11.21.06

Exxon Valdez Oil Spill Trustee Council

Teleconference

June 23, 2010

9:30 a.m. - noon

Call-in #: 800.315.6338, code: 8205

Admin

Womac, Cherri G (EVOSTC)

From: Womac, Cherri G (EVOSTC)
Sent: Monday, June 07, 2010 2:50 PM
To: Craig O'Connor (Craig.R.O'Connor@noaa.gov); Craig Tillery (craig.tillery@alaska.gov); Daniel Sullivan (daniel.sullivan@alaska.gov); Denby S. Lloyd (denby.lloyd@alaska.gov); Jim Balsiger (jim.balsiger@noaa.gov); Kim Elton (kim_elton@ios.doi.gov); Larry Hartig (larry.hartig@alaska.gov); Steve Zemke (szemke@fs.fed.us); 'Craig Tillery (craig.tillery@alaska.gov)'; Pat Pourchot (Pat_Pourchot@ios.doi.gov); Sniffen, Clyde E (LAW); 'Tom Brookover (tom.brookover@alaska.gov)'; Dawn Collinsworth (Dawn.Collinsworth@ogc.usda.gov.); Elise M. Hsieh (elise.hsieh@alaska.gov); Gina Belt (regina.belt@usdoj.gov); 'Jennifer Schorr (DOL)'; Jennifer Schorr (jennifer.schorr_evostc@alaska.gov); Michael Zevenbergen (Michael.Zevenbergen@usdoj.gov); Rich Myers (richard.myers@sol.doi.gov); Ronald McClain (Ronald.McClain@usda.gov); Jenifer Kohout (Jenifer_Kohout@fws.gov); Carol Fries (carol.fries@alaska.gov); Dede Bohn (Dede_Bohn@usgs.gov); Marit Carlson-VanDort (Marit.Carlson-Van.Dort@alaska.gov); Peter Hagen (Peter.Hagen@Noaa.gov); Tom Brookover (tom.brookover@alaska.gov); Veronica Varela (Veronica_Varela@fws.gov)
Cc: Amanda Bauer (amanda@stephenscruises.com); Bill Rosetti (BROSETTI@GCI.NET); Cherri Womac (cherri.womac@alaska.gov); David Totemoff (totemoffdavid@yahoo.com); Douglas L. (Doug) Mutter (douglas_mutter@ios.doi.gov); Gary Fandrei (gfandrei@ciaanet.org); Jason Brune (jbrune@akrdc.org); Jennifer Gibbins (jennifer@pwsoundkeeper.org); John French; 'John Renner'; Kurt Eilo (keilo@akforum.org); Larry Evanoff (lmevanoff@yahoo.com); Lori Polasek (lori_polasek@alaskasealife.org); Patience Andersen Faulkner (andersenpatc@ctcak.net); Stacy Studebaker (tidepoolak@ak.net); Torie Baker (torie@sfos.uaf.edu); Carrie Holba (carrie.holba@alaska.gov); Carrie Holba (carrie@arlis.org); Catherine Boerner (catherine.boerner@alaska.gov); Linda Kilbourne (linda.kilbourne@alaska.gov); Michael Schlei (michael.schlei@alaska.gov); Renee James (renee.james@alaska.gov)
Subject: June 23 TC Teleconference
Attachments: Draft TC Agenda June 23 2010 draft.pdf; Draft May 14 2010 Trustee Council Meeting notes.pdf; IHRP DRAFT- June.pdf; Summary of IHRP Restoration Options.pdf

Hello Trustees, Alternates, Liaisons, PAC and Counselors,

We will be having a teleconferenced Council meeting on Wednesday, June 23 from 9:30 a.m. – 12:00 p.m. The call-in number is 1.800.315.6338, code 8205 and is also on the draft agenda, which is attached.

The agenda items include the following:

1. **Transitions in Administrative Budget regarding ARLIS and AMSS:**

   Based upon earlier Council discussions regarding the EVOSTC administrative budget: I recommend the following transitions in the Administrative Budget, which will be presented for your approval in the August Council meeting. Planning these transitions at this point in time allows each organization involved to plan their staffing and funding needs.

   ARLIS funding is currently at approx. $165K (Carrie Holba's salary plus $26K). I recommend reducing the cash portion starting FFY 2011, and then transitioning Carrie to EVOSTC staff part-time in FFY 2012 and full-time in FFY 2013 to assist the EVOSTC office, which is in need of her document management skills in organizing the extensive EVOSTC records which the office has accumulated. Carrie has discussed these potential changes with the ARLIS Founders Board and Management Team and will make a brief presentation at the Council's meeting.

