short-term effects of the action to water quality and noise levels will be of limited duration and geographical scope due to BMPs. For invasive species removal, the Corps proposes to use no herbicides within 100 feet of the Columbia River or associated water bodies, and therefore does not expect negative effects on instream or riparian function. Short-term disturbances are expected to be minimal and discountable.

Marine Mammals

Marine mammals known to occur in the Columbia River offshore area include whales, dolphins, porpoises, sea lions, and seals. Most cetacean species observed by Green and others (1992) occurred in slope (600- to 6,000-foot depths) or offshore waters. Harbor porpoises and Gray whales were prevalent in shelf waters less than 600 feet deep. Pinniped species likely to occur in the vicinity of the jetties are harbor seal, California sea lion, and Steller sea lion (also known as northern sea lion). An important haul out area for Steller sea lions occurs on the South Jetty.

Steller Sea Lions

The Steller sea lion breeds along the west coast of North America from California's Channel Islands, to the Kurile Islands and the Okshotsk Sea in the western north Pacific Ocean and are year-long residents along the Oregon Coast. Steller sea lions are found in Washington waters and use haul out sites primarily along the outer coast from the Columbia River to Cape Flattery, as well as along the Vancouver Island side of the Strait of Juan de Fuca. Although breeding rookeries are located along the Oregon and British Columbia coasts, no breeding rookeries are found in Washington. In Washington, Steller sea lion numbers vary seasonally with peak counts of 1,000 animals present during the fall and winter months. Haulout sites are found on jetties, offshore rocks, and coastal islands. This species may also be found occasionally on navigation buoys in Puget Sound (Jeffries et al., 2000). Important haul out sites in Oregon include the Columbia River South Jetty, Ecola State Park, Sea Lion Caves, Three Arch Rock, Cape Arago, and Seal Rock. Steller sea lions are not known to use the MCR North Jetty or Jetty A. While breeding areas in Oregon including Rogue Reef (Pyramid Rock) and Orchard Reef (Long Brown Rock and Seal Rock) are federally-designated as critical habitat, the MCR South Jetty is not.

Steller sea lion population counts for Oregon have increased since 1976. Counts were relatively stable in the 1980s in Oregon and ranged from 2,000 to 3,000 Steller sea lions. The 1996 Steller sea lion count for the Oregon Coast was 3,990 (Hill and DeMaster 1998). In 1984 and 1985, year-round counts ranged from 769 to 2,352. During this survey, peak counts (2,352) were made on May 21 and 23, 1984 with haul out attendance greatest at Ecola State Park, Sea Lion Caves, Orford Reef, and Rogue Reef (Brown 1988). Peak attendance at the two Oregon rookeries occurs during May, June, and July. Sea lions begin to leave the rookeries in August. Males are the first to leave, followed by females within a few months (Gentry and Winthrow 1986). Seasonal shifts in the use of haul out sites are common among Steller sea lions. Steller sea lion numbers appear to be lower off Oregon in the winter than summer. Steller sea lions forage at river mouths and nearshore areas along the coast. Roffe and Mate (1984) determined that proximity to the mouth of a river was the most important factor in determination of forage areas.

The Columbia River South Jetty is used only as a haul out site and no known reproductive activity occurs there, although limited reproductive activity may occur. Use occurs chiefly at the far west end (approximately the last 1,000 yards) west of the highly eroded area. With erosion of the jetty landward, this area has become and island and is different than the rest of the jetty as it is composed of concrete blocks instead of irregularly shaped rocks. California sea lions (*Zalophus californianus californianus*) also use this area and can intermingle with Steller sea lions but use the rubble mound structure more; it appears Steller sea lions outcompete California sea lions for the preferred haul out area on the concrete block structure. A flyover count of the

South Jetty on May 23, 2007, observed 1,146 Steller sea lions on the concrete block structure and none on the rubble mound, while 352 California sea lions were observed on the rubble mound and none on the concrete block structure. Both species use the rubble mound structure extensively during winter when the concrete block structure is underwater with high seas.

California sea lions are known to occur in close proximity to human activity at various locations in Oregon bays and rivers and over the past several years have caused concerns because of their presence at Bonneville Dam, including in the fish ladder. Steller sea lions generally don't occur in close proximity to human activities in Oregon, but during spring of 2007 several were recorded at Bonneville Dam along with California sea lions and were trapped and relocated.

The Steller sea lion has no distinct migration but disperse to areas like the jetty from rookery areas after the breeding season (spring). Steller sea lions are present, in varying abundances, all year (Table 37). Abundance is typically lower from May-July as adults are at the breeding rookeries, although this is not always true as evidenced by the flyover count of the South Jetty on May 23, 2007 (WDFW 2007). Only non-breeding individuals are typically found on the jetty during May-July, and a greater percentage of juveniles are present. Abundance increases following the breeding season. All population age classes, and both males and females, use the South Jetty for haul out as opposed to the California sea lions, where only dispersing males from the south (California and Mexico) are found as far north as Oregon and use the jetty.

Table 37. Average Number of Pinnipeds by Month at South Jetty, 1995-2004

Month	Number of Years Surveyed	Average Number of Steller Sea Lions	Average Number of California Sea Lions	Average Number of Harbor Seals
January	1	246	18	0
February	4	246	50	0
March	1	635	39	0
April	3	613	48	1
May	4	252	42	0.75
June	8	245	82	1.75
July	4	385	56	0
August	2	486	27	0
September	0	---	---	---
October	1	168	63	0
November	1	923	297	0
December	1	1,106	725	0

Data from Oregon Department of Fish and Wildlife

Rock Transport. Though within the navigation channels rock transport could increase the possible exposure for vessel collisions with Steller sea lions, negative effects are unlikely to occur. Marine mammals using this area are likely already attuned to this traffic, and their swimming speeds and mobility would allow perception and avoidance of these vessels. Further, vessels are slow-moving, follow a predictable route, and do not target sea lions.

Steller sea lions may be more skittish than California sea lions on the South Jetty. During a boat trip around the South Jetty on June 20, 2006, a group of approximately 50 sea lions, all or the majority being Steller sea lions, were flushed off the seaward end of the rubble mound upon

approach of a Corps' hydro-survey boat. Flushing occurred at a distance greater than 100 yards, and was reported to NMFS under Section 109 of the MMPA (Corps 2006). This group of sea lions was observed back on the jetty 0.5 hour later. On that day, three California sea lions that were hauled out at approximately station 287 at the area of the South Jetty formerly known as the "notch" (landward of the group of Steller sea lions) permitted closer approach without flushing than did the Steller sea lions on that same day. With major rehabilitation of the Columbia River jetties, an IHA permit would again be obtained from the NMFS. With issuance of the IHA, disturbances of pinnipeds are recorded and reported to NMFS throughout the construction period. Sound disturbance is discussed in further details under Pile Installation and Removal.

Construction Access, Staging, Storage, and Rock Stockpiling. As mentioned previously, South Jetty is an important year-round, non-breeding haul out site for Steller sea lions. They primarily use the concrete block structure which has separated and become an island with erosion of the rubble mound structure landward of the concrete monolith. This concrete block structure is the farthest ocean-ward, above-water portion of the South Jetty. Steller sea lions are not known to use the North Jetty or Jetty A. Because Steller sea lions and other pinnipeds are known to haul out on the rubble mound structure in the vicinity of where the jetty head will be rebuilt, disturbance from construction will likely force animals off the rubble mound structure. However, construction will occur within limited temporal scale from May to October of any given year. During this time, sea levels typically allow sea lions to access the concrete block structure, rather than forcing them to use the more landward jetty root and trunk. Sea lions use the rubble mound structure more in the winter when the concrete block structure is under water. Available space on the concrete block structure is greater during summer because fewer animals are typically there. None of the proposed actions at the South Jetty directly involve these locations, so it is unlikely that activities will have a long-term effect on use of the nearshore waters, haulouts, or traditional rafting sites.

Noise will be generated above and below the water by operation of construction equipment and related activities. The trucks and crane used to move the jetty rocks will generate a moderate degree of noise. Acoustic disturbance may have some effect on the zones around terrestrial and aquatic habitats used by sea lions and therefore could cause some disturbance and movement. However, this is not expected to be significant, given responses under previously conducted actions. Interim repairs on the South Jetty during spring and summer of 2007 occurred to station 290 and had minimal effects on pinnipeds. Monitoring of sea lions (and harbor seals, *Phoca vitulina*) during construction was required by an Incidental Harassment Authorization (IHA) permit issued by NMFS under the Marine Mammal Protection Act (MMPA; NMFS 2007b). During construction, sea lions were often seen in the water close to the jetty and to a lesser extent on the jetty but appeared to be unaffected by construction activities and often swam close to construction activities and at times appeared to feed (several animals diving underwater at the same time) in close proximity to construction activities. Two incidental harassments of pinnipeds were reported during the 2007 interim repairs, and both occurred when a pinniped monitor unknowingly approached close to animals on the jetty; one was a California sea lion and the other was a harbor seal (Corps 2007). Both occurrences were minor and resulted in the animals moving. The majority of Steller sea lions occurring on the concrete block structure were far away from construction activities and undisturbed.

The Corps will again request an IHA permit from NMFS for incidental harassment of Steller sea lions, as well as non-federally listed California sea lions and harbor seals during construction.

Rock Placement. Acoustic and equipment traffic disturbances and effects similar to those described in the Construction Effects section may also occur during rock placement and are applicable here. Construction is not expected to change current patterns around the South Jetty head since the gap between the rubble mound head and the concrete block structure will not be filled in. Prey resources for sea lions are not expected to be affected. When construction is complete, more available jetty rock will exist but is not expected to substantially improve haul out opportunities; this not a limiting factor controlling Steller sea lion population numbers at the South Jetty. The preferred concrete block structure used extensively for haul out of Steller sea lions will be unaffected by repair actions. Steller sea lions are not expected to experience direct or long-term negative effects due to changing environmental conditions at the MCR.

According to the Biological Opinion for interim jetty repairs (NMFS September 2006), behaviorally, Steller sea lions respond to anthropogenic disturbances by vacating the area. Sea lions will likely redistribute themselves along portions of the jetty away from construction activities and to other haul out sites in the lower river and along the coast to the south and north. With this expected response the number of sea lions present on the jetty will likely temporarily decrease, followed by a gradual re-population of the jetty as substrate for hauling out is left undisturbed after construction. The proposed action likely will not cause a permanent reduction in the number of Steller sea lions that haul out on the South Jetty. Because the nearest breeding in Oregon occurs farther to the south, the proposed action will not affect Steller sea lion breeding activity because breeding adults will not be present during the proposed construction periods and. The project likely will cause short-term displacement of individuals but no mortality or injuries (NMFS September 2006). See Pile Installation and Removal for additional discussion regarding acoustic effects.

Dredging. Besides avoidance responses similar to that described under Rock Transport and Construction Staging, dredging activities are not likely to have any other significant impacts to the prey resources or habitat use by Steller sea lions. Slightly increased acoustic effects are not expected to reach harmful levels, though through disturbance could cause additional movement. Facilities requiring dredging are likely to be at least 1000 ft from the concrete monolith, and could be as far as 6000 feet from the monolith. This will allow some sound attenuation and reduces exposure sea lions will experience from construction and maintenance of the nearest offloading facility. These actions are also not expected to significantly alter aquatic habitats or nearshore waters around this haul out, or affect traditional rafting sites.

Disposal. As with disposal actions and vessel traffic, these activities are not expected to increase disturbance levels that will have additional significant negative impacts to Steller sea lions. Acoustic impacts from disposal will be even less than those from dredging, as disposal sites are further away from the South Jetty. They would be unlikely to cause any increase above background noise or vessel traffic near the South Jetty head. Water quality effects are discussed below.

Barge Offloading Facilities. These facilities will not be located along the jetties where sea lions prefer to haul out. Though they could experience effects previously described under Rock Placement as well as under Pile Installation and Removal, these indirect disturbances are expected to be minor and of short duration. No nearshore or haul-out habitat would be permanently reduced or altered in a way that would significantly reduce access by Steller sea lions. Facilities requiring piles are likely to be at least 1000 ft from the concrete monolith, and could be as far as 6000 feet from the monolith, which is one of the areas of heaviest use. This reduces some of the effects exposure sea lions will experience from construction of the nearest offloading facility. Sound levels will likely attenuate closer to background at this distance.

Pile Installation and Removal. Pilings for the barge offloading facility on the South Jetty would be in closest proximity to the haul-out area most heavily used by stellar sea lions. This means about 24 Z- or H-piles of 12-16 inches in diameter could be installed as dolphins, and up to about 94 sections of Z or H pile to retain rock fill installed by vibratory hammer within 200-ft of the jetty structure. These facilities are likely to be at least 1000 ft from the concrete monolith, and could be as far as 6000 feet from the monolith. This reduces some of the exposure sea lions will experience from construction of the nearest offloading facility. Furthermore, vibratory hammers will attenuate most of the acoustic effects from these installation and removal operations. Acoustic effects are not expected to reach harmful levels and will be further dampened farther from the source, becoming somewhat closer to background in the vicinity of the monolith. The additional sound levels may cause some avoidance behavior, but it is not expected to cause a long-term alteration in use of the haul-out or to foraging behavior. According to NMFS guidance (NMFS 2010c), current in-water acoustic thresholds (excluding tactical sonar and explosives) for Level B Behavioral Disruption from non-pulse noise like vibratory hammers is 120 dB_{RMS}. The threshold for Level A Injury is 190 dB_{RMS} for pinnipeds and 180 dB_{RMS} for cetaceans. Current in-air acoustic thresholds for Level A injury are not established. For Level B, behavioral disruption in harbor seals, the threshold level is 90 dB_{RMS}, and for non-harbor seal pinnipeds is 100 dB_{RMS}. Frequency bands relevant to pinnipeds (Steller and California sea lions, harbor seals, northern elephant seals) are 0.75-75 kHz (NMFS 2010c).

