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Natural Resource Damage Assessment Plan for the M/V *Selendang Ayu* Oil Spill

Draft Final | October 2015

All pictures were taken as part of Shoreline Cleanup Assessment Technique (SCAT) efforts conducted as part of the oil spill response.

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES *iv*

LIST OF ACRONYMS *vi*

EXECUTIVE SUMMARY *ES-1*

CHAPTER 1 | INTRODUCTION AND PURPOSE

1.0 Overview of Incident *1-1*
1.1 Initial Response Actions *1-1*
1.2 Coordination and Compliance *1-4*
1.3 Public Participation *1-5*
1.4 Purpose of the NRDA Plan and Budget *1-5*
1.5 Plan Organization *1-6*

CHAPTER 2 | ENVIRONMENT AFFECTED BY THE SPILL

2.0 Physical Environment *2-1*
2.1 The Biological Resources *2-2*
2.2 Human Use *2-5*

CHAPTER 3 | INJURY QUANTIFICATION

3.0 Overview of Response and Pre-Assessment Activities and Findings *3-1*
3.1 Marine Resources *3-2*
- 3.1.1 Assessment Activities for Marine Resources *3-5*
- 3.1.2 Proposed Marine Resources Assessment Methods *3-13*

3.2 Marine Mammals *3-13*
- 3.2.1 Marine Mammals Assessment Activities *3-14*
- 3.2.2 Proposed Marine Mammal Assessment Methods *3-15*

3.3 Marine Birds *3-15*
- 3.3.1 Marine Bird Assessment Activities *3-16*
- 3.3.2 Proposed Marine Bird Assessment Methods *3-21*

3.4 Human Uses *3-23*
- 3.4.1 Human Use Assessment Activities *3-24*
- 3.4.2 Proposed Human Use Assessment Methods *3-24*

CHAPTER 4 | RESTORATION PLANNING

4.0 Restoration Strategy *4-1*
4.1 Project Evaluation Criteria Development *4-2*
4.2 Project Identification and Scaling *4-3*
4.2.1 Potential Oil Abatement Restoration Options *4-3*
4.2.2 Potential Restoration Options for Birds *4-5*
4.3 Proposed Restoration Planning Costs *4-10*

CHAPTER 5 | BUDGET

5.0 Introduction *5-1*
5.1 Past Costs *5-1*
5.2 Trustee Coordination *5-2*
5.3 Public Outreach *5-2*
5.4 Summary of Funding Request *5-2*

REFERENCES

LIST OF ATTACHMENTS:

Attachment A: Federal Register Announcement *A-1*
Attachment B: Funding and Participation Agreement *B-1*
Attachment C: Scientific Names *C-1*
Attachment D: Detailed Maps Showing the SCAT Segments *D-1*
Attachment E: Shoreline Cleanup Methods by Segment *E-1*

LIST OF TABLES AND FIGURES

TABLES

Table 3.1 Summary of Miles of Shoreline Oiling by Habitat and Oiling Degree Based on SCAT Data for both Winter 2004/2005 and Spring 2005 *3-2*

Table 3.2 Total PAH Concentrations in Mussel Tissues Collected after the M/V *Selendang Ayu* Oil Spill in Bays with any Shoreline Oiling *3-8*

Table 3.3 Counts of Avian Carcasses and Live Oiled Birds *3-19*

Table 5.1 Summary of Unreimbursed Past Cost *5-1*

Table 5.2 Summary of Funding Request *5-3*

FIGURES

Figure 1.1 M/V *Selendang Ayu* Grounding Location *1-2*

Figure 1.2 Examples of Natural Resources Impacted by the Spill *1-3*

Figure 2.1 The *Selendang Ayu* Spill Area on Unalaska Island, Alaska *2-2*

Figure 2.2 Examples of Shoreline Habitats Along the Western Shore of Unalaska Island *2-4*

Figure 3.1 Examples of Cleanup Activities Using Excavating Machinery *3-4*

Figure 3.2 Examples of Manual Cleanup Activities *3-5*

Figure 3.3 Locations of the Study Sites for Vegetation and Anadromous Streams *3-7*

Figure 3.4 Locations of the Study Sites for the 2008 Lingering Oil Study *3-12*

Figure 3.5 Locations of the Study Sites for the 2005 Background Avian Carcass Deposition Study *3-20*

Figure 3.6 Harlequin Duck Trap Sites (black circles) in Humpback, Portage, Skan, and Chernofski Bays, Overlain on the SCAT Shoreline Oiling Categories *3-22*

ACRONYMS

Alaska Depart of Fish and Game (ADF&G)

Alaska Department of Environmental Conservation (ADEC)

Alaska Department of Natural Resources (ADNR)

Aleutian Islands Risk Assessment (AIRA)

Assessment Plan (the Plan)

Automatic Identification System (AIS)

Damage Assessment and Restoration Plan (DARP)

ethoxyresorufin O-deethylase (EROD)

Federal Lead Administrative Trustee (FLAT)

Full Time Employees (FTEs)

Habitat Equivalency Analysis (HEA)

National Environmental Policy Act (NEPA)

National Oceanic and Atmospheric Administration (NOAA)

National Pollution Funds Center (NPFC)

Natural Resource Damage Assessment (NRDA)

Notice of Intent (NOI)

Oil Pollution Act of 1990 (OPA)

Polycyclic Aromatic Hydrocarbons (PAHs)

Resource Equivalency Analysis (REA)

Responsible Party (RP)

Shoreline Cleanup Assessment Technique (SCAT)

State of Alaska Departments of Law (ADOL)

United States Coast Guard (USCG)

United States Fish and Wildlife Service (FWS)

EXECUTIVE SUMMARY

On December 6, 2004, while traveling through the Aleutian Islands, the M/V *Selendang Ayu* experienced engine trouble and encountered adverse weather conditions. After several hours of attempting to repair the engine, the vessel grounded on December 8, 2004 in rough seas off Unalaska Island, Alaska. Upon notification of an oil spill threat, Federal, State, and local agencies responded to the incident to supervise and assist in the cleanup and begin to assess the impact of the oil spill on natural resources. Under the Federal Oil Pollution Act of 1990 (33 U.S.C. §§ 2701, et seq.) (OPA), the National Oceanic and Atmospheric Administration (NOAA), the United States Fish and Wildlife Service (FWS), and four State agencies—State of Alaska Departments of Law, Natural Resources Environmental Conservation , and Fish and Game—are responsible for restoring natural resources injured by the M/V *Selendang Ayu* oil spill.

Acting as Natural Resource Trustees on the public's behalf, the two Federal agencies and four State agencies conducted pre-assessment studies to document injuries to Trust resources. Based on the results of pre-assessment studies, the Trustees documented injury and potential injury to shoreline habitats, anadromous fish streams, sub- and intertidal habitats, marine mammals, and birds. Examples include, but are not limited to, the following:

- Approximately 86 miles of beach, rocky shore, and vegetated shoreline habitats were oiled and subsequent studies documented exposure of marine resources within these habitats.
- The Trustees collected 1,795 oiled bird carcasses and documented oiling on live birds and harbor seals.
- Two sea otter carcasses were collected and necropsies confirmed their deaths were consistent with exposure to oil.
- In 2008, the presence of lingering oil was documented at 21 of 24 subjectively selected beach locations.

Based on the results of pre-assessment studies, in 2007, the Trustees determined it was necessary to conduct a natural resource damage assessment (NRDA) to determine the full nature and extent of natural resource losses resulting from the incident and the restoration actions needed to restore these losses.

As part of the NRDA process, the Trustees developed this Assessment Plan (Plan) to ensure that the NRDA is conducted in an efficient and cost effective manner. This Plan describes the results of pre-assessment studies, the Trustees' proposed approach to

determining injury and appropriate compensation, and how the Trustees will scale the benefits of restoration. The Trustees encourage active participation of the public in the assessment through the public comment process. Comments regarding this Plan may be submitted in writing by November 4, 2015 to:

Veronica Varela
U.S. Fish and Wildlife Service
Alaska Regional Office
1011 East Tudor Road, Mail Stop #361
Anchorage, Alaska 99503
Veronica_Varela@fws.gov

Upon completion of the NRDA described in this Plan, the Trustees will release a Restoration Plan for public comment. This Restoration Plan will describe the results of the NRDA and the Trustees' proposed restoration alternatives for compensating for the environmental harm caused by the M/V *Selendang Ayu* oil spill.

CHAPTER 1 | INTRODUCTION AND PURPOSE

On November 28, 2004, the M/V *Selendang Ayu* departed Seattle, Washington for Xiamen, China carrying approximately 132 million pounds of soybeans, 424,000 gallons of intermediate fuel oil, and 18,000 gallons of marine diesel. The 738-foot freighter was registered under the flag of Malaysia, owned by Ayu Navigation Sdn Bhd and operated by IMC Shipping Company Pte. Ltd. (hereinafter, collectively referred to as the Responsible Party or RP). Traveling west on the northern side of the Aleutian Islands, Alaska, the M/V *Selendang Ayu* encountered engine trouble and inclement weather which ultimately resulted in the ship's grounding and the release of approximately 350,000 gallons of oil. Released oil was transported by natural physical processes, resulting in impacts to water column habitats, birds, marine mammals, and shoreline habitats.

1.0 OVERVIEW OF INCIDENT

On December 6, 2004, while traveling through the Aleutian Islands, the M/V *Selendang Ayu* experienced engine trouble and encountered adverse weather conditions in the vicinity of Unalaska Island, Alaska. The crew initially shut down the engine and attempted to repair it but they were unsuccessful. With the engine shutdown, the vessel drifted toward Unalaska Island. After several hours of attempting to repair the engine, the crew was unable to restart the engine and the vessel grounded on December 8, 2004 in rough seas off Unalaska Island (Figure 1.1). Shortly after grounding, the M/V *Selendang Ayu* broke in half resulting in the immediate release of approximately 350 thousand gallons of oil.[1] At the time of the release, ongoing rescue efforts and adverse weather conditions prevented oil recovery response activities from occurring immediately. Further, oil sheens originating from the wreck were continually observed through October of 2005, by which time the removal of remaining oil from the ship was completed. Following emergency response efforts, the majority of the ship was removed but some of the hull remains today.

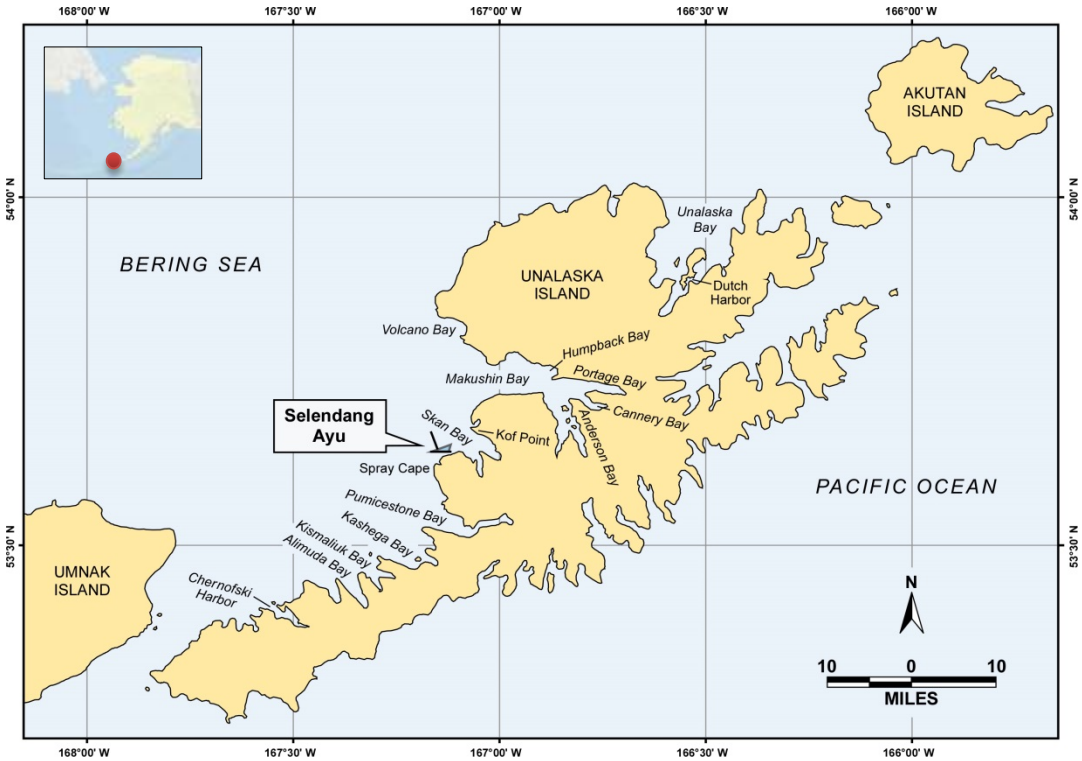
1.1 INITIAL RESPONSE ACTIONS

Released oil was subsequently transported via winds and currents, resulting in impacts to water column habitats, birds, marine mammals, and approximately 86 miles of shoreline habitats. In addition to impacting water column and shoreline habitats, oil was also transported to inter- and sub-tidal sediment habitats and distributed onto wetland, riparian, and terrestrial vegetation on Unalaska Island. Response efforts included using

[1] Approximately 339 thousand gallons of bunker oil and 14 thousand gallons of marine diesel and miscellaneous oils.

booms to prevent oil from being transported into anadromous salmon streams, wildlife rescue and rehabilitation (e.g., birds), shoreline cleanup, carcass recovery, and open burning of oily debris. Impacted biota included, but were not necessarily limited to, fish, shellfish, marine mammals, and birds. Figure 1.2 presents examples of natural resources impacted by the spill.