   AMSS: I recommend continuing to fund the Alaska Marine Science Symposium at its existing $10K level through FFY 2013 with a planned end of funding at that time.

2. **Science Management Contract:**

As you may know, our Science Coordinator, Catherine Boerner, is relocating to Seattle. In her role as Science Coordinator, Catherine has been a critical EVOSTC employee for the last several years and we are very pleased that she will be available to continue to work with us from her new home. With Council approval, we will be contracting with Catherine to cover her existing duties from July 1, 2010 through September 30, 2011. Contracting for these services will cost $109,479 (plus 9% GA) for this period and will save the Council a minimum of $50,000 in benefits costs. This will allow for uninterrupted science program services. This contract is a not-to-exceed amount and will only be billed for actual hours.

3. **IHRP:** This document represents four years of hard work by scientists, natural resource managers and local and native community members and, under current Council proposals, will be used in the FY '12 Invitation for a long-term herring program. It contains information on the past and current status of herring in PWS and eight direct restoration activities that could potentially help move herring toward recovery.

Several of the restoration options outlined, may exceed the Council's interests, abilities, authority, or budget. Because this document will inform our FY'12 Invitation, the IHRP will initially shape the focus of the activities conducted under future herring program. Recognizing this, we recommend the Council approve this draft IHRP but narrow the document to the restoration activities the Council is realistically interested in pursuing. Our recommendations are that the Council focus its herring restoration efforts on Enhanced Monitoring and Altering Carrying Capacity. These recommendations are discussed in the document attached, "Summary of IHRP Restoration Options."

Please let me know if you have any questions or need additional information about any of the agenda items or other topics.

Thank you!
Elise

Motions for June 23, 2010 Trustee Council Teleconference

Agenda Item 2:

Motion to approve June 23, 2010 teleconference meeting agenda.

Motion to approve the May 14, 2010 Trustee Council meeting notes.

Agenda Item 5: Science Management Contract and Annual Marine Science Symposium (AMSS)

Motion to approve Resolution 10-08 authorizing the Executive Director to enter into a contract for Science Management Services July 1, 2010 through September 30, 2011 with Catherine Boerner of Natura Consulting in the amount of $119,332 which includes 9% General Administration. The remaining amount in the FFY 2010 Administrative Budget devoted to Catherine's FFY 2010 salary is no longer to be used for that purpose. Project management fees are not applicable to this contract.

Motion to approve Resolution 10-09 authorizing final annual contributions in the amount of $10,000 to the 2011, 2012 and 2013 Alaska Marine Science Symposiums to be distributed annually through the Science Management portion of the EVOS Annual Program Development and Implementation Budget (APDI).

Agenda Item 6: Habitat

Motion to approve Resolution 10-11 reauthorization of funds in the amount of $192,000 authorized for the purchase of the Capjohn parcel KAP 3002. Authorization shall terminate if a purchase agreement is not executed by June 30, 2011.

Motion to approve Resolution 10-12 authorizing expenditure of $43,600 which includes 9% General Administration from FFY 2010 funds for due diligence expenses, consistent with State and Trustee Council requirements, in support of Kodiak Island Habitat Protection Efforts for lands owned by the Leisnoi Native Corporation. Authorization of the approved funding shall terminate if not executed by September 30, 2011.

Motion to approve Resolution 10-13 authorizing expenditure of $100,000 for the State of Alaska to purchase all of the Seller's rights and interested in small parcel KEN 3006 comprised of Lots 4 and 5, block 1 of Coal Creek Moorage Subdivision. Authorization of the approved funding shall terminate if the purchase agreement is not executed by July 31, 2011.

Agenda Item 7: transition in Admin Budget – ARLIS

Motion to approve the Alaska Resources Library and Information Services (ARLIS) FFY 2011-2013 transition as outlined in Resolution 10-10.

Agenda Item 8: Draft IHRP

The Draft IHRP may be finalized in October and included with the Council's FY 2012 Invitation to guide the proposals for a long-term herring program.

So that the document provides the most focused guidance possible, the Council requests the Council staff to highlight in the Draft IHRP [enhanced monitoring] and [altering carrying capacity] as the restoration options the Council is interested in pursuing at this time and make conforming revisions.

The Council hereby approves the release of the Draft IHRP, with appropriate revisions as discussed, for public comment.

Agenda Item 9: Boufadel Project 070836-B

Motion to approve Boufadel Project 070836-B Amendment requesting additional funds in the amount of $81,030, which includes 9% General Administration. NOAA waives the project management fees.

