



Environment

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Environmental Damage Assessment of Refinery Equipment Recovery at Gulf Road, Whatcom County, December 9, 2011

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1.0 Introduction

On Friday, December 9, 2011, a reactor vessel in transport to the BP Cherry Point Refinery was displaced off a barge while approaching the beach at Gulf Road (Figure 1). An electric manlift also fell off the barge at the same time. The reactor vessel was a steel cylindrical pressure vessel 139 ft long and 12 ft in diameter except at the lower end where a skirt flared to 16 ft. The vessel weighed approximately 970,000 pounds. The bottom end (16-ft diameter skirt) sank to the seafloor. The vessel was recovered on December 21, 2011, and transfer to the refinery was completed successfully.

The location of the incident was in the Southeast Strait of Georgia at N Latitude 48.852688° and W Longitude 122.732258° (Figure 1). The depth at which the reactor vessel impacted the seafloor was approximately 50 ft below mean lower low water (-50 ft MLLW).

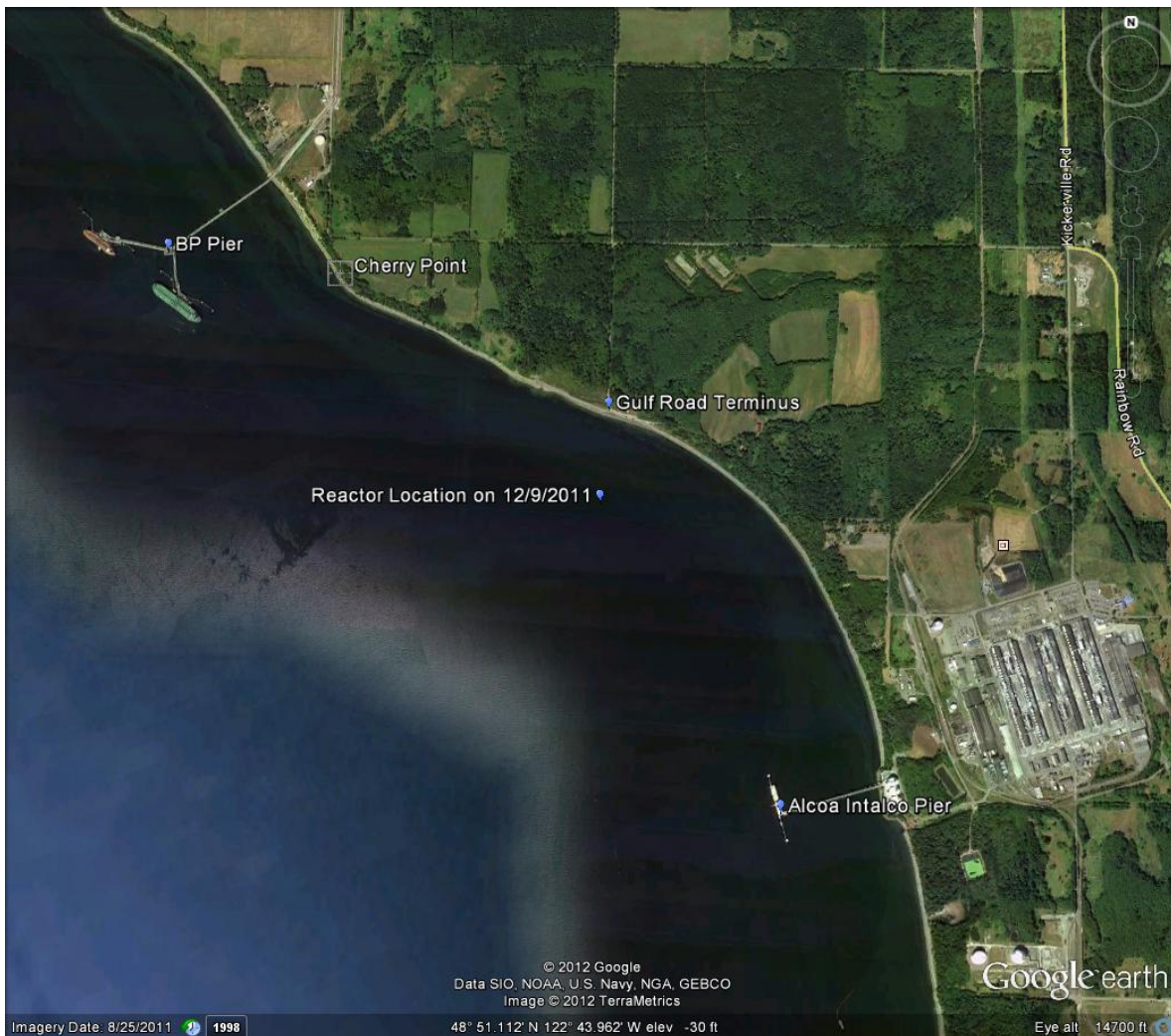


Figure 1. The Vicinity of Refinery Equipment Recovery at Gulf Road

Because the location of the incident was within the Cherry Point Reach Aquatic Reserve established by the Washington Department of Natural Resources (WDNR), the WDNR expressed concern about potential damage to natural resources and habitats within the Reserve. Thus, Michael Kyte, Marine Biologist, was asked to conduct an assessment of the impact to the area's natural resources and marine habitats.

This report provides a description and a damage assessment of the marine natural habitats and resources at and in the vicinity of the incident. The geographic scope of the assessment was the area extending to the shoreline from the point of impact, north to Cherry Point proper, south to the Alcoa-Intalco Works pier, and approximately one nautical mile offshore. This area is referred to as the *assessment zone* or *area* in this report.

2.0 Receiving Natural Environment

2.1 Habitats

2.1.1 Intertidal

The following descriptions are based on the 2011 Cherry Point Beach Walk conducted by Michael Kyte during low tides in June and other sources.