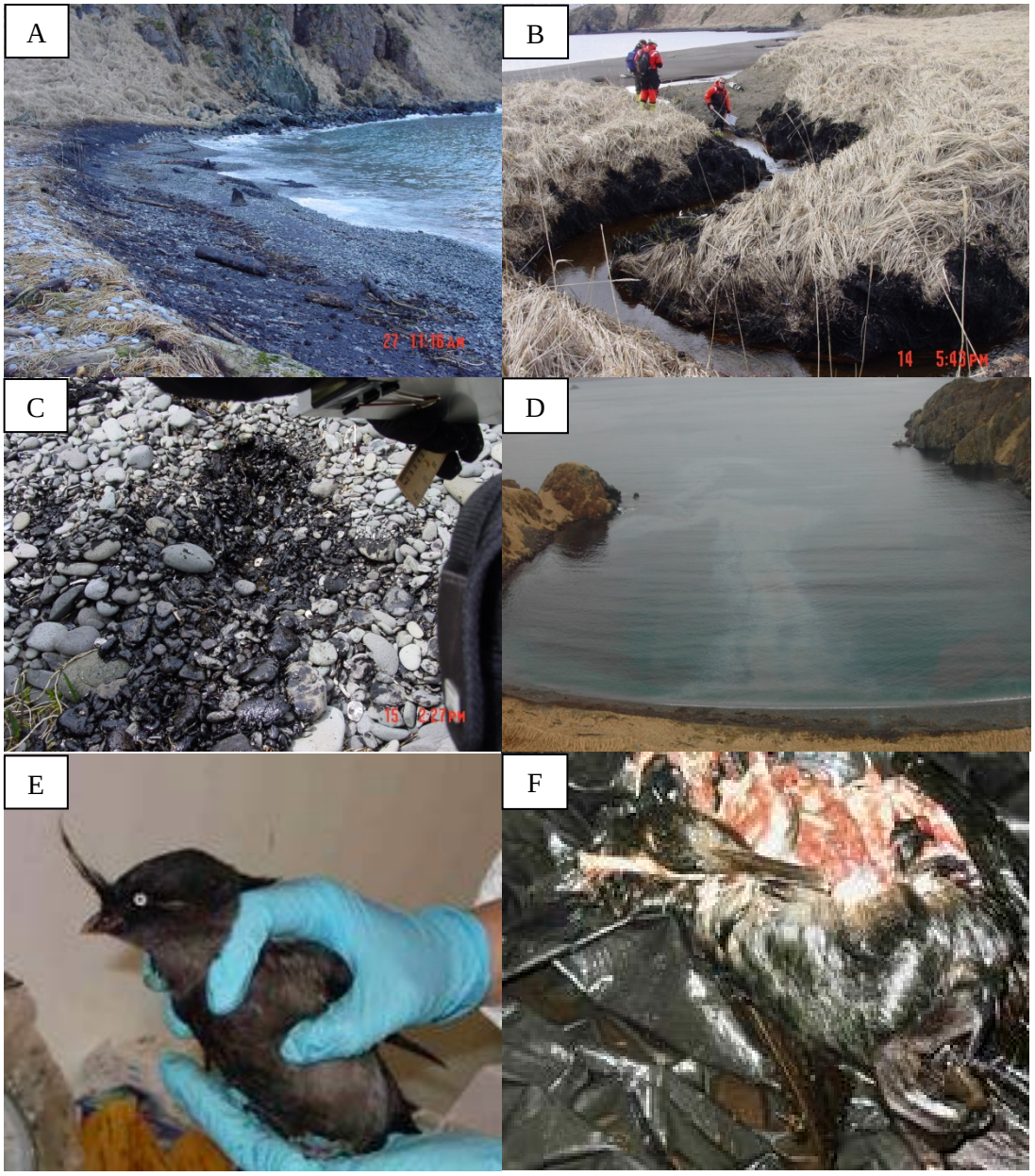
FIGURE 1.1 M/V *SELENDANG AYU* GROUNDING LOCATION



Federal, State, and local agencies responded to the incident to supervise and assist in the cleanup and begin to assess the impact of the spill on natural resources. The United States Coast Guard (USCG) and the State of Alaska established a Unified Command for directing cleanup efforts. The National Oceanic and Atmospheric Administration (NOAA), the United States Fish and Wildlife Service (FWS), the State of Alaska Departments of Law (ADOL), Natural Resources (ADNR), Environmental Conservation (ADEC), and Fish and Game (ADF&G) (hereinafter, the Trustees), and the Responsible Party (RP) began collecting pre-assessment data to determine whether natural resource damage assessment (NRDA) actions under the Oil Pollution Act of 1990 (OPA; 33 U.S.C. § 2706(b)) were justified. On March 30, 2007, based on the available pre-assessment data, the Trustees published a Notice of Intent (NOI) in the Federal Register announcing that they had entered the restoration planning phase of the NRDA (15 C.F.R. § 990.44). A copy of the announcement is included as Attachment A. Additional details regarding response activities and pre-assessment activities can be found in Chapter 3.

FIGURE 1.2 EXAMPLES OF NATURAL RESOURCES IMPACTED BY THE SPILL

A. Heavy oiling of gravel beaches (27 Dec 2004). **B**. Oiled stream bank (14 April 2005). **C.** Buried oil (15 April 2005). **D.** Sheens being released from the shoreline (February 2005). **E**. Oiled auklet in rehab (26 Dec 2004). **F.** Oiled scavenged bird carcass (26 Dec 2004). All pictures were taken as part of the Shoreline Cleanup Assessment Technique.



1.2 COORDINATION AND COMPLIANCE

The Trustees worked together to meet their responsibilities under OPA and other applicable Federal and State laws. The Federal Lead Administrative Trustee (FLAT) and the overall NRDA coordinator for this incident is the FWS. The OPA regulations require the Trustees to invite the RP to participate in the damage assessment process (15 C.F.R. § 990.14). Accordingly, immediately following the spill, the Trustees and the RP initiated cooperative pre-assessment activities, funded by the RP. The cooperative pre-assessment activities are described in Chapter 3. In 2007, the Trustees and the RP entered into a funding and participation agreement in which the Trustees and the RP agreed to cooperate and collaborate on studies and activities conducted during the restoration planning and restoration implementation phase, and the RP agreed to fund such studies and activities. The Funding and Participation agreement is included as Attachment B.

To facilitate assessment and restoration planning activities conducted during the pre-assessment and restoration planning phases, the RP chartered vessels and provided aircraft and helicopters for the Trustees to access the spill area and conduct studies. The RP also hired contractors to perform studies and prepare reports to the Trustees. Additionally, the Trustees and RP met on several occasions to discuss study plans, study results, data interpretation, and restoration alternatives. The RP also provided comments on Trustee draft pre-assessment reports. While this coordination between the Trustees and the RP reduced duplication of studies, increased the cost-effectiveness of the assessment process, and increased information exchange, each party reserved the right to make their own determinations regarding injury. Further, determination of required restoration rests solely with the Trustees. An accounting of past unreimbursed assessment costs can be found in Chapter 5.

On December 10, 2007, the USCG National Pollution Funds Center (NPFC) received a claim from the RP asserting its entitlement to a limit of liability under OPA 33 U.S.C. § 2704(a)(1) for removal costs and damages (USCG, 2012). Based on the available information, the NPFC determined the following:

> "…the incident was not proximately caused by gross negligence, willful misconduct or the violation of an applicable Federal safety, construction, or operating regulation by the responsible party. Additionally, the NPFC's review found that the responsible party met all requirements to report the incident and to provide reasonable cooperation and assistance and complied with orders as required." (USCG, 2012)

As such, the RP's claim was upheld in January 2012 and the Coast Guard set the limit of liability at $23,853,000. At the time of the RP's claim to the NPFC, the RP had incurred removal costs and damages totaling approximately $148 million or approximately $124 million in excess of their liability (USCG, 2012). Thus, the RP is eligible to seek reimbursement for removal and damage costs that exceed the limit of liability, including for costs incurred as part of the NRDA. Following the NPFC's determination, the RP significantly decreased its participation in assessment activities. However, rather than terminate the Funding and Participation Agreement, the Trustees and the RP amended the

Agreement to allow continued cooperation on certain assessment activities and to allow Trustees that had funds remaining to continue using those funds for cooperative assessment activities rather than return the unused funds to the RP.

1.3 PUBLIC PARTICIPATION

From the outset of the spill, the Trustees engaged the public in a variety of assessment and restoration planning activities. For example, in the summer of 2005, the Trustees met with residents of Unalaska Island to ascertain spill-related impacts to their uses of natural resources. Additionally, the Trustees maintain an Administrative Record at the following location:

http://www.fws.gov/alaska/fisheries/contaminants/spill/sa_record.htm

Further, consistent with 15 C.F.R. § 990.14(d), the Trustees will provide opportunities for public involvement to enhance Trustees decision-making as part of the damage assessment and restoration planning. Copies of this NRDA Plan and Budget (Plan) and any modifications or amendments will be made available to the public online at the following Federal and State Websites:

http://www.fws.gov/alaska/fisheries/contaminants/spill/sa_index.htm

http://dec.alaska.gov/spar/perp/response/sum_fy05/041207201/041207201_index.htm

The U.S. Fish and Wildlife Service, acting as the FLAT, is the central point of contact for the Trustees. Copies of the Plan and other information may be requested in writing from Veronica Varela at the address listed below. Additionally, the Trustees encourage active participation of the public in the assessment through the public comment process. Comments regarding this Plan may be submitted in writing by November 4, 2015 to:

Veronica Varela
U.S. Fish and Wildlife Service
Alaska Regional Office
1011 East Tudor Road, Mail Stop #361
Anchorage, Alaska 99503
Veronica_Varela@fws.gov

1.4 PURPOSE OF THE NRDA PLAN AND BUDGET

The Trustees have developed this Plan to ensure the *Selendang Ayu* NRDA is performed in a planned and systematic manner and that the proposed methodologies for estimating damages can be conducted at a reasonable cost. Specifically, the Plan summarizes existing data, describes proposed assessment activities and associated costs, presents restoration planning activities to date, and describes future restoration planning efforts and associated costs.

1.5 PLAN ORGANIZATION

This Plan provides background information and describes the Trustees' approach to injury quantification and restoration planning. Additionally, the Plan provides a cost estimate for conducting the NRDA. The remainder of this document contains the following chapters:

- **Environment Affected by the Spill (Chapter 2):** This chapter identifies and describes the environment, resources, and human uses impacted by the spill.
- **Injury Quantification (Chapter 3):** This chapter is organized by resource. It includes an overview of available information and describes proposed assessment methods and preliminary findings for each resource.
- **Restoration Planning (Chapter 4):** This chapter describes the process that will be used to identify and evaluate restoration alternatives, including, but not limited to, identifying candidate restoration projects/concepts and developing project evaluation and selection criteria.
- **Budget (Chapter 5):** This chapter provides an accounting of past, unreimbursed, NRDA costs and an estimate of future costs that will be required to complete the assessment.

CHAPTER 2 | ENVIRONMENT AFFECTED BY THE SPILL

This chapter briefly describes the physical and biological environments and the potentially impacted human uses in the vicinity of the spill. The affected environment for injury assessment activities includes all areas in the vicinity of Unalaska Island, Alaska where oil from the M/V *Selendang Ayu* came to be located. The biological environment where oil came to be located includes a myriad of fish, birds, mammals, and other biota found within the water column, shoreline, and intertidal habitats. The cultural environment primarily includes those areas in the immediate vicinity of Unalaska Island, Alaska where residents rely on or utilize natural resources.

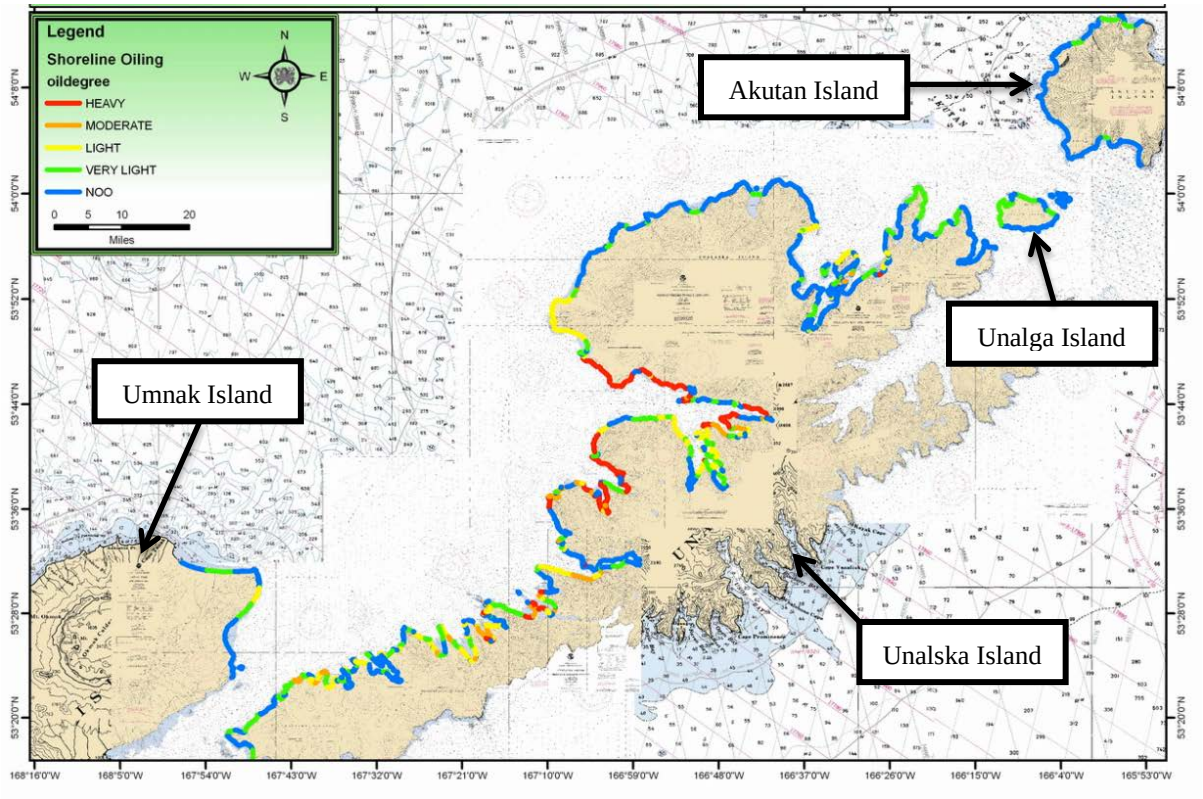
Specifically, the geographic scope includes the marine and coastal habitats where the 350,000 gallons of oil released from the M/V *Selendang Ayu* was observed. Due to adverse weather conditions at the time of the spill and the characteristics of the heavy fuel oil, the full extent of oil on the water surface was never documented. However, the extent of shoreline oiling can be used as a surrogate for estimating the minimum extent of oil on surface waters. Shoreline Cleanup Assessment Technique (SCAT) teams completed a comprehensive survey in the Spring of 2005 to document shoreline oiling (Figure 2.1), which extended from Akutan Island and Unalga Island, along most of the western and northern shorelines of Unalaska Island, and to the eastern tip of Umnak Island.

2.0 PHYSICAL ENVIRONMENT

The Aleutian Island archipelago extends more than 1,900 miles between Alaska and Russia, forming the southern border of the Bering Sea. Because the islands are mostly the tops of volcanoes, they have steep and narrow shelves and are intersected by numerous straits and passes. The Aleutians are affected by the Aleutian North Slope Current in the Bering Sea, and the Alaska Coastal Current and Alaskan Stream in the North Pacific (Favorite et al., 1976; Stabeno et al., 1999). The overall climate in the vicinity of the spill is maritime. Storm systems are frequent in the area and typically originate east of Japan and move northeastward along the Aleutian Chain. These storms result in high winds, often in excess of 50 miles per hour, causing large waves and extensive shoreline wave action (Rodionov et al., 2005). The shorelines of the Aleutian Islands consist of rocky areas, beaches, vegetated areas, and sheltered tidal flats intersected by numerous anadromous streams.

FIGURE 2.1 THE SELENDANG AYU SPILL AREA ON UNALASKA ISLAND, ALASKA.

Assessment was completed with standard shoreline cleanup and assessment techniques (SCAT). "NOO" indicates No Oil Observed.



Within the geographic scope of the assessment area there are 580 miles of shoreline habitats, including rocky shores, beaches, vegetated shorelines, and sheltered tidal flats. Beaches vary extensively in terms of the sediment grain size, degree of exposure to waves, and angularity. There are also wave-built spits composed of rounded pebbles and cobbles across the mouths of streams and glacially carved valleys. Associated currents and weather patterns continuously transport nutrients within the marine environment and shape the physical environment resulting in productive and diverse shoreline and marine ecosystems that support numerous species of biota. Figure 2.2 shows representative photographs of shoreline habitats.

2.1 THE BIOLOGICAL RESOURCES

Numerous species of wildlife can be found within the geographic scope of the assessment, including fish, invertebrates, birds, and marine mammals. One hundred four anadromous streams occur in the geographic scope of the assessment, with three used by chum salmon (spawning July-October), three used by Dolly Varden (present year-round), 12 used by sockeye salmon (spawning July-December), 17 used by coho salmon (spawning October-December), and 69 used by pink salmon (present July-October). Near-shore fish include Atka mackerel (spawning July-September), Pacific cod

(spawning June-September), and Pacific halibut. In deeper waters of the Bering Sea, arrowtooth flounder, Greenland halibut, Pacific cod, and sablefish are present year-round. Invertebrates in the region include king crab, Tanner crab, Dungeness crab, and multiple species of bivalves (ADF&G, 1998; Impact Assessment, Inc., 2011). Attachment C presents scientific names for those species discussed throughout this document.