According to the NMFS Biological Opinion and analysis done for interim jetty repairs (NMFS September 2006), for marine mammals, sound pressure levels (SPLs) greater than 100 decibels (dB) in air re:20μPa when using an impact hammer to drive a pile have been shown to affect behavior. In addition to airborne sound, underwater sound produced by in-water pile driving can have detrimental effects on marine mammals, causing stress, changes in behavior, and interference with communication and detection of predators and prey. The most significant detrimental effect that loud underwater noises can have on marine mammals is a temporary or permanent loss of hearing. Based on studies, previous pile-driving projects, and consultation with experts, and review of the literature, the previous analyses concluded that marine mammals may exhibit behavioral changes when exposed to underwater impulse SPLs of 160 dB root mean square (RMS) re:1μPa (70 FR 333-338; 68 FR 64595) (NMFS September 2006). In addition, underwater SPLs at 190 dB_{RMS} re:1μPa (impulse) and above can cause temporary or permanent hearing impairment in sea lions (NMFS September 2006). NMFS used the practical spreading model for sound levels, dB = 15*log(R1/R2), with peak and RMS values of 177 and 165 dBRMS re: 1μPa respectively (Popper and Hastings 2005), the distance within which Steller sea lions will likely show behavioral changes is 75 feet (NMFS September 2006). The sound level

values used in the equation were for driving 12-inch timber piles with a drop hammer which is a close estimate to the 16-inch timber piles driven with a vibratory hammer in the previously proposed project (NMFS September 2006).

The response of Steller sea lions to disturbances can consist of head alerts, approaches to the water, and flushes into the water. Disturbance of Steller sea lions will occur intermittently throughout the proposed work windows. The number of Steller sea lions disturbed daily will vary based on weather conditions, season, and daily fluctuations of abundance at the South Jetty. Steller sea lions will likely be hauling out in the action area for the duration of the proposed project. Disturbance from airborne and underwater construction noise and pile driving is likely to have no more than a short-term, negligible adverse effect from impact on their behavioral patterns at the South Jetty (NMFS September 2006).

Lagoon and Wetland Fill and Culvert Replacement. These proposed actions will likely be mostly out of the preferred vicinity near the South Jetty haul-out. It is not likely to have any significant affects on foraging behavior or prey availability, and actions are not likely to cause any changes to habitat usage. Acoustic effects are expected to be discountable at this distance from the South Jetty.

Dune Augmentation. This activity may have some effect on nearshore areas that could be used by Steller sea lions due to its proximity to the haul-out at the South Jetty head. Acoustic effects are described further under the Pile Installation and Removal Section. However, this action is expected to occur for a short duration in a single season at a distance of 2.6 miles from the South Jetty monolith, and therefore is unlikely to have any measurable negative impacts on sea lion use of that area.

Water Quality. Water quality effects to Steller sea lions could be similar to those for anadromous fish. However, exposure to suspended sediment could be easily avoided, though possible exposure to spills and contamination could be equally harmful. However, as described under Water Quality in the anadromous fish section, the likelihood of a significant spill occurring is relatively low with the Spill Plan and BMPs that are proposed. Contaminated sediments are also not an issue at the site.

Hydraulic and Hydrological Processes. Any potential effects to water velocity, salinity, plume dynamics or bed morphology are not expected to have significant or negative effects on the aquatic prey resources or physical habitat features utilized by sea lions in the area. Any changes to currents or velocities in the area are expected to be minimal and localized. Sea lions have swimming speeds and mobility that should not be affected by any insignificant modifications to these conditions.

Mitigation and Habitat Improvements. The Corps is not proposing wetland mitigation or habitat improvements that will directly affect Steller sea lions. Indirectly, an improvement in habitat conducive to anadromous fish survival and development could also improve the amount of prey species that may be available to sea lions.

Whales

The blue whale, fin whale, sei whale, sperm whale, humpback whale, and the killer whale all occur as migrants in waters off the Washington and Oregon coasts. They could occur in the vicinity of the barge transport routes, but would be unlikely in the shallower, nearshore and estuary vicinity of the MCR area. Though these species may occur near the proposed project area, information on numbers, distribution, and feeding habits in the immediate action area is lacking. The Southern Resident killer whale population consists of three pods designated J, K and L, each containing 24, 22 and 44 members respectively (Ford et al. 2000; Center for Whale Research 2006, unpublished data). These pods generally spend late spring, summer and fall in inland waterways of Washington State and British Columbia. They are also known to travel as far south as central California and as far north as the Queen Charlotte Islands. Winter and early spring movements are largely unknown for this DPS. There have been four sightings of Southern Resident DPS within the Columbia River plume (NMFS 2007d). There have been four documented sightings of Southern Resident killer whales off the coast of Oregon and Washington near the Columbia River, in 2005 and 2006. Two sightings were in March and two in October (NMFS 2008a).

Several whales were observed from the South Jetty during the 2007 interim repairs. According to Maser and others (1981), occurrence of blue whales off the Oregon Coast is primarily in May and June and August through October. Blue whales typically occur offshore as individuals or in small groups and winter well south of Oregon. Fin whales also winter far south of Oregon and range off the Oregon and Washington coasts during summer. Whaling records indicate that fin whales were primarily harvested off Oregon from May to September. Sei whales also winter south of Oregon. Based on information from central California, sei whales probably occur in southward migration off the Oregon Coast in late summer and early fall. Sperm whales occur as migrants and some may summer off the Oregon and Washington coasts. Sperm whales forage in deep waters and strandings have occurred along the Oregon Coast. Humpback whales primarily occur off the Oregon Coast between April and October with peak numbers occurring during June, July, and August. The following analysis of effects applies to all listed whale species in the action area, including: blue, fin, humpback, killer, sei, and sperm whales.

Rock Transport. As with Steller sea lions, rock transport could increase the exposure for vessel collisions for whales within the navigation channels. However, negative effects are unlikely to occur because the level of traffic increase is insignificant (a maximum increase of 8-22 vessels per year), whales using this area are likely already attuned to this traffic, and their swimming speeds and mobility would allow perception and avoidance of vessels. Further, tugs and barges are slow moving, follow a predictable course, do not target whales, and are easily detectable. Vessel strikes are extremely unlikely and therefore discountable. Any potential encounters with whales are expected to be sporadic and transitory in nature. Sound produced by tugs towing a loaded barge (approximately peak of 500 Hz) are expected to be below the peak hearing sensitivity levels of whales (1-100kHz for killer whales) (based on Szymanski et al. 1999), and sound pressure levels from vessels are expected to return to background levels a short distance from the source. Thus, sounds from vessels are unlikely to mask acoustic signals of biological significance and will most likely be below the behavioral threshold for avoidance.

Remaining Effects. Because a majority of the proposed actions will occur within the vicinity of the MCR, very few of the other effects from the proposed actions will be applicable to whales. These species are extremely unlikely to be present in the vicinity of the action area where most of the work will occur. Whales are expected to be in the deeper, offshore waters and well out of the geographic extents of most of the effects. Faint hydroacoustic effects from pile installation and removal, dredging, disposal, and rock placement could cause minor avoidance behavior, but these effects are not expected to cause significant or permanent changes to migration or feeding patterns. Frequency bands relevant to Killer whales (resident and transient) is 1-100 kHz (based on Szymanski et al. 1999). For all baleen whales (humpback, gray and minke whales) it is 0.07-22 kHz (based on Southall et al. 2007). Acoustic effects from these actions are not expected to reach harmful levels and will likely return to background a short distance from the source. For acoustic effects from pile installation, see that section of analysis for Stellar sea lions. Whales are unlikely to occur in the shallow areas where pile installation and dredging will occur. In the unlikely event that they were in the vicinity, sound would likely be below the disturbance threshold (greater than 160 decibels (dB) in water re:1μPa) and likely will return to closer to background a short distance from the source. Whales are not expected to experience any exposure to effects from upland activities like staging, and storage, wetland fill, or dune augmentation that have been described in previous sections. Water quality effects are expected to be minimal and temporary with respect to suspended sediment, and unlikely with respect to significant spills and leaks. Harmful levels of contaminants have not been identified at the site. Potential minor changes to local hydraulics will not affect whales, since they are not expected to be in the vicinity of the jetties. Piling installation will not create or alter migration routes, as whales will not be present in the vicinity. The close proximity to the jetty and low density of piles and dolphins for the barge offloading facilities will not impede whale movement, and the potential to alter the pathway of whales through the project area is discountable. The Corps is not proposing wetland mitigation or habitat improvement actions that will directly affect whales. However, indirectly, an improvement in habitat conducive to marine and anadromous fish survival and development could also improve the amount of prey species that may be available to whales.

Marine Turtles

The loggerhead turtle, green turtle, leatherback turtle, and the Olive ridley turtle have all been recorded from strandings along the Oregon and Washington coasts since 1982 (J. Scordino, NMFS cited in Green et al., 1992). Green and others (1992) recorded 16 leatherback turtles during their survey of Oregon and Washington coastal waters and found that they were associated with warmer waters over the Pacific slope during summer. Leatherback, loggerhead, green, and olive ridley turtle occurrences off the Oregon and Washington coasts are associated with the appearance of albacore. Albacore occurrence is strongly associated with the warm waters of the Japanese current that tends to approach the Oregon Coast in late summer. During El Nino events, warm water may occur closer to the Oregon and Washington coasts than usual, but typically warm water associated with the Japanese current does not closely approach the Oregon and Washington coasts, generally occurring 30 to 60+ miles offshore.

Leatherbacks forage primarily on cnidarians (jellyfish and siphonophores) and to a lesser extent on tunicates (pyrosomas and salps) (NMFS and USFWS 1998). They exploit convergence zones and areas of upwelling (Morreale et al. 1994). Highly productive areas off the coast of the

Pacific Northwest include wind-driven upwelling areas and areas associated with the Columbia River plume. The productivity of these areas is variable when comparing seasons and years, and upwelling varies considerably with location along the California Current, a south-flowing current, which predominates off the coast of the Pacific Northwest. Most of the present knowledge of Leatherback use of the California Current comes from recent telemetry studies, aerial surveys, and ship-based research conducted primarily in the nearshore areas off the central California coast. The telemetry work has documented trans-Pacific migrations between nesting beaches in the western tropical Pacific and the California Current, but specific migratory corridors, if they exist, remain undefined (NMFS 2009).

The nutrient-rich waters of the Columbia River plume tend to aggregate and retain jellyfish in the northern California Current (Shenker 1984). Graham and others (2001) found that jellyfish tend to collect along boundaries including mesoscale oceanic fronts, local circulation patterns, thermoclines, and haloclines and found that scyphomedusae are closely linked to the physical structure of the water column and the dynamics of upwelling-related circulations. There is some evidence that Leatherbacks feed farther offshore in association with the Columbia River plume and off of Washington in general than they do along the central California coast (PFMC 2006) where they feed in the vicinity of Monterey Bay (NMFS November 2006).

The brown sea nettle (*Chrysaora fuscesens*) appears to be the dominant jellyfish species off the coasts of Oregon and Washington (Shenker 1984; Suchman et al. unpublished data). In a study from the Columbia River to Coos Bay, Oregon conducted from May through August (Shenker 1984), brown sea nettles were found to be largest and most abundant during August, although they were present throughout the duration of the study. Suchman and Brodeur (2005) found brown sea nettles to be more common in August compared to June (but well represented in June) in a study from Newport, Oregon to Crescent City, California. Suchman et al. (unpublished data) found brown sea nettle common during July, August, and September in a study off the coasts of Oregon and Washington. Other species of jellyfish that appear to be much less common than brown sea nettles are also present during late spring, summer, and early fall (Shenker 1984; Suchman and Brodeur 2005; Suchman et al. unpublished data). Leatherbacks are most frequently sighted in ocean waters off Oregon and Washington from late spring to early fall (Bowlby 1994). From the limited amount of research on jellyfish and Leatherbacks in Pacific Northwestern nearshore waters, it appears that there is overlap in time of occurrence of jellyfish and Leatherbacks. Knowledge about Leatherback abundance in the Columbia River plume, as well as foraging activity, is sparse.

Most species of marine turtles are expected to occur further offshore and would not regularly be in the vicinity of the MCR or a majority of the proposed actions. There may be some occurrence of marine turtles along the potential barge routes, which may overlap with designated critical habitat. Leatherbacks are not known to enter the Columbia River, though they are known to feed offshore and nearer shore on jellyfish associated with the Columbia River plume, which acts to aggregate Leatherback food resources in the California Current.