Due to the combination of relatively high wave energy and available mixed glacial sediments from adjacent uplands, the intertidal substrates along the Cherry Point shoreline are diverse and dynamic in nature. The intertidal sediments and those of the shallow subtidal zone, above approximately -10 ft MLLW, are subject to disturbance by wave and tidal current action and are characterized by “mixed coarse” materials dominated by boulders, cobbles, gravel, and the larger particle range of sand (Dethier 1990, Kyte 2011). The shoreline intertidal habitats are classified as follows:

ESTUARINE INTERTIDAL MIXED-COARSE: OPEN

Most open estuarine intertidal sites in the Puget Trough have a poorly sorted substratum of mixed cobble, gravel, and sand, often distributed in patches along the beach. Some small boulders, which are relatively stable, often overlie other substrata. (Dethier 1990)

Patches of sand were present in June 2011 overlaying the cobbles south of Gulf Road (Kyte 2011). The intertidal beach surface from the Gulf Road pier north and at the barge landing site is usually continuously covered with a heavy armor of cobbles. A large patch of sand was found in the middle intertidal zone in 2011 between the pier and the mouth of the Gulf Road stream and north of the barge landing site.

North of the Gulf Road stream, the beach slope becomes less and boulder fields become the dominant substrate and habitat type. Beach substrate at Cherry Point proper is cobbles and boulders that form a heavily armored beach surface in some areas and fields of boulders with patches of cobbles in others. Small patches of sand or sandy gravel were interspersed among the cobbles and boulders in this area. On the south side of Cherry Point, low broad ripples or “waves” in the cobble beds illustrate the high degree of wave action to which this part of shoreline is exposed.

2.1.2 Subtidal

In contrast, the offshore habitat at and in the near proximity to the reactor vessel's point of impact is a depositional environment. This environment is characterized by relatively low current velocities, no wave exposure because of the depth, soft silt/clay sediments, no submerged vegetation because of the lack of hard substrate for attachment, and reduced ambient light levels due to the high turbidity characteristic of the area. The softness and ease with which the sediments in the impact area can be disturbed is noteworthy. Any contact by a diver, remote-operated vehicle (ROV), and/or associated water movements can create a cloud of sediment that would completely block vision.