In addition to fish and marine invertebrates, the region supports a diversity of avifauna and includes important nesting, foraging, and wintering habitats for over 100 species of birds. During the breeding season, the rich waters off the Aleutian Islands are known to support numerous nesting seabird colonies. Waterfowl species found in the region of the spill include both year-round and winter-only residents. For example, crested auklets can overwinter throughout the Aleutian Islands, but Unalaska Island is at the western edge of the highest density wintering area for crested auklets (Gibson and Byrd, 2007), and flocks were seen in the area of the *Selendang Ayu* wreck during and immediately after the incident. Also in the area of the oil spill, during the winter, marine birds such as northern fulmar, pelagic cormorant, harlequin duck, common murre, pigeon guillemot, glaucous-winged gull, and black oystercatcher can be plentiful near Unalaska Island. The Steller's eider, listed as threatened under the federal Endangered Species Act, commonly overwinters in the waters around Unalaska Island. Nesting seabird species, year-round waterfowl, and winter-only residents include, but may not be limited to, the following species:

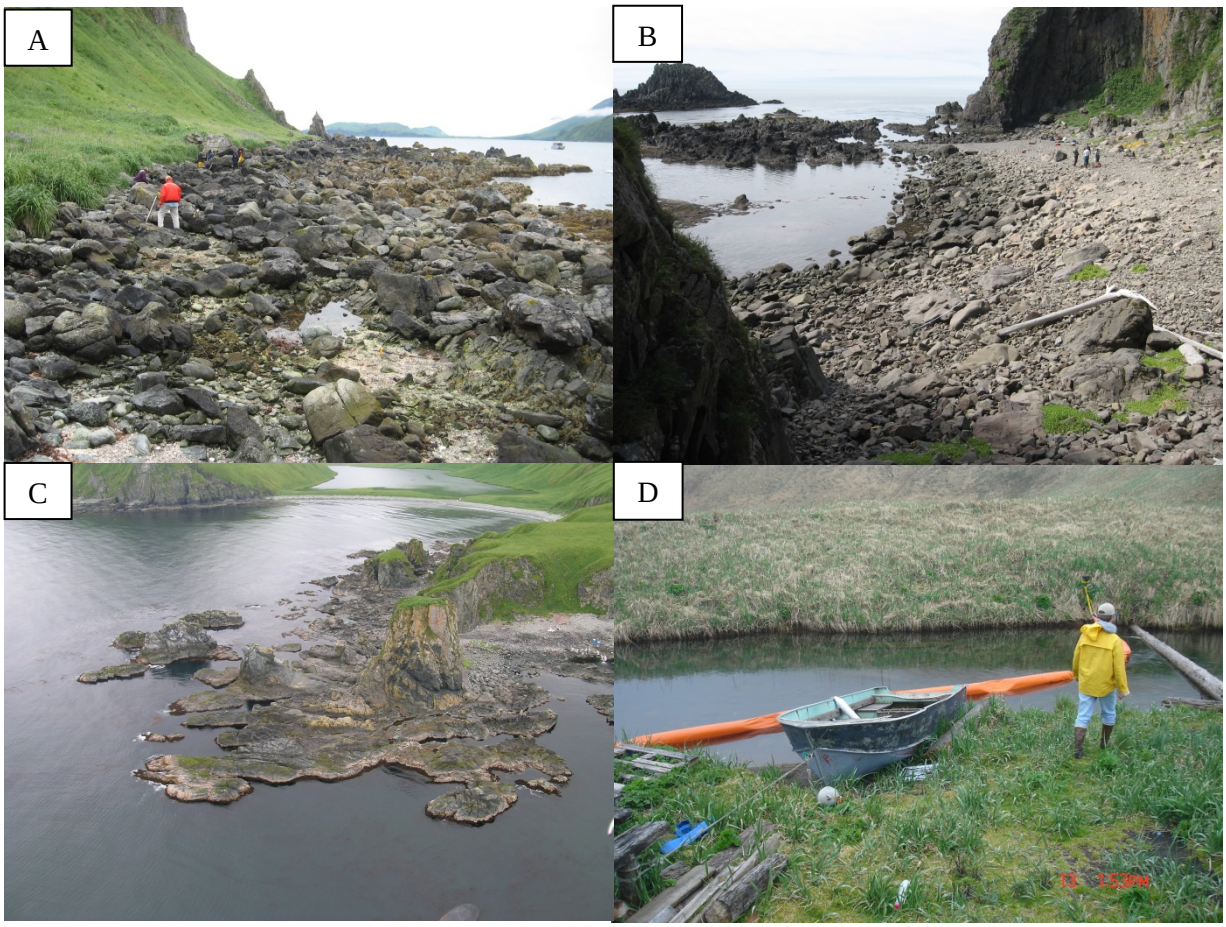
- **Nesting Species**: Ancient murrelet, black oystercatcher, Cassin's auklet, crested auklet, whiskered auklet, parakeet auklet, common eider, common and thick-billed murres, pelagic cormorant, double-crested cormorant, red-faced cormorant, horned puffin, tufted puffin, forked-tailed storm-petrel, Leach's storm-petrel, pigeon guillemot, red-legged kittiwake, and glaucous-winged gull.
- **Year-round Species**: American wigeon, bufflehead, common goldeneye, gadwall, greater scaup, green-winged teal, harlequin duck, mallard, northern pintail, northern shoveler, long-tailed duck, red-breasted merganser, and various scoters.
- **Winter-only Species**: Brant, emperor goose, king eider, Steller's eider (federal threatened), common loon, common merganser, and rock sandpiper.

The productive marine ecosystems of the Aleutian Islands support numerous marine mammals, including two species of pinnipeds, numerous cetaceans, and one species of fissiped, the northern sea otter. In the shoreline area affected by the spill, there are 44 harbor seal haulouts and 10 haulouts for Steller (northern) sea lion. Animals may be present year-round and pupping occurs during May-July for both harbor seals and Steller sea lions. Though there are limited data on abundance and seasonal distribution, many species of whales and porpoises are known to occur in the area. Northern sea otters are the smallest marine mammal and are found throughout the Aleutian Islands. The Aleutian Islands population (Southwest Alaska Distinct Population Segment) of sea otters was listed as threatened in 2005 under the federal Endangered Species Act, and all of the

Aleutian Island nearshore marine waters are identified as critical habitat. Sea otters rely entirely on their fur for thermal insulation in the marine environment, making them particularly sensitive to oiling.

FIGURE 2.2 EXAMPLES OF SHORELINE HABITATS ALONG THE WESTERN SHORE OF UNALASKA ISLAND.

A. Angular bounders on a rocky platform in Humpback Bay. **B.** Steep gravel storm berm in between rocky shores at the entrance to Makushin Bay **C**. Wave-cut rocky platforms with a gravel spit at the head of Humpback Bay in the background. **D.** Vegetated shoreline along a tidal creek in Volcano Bay.



2.2 HUMAN USE

ARCHAEOLOGICAL

Although limited detailed information is available about the archaeological resources within the spill-impacted area, numerous unique archeological sites that span the entire period of human occupation of the area have been identified on Unalaska Island. For example, Veltre et al. (1986) completed an archaeological site survey of the western portion of Unalaska Island which identified 38 previously unreported sites, bringing the total reported number of unique archaeological sites in the region to 62.

SUBSISTENCE

The subsistence culture and traditions of the Aleut residents of the city of Unalaska and Umnak Islands are well established in the literature (Veltre and Veltre, 1982; Hamrick and Smith, 2003). Aleuts fish, hunt, and gather resources for purposes of consumption, sharing, handicrafts, medicine, and traditional education (Hamrick and Smith, 2003; S. Livingston, Qawalangin Tribe, Aleutian Life Forum, Aug. 2005). The most common resources used by Unalaska/Umnak residents are salmon, halibut, seal oil, cod, king crab, and native plants. The Alaska Department of Fish and Game (ADF&G) estimates that approximately 97% of Unalaska households harvest wild resources to some degree (Scott et al., 2001).

There is little documented historical information regarding the degree of use of natural resources specifically from the northwest side of Unalaska where the spill occurred. It appears that most fishing, hunting, and gathering occurs close to Unalaska Bay because access to other areas is limited to those individuals with boats capable of traversing the waterways to the northwest bays on Unalaska Island. However, some community members use boats that allow them to reach Skan and Makushin Bays, located on the northwest side of the island, to gather subsistence foods (Kohout and Meade, 2008). Subsistence and cultural resources likely to be found in Skan and Makushin Bays include salmon, marine invertebrates (e.g., butter clams and razor clams), and wild plants for medicinal purposes (Kohout and Meade, 2008; Shaul et al., 2002). Resources found between Spray Cape and Unalaska Bay include sockeye salmon in Reese Bay and marine mammals (sea lions/harbor seals) along the northern coast to Koriga Point (Shaul et al., 2002; Veltre and Veltre, 1982).

COMMERCIAL FISHING

Dutch Harbor, on the northern side of Unalaska Island, is both the primary port in Unalaska and the largest U.S. commercial fishing port in the northern Pacific Ocean. Major commercial fisheries in Unalaska include a number of groundfish species, as well as several major crab fisheries and a few smaller food and bait fisheries. Additionally, the bays and inshore waters of Unalaska Island support a number of commercially significant groundfish species. Many vessels that fish in the Bering Sea land their catch at Unalaska or Dutch Harbor processors (Nuka Research and Planning, 2005).

RECREATION

The natural resources on Unalaska provide abundant hunting, fishing and sightseeing opportunities. Most recreational activities tend to occur in the vicinity of the communities of Unalaska/Dutch Harbor and nearby areas accessible by road such as Captains Bay, Amaknak Island, and Summer Bay (Kohout and Meade, 2008). For example, a 2001 study estimated a total of 1,281 angler days for the year (Schwarz et al., 2002). Further, according to ADF&G there were seven active halibut charter vessels in 2004 (Schwarz et al., 2002).

CHAPTER 3 | INJURY QUANTIFICATION

This chapter describes the Trustees' past and proposed future efforts to quantify the nature and extent of injuries to natural resources and human use activities resulting from the M/V *Selendang Ayu* incident. It begins with an overview of response and cleanup services, describes NRDA-relevant data collected for marine resources, birds, marine mammals, and human use, and concludes with proposed future assessment activities for which the Trustees are requesting upfront funding from the NPFC. As described in Chapter 2, the affected environment for the purposes of injury assessment activities includes all marine and coastal habitats where oil from the M/V *Selendang Ayu* came to be located.

3.0 OVERVIEW OF RESPONSE AND PRE-ASSESSMENT ACTIVITIES AND FINDINGS

The Trustees initiated the pre-assessment phase on December 7, 2004, immediately after receiving notification of the threat of an oil release due to the M/V *Selendang Ayu* losing power and drifting towards Unalaska Island. To make this determination, the Trustees determined that the criteria promulgated at 15 C.F.R. § 990.41(a) were met:

(1) An incident has occurred, as defined in § 990.30 of this part;

(2) The incident is not:

  (i) Permitted under a permit issued under Federal, State, or local law; or

  (ii) From a public vessel; or

  (iii) From an onshore facility subject to the Trans-Alaska Pipeline Authority Act, 43 U.S.C. 1651, *et seq.*; and

(3) Natural resources under the trusteeship of the trustee may have been, or may be, injured as a result of the incident.

Response and pre-assessment activities, as defined by OPA, focus on collecting ephemeral data essential to determine whether:

- Natural resource injuries have resulted, or are likely to result from, the incident,
- Response actions have adequately addressed, or are expected to address, the injuries resulting from the incident, and
- Feasible restoration actions exist to address the potential injuries.

The Trustees conducted some pre-assessment activities in coordination with the RP. Specifically, cooperative and Trustee-lead pre-assessment efforts included conducting

shore and boat-based surveys, aerial surveys, surveys of sub-tidal habitats, surveys of anadromous fish streams, collecting and cataloging marine bird and mammal carcasses, and evaluating human use services associated with affected natural resources. The Trustees summarized the results of the pre-assessment activities in 12 reports, which were organized by resource and can be found on FWS's *Selendang Ayu* NRDA website:

http://www.fws.gov/alaska/fisheries/contaminants/spill/sa_record.htm

3.1 MARINE RESOURCES

RESPONSE ACTIVITIES FOR MARINE RESOURCES

The Unified Command for the M/V *Selendang Ayu* incident divided the shoreline into 806 potentially impacted shoreline segments. To document oiling and provide response decision makers with the best available information, these segments were surveyed by SCAT teams through June 2005. SCAT teams encountered oil at 519 unique locations within the 806 segments. When SCAT teams encountered oil, if weather conditions and time allowed, they took detailed notes and documented the extent of oiling (length of impacted shoreline). Following the completion of SCAT surveys, field notes were entered into a SCAT database. Miles of impacted shoreline were determined by comparing oiled areas from all SCAT surveys within a segment using both the SCAT database and the detailed SCAT field notes. The SCAT teams were unable to record the extent of oiling for approximately 17% of the areas identified as being oiled. As such, to estimate the extent of oiling in these areas, the Trustees assumed that the extent of oiling was equal to the average extent of oiling for the other 432 areas where oil was encountered. In addition to estimating the extent of oiling, when oil was encountered, the SCAT teams categorized the degree of oiling (e.g., heavy, light) and the shoreline habitat type (e.g., beach, vegetated). Based on the extent of oiling information, a total of approximately 86 miles of shoreline habitat were documented as being oiled. Table 3.1 presents the miles of oiled shoreline by habitat type and degree of oiling. Attachment D provides additional details regarding SCAT segments.

TABLE 3.1 SUMMARY OF MILES OF SHORELINE OILING BY HABITAT AND OILING DEGREE BASED ON SCAT DATA FOR BOTH WINTER 2004/2005 AND SPRING 2005.

HABITAT	HEAVY	MODERATE	LIGHT	VERY LIGHT	TARBALLS	UNKNOWN	TOTALS
Beach	15.27	6.69	25.66	14.47	4.16	0.35	66.59
Rocky Shore	3.77	1.56	5.47	4.74	0.63	0.00	16.16
Vegetated	1.63	0.17	0.00	0.00	0.00	0.00	1.81
Stream Channel/Flat	0.00	0.00	0.03	0.22	0.00	0.00	0.25
Unknown	0.00	1.01	0.06	0.20	0.00	0.00	1.27
Totals	20.67	9.43	31.22	19.63	4.79	0.35	86.08

CLEANUP ACTIVITIES FOR MARINE RESOURCES

For the M/V *Selendang Ayu* incident, the Unified Command determined that 123 of the 806 segments received enough oil to warrant cleanup. However, during the winter surveys 21 of the 123 segments were deemed unsafe for cleanup crews to safely land a vessel and deploy equipment for cleanup activities. During the SCAT surveys the following summer, four of the 21 segments were still considered unsafe for cleanup crews. Of the remaining segments, cleanup activities occurred over approximately 20 miles of shoreline. Cleanup methods included, but were not necessarily limited to, manual removal, vegetation cutting, mechanical removal, tilling, berm relocation, and open burning. Specifically, 2005 cleanup activities included the following:

- Manual Removal, which included both wiping and removal, was performed at numerous locations where oil was encountered.
- Vegetation Cutting occurred at multiple segments but was not tabulated.
- Mechanical Removal was conducted at four sites in Skan Bay, two sites in Makushin Bay, and three sites in Humpback Bay.
- Mechanical Tilling was conducted at six sites in Skan Bay, three sites in Makushin Bay, three sites in Humpback Bay, and one site in Kismaliuk Bay.
- Berm Relocation was conducted at three sites in Skan Bay and two sites in Humpback Bay.
- Open Burning of oily debris was conducted at three sites in Skan Bay, one site in Makushin Bay, one site in Humpback Bay, and one site at Kof Point.

At the conclusion of shoreline cleanup activities in 2005, cleanup goals were met within 76 of the 102 segments. Because cleanup goals were not met within 26 of the 102 segments, SCAT teams resurveyed those segments in 2006 and additional cleanup activities occurred. However, cleanup criteria were still not met at seven segments by the end of 2006. The Trustees are not aware of any additional cleanup activities. Additional details related to observed oiling and cleanup actions are included in Attachment E.

IMPACTS TO NATURAL RESOURCES DURING CLEANUP ACTIVITIES

When planning and conducting cleanup activities, it is necessary to ensure that the benefits resulting from the removal of oil outweigh the additional impacts cleanup activities may have. For example, the mechanical equipment used for manual oil removal often traversed the entire intertidal zone potentially crushing biota and altering the environment. Further, cleanup activities resulted in the remobilization of oil. In addition to the physical impacts, the larger number of humans present in the area likely displaced wildlife that utilize shoreline habitats for foraging, denning, nesting, and cover. Such response related impacts to natural resources are considered injuries under OPA (15 C.F.R. § 990.51) and the Trustees intend to incorporate these injuries into their assessment. Figures 3.1 and 3.2 present examples of cleanup activities including berm relocation and manual cleanup.