Rock Transport. Similar to marine mammals, rock transport could increase the possible exposure for vessel collisions with marine turtles. However, negative effects are unlikely to occur because marine turtles using this area are likely already attuned to this traffic, and their

swimming speeds and mobility would allow perception and avoidance of these vessels. Further, barges are slow-moving, follow a predictable course, and are easily detectable. Vessel strikes are extremely unlikely and therefore discountable.

Remaining Effects. Because the majority of the proposed actions will occur within the vicinity of the MCR and shallower estuarine and nearshore waters, very few of the other effects described in previous sections will be applicable to marine turtles. For the most part, turtles are expected to be in the deeper, offshore waters and well out of the geographic extent of most of the effects. Faint hydroacoustic effects from pile installation and removal, dredging, and rock placement could cause minor avoidance behavior if turtles were nearer shore, but these effects are not expected to cause significant or permanent changes to migration or feeding behavior. Sound waves from pile installation, dredging, or vessel traffic are expected to attenuate near the source and are unlikely to reach areas where turtles would be more likely to occur. The same could be said for the periodic disposal actions, which could occur in the Shallow or Deep Water disposal sites in somewhat closer proximity to potential passage routes. As with whales, marine turtles are not expected to experience any exposure to effects from upland activities such as staging and storage, wetland fill, or dune augmentation.

Water quality effects are expected to be minimal with respect to suspended sediment and turbidity, and unlikely with respect to significant spills and leaks. Contamination is not an expected issue regarding dredge or disposal of sediments, and therefore will not impact prey or contribute to bioaccumulation in the species. Furthermore, previous modeling for a larger rebuild of jetty lengths had indicated only minimal potential changes to local hydraulics. Impacts from earlier modeling were not predicted to significantly impact plume dynamics. Under the current proposed scenario, changes to plume dynamics are even less likely. Therefore, no negative effects on abundance or distribution of prey species reliant on the plume are expected. Turtle exposure to most of the effects is extremely unlikely, and would only be expected to be sporadic and transitory in the event that it did occur. Effects that could have minor impacts to turtles are easily avoided by turtles and are not expected to significantly alter their behavior, prey availability, or migration patterns.

CRITICAL HABITAT

Salmonids

In the action area, critical habitat was designated by the NMFS for all Columbia River steelhead trout and Columbia River salmon ESUs with the exception of the lower Columbia River coho salmon ESU (70 FR 52630; September 2, 2005). The PCEs of critical habitats (Table 38) designated for ESA-listed salmon and steelhead species relevant directly or indirectly in the action area include: (1) estuarine areas, (2) nearshore marine areas, and (3) offshore marine areas.

Table 38. PCEs of Critical Habitats Designated for ESA-listed Salmon and Steelhead and Corresponding Life History Events

Does not include SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, and SONCC coho salmon - see Table 39 for these species.

Primary Constituent Elements		**Species Life History Event**
Site Type	**Site Attribute**	
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and “reverse smoltification” Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine areas	Forage Water quality	Adult growth and sexual maturation Adult spawning migration Subadult rearing

The PCEs of critical habitats (Table 39) designated for SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONCC coho salmon relevant directly or indirectly in the action area include adult and juvenile migration corridors, and areas for growth and development to adulthood.

Table 39. PCEs of Critical Habitats Designated for SR Spring/Summer-run Chinook Salmon, SR Fall-run Chinook Salmon, SR Sockeye Salmon, and SONCC Coho Salmon and Life History Events

Primary Constituent Elements		**Species Life History Event**
Site	**Site Attribute**	
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook and coho) Spawning gravel Water quality Water temperature (sockeye) Water quantity	Adult spawning Embryo incubation Alevin development Fry emergence Fry/parr growth and development Fry/parr smoltification Smolt growth and development
Juvenile migration corridors	Cover/shelter Food Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Fry/parr seaward migration Smolt growth and development Smolt seaward migration
Areas for growth and development to adulthood	Ocean areas – not identified	Adult growth and development Adult sexual maturation Fry/parr smoltification Smolt/adult transition
Adult migration corridors	Cover/shelter Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult “reverse smoltification” Adult upstream migration Kelt (steelhead) seaward migration

For anadromous fish, potential direct or indirect effects of the proposed action on PCEs are summarized below as a subset of the habitat-related effects of the action that were discussed more fully above. In the action area, critical habitat was designated by NMFS for all Columbia River steelhead trout and Columbia River salmon ESUs with the exception of LCR coho salmon ESU (70 FR 52630; September 2, 2005). The PCEs of critical habitats designated for ESA-listed salmon and steelhead species (except for SR spring/summer run Chinook salmon, SR fall-run

Chinook salmon, SR sockeye salmon, SONCC coho salmon) with site attributes that may be affected directly or indirectly in the action area are included below. Overall, within the total project area that does or could fall under designated critical habitat, there could be permanent wetland impacts to an estimated total of ~ 38 acres. This estimate is likely to be significantly reduced after delineations are complete, and proposed wetland mitigation actions will restore long-term ecosystem functions. There will be some temporary effects, but they are not expected to be significant, as previously discussed in this analysis. In-water habitat conversions will total approximately ~ 40 acres. However, this is not expected to have significant negative effects, since it remains less than 1% of the available shallow-water habitat in the vicinity of MCR. Therefore, wetland fill and in-water conversions are not expected to measurably affect the PCEs described.

Temporally, many of the described effects are intermittent in the short term, but over the 20-year construction schedule may result in repetitive sporadic disturbances. However, in many cases these disturbances may occur in consecutive years, but in different geographical locations. Alternatively, effects may occur repetitively in the same location annually, and then a break in actions occurring in the particular geographical area could last for several years. The Corps does not expect that in the short or long-term these effects will cause a meaningful or measureable reduction in the conservation value of salmonid PCEs.

1. Estuarine Areas
    a. Forage – Minor and temporary impacts to benthic invertebrates are expected at localized dredging, disposal, and rock placement sites. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually. However, this is not anticipated to limit productivity or to have any long-term effects on food availability or foraging behavior.
    b. Free of obstruction – Spur groins are small components of the jetty that will protrude slightly into the channel but are expected to accrete sand on their leeward sides, which may provide some resting area for out-migrating juveniles. Their depths and limited geographical effects are not expected to alter migration patterns of juveniles or adults. Pile structures will also be localized and of low density and are not expected to measurably interfere with migration patterns or behaviors.
    c. Natural cover – Most of the construction and staging areas will occur above MHHW. No effects are likely to occur.
    d. Salinity – Changes to the plume are not expected. Therefore, no effects to salinity are likely to occur.
    e. Water quality – Minor, localized, and temporary effects from increased suspended sediment due to dredging, disposal, rock placement, and piling installation and removal are likely. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually or a single event basis. There is also an increased potential for spills or leaks, but BMPs reduce the likelihood of this occurrence. Monitoring will limit the levels and durations of turbidity; therefore long-term or significant effects to water quality are not likely.

f. Water quantity – No effects are likely to occur.

2. Nearshore Marine Areas
    a. Free of obstruction – Spur groins are a small component of the jetty structure that will protrude slightly into the nearshore areas, but they are expected to accrete sand on their leeward sides, which may provide some resting area for juveniles that are feeding and rearing in this environment. Their limited geographical effects are not expected to significantly alter migration patterns of juveniles or adults. Therefore, they are not expected to result in adverse effects to the nearshore areas.
    b. Natural cover – No effects are likely to occur. Most of the construction and staging areas will occur above MHHW.
    c. Salinity – Changes to the plume are not expected. Therefore, no effects to salinity are likely to occur.
    d. Water quality – Minor, localized, and temporal effects from increased suspended sediment due to dredging, disposal, rock placement, and piling installation and removal are likely. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually or a single event basis. There is also an increased potential for spills or leaks, but BMPs reduce the likelihood of this occurrence. Monitoring will limit the levels and durations of turbidity to ensure protection of salmonids and aquatic organisms; therefore long-term or significant effects to water quality are not likely
    e. Water quantity – No effects are likely to occur.

The PCEs of critical habitats designated for SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, and SONCC coho salmon with site attributes that may be affected directly or indirectly in the action area include:

1. Adult and Juvenile Migration Corridors
    a. Substrate – Shallow, sandy intertidal habitat may be converted to rocky or deeper subtidal habitat. This will be a single discrete temporal and geographical event that could occur annually at various locations described in the proposed action. Spawning does not occur in the action area, therefore actions will not impact spawning substrate, and are not expected to significantly limit rearing habitat.
    b. Water quality – Minor, localized, and temporal effects from increased suspended sediment due to dredging, disposal, rock placement, and piling installation and removal are likely. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually or a single event basis. There is also an increased potential for spills or leaks, but BMPs reduce the likelihood of this occurrence. Monitoring will limit the levels and durations of turbidity to ensure protection of salmonids and aquatic organisms; therefore long-term or significant effects to water quality are not likely.
    c. Water quantity – No effects are likely to occur.
    d. Water temperature – No effects are likely to occur.

e. Water velocity – Small localized changes will occur in the vicinity of the spur groins. However, these are not expected to have larger scale or system-wide effects that would limit the habitat use or alter the migration routes of adults or juveniles.
f. Cover/shelter – No effects are likely to occur.
g. Food – Minor and temporary impacts to benthic invertebrates at localized dredging, disposal, and rock placement sites. This is not expected to have any significant or long-term effects on food availability.
h. Riparian vegetation – Most of the construction and staging areas will occur above MHHW and will not impact natural cover or areas of significant wood recruitment. No effects are likely to occur.
i. Space – No effects are likely to occur.
j. Safe passage– No effects are likely to occur.

2. Areas for Growth and Development to Adulthood
    a. Ocean areas – (not identified) – Spur groins will protrude slightly into the nearshore areas, but they are expected to ephemerally accrete sand on their leeward sides dependent on tide, which may provide some temporary resting area for juveniles that are feeding and rearing in this environment. Therefore, they are not expected to result in adverse effects to the nearshore areas.

The effects on the PCEs noted above will not be significant at the watershed or the designation scale of critical habitat for listed salmonid species. Additionally, in the above analysis, the long-term beneficial effects from the proposed wetland mitigation and habitat improvement projects were not incorporated. However, there may be beneficial effects to the PCEs in the areas of natural cover, water quality, forage, and food. As previously discussed, these habitat improvement actions are also in-line with CRE management actions that have been identified for protection and recovery of salmonids (NMFS 2007c). Therefore, they are expected to result in beneficial effects to critical habitat.

Green Sturgeon

Critical habitat was designated by the NMFS for green sturgeon. The PCEs of critical habitats (Table 40) relevant directly or indirectly in the action area include:

1. Estuarine areas
2. Coastal marine areas

Table 40. PCEs of Critical Habitats Proposed for Southern Green Sturgeon and Corresponding Life History Events

Primary Constituent Elements		Life History Event
Site Type	**Site Attribute**	
Freshwater riverine system	Food resources Migratory corridor Sediment quality Substrate type or size Water Depth Water flow Water quality	Adult spawning. Embryo incubation, growth and development. Larval emergence, growth and development. Juvenile metamorphosis, growth and development.
Estuarine areas	Food resources Migratory corridor Sediment quality Water flow Water depth Water quality	Juvenile growth, development, seaward migration. Subadult growth, development, seasonal holding, and movement between estuarine and marine areas. Adult growth, development, seasonal holding, movements between estuarine and marine areas, upstream spawning movement, and seaward post-spawning movement.
Coastal marine areas	Food resources Migratory corridor Water quality	Subadult growth and development, movement between estuarine and marine areas, and migration between marine areas. Adult sexual maturation, growth and development, movements between estuarine and marine areas, migration between marine areas, and spawning migration.

As discussed under effects to salmonid designated critical habitat, temporally there may also be repetitive effects to green sturgeon PCEs on a daily or annual basis, but they are not expected to cause significant long-term negative effects to that reduce the conservation value of PCEs for green sturgeon in the action area.

1. Estuarine Areas
    a. Food Resources – Minor and temporary impacts to benthic invertebrates are expected at localized dredging, disposal, and rock placement sites. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually. This is not anticipated to have any significant or long-term effects on food abundance or distribution.
    b. Migratory Corridor – Spur groins are a small part of the jetties that will protrude slightly into the channel, but they are expected to accrete sand on their leeward sides, which may provide some resting area for out-migrating juveniles. Their limited geographical effects are not expected to significantly alter migration patterns of juveniles or adults.
    c. Sediment Quality – Harmful levels of contaminants have not been identified at the sites, and most of the substrate is over 90% sands. No effects are likely to occur.
    d. Water Flow – No effects are likely to occur.
    e. Water Quality – Minor, localized, and temporal effects from increased suspended sediment due to dredging, disposal, rock placement, and piling installation and removal are likely. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually or to a single event. There is also an increased potential for spills

or leaks, but BMPs reduce the likelihood of this occurrence. Monitoring will limit the levels and durations of turbidity to ensure protection of salmonids and aquatic organisms; therefore long-term or significant effects to water quality are not likely.

f. Water Depth – Shallow, sandy intertidal habitat may be converted to rocky or deeper subtidal habitat. However, this is a very small percentage; it will not impact spawning substrate; and it is not expected to significantly limit holding, rearing, or foraging habitat.