The offshore habitat meets the classification of “Marine Subtidal Mud: Low Energy, Deep” (Dethier 1990). Observations by Kyte (1984, 1994) and video recordings made by Global Diving and Salvage during and immediately after the recovery operation showed the following items:

- An easily disturbed soft mud bottom with anthropogenic debris and evidence of previous disturbance

- Plant debris (e.g., dead and drifting eelgrass blades) (Figure 2)
- Occasional unidentified flatfish
- Burrowing sea anemones *Pachycerianthus fimbriatus* (Figures 3 and 4)
- Abundant worms and small crustaceans (amphipods and hermit crabs)
- A Dungeness crab with associated tracks (Figure 5)



Figure 2. Unattached Plant Debris on Soft Mud near the Impact Point



Figure 3. Burrowing Anemone in Undisturbed Mud near the Impact Point



Figure 4. Burrowing Anemone with Epifauna Tracks on Previously Disturbed Mud



Figure 5. Live Dungeness Crab in the Reactor Vessel Impact Hole

In addition, it appeared that the seafloor had been previously disturbed because of the presence of holes, ridges, and furrows in the mud that had been colonized by burrowing anemones (Figure 4) and other fauna (see videography from time 13:34:18 through 13:47:30 on Global 2011). Older anthropogenic debris supported encrusting fauna (Figure 6) was also found during the ROV survey (Figure 6).



Figure 6. Anthropogenic Debris with Encrusting Fauna

In Figures 2 through 6, the water depth is the 4-digit number in the lower right of each picture. The time and date on the ROV survey (Global 2011) are shown along the upper edge of each photo. A compass rose with the direction of the ROV's movement is in the lower center.

2.2 Natural Resources

The following natural resources are known from or can be expected to occur in the Cherry Point area and within the assessment zone of the reactor vessel as defined in the Introduction:

- Commercially important Dungeness crab
- Native eelgrass
- Salmonid finfish
- Commercially important flatfish
- Forage fish including Pacific herring, surf smelt, and sand lance
- Marine birds, migratory and resident
- Marine mammals, including the Southern Resident Killer Whale group listed as Endangered under the Endangered Species Act.

The following are Endangered Species Act listed species or otherwise protected species that may occur in this area:

- Chinook salmon (*Onchorhynchus tshawytscha*) – Threatened
- Bull trout (*Salvelinus confluentus*) – Threatened
- Coho salmon (*Onchorhynchus kisutch*) – Species of Concern
- Puget Sound Steelhead Trout (*Oncorhynchus mykiss*) – Threatened
- Humpback whale (*Megaptera novaeangliae*) – Endangered
- Leatherback sea turtle (*Dermochelys coriacea*) – Endangered
- Steller sea lion (*Eumetopias jubatus*) – Threatened
- Southern Resident Killer Whale (*Orcinus orca*) - Endangered
- Bald eagle (*Haliaeetus leucocephalous*) – Threatened
- Marbled murrelet (*Brachyramphus marmoratus*) – Threatened

2.2.1 Dungeness Crab (*Cancer magister*)

Adult Dungeness crabs are common along the Cherry Point shoreline and support recreational and commercial fisheries in the area. Previous studies show that the crab population along the Cherry Point shoreline is cyclic and has remained the same in its cycles and distribution over several years. Low catches of crabs in the fall and winter by trawl and trap showed a definite offshore movement of crabs at this time and a low use of inshore habitats. The crabs move inshore in the spring and summer as shown by the trawl and trap data. Four years of accumulated crab trawl catches by Kyte (1994) near the Ferndale and Cherry Point refineries' marine terminals showed that the time of highest abundance is in the spring, with sampling in April yielding the largest catches.