FIGURE 3.1 EXAMPLES OF CLEANUP ACTIVITIES USING EXCAVATING MACHINERY

A. Dry tilling to expose buried oil (2 June 2005). **B.** Excavation of oiled sediments (4 July 2005). **C.** Berm relocation test (27 May 2005). **D.** Dry tilling (15 June 2006).

FIGURE 3.2 EXAMPLES OF MANUAL CLEANUP ACTIVITIES

A. Vegetation cutting (30 April 2005). **B.** Manual removal of oiled sediments. **C.** Manual removal along anadromous stream bank (4 May 2005). **D.** Manual removal (30 May 2006).

3.1.2 ASSESSMENT ACTIVITIES FOR MARINE RESOURCES

Cooperative pre-assessment surveys of marine resources were conducted in early summer 2005 and focused on documenting impacts to intertidal, subtidal, and anadromous stream habitats. Additionally, in 2008, the Trustees and RP cooperatively conducted a lingering oil assessment to determine the location, amount, degradation, and bioavailability of remaining oil. The following paragraphs briefly describe the results of these studies and additional details can be found on FWS's *Selendang Ayu* NRDA website: http://www.fws.gov/alaska/fisheries/contaminants/spill/sa_record.htm.

INTERTIDAL ROCKY SHORE AND BEACH HABITATS

Although, due to winds and waves, some of the oil did come to rest above the high tide line in terrestrial vegetation, oil also came to rest along approximately 86 miles of intertidal shoreline habitats. Thus, the Trustees initiated several studies to characterize the impacts of oil on flora and fauna in rocky shore and beach habitats. Visual surveys of

algae and invertebrates in rocky intertidal habitats at Spray Cape in 2005 observed reduced herbivore populations and physical impacts to kelp that could be attributed to exposure to M/V *Selendang Ayu* oil (Cubit et al., 2008). For example, kelps were reduced to stipes—the main portions of their blades were absent. Further, the study documented "green shore phenomena" at Spray Cape, which is an algae bloom resulting from a reduction in herbivore populations. Such "green shore phenomena" have been observed at other spills and in controlled field experiments that removed herbivores. There were no other visible effects at sites other than Spray Cape. The duration of such of effects and recovery to baseline conditions is unknown because observations were not made post-2005.

On sand and gravel beaches, an abundant and diverse assemblage of cryptic beach invertebrates were observed beneath gravel, drift seaweeds, and other beach wrack. These included talitrid amphipods ("beach hoppers"), centipedes, arachnids, and kelp flies. In some cases, beach biota were found within 10 cm of mats of buried oil, but no oil was found on the biota. Additionally, predators such as foxes were seen overturning gravel and wrack on beaches, apparently feeding on the beach invertebrates found there.

In the course of the surveys, large amounts of beach material were observed being removed from heavily oiled sections of beaches. For example, the excavating machinery was observed removing oiled cobble and gravel, placing it in "Super Sacks" for transport and disposal by response crews. Thus, any biota in the beach material would have also been removed. Excavating machinery could have also crushed beach biota. In addition, oily debris was moved into piles and burned on some beaches, which would have killed beach-wrack fauna and infauna in the vicinity of the fires. However, Cubit et al. (2008) observed that burning sites were often in areas of high wave energy with gravel sediments and thus the density of beach-wrack fauna and infauna may have been low.

During June of 2005, the survey teams observed new deposits of oil in the intertidal zone of Skan Bay, which they attributed to remobilization of oil during beach cleaning operations in adjacent areas. An on-scene biological advisor for the cleanup said that high tides had washed oil from the beach due to excavations made to remove buried oil. Heavy machinery was digging oiled sediment out of the beach, and the highest concentrations of oil in the water and on the shore were observed closest to beach cleaning operations. Oil sheens observed at this time ranged from silver through rainbow in color and some brown-black patches of oil were also observed on the water surface of the cove. Rainbow sheen covered about 50% of the water surface in the landward part of the cove. Bands of floating black oil about one cm thick accumulated against the floating fronds of the kelp, *Alaria*. The oiled *Alaria* bed was about 50 m by 100 m.

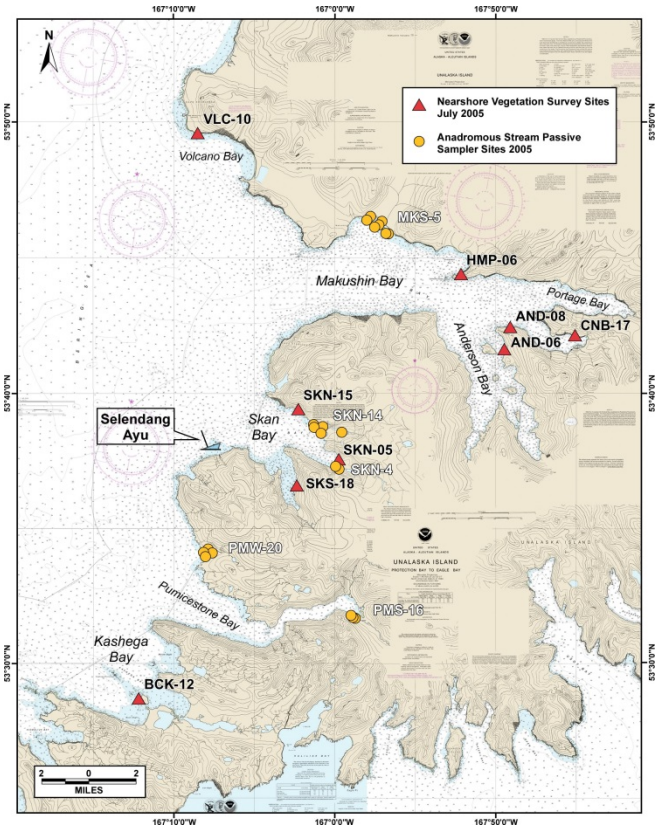
Additionally, Cubit et al. (2008) also compared adverse impacts to various species of marine alga that were likely caused by oil remobilized from beach cleaning operations. To distinguish between the effects of oil exposure from the effects of natural ecosystem variations (e.g., spring low tides), algae fronds were evaluated along a gradient of exposure to remobilized oil. These observations indicated exposure to remobilized oil was a probable cause of adverse impacts on four species of algae (*Palmaria*, *Laminaria*,

Acrosiphonia, and *Agarum*). All four species showed a greater degree of bleaching and tissue erosion in areas where remobilized oil exposure was higher.

VEGETATED SHORELINE HABITATS

From July 19 to 24, 2005, representatives of the FWS and the RP conducted a nearshore vegetation survey at nine locations in the Makushin and Skan Bay areas on Unalaska Island (Rocque and Erickson, 2006; Figure 3.3). General study areas were selected from available SCAT maps and resource maps, but specific plots were selected in the field because available data were too coarse to select study plots at the scale required for this study. Lack of un-cleaned but oiled areas and inclement weather during the survey limited the number of plots surveyed to nine pairs of oiled (i.e., oiled and cleaned) and control (i.e., never oiled) plots (18 total plots). At each of the nine selected locations, two 5 x 10 m plots were delineated. However, due to the nearly continuous band of oiling along the seaward edge of the vegetation at the nine locations sampled, it was necessary in most cases to move control plots back away from the vegetation edge on the beaches to avoid oiled areas. Thus, most of the control plots were located in more landward areas (away from the wave and salt spray zone) and at somewhat higher elevations than the oiled plots.

FIGURE 3.3 LOCATIONS OF THE STUDY SITES FOR VEGETATION AND ANADROMOUS STREAMS.



The study results showed significant differences in species diversity and plant abundance between oiled (oiled and cleaned) and control plots in this single survey. However, these differences may have been due to factors other than oiling or cleaning, such as microhabitat differences between plots. For example, to avoid oiled areas, the majority of control plots were located in more landward areas and at higher elevations which resulted in the plots encompassing a more diverse plant community and/or meadow habitats. Thus, the primary investigators concluded that microhabitat differences appear to be the most likely explanation of the statistical differences rather than any effects of the oiling and cleanup. Impacts to vegetation were likely short-term and greatest during the winter and spring months of 2005. Higher winter impacts are explained because the oil was present and posed contact hazards to animals moving from land to the shoreline. Additionally, vegetation impacts were high during the spring months where the heavily oiled vegetation was removed by cutting.

PAH EXPOSURE IN INTERTIDAL MUSSELS

Mussels and other biota occupying intertidal habitats adjacent to oiled shoreline could potentially be exposed to toxic concentrations of polycyclic aromatic hydrocarbons (PAHs) as oil came to rest along shorelines or when oil was remobilized due to wave action or cleanup activities. Further, mussels can serve as a pathway for contaminants to higher order biota such as birds, sea otters, and humans. As such, mussels from the intertidal zone were collected at seven locations in 2005 and 2006, including two sites in Skan Bay adjacent to response activities. During the winter of 2008 mussels were collected at six locations and during the summer of 2008 mussels were collected at two locations. As shown in Table 3.2, average PAH concentrations in mussel tissues collected in Skan Bay during 2005 were elevated compared to other locations and 2006 and 2008 samples. In Skan Bay, from 2005 to 2006, PAH concentrations decreased by an order of magnitude. A further order of magnitude decrease was observed between 2006 and 2008 summer sampling. However, slightly higher concentrations were observed in Skan Bay during the winter of 2008 than in the summer of 2006, possibly due to increased wave action during winter months which results in increased oil remobilization (Mauseth et al., 2008; Shigenaka and Owens, 2008).

TABLE 3.2 TOTAL PAH CONCENTRATIONS IN MUSSEL TISSUES COLLECTED AFTER THE M/V *SELENDANG AYU* OIL SPILL IN BAYS WITH ANY SHORELINE OILING.

LOCATION	AVERAGE TOTAL PAH, PARTS PER BILLION, DRY WEIGHT (SAMPLE SIZE)			
	JUNE-SEPT 2005	MAY 2006	FEBRUARY 2008	JULY-AUG 2008
Anderson Bay	--	--	244 (3)	--
Cannery Bay	8 (1)	--	194(3)	--
Skan Bay North	8,167 (3)	540 (2)	663 (4)	38 (2)
Skan Bay South	924 (5)	160 (1)	307 (3)	17 (2)
Makushin Bay	55 (2)	51 (1)	224 (3)	--
Humpback Bay	--	--	306 (3)	--
Volcano Bay	--	3 (1)	--	--
Kashega Bay	19 (1)	3 (1)	--	--
Kismaliuk Bay	53 (2)	14 (1)	--	--

ANADROMOUS FISH AND STREAM HABITATS

In addition to oil impacting rocky shorelines and beaches, SCAT surveys reported oil in anadromous streams. By the summer of 2005, natural attenuation and response activities removed most of the visible oil from the upstream (freshwater) portions of oiled streams. Oil still remained at the mouths of some streams and oil may have worked its way into sediments and gravel. Due to the potential for impacts to stream biota, ten anadromous streams where SCAT surveys reported oil were studied in June 2005 (Figure 3.3). Field teams walked the streams, making close visual observations for the presence of oil and fish. In some cases, they examined submerged rock surfaces for biota and collected newly hatched fish in sieves for closer examination. Additionally, in March through May of 2005, passive samplers were used to detect the presence of PAHs in the mouths of anadromous streams. Figure 3.3 presents anadromous streams surveyed as part of the study and their designated SCAT segment identification number, which are used in the following paragraphs. The following paragraphs summarize the survey team's findings:

- **Visual observations**: Visual observations documented oil sheen in the upstream portion of the stream system found at SCAT location SKN-14, including in rearing habitat for pink salmon, coho salmon, and Dolly Varden char. Because oil was deposited along the banks of this system for up to 1.7 km upstream of the mouth, large numbers of juvenile coho, and their invertebrate prey, were potentially exposed to oil. In addition, the survey identified sculpin eggs in the impacted area. Tar spots and tar balls were also found in the streambed at MKS-5. This stream contained juvenile coho salmon (young of the year through two-year old stages) and Dolly Varden char.

- **Fish collections**: Pink salmon spawning habitat and oiled stream reaches rarely overlapped, thus few newly hatched individuals were collected in oiled areas. Of those newly hatched individuals collected, there was little evidence of oil in their tissues. Laboratory analysis determined that PAH concentrations were slightly

elevated in two samples collected in the oiled portion of the SKN-14 (54-81 ng/g) but M/V *Selendang Ayu* oil could not be verified in either sample and naphthalenes were the only detectable PAH in one sample. However, PAH concentrations in newly hatched individuals collected outside of the stream located at SKN-14 ranged from 0 to 16 ng/g (mean 2.8 ng/g, n = 10), which are significantly lower than fish from the oiled portion of the tributary and indicate that fish may have been exposed to oil from the M/V *Selendang Ayu*.

- **Passive sampling**: Due to the high energy environment, loss of passive samplers was a common occurrence. In total, 17 passive samplers were successfully retrieved following deployment. Based on the results of passive sampling, it was concluded that bioavailable PAHs were widely distributed in the area but only the waters of Skan Bay posed a potential risk to fish when the observed concentration were compared to literature-based thresholds (Carls et al., 2008). In one stream in Skan Bay, located at SCAT segment SKN-14, PAHs from the M/V *Selendang Ayu* oil spill were determined to be biologically available at potentially detrimental concentrations. Available PAHs in this stream likely placed resident juvenile fish and possibly embryos at risk, including coho salmon and Dolly Varden char. Pink salmon embryos were generally absent in the affected stream mouth due to marginal habitat quality–too much sand and mud–rather than oil related mortality.

Although bioavailable PAH concentrations in Skan Bay were elevated, several unknowns precluded definitive assessment of risk in marine water, including the residence time of juvenile pink salmon, their dependence on potentially oiled prey, and changing PAH concentrations due to tidal flux and wave action. Overall, in 2005, it was concluded that the M/V *Selendang Ayu* spill placed a relatively small number of salmonids at risk in stream habitat located in Skan Bay. No sampling effort post-2005 occurred (Carls et al., 2008; Cubit et al., 2008).

SUBTIDAL HABITATS

Subtidal habitats were briefly surveyed in June of 2005 (Cubit et al., 2008). Divers examined the subtidal habitats at four locations for presence of oil and impacts that may have resulted from exposure to oil. In addition, a tethered video camera was deployed from the ship to look for the presence of oil and potential impacts.

The Four locations included one dive at Alimuda Bay, two dives at Humpback Bay, and one dive near the M/V *Selendang Ayu* wreck at Spray Cape. The divers found scattered “tar spots” in 15-20 feet of water in one of the Humpback Bay locations. Oil or oil-related impacts were not observed during the other four dives. Further, videos from the tethered camera identified no definite indications of adverse impacts of oil at any of the dive sites. Although no impacts were documented, oil remobilization during sediment relocation activities may have resulted in weathered oil being transported to subtidal habitats and which could potentially impact natural resources in these habitats.

LINGERING OIL IN INTERTIDAL AND SUBTIDAL HABITATS

Lingering oil on shorelines and intertidal and subtidal sediments can be ingested by invertebrates and/or remobilized to the water column via currents, tides, and wave action. Thus, natural resources may continue to be exposed to, and injured by, lingering oil long after the completion of response activities. As noted above, due to the weather, remoteness of the spill, and inaccessibility of some shoreline segments, cleanup goals were not met within all SCAT segments identified for further response operations. Ultimately, some shoreline segments were partially cleaned while others were not cleaned at all. As such, in 2008, the Trustees initiated a series of lingering oil studies which are documented in Bejarano and Michel, 2010; Carls et al., 2010a; Carls et al., 2010b; and Michel and Nixon, 2010.