2. Coastal Marine Areas
    a. Food Resources – Minor and temporary impacts to benthic invertebrates are expected at localized dredging, disposal, and rock placement sites. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually. This is not anticipated to have any significant or long-term effects on food abundance or distribution.
    b. Migratory Corridor – Spur groins are a small component of the jetties that will protrude slightly into the channel, but they are expected to accrete sand on their leeward sides, which may provide some resting area for juveniles that are out-migrating. Their limited geographical effects are not expected to significantly alter migration patterns of juveniles or adults.
    c. Water Quality – Minor, localized, and temporal effects from increased suspended sediment due to dredging, disposal, rock placement, and piling installation and removal are likely. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually or to a single event. There is also an increased potential for spills or leaks, but BMPs reduce the likelihood of this occurrence. Monitoring will limit the levels and durations of turbidity to ensure protection of aquatic organisms; thus, long-term or significant effects to water quality are not likely.

The effects on the PCEs noted above will not be significant at the watershed or the designation scale of critical habitat for green sturgeon.

Eulachon

Critical habitat has not been designated for this species.

Marine Mammals

Steller Sea Lions. Critical habitat was designated by the NMFS for the Eastern Population of Steller sea lions. PCEs of critical habitats include: air zones around terrestrial and aquatic habitats, nearshore waters around rookeries and haulouts; forage resources and habitats; and traditional rafting sites. However, neither the potential barge vessel routes nor the action area at MCR are within designated critical habitat.

Blue, Fin, Humpback, Sei, and Sperm Whales. There is no designated critical habitat in the proposed action areas.

Southern Resident Killer Whale. The PCEs of critical habitats for southern resident killer whales could be included in the action area passed through during vessel transport of rocks. Otherwise, the vicinity of the MCR is not included in the critical habitat designation. The PCEs essential for conservation of this species are:

1. Water Quality – Minor, localized, and temporal effects from increased suspended sediment due to dredge material disposal are likely, but are not expected to have significant effects on migratory or feeding behavior. Actions are temporally limited to a few days only annually. There is also a slight increased potential for localized spills or leaks, but BMPs reduce the likelihood of this occurrence and limit the geographical extent of the effects. Monitoring will limit the levels and durations of turbidity; therefore long-term effects to water quality are minimal and discountable.

2. Prey Species – Effects to prey resources like marine and anadromous fish are expected to be minor and discountable. Therefore effects to this PCE are not likely to limit or reduce prey species that occur in the designated critical habitat areas. Acoustic effects will be intermittent and likely to attenuate near the source. Therefore, they are not expected to interfere with important biological signals that would affect foraging behaviors or cause changes in prey availability.

3. Passage Conditions – Vessel traffic will be a short-term annual occurrence, and will likely be concentrated seasonally during fairer weather months. However, traffic is not expected to increase appreciably due to the action, and therefore not expected to have effects on migration, resting, and foraging behaviors or patterns. Effects to passage from vessel traffic are transitory and discountable. Piles and mooring dolphins will be installed within 200 feet of the jetties in relatively shallow waters. Therefore, they will not create obstacles or cause measurable effects to passage conditions. Acoustic effects will be intermittent and likely to attenuate near the source. Therefore, they are not expected to interfere with important biological signals that would affect passage conditions or cause long-term changes in migration patterns.

As discussed under effects to salmonid designated critical habitat, temporally there may also be repetitive effects to killer whale PCEs on a daily or annual basis, but they are not expected to cause significant long-term negative effects to that reduce the conservation value of PCEs for Southern resident killer whales in the action area. Further, the effects on the PCEs noted above will not be significant at the watershed or the designation scale of critical habitat for southern resident killer whales.

Marine Turtles

Loggerhead and Olive Ridley Sea Turtles. Critical habitat has not been designated for loggerhead turtle and the Olive ridley turtles.

Green Sea Turtle. Critical habitat for green sea turtles is designated but does not occur in the action area.

Leatherback Sea Turtle. In January 2010 there was a proposed rule to revise critical habitat designations for the leatherback turtles from Cape Flattery, Washington to the Umpqua River (Winchester Bay), Oregon east of a line approximating the 2,000 meter depth contour (75 FR 319), which would include the potential barge transport routes of the proposed action area. The PCEs of the proposed revised critical habitat for leatherback turtles relevant directly or indirectly in the action area include: water quality, prey species, and passage conditions. In the vicinity of the Columbia River plume, there is an occurrence of prey of species primarily scyphomedusae of the Semaeostomeae, including the genera *Chrysaora*, *Aurelia*, *Phacellophora*, and *Cyanea* of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development. The following effects to PCEs of critical habitat could occur.

1. Water Quality – Minor, localized, and temporal effects from increased suspended sediment due to dredging, disposal, rock placement, and piling installation and removal are possible. Placement could occur during a limited time window on a seasonal daily basis, and the other actions are temporally limited to a few days only annually or to a single event. These water quality effects will be limited due to BMPs that are proposed, as well as the sandy, uncontaminated character of the substrate. Monitoring will limit the levels and durations of turbidity to protect aquatic life. Transitory exposure is unlikely, as turtles are not expected to be in the vicinity.

2. Prey Species – No significant changes to plume structure are expected; therefore, no effects to jellyfish or other prey items are anticipated. The proposed action is not expected to have short or long-term effects to prey abundance or distribution.

3. Passage Conditions – Vessel passage will be a short-term annual occurrence, and will likely be concentrated seasonally during fairer weather months. However, traffic will be transitory and will not cause a significant increase in traffic levels relative to background. Acoustic effects are expected to attenuate near the source. Sound levels are not expected to have long-term effects on important biological signals that would alter migration patterns. Piles and mooring dolphins will be installed within 200 feet of the jetties in relatively shallow waters. They will not create obstacles or cause measurable effects to passage conditions. Therefore actions are not expected to have significant effects on passage conditions or migration, resting, or foraging behaviors.

As discussed under effects to salmonid designated critical habitat, temporally there may also be repetitive effects to leatherback turtle PCEs on a daily or annual basis. However, they are discountable and are not expected to cause significant long-term negative effects to that reduce the conservation value of PCEs for leatherback sea turtles in the action area. Further, the effects on the PCEs noted above will not be significant at the watershed or the designation scale of critical habitat for the leatherback sea turtle.

CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). For the proposed action, the action area previously defined,

there are no foreseeable non-federal actions subject to their own ESA consultation that have the potential to increase the impacts of actions described in this BA on federally listed species.

SYNTHESIS AND INTEGRATION OF EFFECTS

Species at the Population Scale

Effects to Fish Populations

The following life stages of marine and anadromous fish may be present in the action area and effects to fish at the population level are discussed below.

Salmon and steelhead	Sturgeon	Eulachon
1. Juveniles a. Rearing b. Migration c. Smoltification 2. Adults a. Sub-adult growth and development b. Upstream migration and holding c. Seaward migration (steelhead)	1. Adults a. Sub-adult growth and development b. Upstream migration and holding c. Seaward migration d. Seasonal holding e. Estuarine, nearshore and marine movements	1. Embryos and larvae a. Incubation b. Emergence 2. Juveniles a. Rearing b. Migration c. Metamorphosis 3. Adults a. Sub-adult growth and development b. Upstream migration and holding

Summary of Effects on Anadromous Fish

The action area provides habitat for rearing, smoltification, and migrating juvenile salmon and steelhead. The primary species using the area are ocean-type Chinook, chum, and coho salmon. Stream-type Chinook and juvenile steelhead may also be using the area during ocean outmigration. Adult migrating salmon and steelhead may also be present in the action area. This bulk of the effects analyses pertain to juvenile salmonids only, as adults that could be in the vicinity of the action area are highly mobile and in the process of migration. Adults are not expected to spend extended amounts of time in the vicinity of the jetties and could avoid areas of disturbance. No significant adverse permanent disturbances to habitat that adults use in the MCR would result from the proposed action. The effects on abundance and productivity at the population scale will be insignificant because such a small proportion of each population will be affected and effects on VSP characteristics will not be measurable or meaningfully expressed at the population scale. Therefore, project effects are not likely to impede the survival or recovery of the affected populations.

As described, certain aspects of the proposed action are reasonably likely to result in effects to ESA-listed species in the action area. The Corps does not expect adult salmon and steelhead to be injured or harmed by the proposed action. A summary of possible impacts considered in this analysis for juvenile salmonids from the proposed action includes the following:

Rock Transport. Vessel traffic may induce some movement in juveniles but is not expected to significantly or negatively alter migration, foraging, or holding patterns. Furthermore, juvenile salmonids will likely experience little exposure, as they tend to prefer shallower habitat outside navigation channels used by barges.

Construction Access, Staging, Storage, and Rock Stockpiling. A majority of these actions are above MHHW with BMPs that will avoid water quality effects and reduce juvenile exposure to any significant adverse effects.

Rock Placement. Rock placement may provide ephemeral shallower habitat on their leeward sides that could be used by juveniles. Direct mortality to juveniles is not expected, though, there may be a minimal increase in exposure to predators. There will also be insignificant and localized alteration to pathways immediately adjacent to and along the trunk of the jetties. However, juveniles will be able to pass over submerged groins under a majority of conditions. Rock placement is not expected to increase perching opportunities for avian piscivory, and therefore will not negatively affect juveniles or adults. Effects from habitat conversion are expected to be minimal, due to the relatively small scale and anticipated recovery of benthic and invertebrate food sources.

Dredging. There will be a temporary loss of benthic invertebrates in areas dredged but only negligible losses to food resources of juvenile salmonids, and effects are expected to be localized and minor in scale. Some sandy, shallow-water inter-tidal habitat will be converted to deeper inter- and sub-tidal habitat. While juvenile salmonids may use bottom areas where dredging for barge offloading facilities will occur, entrainment by clamshell dredges is very unlikely and should not result in significant negative effects.

Disposal. As with dredging, there will be a temporary loss of benthic invertebrates in disposal areas. However, this is not expected to result in significant effects to food sources. Juveniles may be present in the disposal area, but direct fish mortality from the disposal plume is not expected. Juveniles may be temporarily displaced while moving to other nearby suitable habitat during disposal activities. These actions are not expected to significantly affect rearing, holding, or migration patterns of juveniles.

Barge Offloading Facilities. Stone placement, dredging, and pile installation and removal could cause limited and temporary effects described in their respective sections. Localized vessel traffic at the offloading sites could induce localized and temporary movement in salmonids. No effects from increased avian piscivory are anticipated.

Pile Installation and Removal. Vibratory drivers will be used, which will dampen any acoustic effects to fish and other species. Acoustic effects from vibratory drivers would be of limited duration and intermittent in frequency, and therefore are not expected to have significant or long-term negative effects on juveniles. Minor avoidance behavior is not expected to significantly alter juvenile migration or holding patterns.

Wetland and Lagoon Fill and Culvert Replacement. Because these actions occur mostly in the uplands, fish use is unlikely, and there are no anticipated significant negative effects on habitat values and functions, no effects on fish are expected from these actions.

Dune Augmentation. These actions occur in the dry sand above MHHW and therefore are not expected to have significant effects on fish.

Water Quality. Water quality changes could occur in the form of temporary and localized increased suspended sediments and turbidity. Monitoring will ensure levels remain within ranges protective of aquatic life. There may also be a slight increased risk of exposure to leaks and spills; however, contamination is not expected to occur because sediments have tested clean and treated wood will be prohibited. Therefore, effects from water quality are expected to be of minimum extent and duration, and will not significantly affect fish.

Hydraulic and Hydrological Processes. Modeling results for a previously proposed, much larger scale lengthening and rehabilitation project indicated minimal and insignificant effects from changes to velocities, channel bed morphology, and salinity. Changes to plume structure were also insignificant. Under the current smaller proposed action, spur groins may have a limited and localized effect on bed morphology and velocities. However, the small range of potential change is not expected to have significant or negative long-term effects on juveniles.

Wetland Mitigation and Habitat Improvements. Actions are expected to have long-term, beneficial effects to juvenile and adult habitat, and would positively affect their PCEs. Therefore, no long-term or significant negative effects are expected.

As demonstrated in the summary above, based on this analysis the proposed action ***may affect and is likely to adversely affect*** all runs of salmonids and steelhead discussed in this BA.

Green Sturgeon

The bulk of this effect analysis pertains to juvenile green sturgeon only, as adults that could be in the vicinity of the action area are highly mobile. Adults are not expected to spend extended amounts of time in the vicinity of the jetties and could avoid areas of disturbance. No adverse permanent disturbances to habitat that adults use in the MCR would result from the proposed action. The effects on abundance and productivity at the population scale will be insignificant because such a small proportion of each population will be affected and effects will not be measurable or meaningfully expressed at the population scale. Therefore, project effects are not likely to impede the survival or recovery of the affected populations.

A summary of possible impacts on juvenile green sturgeon from the proposed action includes the following:

Rock Transport. Vessel traffic may induce some movement in juveniles. However, this is not expected to significantly or negatively alter juvenile migration or holding patterns. Green sturgeon juveniles may be present, but would likely be lower in the water column and tend to

move at night. Therefore their exposure to traffic would be geographically and temporally limited.

Construction Access, Staging, Storage, and Rock Stockpiling. These actions are mostly above MHHW, which limit exposure to sturgeon. Actions are not expected to have any significant or adverse effects on juveniles.