2.2.2 Submerged Marine Vegetation

NOAA Fisheries considers eelgrass (*Zostera* spp.) and macroalgae beds, submerged aquatic vegetation (SAV), as critical habitat for Chinook salmon and other salmonid species because of the use by outmigrating salmonid juveniles and important prey species. Within the assessment zone, the eelgrass and macroalgae assemblages are typical of that found along this portion of the Cherry Point shoreline. On the shoreline at Gulf Road, macroalgae populations including kelp (*Nereocystis luetkeana*) extend from the middle intertidal zone down to approximately -10 ft MLLW and are limited by substrate for attachment and high ambient turbidity. Native eelgrass (*Zostera marina*) occurs on patches of sandy sediments from Cherry Point to the Alcoa-Intalco pier. A continuous eelgrass bed is not present anywhere on the Cherry Point shoreline. In addition, several patches of the introduced eelgrass *Z. japonica* were present in June 2011 on small sand patches and between cobble higher in the intertidal zone and closer to Gulf Road.

2.2.3 Finfish

The Cherry Point shoreline and near shore waters support a wide variety of finfish, the most notable of which is Pacific herring. This forage fish is an ecological keystone species in Pacific Northwest marine ecosystems and is an important food resource for federally listed and other salmonid and marine bird and mammal species.

Pacific herring use attached marine vegetation in the shallow subtidal up to the lower mid-intertidal zones along the Cherry Point shoreline for deposition of eggs during spawning, which occurs in the late spring to early summer from mid-March into June. The spawning peak is in late April or early May, and deposited fertilized eggs incubate for approximately 14 days. Spawning in recent years has extended as far south as the Alcoa Intalco Works marine facility, but has been concentrated since 2008 almost entirely north of Cherry Point and mostly near Point Whitehorn and in Birch Bay. After hatching, larvae spend approximately 10 days to two weeks in near shore waters seeking refuge from predators and feeding in submerged vegetation. During this time, tidal currents winnow these larvae out of near shore waters. After metamorphosis, the juveniles use open waters of the Strait of Georgia and perhaps the Strait of Juan de Fuca for feeding. After approximately two years, adult herring return to spawn at Cherry Point.

In addition to Pacific herring, surf smelt (*Hypomesus pretiosus*) use beaches south of Gulf Road and north of Cherry Point for spawning nearly all year with the heaviest activity from June through August. Pacific sand lance (*Ammodytes hexapterus*) are not known to use the Cherry Point shoreline for spawning.

Large numbers of pink (*Onchorhynchus gorbusha*), chum (*Onchorhynchus keta*), coho (*Onchorhynchus kisutch*), and Chinook (*Onchorhynchus tshawytscha*) salmon have been recorded from the cobble habitats of the Cherry Point shoreline and in the protected eelgrass beds of Birch Bay. Juvenile sockeye salmon (*Onchorhynchus nerka*) were also found in Birch Bay but were generally less abundant than other species. The residence period for each species in these habitats was variable, but in general, juveniles were present from spring until fall, when they presumably began their offshore migrations. Puget Sound steelhead trout (*Onchorhynchus mykiss*) was not noted in any samples for the Cherry Point vicinity, nor was sea-run cutthroat (*Onchorhynchus clarki*), bull, or other trout species.

Adult Chinook, pink, coho, and chum salmon migrating to the Fraser and Nooksack rivers and natal streams in Drayton Harbor can be expected to transit and feed along the Cherry Point shoreline. Sea-run cutthroat stocks have been identified in several tributaries to the Southeast Strait of Georgia. Because sea-run cutthroat are near shore residents throughout much of their marine life and do not migrate extensively, they can be expected to be present in the Cherry Point vicinity year round.

The vicinity of the Gulf Road also supports a variety of flatfish including the following species:

- Dover sole *Microstomus pacificus*
- English sole *Pleuronectas vetulus*
- Rock sole *Pleuronectas bilineatus*
- Sand sole *Psettichthys melanostictus*
- Flathead sole *Hippoglossoides elassodon*
- Pacific sanddab *Citharichthys sordidus*
- Rex sole *Errex zacharias*
- Slender sole *Eopsetta exilis*
- Starry flounder *Platichthys stellatus*

English sole was the most common commercially important species found in previous studies followed by sanddab. Catches by Kyte (1994) of both species were almost entirely composed of juveniles and generally relatively low in number. English sole catches also displayed a definite periodicity with higher catches consistently in the fall, when recruitment from spring spawning probably occurred.