Specifically, the Trustees assessed the location, amount, degradation, and bioavailability of remaining oil within predetermined target zones. Target zones were selected based on historical oil distribution and loading and substrate type (Figure 3.4). Study methods included a combination of the following:

- Shoreline surveys to document surface oiling and excavation of pits to describe the amount of subsurface oil remaining in zones of historical oiling,
- Collection and analytical analysis of oiled sediment samples,
- Collection and analytical analysis of mussel samples, and
- Deployment and analytical analysis of passive water samplers.

According to Michel and Nixon (2010) subsurface oil was identified in 21 of the 24 subjectively selected beach zones. Nearly all subsurface oil (96% of oiled pits) occurred in the supratidal zone, where it was initially deposited during an intense storm following the incident, and where it remains above the zone of normal tidal flushing and sediment reworking. Most (82%) of the subsurface oil was described as 0.1-10 % cover on the gravel. However, 9% occurred as thicker accumulations. The heaviest oiling increased with depth and occurred mostly at 20-50 cm. The zones classified as sheltered boulder rubble accumulations and high storm berms had the highest estimated fraction of oiled sediment volume.

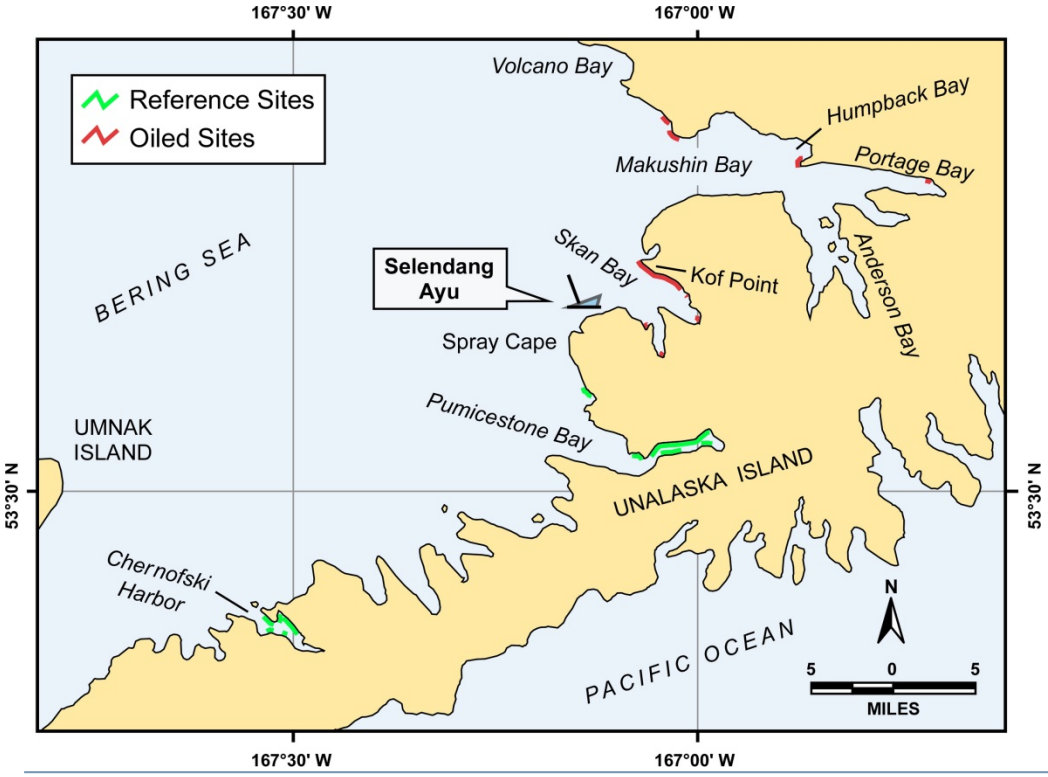
Laboratory analysis confirmed that oil found in 96% of oiled samples was chemically consistent with M/V *Selendang Ayu* oil. Additionally, laboratory analysis confirmed the presence of PAHs in mussel tissue and passive samplers collected during the lingering oil study, indicating that oil was biologically available in summer 2008 (Carls et al., 2010a,b). Although other sources of PAHs exist in the vicinity of Unalaska Island, evidence linking the oil found in sediment, mussel tissues, and passive samplers includes the fact that the source was chemically different from background hydrocarbons found in the reference area and from those found in Chernofski Harbor (the location of a seaplane base). Thus, based on multiple lines of evidence, oil from the M/V *Selendang Ayu* is the most likely source of biologically available hydrocarbons identified during the lingering oil studies. Furthermore, visual observations in 2008 documented the presence of oil at

locations where M/V *Selendang Ayu* oil was predicted to be, which corroborates the chemical analyses and provides strong evidence that nearly all of the remaining oil is from the M/V *Selendang Ayu* spill. Additional results supporting the conclusion that hydrocarbons from the M/V *Selendang Ayu* spill were bioavailable at low concentrations during the summer of 2008 include:

1) Parallel variation in total PAH concentration, least in the reference area, greatest in Chernofski Harbor, and intermediate in oiled areas.
2) Parallel variation in PAH sources as estimated by source modeling, with pyrogenic PAHs in the reference area and Chernofski Harbor and petrogenic PAHs in the oiled area.
3) Consistent variation in PAH sources as estimated by multivariate analysis, which distinguished oiled, reference and Chernofski Harbor areas in mussels and passive samplers.
4) Weathering patterns in mussels and passive samplers that were consistent with weathering patterns in intertidal oil.
5) The presence of intertidal oil containing PAHs which could serve as a source of observed petrogenic PAHs in mussels and passive samplers.

Based on the results of the 2008 lingering oil study, the presence of lingering oil from the M/V *Selendang Ayu* indicates that natural resources were exposed to hydrocarbons through the summer of 2008.

FIGURE 3.4 LOCATIONS OF THE STUDY SITES FOR THE 2008 LINGERING OIL STUDY.



3.1.2 PROPOSED MARINE RESOURCES ASSESSMENT METHODS

The Trustees have compiled available site-specific data that documents injuries to marine resources immediately following the incident and provides strong evidence for continued exposure in subsequent years. This available information describes the geographic extent and magnitude of injuries. However, the Trustees have not generated detailed spatial or temporal analyses needed to quantify the injury. In addition, the Trustees plan to compile and review literature to corroborate evidence of impacts and the magnitude of those impacts (e.g., Michel and Rutherford, 2014). For those resources that were documented as being still exposed to oil in 2008, the Trustees will estimate time to full recovery based on a review of site specific time series data and the compiled literature. Where appropriate, the maps and literature review generated as part of this process will be incorporated into the Damage Assessment and Restoration Plan (DARP).

The Trustees propose to use the spatial extent of impacts and time to recovery to quantify injuries. Specifically, for rocky shore, beach, vegetated shoreline, and anadromous stream channels, the Trustees propose to quantify the impacts from the time of the incident through full recovery. The results of these analyses will be incorporated into the DARP.

The Trustees' funding request to complete the marine resources assessment and draft the corresponding DARP section is $137,300 in contract funds and $241,829 in agency funds. These estimates include travel, indirect, and overhead costs and translate to approximately 0.3, 0.6, and 0.3 full time equivalent (FTE) staff in 2015, 2016, and 2017, respectively. For additional details regarding costs see Chapter 5, including an accounting of unreimbursed past costs and cost estimates for future Trustee coordination and public outreach.

3.2 MARINE MAMMALS

Marine mammals that utilize the waters adjacent to Unalaska Island for foraging and shelter were likely exposed to oil released from the M/V *Selendang Ayu* as it was transported by winds and currents across surface water to shoreline habitats. Marine mammals are likely to come into contact with oil as they surface to breathe or when they leave the water at haul out locations. Response and assessment activities documented oiled marine mammals. The following sections describe marine mammal response activities.

RESPONSE ACTIVITIES FOR MARINE MAMMALS

After the incident, adverse weather conditions made observations of marine mammals difficult and restricted the surveys both temporally and spatially. When weather permitted, observations were conducted by aircraft, vessels, and foot. However, most of the over flights were undertaken primarily for response activities or for bird surveys, and were conducted in a manner best suited for those purposes, rather than for observing marine mammals. Therefore, these observations likely provide an underestimate of marine mammals' presence and likely missed some species. Other Trustee observations

were made from support vessels or skiffs. Based on these observations, the Trustees determined sea otters, Steller sea lions, and harbor seals were the most likely to be at risk (NOAA, 2008).

Other marine mammals that are known to occur in the Unalaska area in the winter, but which were not observed during the limited survey activities include the Northern fur seal, Dall's porpoise, harbor porpoise, killer whale, sperm whale, Cuvier's beaked whale, Baird's beaked whale, Stejneger's beaked whale, gray whale, humpback whale, right whale, minke whale, sei whale, fin whale, and blue whale (Brueggeman et al., 1988). Adverse weather conditions, the large area oiled, the high priority given to response activities over surveys for marine mammals, and other factors made it impossible to comprehensively assess the presence or absence of, as well as the species of, marine mammals. Therefore, the lack of observations of these species does not indicate that they were not necessarily present in the vicinity at the time of the incident.

In December 2004 and January 2005, during response and Trustee coordinated aerial and boat surveys, numerous sea otters, Steller sea lions, and harbor seals were seen within the area affected by oil from the M/V *Selendang Ayu*. Additionally, one whale spout was seen, which was thought to be from a minke whale, but the species could not be confirmed. These surveys documented some oiling on harbor seals in Skan Bay on December 15 and 16, 2004 and between Kof Point and Spray Cape on January 15, 2005. Furthermore, several oiled sea otters were observed although location information for oiled sea otters was not collected. In addition to observations of live sea otters, six dead sea otters were collected following the spill; two carcasses and four skeletons. Necropsies were performed on the two otter carcasses, and the results were consistent with death from exposure to oil. The other four sea otters may or may not have been killed as a result of exposure to M/V *Selendang Ayu* oil and subsequently scavenged. Many individuals of the three identified marine mammal species were seen in the vicinity of oil, including swimming in sheen. Therefore, there is a potential for an unknown number of individuals of these species to have been injured by M/V *Selendang Ayu* oil.

Additionally, in coordination with the Trustees, from January 7 through 18, 2005 International Wildlife Research personnel conducted aerial and skiff-based surveys focused on sea otters. The highest concentrations of sea otters were identified in Anderson Bay, Makushin Bay and the outer shore leading into Makushin Bay. Further, many otters were observed in Kashega and Kismaliuk Bays. Smaller numbers of otters were found in Skan Bay and Pumicestone Bay. In all cases, the animals actively avoided the skiff indicating that they were not lethargic, hypothermic or severely distressed as would be expected if the otters were adversely affected by oiling.

3.2.1 MARINE MAMMALS ASSESSMENT ACTIVITIES

No marine mammal-specific injury assessment activities have been conducted to-date. However, data collected as part of other response-related efforts can be used to support the assessment.

3.2.2 PROPOSED MARINE MAMMAL ASSESSMENT METHODS

Based on the available information described above, the Trustees documented that sea otters, Stellar sea lions, and harbor seals were impacted by the release. To estimate injuries and allow for qualitative comparisons during restoration planning, the Trustees will generate maps of known marine mammal haul out locations within the vicinity of the release. The Trustees will also summarize available literature regarding marine mammal densities in the area and the known effects of oil exposure on marine mammals. The analysis will produce the number of individuals potentially exposed, from which the number of animals potentially injured can be estimated.

The Trustees funding request to complete the marine mammal assessment and draft the corresponding DARP section is $52,150 in contract funds and $109,392 in agency funds. These estimates include travel, indirect, and overhead costs and translate to approximately 0.1, 0.3, and 0.1 FTE staff in 2015, 2016, and 2017, respectively. For additional details regarding costs see Chapter 5, including an accounting of unreimbursed past costs and cost estimates for future Trustee coordination and public outreach.

3.3 MARINE BIRDS

Marine birds that utilize the waters adjacent to Unalaska Island for foraging and shelter were likely exposed to oil released from the M/V *Selendang Ayu* as it was transported by winds and currents across surface water to shoreline habitats. Birds are likely to come into contact with oil as they feed on various marine prey or when they come to rest on surface waters and shorelines. Response and assessment activities documented the presence of oiled and dead marine birds present in the spill area and impacted by oil. The following sections describe marine bird response activities.

RESPONSE ACTIVITIES FOR MARINE BIRDS

Live and dead visibly oiled birds were tallied during animal rescue attempts and efforts to collect and remove oiled wildlife carcasses from beaches. Carcasses of oiled birds were collected from mid-December 2004 through February 1, 2005. Collected carcasses were labeled and stored for later identification because many of the remains were oiled beyond recognition or had been scavenged before recovery. Retrieved carcasses were later officially identified at either the National Wildlife Forensics Lab in Ashland, Oregon or the University of Alaska Museum of the North in Fairbanks, Alaska.

Based on visual observations and carcass collections, 1,795 dead birds and 199 live oiled birds of 41 species were collected (Byrd and Daniel, 2008). Additional aerial surveys evaluating the abundance and distribution of seabirds during January 2005 indicated at least seven additional species that were likely present in the area during the incident but for which no visual confirmation of oiling or mortality exists (Stehn et al., 2008). These seven species include Steller's eider, surf scoter, common goldeneye, bufflehead, gadwall, herring gull, and merlin. However, all of these species, except merlin, were likely exposed to the oil considering their life history habits in oiled areas.

Nearly every species of auk known to winter in the region was recorded as oiled (Table 3.3). Crested auklets and murres made up a major component of both the live, visibly oiled, and carcass totals. Cormorants, specifically pelagic cormorants, were also relatively common in the counts of live, visibly oiled birds and carcasses. Additionally impacted species groups include waterfowl and gulls. At least nine species of waterfowl were definitely recorded as impacted by the spill, with harlequin ducks being the most frequently recorded duck species. At least three of the four species of gulls wintering in the region were known to have been oiled (glaucous, glaucous-winged, and black-legged kittiwake). Although the fourth species, mew gulls, were not documented to be oiled directly, observations of live, visibly oiled unidentified gulls likely included this species, as mew gulls are usually quite common around Unalaska in the winter. Glaucous-winged gulls were seen frequently on oiled beaches, and the number of birds actually oiled was likely far greater than indicated by the data since this species was a main scavenger of carcasses. Offshore tubenoses (e.g., fulmars, albatrosses, shearwaters), and storm-petrels were also affected by the oil to some degree, as were more inshore grebes and loons.

In addition to direct exposure to oil, birds foraging in oiled areas or scavenging on oiled carcasses likely also experienced adverse impacts related to the incident. Thus, the relative abundance and mortality of oiled birds was likely underestimated for species that foraged on oiled beaches (e.g., emperor geese, rock sandpipers, black oystercatchers, song sparrows, winter wrens) or that scavenged on oiled carcasses (e.g., gulls, bald eagles, common ravens) because these scavengers may have died outside surveyed areas and/or after surveys were completed.