RESOLUTION 10-08 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL AUTHORIZING A SCIENCE MANAGEMENT SERIVCES CONTRACT

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill Trustee Council do hereby certify that, in accordance with the Memorandum of Agreement and Consent Decree entered as settlement of *United States of America v. State of Alaska* No. A91-081 Civil, U.S. District Court for the District of Alaska, and after public meetings, unanimous agreement has been reached to expend funds received in settlement of *State of Alaska v. Exxon Corporation, et al.,* No. A91-083 CIV, and *United States of America v. Exxon Corporation, et al.,* No. A91-082 CIV, U.S. District Court for the District of Alaska, for necessary natural resource damage assessment and restoration activities in the amount of $25,244 for FY10 and $84,235 in FY11 plus applicable General Administration (GA). Project management fees are not applicable to the science management services contract. The contractor is Catherine Boerner of Natura Consulting. This science management contractor is tasked with providing science program management during the remainder of federal fiscal year 2010 and all of federal fiscal year 2011. Tasks include the coordination and implementation of FFY 2012 Invitation for Proposals and annual work plan support. The monies are to be distributed according to the following schedule:

Alaska Department of Fish and Game (includes 9% GA)	$27,516
TOTAL TO STATE OF ALASKA	$27,516
TOTAL APPROVED	**$27,516**

By unanimous consent, we hereby request the Alaska Department of Law and the Assistant Attorney General of the Environmental and Natural Resources Division of the United States Department of Justice to take such steps as may be necessary to make available funds for the Science Management Services contract from the appropriate account designated by the Executive Director.

Approved by the Council at its meeting of June 23, 2010 held in Anchorage, Alaska as affirmed by our signatures affixed below.

____
STEVE ZEMKE
Alternate Trustee
Chugach Nation Forest
U.S. Department of Agriculture

____
DANIEL S. SULLIVAN
Attorney General
Alaska Department of Law

____
KIM ELTON
Senior Advisor to the Secretary
for Alaska Affairs
U.S. Department of the Interior

____
CRAIG R. O'CONNOR
Special Counsel
National Oceanic & Atmospheric
Administration
U.S. Department of Commerce

____
DENBY S. LLOYD
Commissioner
Alaska Department of Fish and Game

____
LARRY HARTIG
Commissioner
Alaska Department of Environmental
Conservation

DRAFT 6/23/2010

RESOLUTION 10-09 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL REGARDING FFY 2011-2013 ALASKA MARINE SCIENCE SYMPOSIUMS FUNDING

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill Trustee Council do hereby certify that, in accordance with the Memorandum of Agreement and Consent Decree entered as settlement of *United States of America v. State of Alaska* No. A91-081 Civil, U.S. District Court for the District of Alaska, and after public meetings, unanimous agreement has been reached to expend funds received in settlement of *State of Alaska v. Exxon Corporation, et al.,* No. A91-083 CIV, and *United States of America v. Exxon Corporation, et al.,* No. A91-082 CIV, U.S. District Court for the District of Alaska, for necessary natural resource damage assessment and restoration activities for federal fiscal years 2011 through 2013. These monies will be the final annual contributions for the Alaska Marine Science Symposiums in 2011, 2012 and 2013. The monies are to be distributed annually to the Science Management portion of the Annual Program Development and Implementation Budget (APDI) in the amount of $10,000.

Approved by the Council at its meeting of June 23, 2010 held in Anchorage, Alaska as affirmed by our signatures affixed below.

STEVE ZEMKE
Alternate Trustee
Chugach Nation Forest
U.S. Department of Agriculture

DANIEL S. SULLIVAN
Attorney General
Alaska Department of Law

KIM ELTON
Senior Advisor to the Secretary
for Alaska Affairs
U.S. Department of the Interior

CRAIG R. O'CONNOR
Special Counsel
National Oceanic & Atmospheric
Administration
U.S. Department of Commerce

DENBY S. LLOYD
Commissioner
Alaska Department of Fish and Game

LARRY HARTIG
Commissioner
Alaska Department of Environmental
Conservation

DRAFT 6/22/2010

RESOLUTION 10-10 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL REGARDING THE ALASKA RESOURCES LIBRARY AND INFORMATION SERVICES (ARLIS) FFY 2011- 2013 TRANSITION

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill Trustee Council do hereby certify that, in accordance with the Memorandum of Agreement and Consent Decree entered as settlement of *United States of America v. State of Alaska* No. A91-081 Civil, U.S. District Court for the District of Alaska, and after public meetings, unanimous agreement has been reached to expend funds received in settlement of *State of Alaska v. Exxon Corporation, et al.,* No. A91-083 CIV, and *United States of America v. Exxon Corporation, et al.,* No. A91-082 CIV, U.S. District Court for the District of Alaska, for necessary natural resource damage assessment and restoration activities through transitional funding in support of the Alaska Resources Library and Information Services (ARLIS) as outlined below:

FFY 2011	funding of 100% of Carrie Holba's full-time salary at ARLIS
FFY 2012	funding for Carrie Holba half-time at ARLIS

The monies are to be distributed to the ARLIS portion of the Annual Program Development and Implementation Budget (APDI).