2.2.4 Marine Birds

The Cherry Point shoreline also supports a variety of marine birds and mammals. In addition, bald eagles (*Haliaeetus leucocephalus*) use the marine habitats along the Cherry Point shoreline for feeding. The following bird species have been documented along the Cherry Point shoreline and in near shore waters:

- Red-throated loon *Gavia stellata*
- Pacific loon *Gavia pacifica*
- Yellow-billed loon *Gavia adamsii*
- Harlequin duck *Histrionicus histrionicus*
- Oldsquaw *Clangula hyemalis*
- Black scoter *Melanitta nigra*
- Surf scoter *Melanitta perspicillata*
- White winged scoter *Melanitta fusca*
- Glaucous winged gull *Larus glaucescens*
- Bonaparte's gull *Larus philadelphia*
- Mew gull *Larus canus*
- Ring-billed gull *Larus delawarensis*
- Thayer's gull *Larus thayeri*
- Marbled murrelet *Brachyramphus marmoratus*
- Pigeon guillemot *Cephus columba*
- Common murre *Uria aalge*

- Brandt's cormorant *Phalacrocorax penicillatus*
- Horned grebe *Podiceps auritus*
- Western grebe *Aechmophorus clarkii*
- Pied-billed grebe *Podilymbus podiceps*
- Semipalmated sandpiper *Calidrus pusilla*
- Dunlin *Caladris alpina*
- Killdeer *Charadrius vociferus*
- Belted kingfisher *Ceryle alcyon*
- Bald eagle *Haliaeetus leucocephalus*
- Peregrine falcon *Falco peregrinus*

Bald eagle nests are present and active between Gulf Road and the Alcoa-Intalco Works smelter to the south (see Figure 1 for general location). Bald eagle nesting and breeding occurs from January 1 to August 15. Bald eagles are most sensitive to disturbance between February 1 and April 15 and least sensitive from July 15 to January 31. In addition, eagles use the beaches and bluffs along the shore for foraging.

Marbled murrelets foraging along or transiting the Cherry Point shoreline may use the waters off Gulf Road during normal activities. Previous studies indicated that probably only a few murrelets may use the assessment area, and that these birds would be able to find suitable feeding and "loafing" habitat offshore and north and south of Gulf Road if disturbed.

2.2.5 Marine Mammals

In addition to marine birds, a variety of marine mammals use the Southeast Strait of Georgia. Mammals known to occur along the Cherry Point shoreline include the following species:

- Harbor seal *Phoca vitulina*
- Pacific harbor porpoise *Phocoena phocoena*
- California sea lion *Zalophus californianus*
- Gray whale *Eschrichtius robustus* (sighting by this author)
- Killer whale *Orcinus orca*

These species feed in the SE Georgia Strait offshore of the project area. Harbor seals use rocky beaches to haul-out and to pup from Point Whitehorn south to within approximately one mile north of Cherry Point (proper). Harbor seals have been occasionally seen within the assessment area.

There are no known breeding or haul-out sites for sea lions in the assessment area. The nearest haul-out location for sea lions is on Sucia Island, approximately eight miles southwest of Cherry Point. Harbor seals also use this site and Point Migley on Lummi Island to the south. The Cherry Point shoreline is generally unsuitable for sea lion haul-out or use by whales because of the large areas of shallow water near shore. It is possible that sea lions could be present in the early fall to early spring in offshore waters of the assessment area for occasional feeding.

Humpback whale sightings are a common occurrence along the Washington outer coast, with occasional sightings in the Strait of Juan de Fuca and inland waters. The archives of the Orca Network for 2011 included several sightings in Puget Sound waters but none in the Cherry Point Reach. Humpback whales could occur in SE Georgia Strait but would likely be offshore of the assessment zone.