Rock Placement. Rock placement may provide ephemeral shallower habitat on their leeward sides that could be used by juveniles. Direct mortality to juveniles is not expected due to swimming abilities. There will also be insignificant and localized alteration to migration pathways immediately adjacent to and along the trunk of the jetties. Sturgeons tend to utilize bottom habitats, and rock placement is not expected to increase exposure to piscivorous fish or avian piscivory. Effects from habitat conversion are expected to be minimal, due to the relatively small scale and anticipated recovery of benthic and invertebrate food sources.

Dredging. There will be loss of benthic invertebrates in areas dredged but only negligible losses to food resources of sturgeon, and effects are expected to be localized and temporary in scale. Some sandy, shallow-water inter-tidal habitat will be converted to deeper inter- and sub-tidal habitat. While sturgeon may use bottom areas where dredging for barge offloading facilities will occur, entrainment by clamshell dredges is very unlikely and should not result in significant negative effects.

Disposal. As with dredging, there will be a temporary loss of benthic invertebrates in disposal areas. However, this is not expected to result in significant effects to sturgeon food sources. Juveniles and adults may be present in the disposal area, but direct fish mortality from the disposal plume is not expected. Adults and juveniles may be temporarily displaced while moving to other nearby suitable habitat during disposal activities. These actions are not expected to significantly affect rearing, holding, or migration patterns of juveniles or adults.

Barge Offloading Facilities. Stone placement, dredging, and pile installation and removal could cause limited and temporary effects described in their respective sections. Localized vessel traffic at the offloading sites could induce localized and temporary movement in sturgeon.

Pile Installation and Removal. Vibratory drivers will be used, which will dampen any acoustic effects. Acoustic effects from vibratory drivers would be of limited duration and intermittent in frequency, and therefore are not expected to have significant or long-term negative effects on juveniles. Minor avoidance behavior is not expected to significantly alter juvenile migration or holding patterns.

Wetland and Lagoon Fill and Culvert Replacement. Because these actions occur mostly in the uplands, fish use is unlikely, and there are no anticipated significant negative effects on the habitat values, no effects on fish are expected from these actions.

Dune Augmentation. These actions occur in the dry sand above MHHW; therefore exposure is unlikely and actions are not expected to have significant effects on fish.

Water Quality. Water quality changes could occur in the form of temporary and localized increased suspended sediments and turbidity. There may also be a slight increased risk of exposure to leaks and spills; however, contamination is not expected to occur because sediments have tested clean and treated wood will be prohibited. Therefore, effects from water quality are expected to be of minimum extent and duration, and will not significantly affect fish.

Hydraulic and Hydrological Processes. Modeling results for a previously proposed, much larger scale lengthening and rehabilitation project indicated minimal and insignificant effects from changes to velocities, channel bed morphology, and salinity. Changes to plume structure were also insignificant. Under the current, smaller proposed action, spur groins may have a limited and localized effect on bed morphology and velocities. However, the small range of potential change is not expected to have significant or negative long-term effects on juveniles.

Wetland Mitigation and Habitat Improvements. Actions are expected to have long-term, beneficial effects to that could improve food resources, water flow, and water quality in the estuary. Therefore, actions are expected to positively affect sturgeon PCEs. Therefore, no long-term or significant negative effects to juvenile sturgeon are expected.

As demonstrated in the summary above, based on this analysis the proposed action ***may affect and is likely to adversely affect*** green sturgeon. Green sturgeons are not expected to experience long-term effects due to changing environmental conditions at the MCR.

Eulachon

The bulk of this effects analysis pertains to juvenile eulachon only, as adults that are not likely to be in the vicinity of the action area. There is little seasonal overlap with peak immigration and the majority of construction actions. Adults present are in the process of migration and highly mobile. Adults are not expected to spend extended amounts of time in the vicinity of the jetties and could avoid areas of disturbance. No adverse permanent disturbances to habitat that adult eulachon use in the MCR would result from the proposed action. The effects on abundance and productivity at the population scale will be insignificant because such a small proportion of each population will be affected and effects will not be measurable or meaningfully expressed at the population scale. Therefore, project effects are not likely to impede the survival or recovery of the affected populations.

A summary of possible impacts on juvenile eulachon from the proposed action includes the following:

Rock Transport. The seasonality of potential peak juvenile eulachon usage has little overlap with the likely timing of most barge traffic and therefore, this action is not likely to increase eulachon exposure to vessel traffic. Disturbance from vessel traffic could cause effects to juveniles that would not otherwise occur. However, proposed actions are not expected to have significant impacts to passive emigration behaviors.

Construction Access, Staging, Storage, and Rock Stockpiling. These actions are mostly above MHHW and limit exposure to eulachon. These actions are not expected to have any significant or adverse effects on eulachon.

Rock Placement. Significant direct mortality to juveniles is not expected. However, there may be a minimal increase in exposure to predators with the addition of channel-side spur groins due to predator attraction. There will also be insignificant and localized alteration to migration pathways immediately adjacent to and along the trunk of the jetties. However, juveniles will be able to pass over submerged groins under a majority of conditions. Effects from habitat conversion are not expected to impact food sources. The seasonality of peak potential juvenile eulachon usage in the vicinity of MCR during this activity has little overlap with the likely timing of rock placement. Therefore exposure to these effects is temporally and geographically limited.

Dredging. There will be loss of benthic invertebrates in areas dredged but as planktonic feeders, this will not affect juvenile eulachon. While juvenile eulachon may use bottom areas where dredging for barge offloading facilities will occur, they are more pelagic in nature and would be more likely found in the water column. Entrainment by clamshell dredges is possible, but unlikely and should not result in significant negative effects to the population.

Disposal. As with dredging, this is not expected to result effects to juvenile eulachon food sources. Juveniles may be present in the disposal area, but direct fish mortality from the disposal plume is not expected. Adults and juveniles may be temporarily displaced while moving to other nearby suitable habitat during disposal activities. These actions are not expected to significantly affect rearing or migration patterns of juveniles or adults.

Barge Offloading Facilities. Stone placement, dredging, and pile installation and removal could cause limited and temporary effects described in their respective sections. Occasional vessel traffic at the offloading sites could cause localized and temporary effects to eulachon. The seasonality of peak potential juvenile eulachon usage in the vicinity of MCR during this activity has little overlap with the likely timing of these effects; therefore, exposure is geographically and temporally limited.

Pile Installation and Removal. Vibratory drivers will be used, which will dampen any acoustic effects to eulachon. Acoustic effects from vibratory drivers would be of limited duration and intermittent in frequency, and therefore are not expected to have significant or long-term negative effects on juveniles. The seasonality of potential juvenile eulachon usage in the vicinity of MCR during this activity has little overlap with the likely timing of these effects; therefore, exposure is not likely.

Wetland and Lagoon Fill and Culvert Replacement. Because these actions occur mostly in the uplands, fish use is unlikely, and there are no anticipated significant negative effects on the habitat values, no effects on eulachon are expected from these actions.

Dune Augmentation. These actions occur in the dry sand above MHHW; therefore exposure is unlikely and actions are not expected to have significant effects on eulachon.

Water Quality. Water quality changes could occur in the form of temporary and localized increased suspended sediments and turbidity; but monitoring will ensure levels remain

within ranges safe for aquatic life. There may also be a slight increased risk of exposure to leaks and spills; however, contamination is not expected to occur because sediments have tested clean and treated wood will be prohibited. Therefore, effects from water quality are expected to be of minimum extent and duration, and will not significantly affect eulachon.

Hydraulic and Hydrological Processes. Modeling results for a previously proposed, much larger scale lengthening and rehabilitation project indicated minimal and insignificant effects from changes to velocities, channel bed morphology, and salinity. Changes to plume structure were also insignificant. Under the current, smaller proposed action, spur groins may have a limited and localized effect on bed morphology and velocities. However, the small range of potential changes is expected to be minimal and discountable and is not expected to have significant or negative long-term effects on juvenile eulachon.

Wetland Mitigation and Habitat Improvements. No long-term or significant negative effects to juveniles are expected.

As demonstrated in the summary above, based on this analysis the proposed action ***may affect and is likely to adversely affect*** eulachon as discussed in this BA.

Steller Sea Lion

This effect determination pertains to Steller sea lions that could be in the vicinity of the action area. No adverse permanent disturbances to habitats that sea lions use at the MCR would result from the proposed action. The effects on abundance and productivity at the population scale will be insignificant because such a small proportion of each population will be affected and effects will not be measurable or meaningfully expressed at the population scale. Therefore, project effects are not likely to impede the survival or recovery of the affected populations.

A summary of possible impacts on Steller sea lions from the proposed action includes the following:

Rock Transport. Exposure to vessel traffic may cause some disturbance and avoidance behavior. However, sea lions using this area are likely already attuned to this traffic, and have the ability to and could exercise avoidance behavior. Therefore, these actions are not expected to have any significant or long-term negative effects. Additionally, an IHA permit would be obtained from the NMFS.

Construction Access, Staging, Storage, and Rock Stockpiling: Disturbance from construction could force animals off the rubble mound structure. However, seasonal use levels, construction location, and temporal spatial availability in and around the preferred haul-out site somewhat limits the overlap between high pinniped use and the peak construction season. Therefore, it is unlikely that activities will have a long-term effect on use of the nearshore waters, haulouts, or traditional rafting sites. Acoustic disturbance may have some effect on the zones around terrestrial and aquatic habitats used by sea lions and therefore cause some disturbance and movement. However, this is not expected to be significant, given pinniped responses during previously conducted actions.

Rock Placement. Acoustic and equipment traffic disturbances and effects similar to those described under the Construction effects section may also occur during rock placement; and are therefore applicable here. However, rock placement is not expected to significantly change physical conditions or prey resources in the vicinity of the MCR. Steller sea lions are not expected to experience direct or long-term negative effects due to changing environmental conditions at the MCR.

Dredging. Besides an avoidance response similar to that described under Rock Transport, dredging activities are not likely to have any other significant impacts to habitat use by Steller sea lions. Therefore, no negative effects to aquatic habitats, or nearshore waters, or traditional rafting sites are expected.

Disposal. As with disposal actions, these activities are not expected to have additional negative impacts to Steller sea lions.

Barge Offloading Facilities. These facilities will not be located along the jetties where sea lions prefer to haul out. Although they could experience effects described under the Rock Placement and Pile Installation and Removal sections, these indirect disturbances are expected to be minor and of short duration. No nearshore or haul-out habitat would be altered in a way that would have negative effects to Steller sea lions.

Pile Installation and Removal. Acoustic effects may cause some temporary avoidance behavior, but are not expected to cause long-term negative effects. Acoustic effects are not expected to reach levels that cause significant or long-term disturbance or harm.

Lagoon and Wetland Fill and Culvert Replacement. Because these proposed actions are out of the immediate vicinity of the South Jetty, potential exposure to disturbance is not likely to have any significant affect on behavior or habitat usage.

Dune Augmentation. This activity is in proximity to the haul-out and may have some minimal discountable effect on nearshore areas that could be used as a rafting site.

Water Quality. Water quality effects from suspended sediment are not likely, though exposure to spills is possible but the likelihood is reduced due to BMPs.

Hydraulic and Hydrological Processes. No significant or negative effects to prey resources or physical habitat features are expected. Therefore, no direct effects are expected.

Wetland Mitigation and Habitat Improvements. Indirect benefits from improved prey resources may affect sea lions but no negative long-term or significant adverse effects are expected.

As demonstrated in the summary above, based on this analysis the proposed action ***may affect and is likely to adversely affect*** Steller sea lions. No long-term effects due to changing environmental conditions at the MCR are expected.

Whales

This effect determination pertains to whales that could be in the vicinity of the barge transport routes or disposal sites at the MCR. No adverse permanent disturbances to habitats that whales use in the vicinity of the MCR would result from the proposed action. The effects on abundance and productivity at the population scale for all whale species will be insignificant because such a small proportion of each population will be affected and effects will not be measurable or meaningfully expressed at the population scale. Therefore, project effects are not likely to impede the survival or recovery of the affected populations. A summary of possible impacts on whales from the proposed action includes the following:

Rock Transport. Whales within navigation channels could have increased exposure to vessels; however, there is no appreciable increase in traffic expected, and their perception and avoidance abilities make collisions unlikely.

Remaining Effects. Because whales are expected to be in the deeper, offshore waters and not within the geographic extent of the proposed actions, effects from activities are anticipated to be immeasurable and discountable. Periodic disposal actions in closer proximity to potential whale passage routes are not expected to cause significant or permanent changes to whale migration or feeding behavior. Water quality effects are expected to be minimal and discountable. Minor changes to local hydraulics and proposed restoration actions will have no negative effects on whales. Acoustic effects are not expected to reach levels that cause significant or long-term disturbance or harm. Proposed wetland mitigation and habitat improvement actions will have no long-term or significant negative effects on whales, nor will upland actions.

As demonstrated in the summary above, based on this analysis the proposed action ***may affect, but is not likely to adversely affect*** each of the six whale species discussed in this BA (blue whale, fin whale, sei whale, sperm whale, humpback whale, and killer whale). No long term effects due to changing environmental conditions at the MCR are expected.