Approved by the Council at its meeting of June 23, 2010 held in Anchorage, Alaska as affirmed by our signatures affixed below.

STEVE ZEMKE
Alternate Trustee
Chugach Nation Forest
U.S. Department of Agriculture

DANIEL S. SULLIVAN
Attorney General
Alaska Department of Law

KIM ELTON
Senior Advisor to the Secretary
for Alaska Affairs
U.S. Department of the Interior

CRAIG R. O'CONNOR
Special Counsel
National Oceanic & Atmospheric
Administration
U.S. Department of Commerce

DENBY S. LLOYD
Commissioner
Alaska Department of Fish and Game

LARRY HARTIG
Commissioner
Alaska Department of Environmental
Conservation

RESOLUTION 10-11 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL REGARDING SMALL PARCEL KAP 3002

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill Trustee Council ("Trustee Council"), after extensive review and after consideration of the views of the public, find as follows:

1. On March 17, 2008, the Council resolved through Resolution 08-07 to provide funds for the State of Alaska to purchase all of the seller's rights and interests in the small parcel KAP 3002, consisting of 160 acres, subject to certain conditions. One of the conditions was that a purchase agreement had to be executed by June 30, 2009. The Seller is Ralph Capjohn represented by the Department of Interior, Bureau of Indian Affairs (BIA).

2. On August 31, 2009, the Council resolved through Resolution 09-11 to extend the condition that a purchase agreement had to be executed by June 30, 2009 to June 30, 2010.

3. Although Mr. Capjohn has agreed to sell the land to the State for the price in the Council's Resolutions 08-07 and 09-11 ($192,000) and the State expects to be able to complete the acquisition, a purchase agreement was not executed prior to June 30, 2010, as required by the Council's Resolution 09-11.

4. For all of the reasons detailed in the Trustee Council's Resolutions 08-07 and 09-11, the Council continues to find that the purchase of KAP 3002 is an appropriate means to restore a portion of the injured resources and services in the spill area.

THEREFORE, we resolve to provide funds for the State of Alaska to purchase all of the seller's rights and interests in the small parcel KAP 3002 pursuant to the conditions detailed in the Trustee Council's Resolutions 08-07 and 09-11, except that authorization for funding the purchase of small parcel KAP 3002 shall terminate if a purchase agreement is not executed by June 30, 2011.

Approved by the Council at its meeting of June 23, 2010 held in Anchorage, Alaska, as affirmed by our signatures affixed below:

JOE L. MEADE
Forest Supervisor
Forest Service Alaska Region
U.S. Department of Agriculture

DANIEL S. SULLIVAN
Attorney General
State of Alaska

KIM ELTON
Senior Advisor to the Secretary
for Alaska Affairs
U.S. Department of Interior

CRAIG R. O'CONNOR
Special Counsel
National Oceanic & Atmospheric
Administration
U.S. Department of Commerce

DENBY S. LLOYD
Commissioner
Alaska Department of Fish and Game

LARRY HARTIG
Commissioner
Alaska Department of Environmental
Conservation

DRAFT 6/16/2010

RESOLUTION 10-12 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL REGARDING KODIAK ISLAND HABITAT PROTECTION

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill Trustee Council ("Trustee Council") do hereby certify that, in accordance with the Memorandum of Agreement and Consent Decree entered as settlement of *United States of America v. State of Alaska* No. A91-081 Civil, U.S. District Court for the District of Alaska, and after public meetings, unanimous agreement has been reached to expend funds received in settlement of *State of Alaska v. Exxon Corporation, et al.*, No. A91-083 CIV, and *United States of America v. Exxon Corporation, et al.*, No. A91-082 CIV, U.S. District Court for the District of Alaska, for necessary natural resource damage assessment and restoration activities for federal fiscal year 2010, as described in Attachment A.

This resolution authorizes the distribution of $40,000 of FFY 2010 funding for due diligence expenses, consistent with State and Trustee Council requirements, in support of Kodiak Island Habitat Protection Efforts for lands owned by the Leisnoi Native Corporation, as described in Attachment A, to be distributed according to the following schedule:

Alaska Department of Natural Resources (includes 9% GA)	$43,600
TOTAL TO STATE OF ALASKA	$43,600
TOTAL APPROVED	**$43,600**

Authorization of the approved funding shall run from July 1, 2010 to September 30, 2011.