Killer whales frequent a variety of marine habitats and do not appear to be constrained by water depth, temperature, or salinity. Killer whale habitat use is dynamic and specific breeding, calving, or resting areas are not currently documented. Ranges are best known from late spring to early autumn (May through September) when survey effort is greatest. During this period, all three Southern Resident pods J, K, and L are regularly present in the Georgia Basin (defined as the Georgia Strait, San Juan Islands, and Strait of Juan de Fuca). While using inland waters during summer months, all the pods concentrate their activity in Haro Strait, Boundary Pass, the southern Gulf Islands, the northeastern end of the Strait of Juan de Fuca, and several localities in southern Georgia Strait. The largest number of sightings in Washington's inland waters is from Haro Strait off the west side of San Juan Island. Killer whales have also occasionally been seen offshore of the assessment area and in the vicinity of the BP Refinery pier.

3.0 Effects of Refinery Equipment Recovery and Conclusions

3.1 Physical Effects

The reactor vessel was displaced from the transport barge and partly sank, impacting the seafloor at an approximately 50-ft depth (Figure 7) and about 1,350 ft from the shoreline. The lower end of the vessel sank into the soft sediments serving to anchor the vessel and holding it in place (Figure 7) until it was recovered on December 21, 2011. The vessel was continually monitored by BP and its contractors.

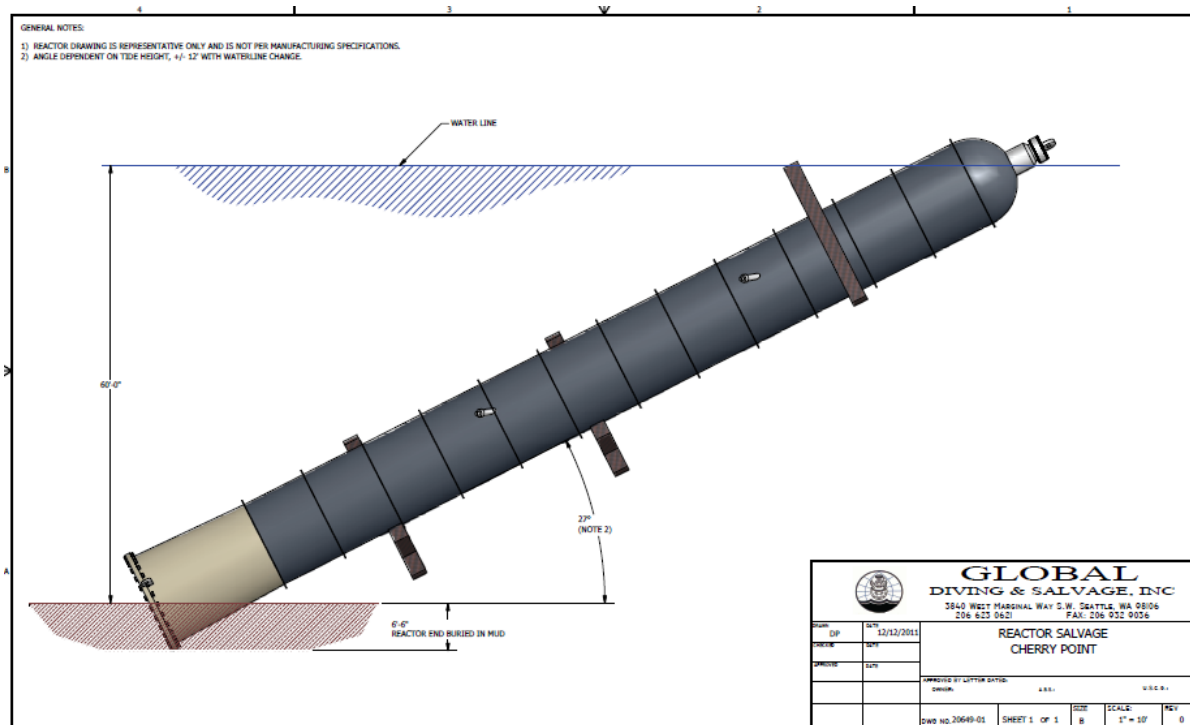


Figure 7. The Relation of the Reactor Vessel to the Sea Floor

At the point of impact, a hole approximately 6 ft deep and about 16 ft in diameter was formed in the muddy seafloor. A survey by Global Diving and Salvage using a ROV immediately following the removal of the vessel showed that sediment was being deposited into this hole by currents and biogenic action (e.g., crabs).