Marine Turtles

This effect determination pertains to marine turtles that could be in the vicinity of the barge transport routes or disposal sites at MCR. No adverse permanent disturbances to habitats that marine turtles use in the vicinity of the MCR would result from the proposed action. The effects on abundance and productivity at the population scale for all whale species will be insignificant because such a small proportion of each population will be affected and effects will not be measurable or meaningfully expressed at the population scale. Therefore, project effects are not likely to impede the survival or recovery of the affected populations. A summary of possible impacts on turtles from the proposed action includes the following:

Rock Transport. Marine turtles within navigation channels could have increased exposure to vessels. However, there is no appreciable increase in traffic expected, and their perception and avoidance abilities make collisions unlikely.

Remaining Effects. Because turtles are expected to be in the deeper, offshore waters and not within the geographic extent of the proposed actions, no impacts are anticipated from activities. Marine turtles do not typically occur close to shore and would only occur in the vicinity of the proposed project site under unusual circumstances. Periodic disposal actions in closer proximity to potential turtle passage routes are not expected to cause significant or permanent changes to migration or feeding behavior. Water quality effects are expected to be minimal with respect to suspended sediment, and unlikely with respect to significant spills and leaks. Minor changes to local hydraulics are not expected to affect the plume, and proposed wetland mitigation and habitat improvement actions will have no negative long-term or significant effects on marine turtles. Upland actions will have no affect on turtles.

As demonstrated in the summary above, based on this analysis the proposed action will have ***no effect*** on each of the four marine turtle species discussed in this BA (loggerhead sea turtle, green sea turtle, leatherback sea turtle, and Olive Ridley sea turtle).

Critical Habitat at the Watershed Scale

Salmonids

The effects on PCEs of estuarine areas and nearshore marine areas in the action area will not be significant at the watershed or the designation scale of critical habitat for all Columbia River steelhead trout and Columbia River salmon ESUs, with the exception of the lower Columbia River coho salmon ESU that is not designated (70 FR 52630; September 2, 2005).

Critical habitat designations for ESA-listed salmon and steelhead species (except for SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONCC coho salmon) have PCEs of with site attributes that may be affected directly or indirectly in the action area which include: minor impacts to benthic invertebrates and foraging opportunities, as well as minor and temporary impacts to water quality. Insignificant permanent habitat conversion will occur, and spur groins may cause minor disturbance and insignificant obstructions to migration patterns in the local proximity of the jetties. Estuarine and nearshore marine areas may also experience temporary and insignificant effects to water quality.

The PCEs of critical habitats designated for SR spring/summer run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONCC coho salmon with site attributes that may be affected directly or indirectly in the action area include adult and juvenile migration corridors and areas for growth and development to adulthood. Substrate conversion will be localized and insignificant, and is not expected to limit spawning (which does not occur in the action area) or rearing habitat. There will also be temporary and localized impacts to water quality. Localized changes in velocity will occur near the spur groins, but changes are not likely to significantly affect juvenile or adult rearing, migration, or holding patterns. Minor and temporary impacts to benthic invertebrates are not expected to have any significant or long-term effects on food availability. In ocean areas, spur groins will protrude slightly into the nearshore areas, but are not expected to result in significant adverse effects to the rearing or migration.

The effects on the PCEs noted above will not be significant at the watershed or the designation scale of critical habitat for listed salmonid species. Additionally, in the above analysis, effects

from the proposed wetland mitigation and habitat improvement actions were not incorporated. However, there may be beneficial effects to the PCEs in the areas of natural cover, water quality, forage, and food.

For these reasons, the proposed action ***may affect and is likely to adversely affect*** critical habitat designated for listed salmonids discussed in this BA (LCR coho salmon currently has no designated critical habitat).

Green Sturgeon

The effects on PCEs of estuarine areas and coastal marine areas in the action area will not be significant at the watershed or the designation scale of critical habitat for green sturgeon. The PCE site attributes that may be directly or indirectly affected include insignificant impacts to food resources from minor, localized impacts to benthic invertebrates. Limited and minor effects on migratory corridors could occur from the localized protrusions of the spur groins. Temporary, minor, and localized effects to water quality could occur from the proposed action, but are not expected to have significant impacts on rearing, migration, or development. Insignificant impacts to water depths will occur as habitat is converted, but this is not expected to impact spawning substrate (no spawning occurs in the vicinity of MCR) or holding, rearing or foraging habitat. These effects are not expected to result in significant negative impacts to estuarine or coastal marine PCEs.

The effects on the PCEs noted above will not be significant at the watershed or the designation scale of critical habitat for green sturgeon. Additionally, in the above analysis, effects from the proposed wetland mitigation and habitat improvement actions were not incorporated. However, there may be beneficial effects to the PCEs in the areas of food resources and water quality.

For these reasons, the proposed action ***may affect and is likely to adversely affect*** critical habitat designated for listed green sturgeon discussed in this BA. However, Green sturgeons are not expected to experience long-term effects due to changing environmental conditions at the MCR.

Eulachon

Critical habitat has not been designated for this species.

Marine Mammals

Steller Sea Lions. Critical habitat was designated by the NMFS for the Eastern Population of Steller sea lions, but is not located within the proposed action areas.

Blue, Fin, Humpback, Sei, and Sperm Whales. These species do not have designated critical habitat in the action area.

Southern Resident Killer Whale. Water quality effects that could occur are localized and temporary, as are minor effects to passage conditions. No significant long term-effects are anticipated to prey species. Therefore, effects to PCEs are not expected to have measurable effects on critical habitat of southern resident killer whale. The noted potential effects on PCEs

will not be significant at the watershed or the designation scale of critical habitat for southern resident killer whales. For these reasons, the proposed action ***may affect but is not likely to adversely affect*** critical habitat designated for southern resident killer whales as discussed in this BA. This species is not expected to experience long-term effects due to changing environmental conditions at the MCR.

Marine Turtles

Loggerhead Sea Turtle and Olive Ridley Sea Turtle. Neither species has designated critical habitat in the action area.

Green Sea Turtle. Critical habitat for green sea turtles is designated but does not occur in the action area.

Leatherback Sea Turtle. Currently, there is no critical habitat designated in the vicinity of the proposed action, but there is a proposed revision that would include parts of the action area. Potential barge routes may occasionally come within the vicinity of proposed critical habitat PCE migratory pathway conditions that allow for safe and timely passage and access to/from/within high use foraging areas. Water quality effects in the potential routes would be minor, temporary and localized. Because changes are not expected to affect the plume, reduction or distribution of prey species are not anticipated, and effects to passage conditions are not expected to cause significant changes to migration or behavior patterns of leatherback sea turtles.

The effects on the PCEs noted above will not be significant at the watershed or the designation scale of critical habitat for the leatherback sea turtle.

For these reasons, the proposed action ***may affect but is not likely to adversely affect*** potential critical habitat designated for listed leatherback turtles as discussed in this BA. Leatherback sea turtles are not expected to experience long-term effects due to changing environmental conditions at the MCR.

CONCLUSION

Due to the minimal likelihood that species would encounter any elements of the proposed action or that actions would affect their critical habitat, the Corps has determined that the proposed action will have no affect on the following species of marine turtles: loggerhead sea turtles (*Caretta caretta*), green sea turtles (*Chelonia mydas*), and olive ridley sea turtles (*Lepidochelys olivacea*). Due to the minimal likelihood that species would encounter any elements of the proposed actions, or that actions would significantly affect PCEs their critical habitat, the Corps has determined that the proposed action is not likely to adversely affect (NLAA) leatherback sea turtles (*Dermochelys coriacea*). Due to the minimal likelihood that species would encounter any elements of the proposed actions, or that vessel traffic would significantly affect their critical habitat, the Corps has determined that the proposed action is not likely to adversely affect (NLAA) the following marine mammal species: blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), killer whales (*Orcinus orca*) and sei whales (*B. borealis*). This Biological Analysis further demonstrates the Corps' determination that the proposed action is likely to adversely affect eulachon (*Thaleichthys pacificus*). The Corps has also determined that the proposed action is likely to adversely affect green sturgeon (*Acipenser medirosris*) and Stellar sea lions (*Eumotopias jubatus*). Finally, through this analysis the Corps has also reached the determination that the proposed action may affect and is likely to adversely affect all runs of listed salmonids and steelhead.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitats, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that may be taken by the action agency to conserve EFH.

The Pacific Fishery Management Council (PFMC) described and identified EFH for groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Chinook salmon, coho salmon, and Puget Sound pink salmon (PFMC 1999). The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of species noted in Table 17.

The NMFS conducted groundfish stock assessment studies in the areas offshore of California, Oregon, Washington, and southern British Columbia triennially from 1977 to 2001 (Weinberg et al., 2002). The 2001 assessment collected data from depths ranging from 55 to 500 meters and provides useful information on the distribution of groundfish species. A detailed discussion of EFH for groundfish is provided in Appendix B of Pacific Coast Groundfish Fishery Management Plan [Pacific Fisheries Management Council (PFMC) 2005]. The report includes groundfish life history descriptions (Part 2), EFH text descriptions (Part 3), and habitat suitability maps for groundfish species with life history stages. A detailed discussion of EFH for coastal pelagic species is provided in Amendment 8 to the Coastal Pelagic Species Fishery Management Plan (PFMC 1998). The salmon EFH is discussed in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). The Corps reviewed all of this information to assess the possible impacts to these species' EFH from the proposed action.

Based on information provided in this BA and the analysis of effects presented in the ESA portion of this document, the Corps concludes that the proposed action will have effects on EFH designated for the species identified in Table 17. Permanent negative impacts could be imparted on EFH for Chinook salmon, coho salmon, English sole, sand sole, and starry flounder. Short-term disturbances to EFH would result for lincod, English sole, sand sole, starry flounder, and black, brown, China, copper and quillback rockfish species. Permanent positive effects from addition of rock would increase the area of EFH for lincod and black, brown, China, copper and quillback rockfish species.

POTENTIAL EFFECTS OF THE PROPOSED ACTION ON EFH

Salmon EFH

Marine EFH for Chinook and coho salmon includes (1) estuarine rearing; (2) ocean rearing; and (3) juvenile and adult migration. Important features of this estuarine and marine habitat include (1) adequate water quality; (2) adequate temperature; (3) adequate prey species and forage base; and (4) adequate depth, cover, marine vegetation, and algae in estuarine and near-shore habitats.

The proposed action has the potential to impact EFH of adult and juvenile salmon migration habitat and juvenile rearing habitat. Noise from pile installation and removal is expected to be minimal and not cause an impact since all piles will be installed by vibratory driver. Sound levels will likely be somewhat attenuated towards background in the vicinity of the source. Offloading and under water placement of rock may temporarily displace both adult and juvenile salmon during their migration.

Short-term increases in suspended sediment and resultant turbidity from installing piles or the placement of jetty stones and larger rocks may also impact salmon EFH. Increases in suspended sediment and turbidity will generally be limited to the construction areas along the jetty bases and will be intermittent and of short duration. No contaminated material would be suspended, as sediment in the region is nearly pure sand. Course-grained sand, characteristic of the region, will tend to settle relatively quickly; therefore effects to water quality are expected to be minimal. Alteration of bottom habitat by pile installation and removal or additional rock placement to repair the jetties or add spur groins along the jetties should not adversely affect salmon EFH since these areas do not provide valuable resting or feeding habitat. The MCR is an active migration corridor and it is unlikely that salmon are feeding to any extent in this area. Consequently, there will be no effect on salmon feeding habitat.

Juvenile rearing habitat could be negatively affected by the proposed action. Approximately 15.5 acres of shallow water, and nearshore sandy habitat would be covered at the North and South Jetties and at Jetty A by spur groins, barge offloading facilities, and rehabilitation construction: 7 acres at the North Jetty, 5 acres at Jetty A, and 3.5 acres at the South Jetty. Some causeway structures would be removed upon project completion.

Shallow water, nearshore sandy habitat that could be used as rearing habitat by juvenile salmonids will likely be temporarily (5-20 years of construction is projected) negatively affected by dredging barge offloading facilities at the North Jetty, Jetty A, the Clatsop Spit near the South Jetty adjacent the jetty and also at Parking Area D at the east end of Clatsop Spit in Fort Stevens State Park. Dredging would occur to a finish depth of -25 below MLLW, with a possible overdredge depth of -32 feet in shallow water (a range of water depths from 0 to 20 feet below MLLW) that could be used by rearing juvenile salmonids. Approximately 16 acres of shallow water, sandy bottom habitat would be dredged.

Some effects to migration from artificial obstruction by rock placement may occur, but they are not expected to be measurable. Besides the expected limitations to exposure, this is also because a majority of the spur groins most likely to be encountered by juveniles and adults are submerged

so that fish can easily pass over the tops of them (see Table 36). A limited number of juvenile salmonids could use the North Jetty area for migration. Little data is available regarding juveniles use of the South Jetty area, but it is possible that outmigration occurs in close proximity to the South Jetty as it does the North Jetty. Only spur groins on the channel side with elevations at or above MLLW could be capable of altering outmigration routes of juvenile salmonids by forcing them away from the shallower waters along the jetty proper and into deeper waters as they swim around spur groins. Otherwise, juveniles are assumed to pass over the submerged groins. Spur groins that could interfere with outmigration at times, depending on tidal level, would be located only on the South Jetty and include spur groins SJ2C and SJ3C at +5 MLLW (both 70 feet long) and spur groin SJ4C at 0 MLLW (90 feet long).