3.3.1 MARINE BIRD ASSESSMENT ACTIVITIES

COLLECTION OF SITE-SPECIFIC INFORMATION TO SUPPORT A SEABIRD MORTALITY MODELS

Since early in the NRDA, the Trustees anticipated using a seabird mortality model (a.k.a., beached bird model) to quantify the total number of birds that died due to the oil spill, using the number of birds collected from beaches and adjustment factors to account for, among other factors, the likelihood that carcasses drifting at sea would strand on shorelines, carcass persistence on shorelines, and searcher efficiency (Ford, 2006; Ford and Zafonte, 2009; Wiese and Robertson, 2004). The Trustees immediately began studies of carcass drift, carcass persistence, and searcher efficiency in January 2005. At the same time, the Trustees and Responsible Party worked cooperatively to develop study plans to collect data that would facilitate the estimation of bird mortality. Three “protocols,” collectively referred to as “reference beach studies,” were agreed to by the parties in later January 2005: 1) Joint Protocol for Determining Levels of Bird Background Mortality, 2) Joint Protocol for Assessment of Bird Carcasses Lost to Scavengers and to Rewash, and 3) Joint Protocol for Determining Searcher Detection Efficiency. The Responsible Party agreed to pay all costs associated with these three studies, and they were jointly implemented in February 2005. Therefore, in addition to the aerial and ground surveys discussed above, several studies were conducted to collect field data to support such a model for this spill, including:

- *Studies of carcass persistence rate by depositing unoiled carcasses in the field and monitoring their state (intact/scavenged) and persistence (present/absent) during repeated visits* (Byrd and Reynolds, 2008; Varoujean and Polaris, 2005; Varoujean, 2010): The number of carcasses found during field surveys following an oil spill is in part determined by the carcass persistence rate, which is the probability that a carcass will remain on the study area for a given period of time. Persistence rates can vary with habitat type, time since deposition, weather, tidal activity, carcass size, and scavenger activity. Carcass persistence rate was estimated in January and February 2005 and in February 2010 by experimentally depositing unoiled carcasses in the field and monitoring their state (intact/scavenged) and persistence (present/absent) and using standard mark-recapture models. Makushin Bay was evaluated in January 2005 by a Trustee-only field study. Chernofski Harbor was evaluated in February 2005 during a cooperative Trustee and RP effort. The RP evaluated carcass persistence in Chernofski Harbor again in February 2010. In Makushin Bay in January 2005, the probability that an intact carcass remained on the beach after the first day is 0.146 (although it was in a scavenged state afterwards), and the probability that an intact carcass remained on the beach ten days after deposition was estimated to be 0.018 (Bryd and Reynolds, 2008). At Chernofski Harbor in February 2005, only about 18% of the carcasses remained on a beach for more than a couple of days (Varoujean and Polaris, 2005). At Chernofski Harbor in February 2010, 25 to 28% of the study birds identified as carcasses remained after 24 hours, and 17 to 20% remained after 48 hours (Varoujean, 2010).

- *Field studies to determine the detection probabilities for bird carcasses on beaches of Unalaska Island* (Byrd and Reynolds, 2008; Varoujean and Polaris, 2005; Varoujean, 2010): The number of carcasses found during field surveys following an oil spill is also, in part, determined by the probability of an observer detecting a carcass. Detection rates can vary with such factors as habitat type and weather conditions. To estimate detection probability, study carcasses were deployed on beaches, and survey teams were monitored to determine which of the study carcasses they found. Makushin Bay was evaluated in January 2005 through a Trustee-only field study, while Chernofski Harbor was evaluated in February 2005 through a cooperative Trustee and RP field effort and in January 2010 through an RP-only study. In Makushin Bay in January 2005, the estimated detection rate for a beach survey team making a single pass through the study beach was 0.41 (Byrd and Reynolds, 2008). At Chernofski Harbor in February 2005, search teams found 30-45% of the study carcasses (Varoujean and Polaris, 2005), while in January 2010, the searchers detected overall approximately 60% of the carcasses present (Varoujean, 2010).

- *Field studies to evaluate background bird mortality* (Varoujean and Polaris, 2005; Varoujean, 2010): It is possible that some of the birds recovered from beaches following the spill would have washed up on beaches even if the spill had not occurred. As such, the Trustees and RP conducted studies to quantify the number of birds that likely would have died due to normal causes but for the M/V *Selendang Ayu* oil spill. The deposition of the carcasses of these birds is referred to as "background deposition." To estimate the number of birds collected during the response activities that could have died of natural causes, in January and February of 2005, two un-impacted study sites were chosen: one at Chernofski

Harbor, Unalaska Island, and one at Nikolski Bay, Umnak Island. A total of 12 beaches at Chernofski Harbor and nine beaches at Nikolski Bay were chosen for surveys (Table 3.4 and Figure 3.5). The results of the 2005 study were complicated by the fact that several oiled dead birds were collected from the Chernofski Harbor beaches. In January and February 2010, the RP conducted follow up surveys in Chernofski Harbor and Nikolski Bay and shared the data they collected with the Trustees (Varoujean, 2010). The Trustees have not yet completed an interpretation of the available background mortality information.

- *Drift block experiment to estimate seabird carcass deposition on beaches at Unalaska Island, Alaska* (Byrd and Reynolds, 2007): To estimate the number of birds killed by the oil spill, it is necessary to estimate the proportion of birds killed that actually washed ashore. To estimate this variable, researchers typically employ a methodology that uses drift blocks to simulate a bird carcass. In this study, the Trustees released drift blocks in the area of the wreck on January 4, 2005, the first opportunity that weather patterns were similar to those at the time of the spill. Following the release of drift blocks, the researchers surveyed beaches for presence of the drift blocks and recovered approximately 16% of the blocks released.

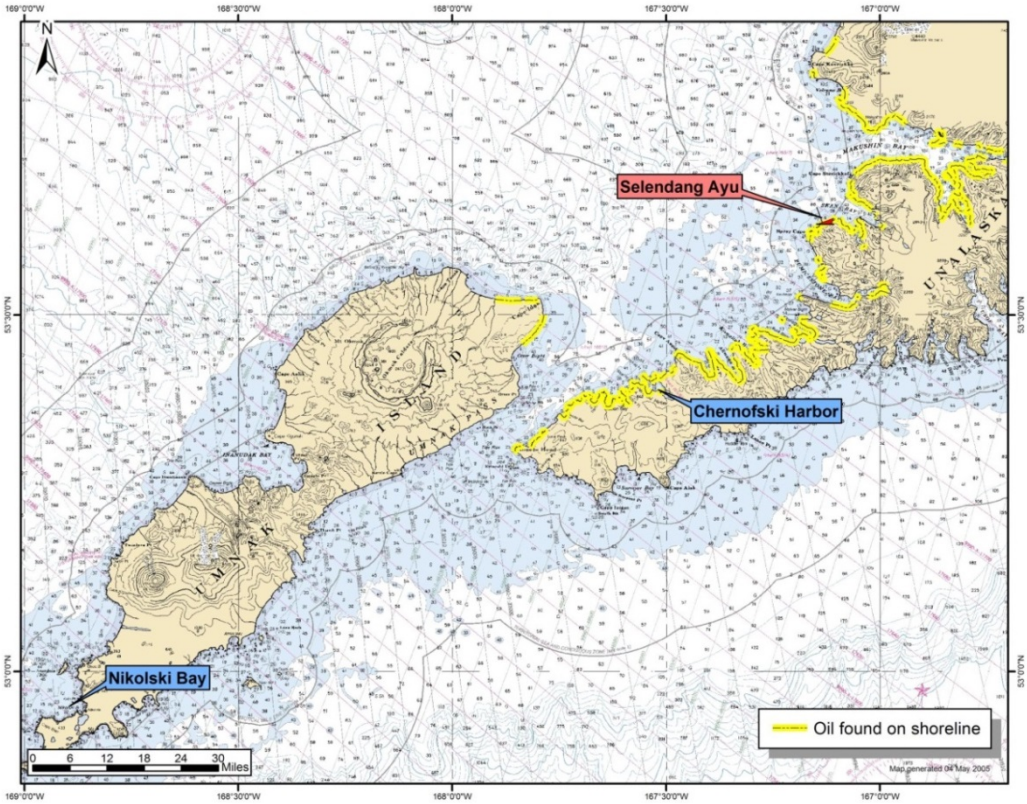
Combined, the carcass persistence, detection probability, and drift block studies described above strongly suggested that only a small proportion of all deposited carcasses were counted during beach surveys following the spill event.

TABLE 3.3 COUNTS OF AVIAN CARCASSES AND LIVE OILED BIRDS.

TOTAL ALL BIRDS CARCASSES: 1,795
LIVE OILED: 199
TOTAL IDENTIFIED SPECIES: 41

SPECIES	CARCASSES	LIVE OILED	SPECIES	CARCASSES	LIVE OILED
Unidentified auklets	753	3	Unidentified duck	23	0
Crested auklet	449	20	Unidentified gull	2	0
Whiskered auklet	8	0	Unidentified *Larus* gull	35	0
Least auklet	4	0	Glaucous-winged gull	3	29
Unidentified Murre	86	0	Glaucous gull	0	1
Common murre	11	10	Black-legged kittiwake	1	0
Thick-billed murre	10	0	Unidentified kittiwake	4	0
Unidentified *Brachyramphus*	3	0	Northern fulmar	17	0
Marbled murrelet	2	0	Laysan albatross	5	0
Unidentified puffins	11	0	Unidentified albatross	5	0
Tufted puffin	6	0	Short-tailed shearwater	3	0
Horned puffin	4	0	Unidentified shearwater	1	0
Pigeon Guillemot	12	8	Fork-tailed storm-petrel	2	0
Unidentified Alcids	18	0	Horned grebe	12	4
Unidentified cormorants	87	0	Red-necked grebe	2	8
Pelagic cormorant	15	44	Unidentified grebe	3	0
Red-faced cormorant	5	0	Yellow-billed loon	0	1
Double-crested cormorant	0	1	Common loon	0	1
Harlequin duck	40	48	Unidentified Loon	1	0
Long-tailed duck	11	5	Bald eagle	8	6
Black scoter	9	1	Peregrine falcon	1	0
White-winged scoter	3	0	Common raven	1	0
Black or white-winged scoter	1	0	Rock sandpiper	7	2
King eider	2	0	Black oystercatcher	0	1
Common eider	1	0	Emperor goose	2	0
King or Common eider	3	0	Gray-crowned rosy finch	1	0
Green-winged teal	1	0	Song sparrow	0	3
Mallard	0	1	American dipper	0	1
Unidentified merganser	0	1	Unidentified bird	101	0

FIGURE 3.5 LOCATIONS OF THE STUDY SITES FOR THE 2005 BACKGROUND AVIAN CARCASS DEPOSITION STUDY.



CHRONIC EXPOSURE OF AVIAN SPECIES VIA THEIR DIET

In addition to direct mortality from oiling, birds can experience adverse effects through the consumption of contaminated prey. For example, studies of harlequin ducks in Prince William Sound following the *Exxon Valdez* oil spill revealed that they have high site fidelity and feed on intertidal resources that can be contaminated with residual oil, making the birds susceptible to prolonged oil exposure. The research has shown that chronic exposure to oil can have long-term deleterious effects on survival of harlequin ducks (Esler and Iverson, 2010; Esler et al., 2000, 2010). Accordingly, chronic exposure to sub-lethal levels of oil may hinder population recovery following an oil spill. As such, the Trustees conducted studies to determine the potential chronic exposure of birds to PAHs associated with the M/V *Selendang Ayu* spill (Flint et al., 2008). In 2005, 2006, and 2008, harlequin ducks were captured in three oiled bays (Skan, Humpback and Portage Bays; Figure 3.6 top) and one minimally oiled reference bay (Chernofski Bay; Figure 3.5 bottom). Liver biopsies were surgically obtained and birds were released at the capture sites. Via ethoxyresorufin O-deethylase (EROD) assays, the liver samples were analyzed for induction of the cytochrome P450 IA gene ("P450"), a widely used indicator of PAH exposure in wildlife. In all three years of studies, results of EROD assays identified significantly higher P450 activity in ducks captured in Humpback Bay and

Skan Bay compared with those captured in the Chernofski Bay reference area (Flint et al., 2012). However, samples collected from Portage Bay did not differ from Chernofski Bay in 2005 and 2008 but were significantly higher in 2006. These results indicate that harlequin ducks continued to be exposed to oil from the M/V *Selendang Ayu* for up to three years after the spill.

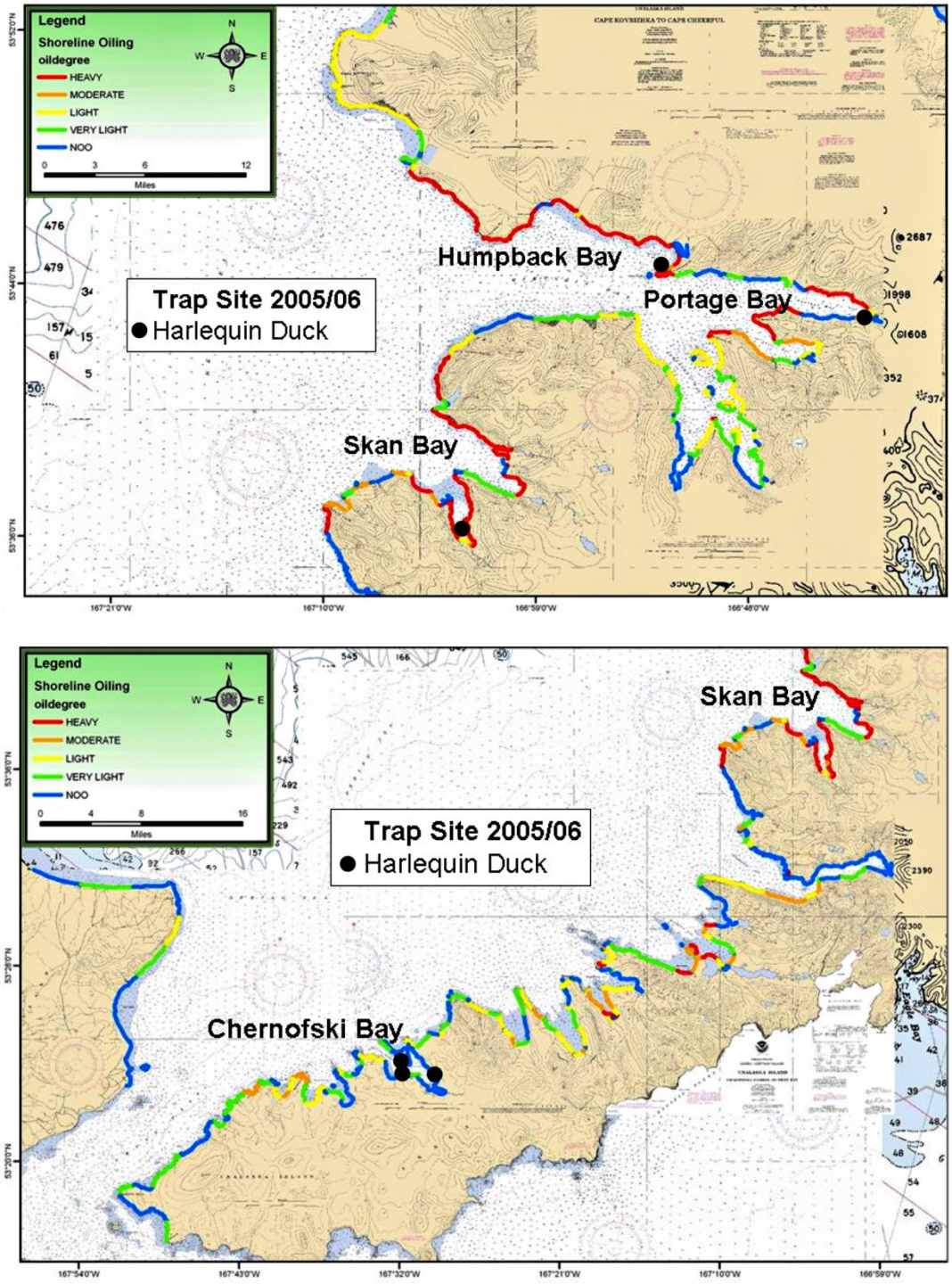
3.3.2 PROPOSED MARINE BIRD ASSESSMENT METHODS

The Trustees' avian injury assessment has not been completed. The trustees will complete the background mortality study and then estimate the total number of birds killed using a seabird mortality model. The results of the mortality model will be adjusted for background mortality (i.e., the number of birds that would have likely died due to natural causes but for the oil spill) to yield the number of birds injured by the M/V *Selendang Ayu* oil spill. The data used, methods, and results of the seabird mortality model will be incorporated into the DARP.

To estimate avian injuries associated with chronic exposure to oil, the Trustees will generate maps presenting densities of birds in the areas where they may have been exposed to residual oil. In addition, the Trustees will summarize available literature regarding the effects of dietary PAH exposure on birds. This information will be combined to estimate the proportion of the exposed population that likely experienced injury from chronic exposures and the duration of such injury. This information should be additive to the seabird mortality model, and the Trustees will ensure that there is no double-counting of injuries. The data used, methods, and results related to chronic exposure will be incorporated into the DARP.