In addition to the reactor vessel, a battery-powered manlift was displaced off the barge and recovered at the same time as the reactor vessel. This manlift probably also left a hole in the muddy sediments. The effects of this impact were not seen during the ROV survey.

Pieces of debris including fragments of apparently the manlift housing (Figure 8), plastic sheeting (Figure 9), and a tarp with a mat of rubber-like material (Figure 9) were also deposited around the impact site. Because of the poor underwater visibility and the soft sediments, this debris was not recovered by Global Diving and Salvage.



Figure 8. Plastic Debris in Reactor Vessel Impact Hole with Edge of Hole in Foreground



Figure 9. Incident Debris near the Reactor Vessel Impact Hole

It is likely that this debris will be colonized by encrusting fauna in the same way that the older debris seen in the ROV survey has been (Figure 6). This encrusting fauna will increase the biodiversity and biomass in the impact area. Because these materials are relatively inert, little to negligible chemical effects would be expected from their presence. It should be noted that recovery of this debris would require re-deploying a dive team by boat into the area without a guarantee of recovery because of the soft sediments and low ambient visibility.

In addition to the solid debris, a small amount of oil and antifreeze was released during the displacement of the reactor vessel. BP and Barnhart personnel reported that the fuel tank of the diesel pump on board the barge was intact while the radiator cap and approximately three quarts of antifreeze from the radiator were missing. Approximately five quarts of non-detergent engine oil from the diesel engine was also lost. BP mobilized the Marine Spill Response Corporation (MSRC), BP's Primary Response Contractor, at the time of the incident.

3.2 Biological Effects

While a number of listed and other ecologically important species are known to use the vicinity of the assessment area, it is unlikely that the incident would generate significant direct negative effects to listed species and species of concern due to its limited physical and chemical scope, short duration, and the winter season. The incident occurred during December when no spawning activity by Pacific herring or out-migratory movement by salmonids was present. In fact, the barge landing was scheduled in cooperation with the Washington Department of Fish and Wildlife to avoid effects on sensitive marine finfish and other natural resources. In addition, sensitive marine mammals, birds, and fish could easily avoid the reactor vessel and associated vessels during the incident. The shoreline survey by Polaris (Taylor 2011) did not note the presence of any marine birds or mammals in the area.

It is unlikely that the small amounts of chemicals that were released would have a biologically significant effect on the Cherry Point marine environment. In fact, a shoreline survey by Polaris Applied Sciences, BP's primary oil spill contractor for biological assessments, did not find any sheens or other signs of spilled chemicals (Taylor 2011).

According to observations made during the 2011 Cherry Point Beach Walk (Kyte 2011), little macroalgae and no eelgrass was present at the barge landing site in June. Because of winter conditions, even less macroalgae would be expected to be present at the time of the incident and associated barge landing. A small population of bull kelp (*Nereocystis luetkeana*) has been present in some years in the shallow subtidal zone near the designated barge landing site. However, this kelp was not present in June 2011, and would not be present in December because of its life cycle and winter storm wave action.

3.3 Conclusion

The most notable effect of the December 9, 2011 incident at Gulf Road was the physical disturbance of the soft subtidal sediments at the point of impact and the deposition of associated plastic debris. Because of the relatively high local sediment deposition rate and bioturbation¹ by crabs, infauna, and

¹ Bioturbation is the displacement and mixing of sediment particles and solutes by animals or plants, typically annelid worms, bivalves, gastropods, holothurians, and other infaunal and epifaunal organisms. Faunal activities, such as burrowing, ingestion and defecation of sediment grains, construction and maintenance of burrows, and infilling of abandoned dwellings displace sediment grains and mix the sediment matrix.

flatfish, most signs of the disturbance will gradually disappear. Figures 4 and 6 demonstrate the likely appearance of the impact area within a few months to years. In fact, a live female Dungeness crab was photographed in the impact hole (Figure 5).

Because a substantial release of chemically active materials did not occur, the reactor vessel and manlift were quickly recovered, and the incident occurred during a period of relatively low biological activity, it appears that the incident did not have significant or long-term effects.

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