Figure 62 shows percentage of time that the crests of spurs at 0 MLLW, +5 MLLW, and +8 MLLW would be exceeded (i.e., overtopped by water). Both spur groins with elevation +8 MLLW are not relevant to outmigration because they are on the ocean side of the jetties. Spurs SJ2C and SJ3C on the South Jetty at an elevation of +5 MLLW would be above water 60% of the time for August-September and 55% for October-November. Spur SJ4C would be above water 5% of the time. It is expected that at some point on most ebb tides that spurs SJ2C and SJ3C would be above water, and that fish outmigrating within 70 feet of the South Jetty during that part of the ebb tide when the tops of these spur groins are exposed would have to swim around them. Though sub-yearling Chinook use nearshore areas by the North Jetty more than older juvenile salmonids and typically leave the MCR area over a period of more than one ebb tide, their exposure to these effects is expected to be minimal, and not anticipated to measurably change their migration behaviors.

Coastal Pelagic EFH

Northern Anchovy. The water column near the MCR jetties provides EFH for the northern subpopulation of northern anchovy. The northern subpopulation ranges from Monterey Bay, California to British Columbia. There is a major spawning area of the northern subpopulation off Oregon and Washington that is associated with the Columbia River plume. Anchovy spawn year-round but peak spawning occurs from February to April. Females release eggs into the water column at 7- to 10-day intervals throughout the spawning season. Eggs and larvae are both found near the water surface. Anchovies are typically found in schools at the surface where they feed upon phytoplankton and zooplankton. It is unlikely that rehabilitation of the MCR jetties would affect northern anchovy EFH, because it occurs primarily at the surface away from the jetty construction zones. The previous USGS modeling results predicted that changes to environmental conditions in the plume would be negligible with implementation of the earlier, larger-scale proposed action. The current proposed action is of smaller scale and maintains the current jetty lengths. Therefore environmental changes to conditions in the plume would be even less likely than before.

Jack Mackerel. The MCR area provides EFH for jack mackerel. Jack mackerel are a pelagic schooling fish that ranges from the coastal areas to over 200 miles offshore in deep water. They move offshore and inshore as well as north and south depending upon the time of year. They are generally more abundant on the offshore banks in the late spring through early fall. In the southern portion of their range, they are found offshore but are near the coastline north of Point Conception, California. Jack mackerel collected off Oregon and Washington ranged from 30-62

cm in length. Recent data collected at the Shallow Water Ocean Disposal Site off the tip of the North Jetty showed a large abundance of jack mackerel during October 2002 sampling. Most collected were ripe and appeared ready to spawn (Jack Word, MEC Analytical, personal communication). Although peak spawning occurs from March to July in the southern portion of the range, it apparently occurs later in the northern part of the range. Jack mackerel are water column feeders feeding primarily on plankton and pelagic fish. It is unlikely that rehabilitation of the MCR jetties would affect jack mackerel EFH. These fish are predominately a pelagic species that do not occur near the bottom or near the MCR jetties.

Pacific Sardine. Pacific sardine are a small, pelagic schooling fish that occur in coastal waters from Baja California to Alaska. Historically, sardines may have been the most abundant fish in the California Current. The population off Oregon and Washington is part of a northern subpopulation that ranges from northern Baja California to Alaska. Abundance of sardines in the northern part of the range is seasonal. During years of high abundance sardines will move north as far as Alaska but during years of low abundance they are not found any further north than Point Conception. They migrate north in the summer and return to the southern part of the range in the fall. It is normally the older and larger fish that move the furthest north. Sardine spawn in loosely aggregated schools in the upper 50 meters of the water column. The principal spawning area is from Point Conception to San Diego out to 100 miles offshore and occasionally as far as 250 miles offshore. Spawning has been observed off Oregon and Washington and young fish have been observed as far north as British Columbia during periods of warm water temperatures. Sardines are pelagic feeders feeding on both phytoplankton and zooplankton. It is unlikely that rehabilitation of the MCR jetties would affect Pacific sardine EFH. Pacific sardines occur primarily in the upper water column, offshore of the MCR; thus the MCR area does not provide important EFH for Pacific sardine.

Pacific Mackerel. Pacific mackerel range from Mexico to southeastern Alaska, but are most common south of Monterey Bay, California. Pacific mackerel that occur off Oregon and Washington are part of the northern subpopulation that extends from Mexico north. Although Pacific mackerel are most abundant off Point Conception, they migrate north to off Tillamook Bay in the summer. During periods of warm ocean temperatures they may migrate much further north. Pacific mackerel are usually found within 20 miles of shore but occasionally occur out to 250 miles offshore. Adults are found near shallow banks while juveniles are found off sandy beaches, around kelp beds and in open bays. Pacific mackerel seldom spawn north of Point Conception, although young of the year fish have been found off Oregon and Washington in recent years when water temperatures have been higher than normal. Pacific mackerel feed primarily in the water column on zooplankton and pelagic fish. It is unlikely that jetty rehabilitation would affect Pacific mackerel EFH. They are a pelagic species and would not be near the bottom where the construction activity is occurring. In addition they occur primarily in California and only rarely occur as far north as the MCR. Thus, the MCR area does not provide important EFH for Pacific mackerel.

Market Squid. Market squid range from Mexico to Alaska, although they are most abundant from Monterey Bay to Mexico. Although they are considered pelagic they actually occur from the surface to depths of 800 meters. They prefer ocean salinities and are rarely found in bays, estuaries, or near river mouths. Squid spawn in dense schools on the bottom in spawning areas

that range in depth from near shore shallow areas to depths of 800 meters. Known spawning areas are inshore protected areas with sand or mud bottoms at depths between 5 and 55 meters. Squid spawning off Oregon has been observed from May to July and in late summer off Washington and Canada. No squid spawning areas have been found off the MCR. Squid feed on copepods as juveniles and gradually change to euphausiids, other small crustaceans, small fish, and squid. The proposed action would have no effect on market squid EFH. Squid do not occur in the vicinity of the MCR where salinities are lower than ocean waters. As discussed previously, the USGS modeling results predicted that changes to environmental conditions in the plume, including salinity, would be negligible with implementation of the earlier action. However, the current proposed action is of smaller scale and maintains the current jetty lengths; thus, environmental changes to conditions in the plume would be less likely.

Groundfish EFH

The MCR jetties are designated as EFH for several species of groundfish. Some of these species use the MCR as a migratory corridor to rearing areas in bays and intertidal areas that have large concentrations of food organisms, such as the amphipod *Corophium salmonis*. Other groundfish species, principally rockfish, may use the jetties as habitat. Effects on groundfish migratory EFH, however, is likely to be minor since the jetty areas to be disturbed are small relative to the amount of available migratory habitat at the MCR. It is unlikely that disturbance to this small amount of migratory habitat would impact the population levels of groundfish in the MCR area.

Impacts to EFH habitat associated with the jetties is also likely to be minor because the jetties do not provide highly productive rocky habitat because of the low benthic productivity, unstable bottoms, and high current and wave action in the jetty areas. Some groundfish species that use this habitat may be affected in the short term by the disturbance during construction. However, the rehabilitation at the MCR jetties will create additional rocky habitat that will benefit these species, and they will likely quickly recolonize the areas after construction is completed.

California Skate. California skates range from Canada south to Mexico along the Pacific Coast. They are most common off the California Coast inshore and in shallow water bays. They occur at depths from 18 to 671 meters primarily on muddy bottoms. No information is available on spawning habitat. Fertilization is internal and the egg cases are laid on the bottom and drift with the current. When the eggs hatch the young are fully developed though they still have a yolk sac that is slowly absorbed. No California skates have been collected off the MCR though it is possible that they occur in the area. Since they prefer muddy bottoms, it is unlikely that California skates would be in any of the jetty work areas, as these areas are characterized by sand bottoms. Consequently, the proposed actions are not expected to affect California skate EFH.

Soupfin Shark. Soupfin shark are an abundant coastal pelagic species that ranges from Canada to Mexico. They inhabit bays and muddy shallow water areas where they are associated with the bottom. They occur in depths from 2 to 471 meters. Adult males occur in deeper water in northern California while females occur closer to shore in southern California. Juveniles are also more abundant in the southern portion of the range associated with the females. Juveniles also occur in bays such as San Francisco Bay to rear. Soupfin shark exhibit large coastal migrations; the population moves north in the summer and south in the winter. The purpose of these movements is not known. Mating occurs in the spring and fertilization is internal. The gestation

period is about 1 year and the females move into bays to give birth to live young. Based on this information, it is unlikely that rehabilitation of the MCR jetties would affect soupfin shark EFH, as the project would not likely influence movement of this species into and out of the estuary.

Spiny Dogfish. Spiny dogfish are an inner shelf mesobenthal species that occur at depths from 0 to 900 meters, but most occur in depths less than 350 meters. Adult females move inshore to shallow waters in the spring to release their young. Young juveniles are neritic while juveniles and adults are sublittorial bathyal. Juveniles occur principally on mud bottoms when not in the water column while adults can occur from the intertidal to great depths. Based on these habitat requirements, the MCR jetty areas would provide only migratory habitat for adult and juvenile spiny dogfish moving in and out of the estuary. However, the jetty areas do not provide any unique habitat that is not available elsewhere, and contain only a small proportion relative to the amount of available migratory habitat for spiny dogfish at the MCR. The project would not likely influence movement of this species into and out of the estuary. Consequently, rehabilitation of the MCR jetties is not expected to adversely affect spiny dogfish EFH.

Ratfish. Ratfish are a middle shelf mesobenthal species that occur in depths from 0 to 913 meters. They are most abundant in depths from 100 to 150 meters. They also occur in the estuaries during the winter and early spring to feed and mate. Ratfish are generally a deep water species that prefer low relief, rocky bottoms or exposed gravel or cobble. They are not commonly found over sand or boulders. Based on these habitat requirements, the MCR jetty work areas do not provide EFH habitat for ratfish. Consequently, jetty rehabilitation is not expected to affect ratfish EFH.

Lingcod. Lingcod are an estuarine mesobenthal species that occurs in depths from 0 to 475 meters. Spawning occurs from 3 to 10 meters below mean lower low water over rocky reefs in areas of swift currents. Larvae occur in near shore areas from winter to late spring. Larger larvae are epipelagic, primarily found in the upper 3 meters of the water column. Juveniles settle in estuaries and shallow waters along the coast while older juveniles move offshore as they grow but are most common in waters greater than 150 meters. Adults prefer slopes of submerged banks 10 to 70 meters below the surface with sea weeds, kelp and eelgrass beds that form feeding grounds for small prey fish. They also prefer channels in rocky intertidal areas with swift currents that concentrate plankton and plankton feeding fish. Based on these habitat requirements, the MCR jetty areas may provide some habitat for lingcod. They were shown to utilize newly constructed jetty habitat at Washaway Beach, Washington. Jetty rehabilitation is expected to disturb habitat for lincod in the short term, while adding some additional habitat with construction of spur groins.

Cabezon and Kelp Greenling. Both of these species are abundant all year in estuarine and subtidal areas. Larvae and young juveniles are pelagic and have been found offshore in waters over 300 kilometers in depth. Juveniles settle to the bottom and are found primarily in shallow-water bays and estuaries. The MCR jetty areas only provide minimal habitat for cabezon and kelp greenling. Rehabilitation of the jetties is not expected to adversely affect cabezon and kelp greenling EFH.

Pacific Cod. Pacific cod are a member of the inner shelf-mesobenthal community. The majority of Pacific cod are found at depths from 50 to 300 meters with spawning occurring at depths from 40-265 meters. The eggs are demersal, adhesive, and are found sublittorally. Larvae and small juveniles are pelagic, with the highest abundance in the upper 15 to 30 meters of the water column. Larvae are found over the continental shelf from winter through summer. Small juveniles occur in depths from 60 to 150 meters gradually moving to deeper water with increased age. Larger juveniles and adults are parademersal occurring over mud, sand and clay, and occasionally coarse sand and gravel bottoms. Based on these habitat requirements, the MCR jetty areas would not provide habitat for Pacific cod. Consequently, rehabilitation of the jetties is not expected to affect Pacific cod EFH.

Pacific Hake. Pacific hake is a migratory species that inhabits the continental slope and shelf from Baja California to British Columbia. Juvenile hake usually reside in shallow coastal waters, bays, and estuaries with adults occurring further offshore, usually at depths from 50 to 500 meters. Along the Pacific Coast from British Columbia to California, adults use a narrow band of feeding habitat near the shelf break for 6-8 months per year. Based on these habitat requirements, the MCR jetty areas would not provide habitat for Pacific hake. Consequently, rehabilitation of the jetties is not expected to affect Pacific hake EFH.

Sablefish. Sablefish are an inner shelf-bathybenthal species that occurs in deep water. Sablefish are most abundant in depths from 200 to 1,000 meters but have been reported to depths of 1,900 meters. Spawning occurs at depths greater than 300 meters. Larvae and young juveniles are pelagic and may move inshore and remain there for up to 4 years to rear. Older juveniles and adults inhabit progressively deeper water and are benthopelagic on soft bottoms. Based on these habitat requirements, the MCR jetty areas would not provide habitat for sablefish. Consequently, rehabilitation of the jetties is not expected to affect sablefish EFH.