The Trustees funding request to complete the marine bird assessment and draft the corresponding DARP section is $76,500 in contract funds and $212,324 in agency funds. These estimates include travel, indirect, and overhead costs and translate to approximately 0.2, 0.5, and 0.2 FTE staff in 2015, 2016, and 2017, respectively. For additional details regarding costs see Chapter 5, including an accounting of unreimbursed past costs and cost estimates for future Trustee coordination and public outreach.

FIGURE 3.6 HARLEQUIN DUCK TRAP SITES (BLACK CIRCLES) IN HUMPBACK, PORTAGE, SKAN, AND CHERNOFSKI BAYS, OVERLAIN ON THE SCAT SHORELINE OILING CATEGORIES. ADAPTED FROM FLINT ET AL. (2008).



3.4 HUMAN USES

Most of the residents of Unalaska, including Dutch Harbor, fish, hunt or gather wild resources. The spill may have impaired these activities, resulting in a loss of natural resource services for residents and visitors, including cultural uses, subsistence and recreation. For the purposes of NRDA, the focus is on shared public human use injuries, not individual economic losses (Kohout and Meade, 2008).

3.4.1 HUMAN USE ASSESSMENT ACTIVITIES

The Trustees evaluated existing data and information, held public meetings and spoke with key individuals after the M/V *Selendang Ayu* oil spill to determine whether human use services associated with affected natural resources had been injured.

RECREATIONAL AND SUBSISTENCE RESOURCE UTILIZATION

Response activities, fisheries closures, USCG access restrictions and concerns about oiling likely impaired the ability of residents and visitors to engage in subsistence and recreational activities from Spray Cape to Unalaska Bay and south to Chernofski Harbor. It is also conceivable that some individuals, who might have otherwise visited Unalaska Island to recreate, changed their plans due to the spill (W. Ayers, Aleutian Life Forum, Aug. 2005), which would have resulted in a loss of use for the potential visitors.

In and around Skan and Makushin Bays, public access was also limited by USCG restrictions on water and air access. Public perception regarding access to subsistence use and recreation sites was influenced by various factors including the “impaired water body” declaration and spill-related commercial fishery closures. Compounding the official closures was the increased level of human activity associated with shoreline assessments conducted by helicopter and boat throughout the region. Initial cleanup activities beginning in 2005 and continuing through 2006 peaked with deployment of 22 vessels and other heavy equipment and the involvement of 230 workers (Kohout and Meade, 2008).

Although there were no beach closures between Volcano Bay and Unalaska Bay, response activities such as frequent beach monitoring, tarball collection in Unalaska Bay, and cleanup at Wide Bay likely disrupted subsistence and recreational activities. Areas south of Spray Cape to Chernofski Harbor were also affected by response activities (Kohout and Meade, 2008).

In addition to direct conflicts, the spill and response activities likely affected public perception about the extent and danger posed by the spill to subsistence resources. The Unified Command issued a Subsistence Advisory for Unalaska Island on March 8, 2005 that instructed users to take caution when collecting fish, shellfish, plants, or other intertidal species in areas where oil has been observed and to inspect food items by sight or smell before consumption. The Unified Command also formed a Subsistence Fishery Advisory Group whose charge was to evaluate whether subsistence foods in the Unalaska area were impacted by the spill. Samples of black chiton, sea urchin roe, blue mussels, salmon, Pacific cod, and harbor seal tissues were collected from Unalaska Bay and along

the western shoreline of Unalaska Island. One sample of blue mussels from North Skan Bay in April 2005 exceeded the screening criteria established by the advisory group. Additional observation of ten samples of blue mussels collected in 2005 did not have any petroleum smell or visible oil based on organoleptic testing. No samples collected in 2006 exceeded the screening criteria (Mauseth et al., 2008).

Impacts to subsistence and recreational use of resources can also impact cultural uses including teaching of traditional practices, sharing of wild resources, traditional medicine, and language. Some areas impacted by the spill are considered traditional subsistence use areas by tribal members from Nikolski and Unalaska (Kohout and Meade, 2008).

ARCHAEOLOGICAL AND CULTURAL RESOURCES

Archaeologists working on the response and cleanup effort reported that there were no impacts to archaeological sites from the oil or cleanup activities (C. Williams, Northern Land Use, pers. comm. 2005). Other than subsistence resources as discussed above, the Trustees have not identified any cultural resources that were impacted by the spill.

PASSIVE USE LOSS

Passive use loss, sometimes referred to as existence or non-use losses, involves harm to anyone impacted by the spill who is not a direct user of the injured resources. Since the spill impacted unique wildlife and relatively pristine natural resources, individuals within and outside of Unalaska may have experiences passive use losses.

3.4.2 PROPOSED HUMAN USE ASSESSMENT METHODS

Due to the lack of available quantitative information, the Trustees propose to qualitatively describe the likely injuries and summarize supporting literature. This will allow for the Trustees to qualitatively correlate the human use injuries to the benefits likely to result from restoration projects being considered. The Trustees funding request to complete the human use DARP section is $16,890 in contract funds and $46,680 in agency funds. These estimates include travel, indirect, and overhead costs and translate to approximately 0.1, 0.1, and 0.1 FTE staff in 2015, 2016, and 2017, respectively. For additional details regarding costs see Chapter 5, including an accounting of unreimbursed past costs and cost estimates for future Trustee coordination, restoration planning and public outreach.

CHAPTER 4 | RESTORATION PLANNING

The goals of restoration planning under OPA are to quantify the natural resource injuries and identify actions appropriate to restore natural resources or services to the condition that would have existed if the incident had not occurred and compensate for interim service losses. The later goal is achieved through the restoration, rehabilitation, replacement, or acquisition of equivalent natural resources and/or services (33 U.S.C. §2706(b)). The development and consideration of restoration alternatives also is required to fulfill the intent of the National Environmental Policy Act (NEPA). This chapter focuses on the development of restoration alternatives, the scaling of the alternatives, the justification of the chosen preferred restoration alternatives, and the formulation of the final natural resource damages claim to be presented in the Restoration Plan.

The restoration planning process may involve two components: primary restoration and compensatory restoration. Primary restoration actions are designed to assist or accelerate the return of a resource, including its services, to baseline conditions (i.e., the condition that would have existed if the incident had not occurred). In contrast, compensatory restoration actions serve to compensate for the interim loss of resources and their services incurred from the time the injury began until the return of the resource to baseline conditions or service levels. The scale of a compensatory restoration project depends on the nature, extent, severity, and duration of the resource injury. Primary restoration actions that speed resource recovery reduce interim losses, as well as the amount of restoration required to compensate for those losses.

In the case of the M/V *Selendang Ayu* oil spill, response actions undertaken following the spill were expected to protect natural resources from further or future harm and to allow resources to return to pre-injury conditions within a reasonable timeframe. Due to the logistical difficulties associated with site access and the potential for further disturbance of recovering areas via the use of construction equipment, the Trustees are not pursuing primary restoration. Accordingly, this Plan focuses on the steps necessary to identify, evaluate, and scale appropriate compensatory restoration actions. The remainder of this chapter provides an overview of the Trustees' restoration strategy, proposed project evaluation criteria development, and proposed project identification and scaling methodology.

4.0 RESTORATION STRATEGY

In accordance with the OPA regulations, the Trustees will identify and evaluate a range of project alternatives capable of restoring natural resources and services to the same as or comparable to those lost due to the M/V *Selendang Ayu* oil spill. These alternatives

will be identified through a combination of consultations with local, State, and Federal governmental agencies, non-profit organizations, and stakeholders. Where possible, the Trustees will employ a resource-to-resource scaling methodology such that restoration projects provide natural resources and/or services of the same type and quantity as those lost. Alternatively, restoration projects that provide natural resources and/or services of comparable type, quality, or value to those lost will also be appropriately considered. Identified alternatives will be subject to a rigorous screening process to narrow the field of potential projects and focus information-gathering efforts on the alternatives with the greatest potential to meet the Trustees' restoration goals. Additionally, as required by OPA and NEPA regulations, the "No Action" alternative will also be included for consideration.

4.1 PROJECT EVALUATION CRITERIA DEVELOPMENT

The Trustees propose to develop a two-tiered approach for evaluating potential restoration projects. Tier One screening will determine the project's potential to result in a quantifiable increase in the services provided by one or more of the injured resources (i.e., nexus to the injury). Tier One will also evaluate whether sufficient information exists for evaluation under OPA and NEPA, scaling, and implementation within a reasonable timeframe following receipt of funding. The Trustees will develop a final set of Tier One screening criteria as part of the restoration planning phase. Tier Two screening will include those criteria presented in the OPA regulations and site-specific criteria adopted by the Trustees. The OPA regulations (15 C.F.R .§ 990.54(a)) identify the following criteria:

A. Cost to carry out the alternative;

B. Extent to which each alternative is expected to meet the Trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses;

C. Likelihood of success of each alternative;

D. Extent to which each alternative will prevent future injury as a result of the incident and avoid collateral injury as a result of implementing the alternative;

E. Extent to which each alternative benefits more than one natural resource and/or service; and

F. Effect of each alternative on public health and safety.

In addition to the six OPA criteria, the Trustees will adopt several additional factors to assess the appropriateness of proposed restoration alternatives. The Trustees will identify Federal and State agency restoration priorities and guidelines and work with local natural resource managers and stakeholders as they evaluate restoration alternatives. Potential additional Tier Two criteria include the following:

- Site ownership;
- Logistical considerations;
- Consistency with local, regional, and national goals and initiatives;
- Long term operation and maintenance; and
- Opportunities for community involvement.

4.2 PROJECT IDENTIFICATION AND SCALING

To identify potential restoration projects, the Trustees will engage Federal, State, and local natural resource planners and managers. Information from other relevant groups (e.g., experts from academia and non-governmental organizations) will also be sought, as appropriate. Proposed projects will be reviewed by the Trustees based on the criteria partly described above, and for each project considered, the Trustees will gather additional information related to costing and scaling. Cost estimates will be developed using data from similar completed projects. For scaling the size of restoration projects, the Trustees will employ methods appropriate for the specific project and resources being restored. For direct habitat or resource restoration projects, the Trustees anticipate using Habitat Equivalency Analysis or Resource Equivalency Analysis (HEA or REA). For projects that are not amendable to scaling via HEA or REA, the Trustees propose to develop project specific methodologies for measuring project benefits and comparing them to the injuries the projects will offset.

Early after the oil spill began, the Trustees and RP began to develop potential restoration project ideas, but the majority of the restoration planning activities still remain to be completed. Additional restoration options for human use and marine mammals will be scoped out and evaluated.

The following sections describe the conceptual restoration alternatives that the Trustees have already developed and those that the Trustees will fully develop and evaluate in the Restoration Planning phase. All will be evaluated against the Tier One and Tier Two criteria and the findings of those evaluations will be explained in the Restoration Plan.

4.2.1 POTENTIAL OIL ABATEMENT RESTORATION OPTIONS

The Trustees are considering oil abatement as part of a portfolio of compensatory restoration projects. The purpose of oil abatement is to remove existing oil in the environment and/or prevent future releases. Specifically, oil abatement projects would remove and/or prevent the release of oil in an amount that would prevent similar impacts, in type and quantity, to those that resulted from the M/V *Selendang Ayu* spill. To assist with the identification and evaluation of potential oil abatement projects, the RP hired Oasis Environmental Services to perform an oil abatement feasibility study in conjunction with the Trustees and the RP (Oasis, 2012). The feasibility study included a literature review to identify candidate projects and preliminary scaling calculations for several projects. According to the Oasis report, the major contributors of oil to the environment in the vicinity of the M/V *Selendang Ayu* spill, besides the M/V *Selendang*

Ayu itself, include creosote pilings, vessel bilge discharges, and vessel oil spills. To prevent the release of oil from these sources, the Trustees identified three potential abatement projects:

1. Wrapping and removing creosote treated pilings at the City of Unalaska Spit and Unalaska Marine Center Dock,
2. Distributing bilge socks and sorbent pads, and
3. Upgrading/Expanding the number of real-time Automatic Identification System (AIS) stations that provide vessel monitoring in the Aleutian Islands.

The Trustees preliminarily evaluated each option and determined the piling project is not feasible because it is not cost effective on a per gallon of oil removed basis. Similarly, bilge socks and sorbent pads have the potential to collect a limited amount of oil. Additionally, the logistics associated with distributing, training, collecting, and disposing of sorbent materials makes the project infeasible in its proposed form.

Upgrading the number of real-time AIS stations has the potential to prevent the release of tens of thousands to hundreds of thousands of gallons of oil over a multi-year timeframe. In addition, expanding the number of AIS stations is one of seven recommendations the Aleutian Islands Risk Assessment (AIRA) project's Analysis Team put forth to meet the goal of developing an Optimal Response System for the Aleutian Islands.[2] Further, to the best of the Trustees knowledge, at the time of this Plan, no funding sources for expanding the number of AIS stations is available.

From 1981 to 2004, the Aleutian Islands experienced 26 oil spills ranging in size from approximately 1,000 to 2,000,000 gallons, with a median of 12,000 gallons and an average of 110,000 gallons (ADEC, 2007). In the extremely remote and treacherous Aleutian Islands, preventing and responding to threats of releases (e.g., a vessel that has lost power) can be slow and dangerous. However, expansion of the AIS will reduce response time via the prompt detection of vessels not under command, deviating from planned routes, or otherwise in danger. Further, the AIS can be used to identify commercial and recreational vessels capable of assisting a vessel in distress and direct them to the exact location of the at-risk vessel. Additionally, based on the AIRA findings, vessel traffic in the Aleutian Islands is expected to increase significantly over the next 20 years. Thus, on a volume of oil basis, an expansion of the AIS stations has the potential to prevent and/or recover hundreds of thousands of gallons of oil over the coming decades which will result in a reduction of impacts similar to those that resulted from the M/V *Selendang Ayu* spill.

AIS EXPANSION SCALING METHODOLOGY

[2] Nuka Research and Planning Group, LLC. 2014. Aleutian Islands Risk Assessment Project, Recommending an Optional Response System for the Aleutian Islands: Summary Report.

To scale the benefits of an AIS expansion, the Trustees will develop a probabilistic model to estimate the quantity of natural resource impacts over time that will be avoided due to the prevention of future oil spills. The Trustees' approach will focus on estimating prevented impacts to those resources injured by the M/V *Selendang Ayu* spill and funding the expanded AIS for the time period into the future necessary to compensate for such losses. The probabilistic model will be applied to a range of future years and will be based on, but will not necessarily be limited to, the following inputs:

- **Frequency of oil spills**: Based on the historical frequency of oil spills in the Aleutian Islands, the Trustees will estimate the yearly probability of a spill occurring within the area covered by the expansion of AIS stations.
- **Spill Volume**: Based on historical spill volumes in the Aleutian Islands, the Trustees will develop a range of potential spill volumes and determine the likelihood of each volume (i.e., a distribution of spill volumes).
- **Location**: Within the area of the expanded AIS stations, the Trustees will assign each predicted spill to a location.
- **Geographic Scope**: For each predicted spill, based on the spill volume and location, the Trustees will estimate the geographic extent of impacts along the Aleutian Islands.
- **Natural Resource Densities**: In the area covered by the expanded AIS stations, the Trustees will characterize shoreline habitat, enumerate anadromous streams, and determine the densities of marine mammals and seabirds.
- **Prevented Resource Impacts**: Based on the assigned location, modeled geographic scope, and estimated densities, the Trustees will estimate shoreline, anadromous stream, marine mammal, bird and human use impacts associated with each predicted spill.

For each year modeled, the Trustees will apply a three percent discount rate to the benefits and sum the discounted benefits across years by resource. This will result in an estimate of the number of shoreline miles, anadromous fish streams, marine mammals, and birds that would not be injured if the AIS stations were expanded.

4.2.2 POTENTIAL RESTORATION OPTIONS FOR BIRDS

Because the scale (timeframe) of the funding available for expansion of the AIS system may not be sufficient to compensate for all losses, particularly avian losses, the Trustees are considering restoration options that would benefit crested auklets due to the M/V *Selendang Ayu's* large impact on this species. The following paragraphs describe crested auklet nesting and wintering habitats and the restoration concepts considered. Other restoration options that may benefit other species impacted by the spill are also conceptually described.