Butter Sole. Butter sole occurs from Alaska to southern California where they are common in shallow waters on muddy or silty bottoms. They utilize the waters off the Oregon Coast as a rearing area. Spawning occurs primarily in coastal areas from winter to spring. Larvae drift offshore and then settle to the bottom in the spring as young juveniles. They remain offshore as juveniles. Butter sole would not use the types of habitats associated with the MCR jetty work areas. Consequently, rehabilitation of the jetties is not expected to affect butter sole EFH.

Curlfin Sole. Curlfin sole occur from Alaska to Mexico in shallow waters less than 90 meters in depth over soft bottoms. Little else is known of their habitat requirements, but they apparently do not occur to any extent around rocky areas such as in the vicinity of the MCR jetties. Consequently, rehabilitation of the jetties is not expected to affect curlfin sole EFH.

English Sole. English sole are an inner shelf-mesobenthal species that occur to depths of 55 meters. Adults spawn in inshore waters and the eggs and larvae are pelagic settling to the bottom as young juveniles. Juveniles rear in the inshore areas and in the bays and estuaries. They move offshore as they grow older. English sole are distributed throughout the inshore area on soft bottom habitat. Based on these habitat requirements, English sole could occur in the vicinity of the MCR as either adults or juveniles migrating into or out of the estuary. Consequently, it is

possible that English sole EFH could be impacted by rehabilitation of the MCR jetties. However, migratory habitat for English sole is abundant in the MCR area.

Flathead Sole. Flathead sole are mesobenthic, occurring on the continental shelf to depths of 550 meters, but usually are found at depths less than 366 meters. Spawning occurs at depths of 80 to 140 meters. Eggs and larvae are generally buoyant in seawater. The juveniles settle to the bottom and rear in the inshore areas and bays and estuaries. Larger juveniles and adults are usually found further offshore on soft, silty or mud bottoms. Based on these habitat requirements, the MCR jetties do not provide important habitat for flathead sole. Consequently, rehabilitation of the jetties is not expected to affect flathead sole EFH.

Pacific Sanddab. Pacific sanddab is an inshore sublittorial species that occurs in depths up to 306 meters, but are most abundant offshore of Oregon in depths from 37 to 90 meters. Juvenile pacific sanddab occur in shallow water coastal areas, bays, and estuaries on silty sand bottoms. Adults are found further offshore on coarser sandy areas. Based on these habitat requirements, the MCR jetties do not provide important habitat for Pacific sanddab. Consequently, rehabilitation of the jetties is not expected to affect Pacific sanddab EFH.

Petrale Sole. Petrale sole range from Alaska to Mexico where they occur primarily in deeper waters on the continental shelf. Juveniles and adults rear in estuaries in the summer where they are generally found on sand, sandy mud, or occasionally muddy bottoms. Petrale sole do not occur in rocky areas and would not be expected to be in the vicinity of the MCR jetties. Consequently, rehabilitation of the jetties is not expected to affect petrale sole EFH.

Rex Sole. Rex sole is a middle shelf-mesobenthal species occurring at depths from 0 to 850 meters. It is one of the mostly widely distributed sole on the shelf and upper slope, occurring in a variety of depths and sediment types. Spawning occurs at depths from 100 to 300 meters. Larvae are pelagic and are widely distributed offshore with a peak of abundance at about 46 kilometers offshore. Rex sole settle to the bottom at the outer continental shelf and rear in the outer continental shelf. Intermediate size rex sole move inshore to depths of 55 to 150 meters. Adults are distributed throughout the depth range but are more abundant inshore in the summer when feeding. Based on these habitat requirements, the MCR jetties do not provide important habitat for rex sole. Consequently, the proposed actions are not expected to affect rex sole EFH.

Rock Sole. Rock sole range from southern California to Alaska. Juveniles and adults are demersal and are found primarily in shallow water bays in the summer. They prefer sandy or gravel substrate or soft bottoms. Spawning occurs over a variety of substrates from rocky banks to sand and mud. In the winter they migrate to spawning grounds offshore on the edge of the continental slope. Eggs are demersal and adhesive while larvae are pelagic and found primarily in the upper 30 meters of the water column. Based on these habitat requirements, it is unlikely that rock sole would occur to any extent near the MCR jetties or that the jetties provide any important habitat. Consequently, the proposed actions are not expected to affect rock sole EFH.

Sand Sole. Sand sole range from southern California to Alaska. They are a shallow-water species that occur in estuaries as adults, larvae, and juveniles year around. Adults may move into shallow inshore waters to spawn in the winter then may move offshore in the summer to

feed. Sand sole prefer sandy and muddy substrates all along the Pacific Coast. Sand sole may occur in the sandy habitat next to the MCR jetties during their migrations into and out of the Columbia River estuary. Consequently, this species may be impacted during rehabilitation of the jetties. Permanent habitat loss could occur with placement of rock on sandy bottom habitat. There is an abundance of sandy habitat in the vicinity of the jetties, however.

Starry Flounder. Starry flounder range from Alaska to the southern California where they are common in the shallow coastal areas. Adults and large juveniles can occur from the outer continental shelf to upstream into freshwater areas in major coastal rivers. Spawning occurs in estuaries or sheltered bays. Eggs and larvae are epipelagic and occur near the surface over water 20 to 70 meters deep. Juveniles are demersal and occur in the estuaries or in the lower reaches of the major coastal rivers. Based on these habitat requirements, this species could occur in the vicinity of jetties during their migration into and out of the Columbia River and could be impacted during the jetty rehabilitation. However, there is an abundance of migratory habitat at the MCR and it is likely that starry flounder would avoid the construction areas. Also, it is expected that EFH habitat for starry flounder would quickly recover following the completion of rehabilitation at each jetty. Permanent habitat loss could occur with placement of rock on sandy bottom habitat. However, there is an abundance of sandy habitat in the vicinity of the jetties.

Black Rockfish. Black rockfish occur from southern California to Alaska. They occur from near the surface to depths of 366 meters or greater, but are most abundant at depths to 54 meters. Adults generally occur near the surface and are frequently found associated with large kelp. Larvae and juveniles are pelagic but become benthic when they reach a larger size. Off the Oregon Coast, age 0 juveniles occur seasonally from June to October. The June transition from pelagic to benthic habitat is accompanied by a movement to estuaries, tide pools, and inshore areas with depths less than 20 meters. Larger juveniles up to 15 centimeters occur in rocky holes such as in the jetties or on sand bottoms associated with rocky areas. Black rockfish appear to migrate south from the central Washington Coast to the Columbia River and north from the northern Oregon Coast to the Columbia River during summer. Black rockfish spawn offshore and have internal fertilization. They release live young from January to March off the Oregon Coast. Rehabilitation of the MCR jetties has the potential to impact EFH for large juvenile black rockfish that may occur in the vicinity of the MCR jetties during the summer construction periods. Since there is an abundance of rocky habitat at the jetties, it is likely that individual black rockfish could avoid the construction activities. In addition, the habitat would quickly recover following project completion, and the rehabilitation would provide additional rocky habitat that would be beneficial to black rockfish.

Brown Rockfish. Brown rockfish range from California to Alaska where they are common in shallow water estuaries and bays. Adults are bottom dwellers living on hard bottoms of siltstone and sand. They also aggregate near rocks and other structures and are particularly attracted to artificial reefs. They set up home ranges of 30-400 square meters around these structures. Artificial reefs become less desirable in the summer and they exhibit considerable off reef movement. Juveniles usually inhabit shallower waters than adults and they utilize the estuaries as nursery areas. Brown rockfish may use the MCR jetty areas either as habitat or during their migrations into and out of the Columbia River estuary and may be impacted during the rehabilitation. Since there is an abundance of rocky habitat at the jetties, it is likely that

individual brown rockfish could avoid the construction activities. In addition, the habitat would quickly recover following project completion, and the rehabilitation would provide additional rocky habitat that would be beneficial to brown rockfish.

China Rockfish. China rockfish range from California to Alaska where they occur both inshore and along the open coast in shallow water. They occur principally among rocks and reefs where they sit on the bottom often sheltering in crevices and likely occur around the MCR jetties. They also seem to prefer more exposed, high energy areas. Juveniles occur in the shallow subtidal areas in the summer and early fall. China rockfish are likely associated with the MCR jetties since these fish prefer high energy rocky habitat with an abundance of crevices, and may be impacted during the rehabilitation. Since there is an abundance of rocky habitat at the jetties, it is likely that individual China rockfish could avoid the construction activities. In addition, the habitat would quickly recover following project completion, and the rehabilitation would provide additional rocky habitat that would be beneficial to China rockfish.

Copper Rockfish. Copper rockfish range from Alaska to Mexico where they are predominately a shallow-water species. They occur commonly in rocky areas or on rock-sand bottoms in shallow areas. They are found on natural rock reefs, artificial reefs, and rock piles, typically near the bottom associated with the reefs or vegetation and likely occur at the MCR jetties. Copper rockfish spawn once a year and may move further inshore to release their young. Young are pelagic and then become associated with some type of structure as they mature into juveniles. Once adults find a rocky area they prefer they normally do not move to any extent. Copper rockfish likely occur associated with the jetties since they provide rocky habitat with an abundance of crevices and have the likelihood to be impacted during the rehabilitation. Since there is an abundance of rocky habitat at the jetties, it is likely that individual copper rockfish could avoid the construction activities. In addition, the habitat would quickly recover following project completion, and the rehabilitation would provide additional rocky habitat that would be beneficial to copper rockfish.

Quillback Rockfish. Quillback rockfish range from southern California to Alaska where they are a common shallow water reef dweller that lives close to the bottom. They may also be found over sand bottoms associated with rock reefs. They normally maintain small home ranges with off reef movement occurring in the summer. Young of the year are pelagic and settle to the bottom in vegetated area. Juveniles migrate between low relief and high relief reefs while adults migrate from artificial reefs to natural reefs in the summer when kelp is abundant. They return to the artificial reefs in the fall when the kelp disappears. They show a high homing instinct to their home reefs. Quillback rockfish likely occur associated with the jetties since they provide rocky habitat with an abundance of crevices and have the likelihood to be impacted during the rehabilitation. Since there is an abundance of rocky habitat at the jetties, it is likely that individual quillback rockfish could avoid the construction activities. In addition, the habitat would quickly recover following project completion, and the rehabilitation would provide additional rocky habitat that would be beneficial to quillback rockfish.

Vermilion Rockfish. Vermillion rockfish range from Mexico to Alaska where they are usually found in shallow waters over rocks along drop offs and hard bottoms associated with the bottom. They occur in shallow water as young and in deeper waters as adults. Newly hatched larvae are

pelagic and remain near the surface for three to four months. Vermilion rockfish may be associated with the MCR jetties because the jetties provide rocky habitat with an abundance of crevices. However, vermilion rockfish prefer natural reef habitat so it is unlikely that they occur in any numbers in the jetty work areas. Vermilion rockfish may be associated with the MCR jetties since they provide rocky habitat with an abundance of crevices and have the likelihood to be impacted during the rehabilitation. Since there is an abundance of rocky habitat at the jetties, it is likely that individual vermilion rockfish could avoid the construction activities. In addition, the habitat would quickly recover following project completion, and the rehabilitation may provide additional rocky habitat that may be beneficial to vermillion rockfish.

DETERMINATION FOR ESSENTIAL FISH HABITAT

As described above, permanent negative impacts could be imparted on EFH for Chinook salmon, coho salmon, English sole, sand sole, and starry flounder. Short-term disturbances to EFH would result for lincod, English sole, sand sole, starry flounder, and black, brown, China, copper and quillback rockfish species. Permanent positive effects from addition of rock would increase the area of EFH for lincod and black, brown, China, copper and quillback rockfish species. The anticipated effects are summarized below.

1. The effects on EFH from pile installation and removal would be intermittent, only occurring for short periods of time followed by longer periods of no vibration or noise while the piles are being prepared for the next activity. Because vibratory drivers will be used for pile installation and removal, impacts will be minimal. Dredging will alter bottom topography, but the resulting bottom habitat is expected to be useable. It is likely that migratory species such as salmon and some groundfish could avoid the EFH effects from these activities. No long-term or significant effects to prey species or foraging base is expected as a result of stone placement, pile installation and removal, or dreding activities.

2. There will be permanent conversion of sandy bottom habitat from jetty and spur groin construction and temporary loss from offloading causeway construction in the vicinity of the jetty for certain groundfish species. Impacts to the rocky (jetty) habitat are expected to be temporary and new habitat is expected to be re-colonized by rockfish using existing jetty habitat. Additional EFH for some species of rockfish will be available with jetty rehabilitation and spur groin construction.

3. The proposed action at the MCR jetties may have a short-term, adverse effect on water quality for groundfish and salmon species due to localized increased concentration of suspended sediment and turbidity from installing piles, dredging, or the placement of jetty stones and larger rocks. The increases in suspended sediment and turbidity would generally be limited to the construction areas along the jetty bases and would be intermittent and of short duration. Suspended sediment would not be contaminated as sediment in the vicinity of the jetties is nearly pure sand.

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