CRESTED AUKLET NESTING AND WINTERING HABITATS

In the summer, crested auklets nest deep in rock crevices and burrow on the Aleutian Islands in colonies that consist of hundreds of thousands of individuals. Because they nest deep in rock crevices and underground in remote areas, obtaining an accurate census of individuals is difficult. Thus, scaling with precision the benefits of a project related to breeding colonies would be challenging and would alternatively have to rely on the number of individual birds observed at the surface of a colony or some other proxy metric. Although their winter range is not fully documented, when not breeding they can be found in flocks at sea near their breeding areas.

PREDATOR MANAGEMENT AT BREEDING COLONIES

Crested auklets nest in large colonies on remote oceanic islands, so they are especially susceptible to introduced predators. Two introduced predators on the Aleutian Islands include arctic foxes and Norway rats. Arctic foxes were introduced for fur farming purposes and Norway rats accidently via fishing vessels. These predators are responsible for the demise of many seabird colonies throughout the Aleutians.

Arctic foxes have since been removed from most of the Aleutian Islands within the Alaska Maritime National Wildlife Refuge. Fox removal at Avatanak Island (just east of the M/V *Selendang Ayu* spill area) was a successful restoration project implemented through an NRDA settlement to compensate for bird injuries associated with the 1997 M/V *Kuroshima* oil spill. Precedent for rat control programs in the Aleutian Islands includes successful rat eradication from Hawadax Island, Alaska (formerly known as Rat Island). Further, rat eradication projects have been successfully implemented at over 400 islands globally, including very large islands in the Antarctic region and the Galapagos Islands chain (http://news.nationalgeographic.com/ news/2013/07/130729-rats-islands-invasive-species-animals-environment/). Seabird colonies decimated by predatory invasive rats have been documented as significantly rebounding in numbers after successful rat eradication projects were implemented (Bourgeois et al., 2013; Le Corre et al., 2015; Whitworth et al., 2013).

Given the demonstrated high likelihood of success of this type of project, the Trustees are considering predator management programs, including predatory eradication, as a potential restoration option for the M/V *Selendang Ayu* NRDA. The Trustees have focused in the past on such a project at crested auklet colonies, but the action may also be appropriate for other impacted species. To evaluate the potential for predator management efforts the Trustees will engage in the following activities:

1. **Review of Past Predator Management Programs**: The Trustees will review past predator management efforts to identify feasible and successful methods and the project characteristics that resulted in successful permanent eradication (e.g., island size).
2. **Site identification**: The Trustees will identify those islands in the Aleutian archipelago, along the Alaska Peninsula, and in the Bering Sea with nesting colonies of crested auklets or other impacted bird species and introduced

predators. Each identified island will then be evaluated based on the metrics identified in step one.

3. **Predator Management Method and Costs**: For each island, the Trustees will identify viable predator management options, including eradication, and estimate the costs associated with implementing each option.

4. **Scaling Approach**: Depending upon the data available for the proposed predator management sites, the Trustees will scale the size of the predator management project based on metrics such as the estimated number of birds and/or bird eggs saved from predation each year by the project or the estimated rate of increase in the size of the breeding colony in the absence of the predator. The Trustees will develop a REA to scale the benefits of predator management.

If predator management, particularly eradication, is identified during the restoration planning process as a preferred restoration alternative in the Restoration Plan, the proposed project would still face additional scrutiny and evaluation through the process of obtaining regulatory permits and addressing other regulatory, administrative, and public review requirements before implementation could take place. It may be that a feasibility study or pilot project is required before the final implementation work plan and budget could be developed with certainty. Costs for feasibility studies are not included in this budget and would be requested as part of restoration implementation or through a separate presentment. The Trustees would be particularly careful to create a project implementation plan that avoids or minimizes collateral harm to non-target natural resources. The Restoration Plan will describe all required steps.

BREEDING HABITAT MODIFICATION

For bird species that experience competition among breeding individuals for optimal nesting habitat, restoration projects that increase the quantity or quality of existing nesting habitat may be appropriate compensatory restoration projects.

a) **Vegetation Manipulation**. It has been hypothesized that crested auklets are nesting site limited. In particular, vegetation growth reduces the number of available nesting sites over time because it fills the crevices where the crested auklets nest or makes the crevices difficult to access. The RP initiated a multi-year study of the impact of vegetation removal on nesting crested auklets, beginning in 2009. While the study found that vegetation removal increased the auklet surface activity in the de-vegetated areas, the study was unable to confirm that vegetation removal resulted in an increase in nesting in the colony. (Connors and Jones, 2009; Jones et al., 2011; Jones et al., 2012). However, this could have been due to numerous factors, including the fact that crested auklets are difficult to census in their breeding colonies. The development or implementation of new research technology may be necessary to precisely quantify the restoration benefits of a crested auklet habitat manipulation project. Vegetation manipulation would likely not be allowed in Designated Wilderness Areas of the Alaska Maritime National Wildlife Refuge, as the action may be inconsistent with the

Wilderness Act (16 U.S.C. ch. 23 § 1131 et seq). Therefore, the choice of this option as a preferred restoration alternative would depend on the identification of breeding habitat in need of restoring that is not located within a Designated Wilderness Area.

b) **Removal of Volcanic Debris**. In 2008 the volcano on Kasatochi Island, Alaska erupted and covered crested auklet nesting areas with 15 to 20 centimeters of ash, and crested auklets returning the following summers were unable to nest. As such, the RP proposed an ash removal project to expose crevices for crested auklets. However, because Kasatochi Island is part of the Designated Wilderness Area of the Alaska Maritime National Wildlife Refuge, the Refuge was unlikely to authorize a debris removal project that would interfere with the natural recovery of the island, an action inconsistent with the Wilderness Act.

The Trustees will continue to evaluate potential habitat modification programs for the impacted bird species and will use a similar approach to identifying, costing, and scaling proposed projects as described above for predator management programs.

HABITAT PROTECTION

Areas of habitat that are important for birds, whether it be for breeding, rearing young, resting, or foraging, can be protected from human disturbance and encroachment as a potential restoration alternative. Such protection may be in the form of land acquisition (surface and/or subsurface rights), creation of conservation easements on the land, or implementation of management actions to minimize human-related impacts. Much of the Aleutian Islands are a part of the Alaska Maritime National Wildlife Refuge, and thus bird habitats there are relatively protected. However, there may be other opportunities to protect bird habitat in the areas important to the species impacted by the M/V *Selendang Ayu* oil spill. To evaluate and identify possible habitat protection projects, the Trustees will take the following steps.

1. **Identify areas of important habitat for birds where habitat protection would be beneficial**. Working with State and Federal natural resource agencies and other non-governmental organizations with relevant expertise, the Trustees will identify the habitat areas of importance to the bird species impacted by the M/V *Selendang Ayu* oil spill. These sites will be evaluated to identify the areas that currently suffer, or are highly likely to suffer in the near future, from human-related issues such as visitor disturbance, encroachment of infrastructure and development, pollution, or other types of human-related degradation of habitat quality.

2. **Identify the most appropriate means for habitat protection**. The Trustees will evaluate which of the habitat protection techniques (fee simple acquisition, conservation easement, and/or management actions) are most beneficial and feasible for particular parcels of interest. This step will bring in realty specialists, if not involved in the first step. Evaluation factors would include issues such as, but not limited to, whether the current landowner would be a willing seller,

whether there is a natural resource agency willing to take on the management of the parcel, and the scope/frequency of the management needed to ensure habitat protection.

3. **Develop the scaling metrics**. The Trustees will estimate the likely restoration benefits that the proposed parcel and protection method should provide. Likely scaling metrics would be "discounted bird-years" to be used in a Resource Equivalency Analysis.
4. **Develop cost estimates**. If the chosen protection method is land acquisition or conservation easement, the final cost of a project will depend on the many factors that typically affect real estate transaction prices and cannot be known without due diligence work (e.g., appraisal). The Trustees will begin discussions with the landowner and conduct due diligence work in order to present the final cost of a project in the Restoration Plan.

RAT INVASION PREVENTION

When non-native rats are introduced to islands that provide important habitats for birds, they can be very destructive to the bird populations, particularly to breeding seabirds that have evolved without such predation pressure and lack the ability to successfully defend themselves, as well as their eggs and chicks, from predatory rats. Non-native rats are typically accidentally transported to remote islands by boats and aircraft purposefully visiting an island (e.g., to deliver cargo or transport people) or by the accidental grounding or sinking of vessels near the shores of an island. The Trustees are considering as potential restoration options programs that would prevent "stow-away" rats from invading islands important for breeding birds.

A "rat spill" prevention program was successful in keeping the Pribilof Islands rat-free while the program was in place. The FWS, in its role in oil spill response, promotes "rat spill" prevention, particularly within the Alaska Maritime National Wildlife Refuge, and tries to deploy "rat spill" prevention kits to the site of a grounded vessel. The State of Alaska developed an action plan in October 2007 titled "Wildlife and People at Risk: A Plan to Keep Rats Out of Alaska" and passed a law making it illegal to release rats into the wild. However, all of these efforts have struggled with uncertainty in the availability of funding, and the risk of a "rat spill" remains.

To develop and evaluate a program focused on rat invasion prevention as a possible restoration alternative, the Trustees would implement the following steps.

1. **Consult experts to identify where rat invasion prevention improvements would be beneficial.** The Trustees would consult with local, State, and Federal natural resource agencies to evaluate the current rat invasion prevention programs and identify ways that existing programs could be strengthened or new programs could be developed. Discussions with other stakeholders would be necessary, as it is envisioned that a successful program would include cooperation and

participation from local governments, harbormasters, airport operators, cargo handlers, community members, and vessel owners.

2. **Identify the most appropriate means for rat invasion prevention.** The Trustees will work with stakeholders to develop a multi-faceted program that may include, as appropriate:
    - Education and awareness programs aimed toward those likely closest to the invasion sites (e.g., local governments, harbormasters, airport operators, cargo handlers, community members, and vessel owners) as well as toward those most likely to be able to provide emergency response actions in the event of a threat of a "rat spill" (e.g., Alaska Regional Response Team and oil spill removal organizations);
    - Assembly and distribution of "rat spill" prevention/control kits;
    - Establishment of a "rat spill" strike team that would deploy to vessels grounding/sinking sites to implement and oversee the rat invasion prevention program;
    - Vessel / harbor inspection program to identify areas/conditions likely to harbor rats and to reduce or eliminate such conditions; and
    - Oher activities to ensure rat invasion prevention.
3. **Develop the scaling metrics.** The Trustees will estimate the likely restoration benefits that a rat invasion prevention program would provide. This would employ some of the same risk assessment activities described for the AIS project for marine resources in order to predict the likelihood of a rat-infested vessel grounding or sinking near an island important for birds that didn't already have rats. Information on the size or productiveness of the bird colonies on such islands would be used to gauge the likely restoration benefits from preventing rat predation. Likely scaling metrics would be "discounted bird-years" to be used in a REA.
4. **Develop cost estimates**. The Trustees would work with stakeholders to identify the costs of the proposed project for inclusion in the Restoration Plan.

4.3 PROPOSED RESTORATION PLANNING COSTS

The data, methods, and results of restoration planning activities described above will be incorporated into the DARP and related NEPA documentation. The Trustees funding request to complete restoration planning activities and draft the corresponding DARP section is $294,250 in contract funds and $976,762 in agency funds. These estimates include travel, indirect, and overhead costs and translate to approximately 0.5, 1.5, and 0.2 FTE staff in 2015, 2016, and 2017, respectively. For additional details regarding costs see Chapter 5, including an accounting of unreimbursed past costs and cost estimates for future Trustee coordination and public outreach.

CHAPTER 5 | BUDGET

5.1 INTRODUCTION

Chapters 1 through 4 present estimated future costs specific to completing injury assessment and restoration planning activities. In addition to the funding request for the injury assessment and restoration planning activities described above, the Trustees are also requesting reimbursement from the NPFC for unreimbursed past NRDA costs. Further, as described above, the Trustees are requesting funding from the NPFC for future Trustee coordination costs and future public outreach costs. Trustee coordination and public outreach encompasses both injury assessment and restoration planning activities and it is not possible for the Trustees at this time to assign expected costs specifically to injury assessment or restoration planning. The remainder of this chapter provides an accounting of past unreimbursed costs and cost estimates for future Trustee coordination and public outreach.

5.1 PAST COSTS

As described in Chapter 1, following the NPFC's determination that the RP had reached their limit of liability, the RP significantly decreased its participation in assessment activities. Although the RP allowed Trustees that had funds remaining to continue using those funds, some of the Trustees exhausted the remaining funds provided by the RP and continued to incur costs related to the NRDA activities described Chapter 3. Throughout the NRDA process, the Trustees maintained accounting records to document the point at which RP funding was exhausted and document unreimbursed past costs. Any costs incurred by the Trustees after February 7, 2015 are considered future costs. Table 5.1 provides a summary of unreimbursed past costs for which reimbursement from the NPFC is being sought. Past unreimbursed costs presented in Table 5.1 include labor, travel, and equipment solely related to assessing impacts resulting from the *Selendang Ayu* oil spill.

TABLE 5.1 SUMMARY OF UNREIMBURSED PAST COSTS.

AGENCY	COSTS
National Oceanic and Atmospheric Administration	$1,038,720
U.S. Fish and Wildlife Service	$0
Alaska Department of Fish and Game	$583
Alaska Department of Environment Conservation	$5,021
Alaska Department of Natural Resources	$0
Alaska Department of Law	$21,948
Total	$1,066,273

5.2 TRUSTEE COORDINATION

The six *Selendang Ayu* Trustees coordinate regularly with each other on all aspects of the injury assessment and restoration planning. Such coordination efforts include, but are not limited to, scheduling, attending, and logistical operations for conference calls, presentations via webinars, in-person meetings in Anchorage, Alaska, and dissemination and review of Trustee produced documents. The Trustees' funding request for trustee coordination activities is $51,566 in agency funds. This estimate includes travel, indirect, and overhead costs and translate to approximately 0.1, 0.1, and 0.1 FTE staff in 2015, 2016, and 2017, respectively.

5.3 PUBLIC OUTREACH

As described in section 1.3 of this Plan, from the outset of the spill, the Trustees engaged the public in a variety of assessment and restoration planning activities. The Trustees feel that public participation and review is an integral part of the restoration planning process, and is specifically mentioned at 15 C.F.R. § 990.14. The Trustees intend to continue involving the public and seeking the public's review.

In addition to releasing this Plan for public comment, the Trustees will engage the public in the restoration planning process by holding public meetings to solicit and evaluate proposed restoration projects. Furthermore, the Trustees will maintain an Administrative Record and make it available to the public. Upon completion, the Trustees will release the DARP for public comment, hold public meetings to present the DARP's findings, and respond to public comment. The Trustees funding request for public outreach is $31,900 in contract funds and $210,819 in agency funds. These estimates include travel, indirect, and overhead costs and translate to approximately 0.1, 0.2, and 0.4 FTE staff in 2015, 2016, and 2017, respectively.

5.4 SUMMARY OF FUNDING REQUEST

The Trustees total funding request, including unreimbursed past and future costs, is $3,524,735. Table 5.2 presents a summary of the Trustees funding request, including past and future costs.

TABLE 5.2 SUMMARY OF FUNDING REQUEST.

ACTIVITY	COSTS
Injury Assessment	**$893,065**
Marine Resources Assessment Activities	$379,129
Marine Mammals Assessment Activities	$161,542
Marine Birds Assessment Activities	$288,824
Human Use Assessment Activities	$63,570
Restoration Planning	**$1,271,012**
Restoration Planning Activities	$1,271,012
Trustee Coordination	**$51,666**
Trustee Coordination Activities	$51,666
Public Outreach	**$242,719**
Public Outreach Activities	$157,585
Administrative Record Activities	$85,134
Unreimbursed Past Cost	**$1,066,273**
Unreimbursed Past Costs	$1,066,273
Total	$3,524,735

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