By unanimous consent, we hereby request the Alaska Department of Law and the Assistant Attorney General of the Environmental and Natural Resources Division of the United States Department of Justice to take such steps as may be necessary to make funds available in the amount of $43,600 from the appropriate account as designated by the Executive Director.

Approved by the Trustee Council at its meeting of June 23, 2010 held in Anchorage, Alaska, as affirmed by our signatures affixed below:

STEVE ZEMKE
Trustee Alternate
Chugach National Forest
U. S. Department of Agriculture

DANIEL S. SULLIVAN
Attorney General
Alaska Department of Law

KIM ELTON
Senior Advisor to the Secretary
for Alaska Affairs
U.S. Department of Interior

CRAIG R. O'CONNOR
Special Counsel
National Oceanic & Atmospheric Administration
U.S. Department of Commerce

DENBY S. LLOYD
Commissioner
Alaska Department of Fish and Game

LARRY HARTIG
Commissioner
Alaska Department of Environmental Conservation

Attachment A - Restoration Benefits Report and Map

KAP 145: Termination Point

Owner:	Leisnoi, Inc.
Physical Location:	This parcel is located on Monashka Bay on the northeast coast of Kodiak Island approximately 4 miles from the town of Kodiak.
Acreage:	1,028 acres
Brief Description:	Tract C, T 27 S, R 19 W, SM
Agency Sponsor:	Alaska Department of Natural Resources
Appraised Value:	Unknown

Parcel Description. This parcel is located on Monashka Bay on the northeast coast of Kodiak Island approximately 4 miles from the town of Kodiak. This relatively flat coastal tract is forested with Sitka spruce and has an understory of shrubs and grasses. The parcel includes four miles of convoluted shoreline that is characterized by rocky cliffs and protected beaches. The coastline has numerous nearshore rocks and extensive kelp beds.

Linkage to Restoration:

Restoration Benefits.
The productive intertidal area and the adjacent Narrow Strait are important feeding areas for marbled murrelets and pigeon guillemots as well as other marine birds. Additionally the mature Sitka Spruce forest of Termination Point offers prime nesting habitat for marbled murrelets, a species for which recovery has been difficult to determine. Three cultural resource sites containing middens and barabara depressions (remnant house pits) are located on the parcel. The parcel also provides subsistence resources for the village residents of Ouzinkie. Residents harvest marine mammals and fish, salmon and deer.

The parcel also possesses high recreational qualities for the residents of Kodiak because of its proximity to town and road access. The area was historically used by the public on a regular basis for both beach and trail use and is popular with bird viewing groups. The parcel is unique because it can provide for a variety of road-accessible year-round recreational opportunities such as hiking, fishing, hunting, ice skating, camping and bird watching. As Leisnoi's conveyances have been resolved, the relatively easy and free public access to which Kodiak residents have become accustomed has changed to a fee permit system administered by Leisnoi, which may impact public use.

Potential Threats.
The continued use of this parcel for recreation and the quality and popularity of recreational use are potentially at risk because of the potential for timber harvest or more likely subdivision development of the parcel. Acquisition of the parcel would ensure that residents of Kodiak would continue to have access to a popular recreational area.

Proposed Management.
This parcel has been identified as a priority for the Division of Parks and Outdoor Recreation. This parcel will be managed by the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation, Kodiak Area Office in consultation with the State Historic Preservation Officer for the purposes of protecting resources and services injured by the *Exxon Valdez* Oil Spill.

Support for this parcel was previously expressed by the Kodiak Island Borough Assembly (Resolution 95-23), Kodiak State Park Citizen's Advisory Board, and a variety of individuals testifying at a public scoping meeting for the *Exxon Valdez* Oil Spill Trustee Council's Supplemental Environmental Impact Statement.

KAP 3003 Mouth of the American River

Owner:	Leisnoi, Inc.
Physical Location:	This parcel is located on Middle Bay approximately 15 miles from the town of Kodiak.
Acreage:	Unknown. Preliminary footprint includes approximately 25-40 foot easements on either side of the river for approximately 1 mile upstream from the mouth.
Brief Description:	Downstream of the Chiniak Highway bridge: Portions of sections 20, 21 and 28, T 29 S,R 20 W, SM adjacent to the American River: Upstream of the Chiniak Highway bridge: Portions of sections 28 and 29, T29S, R20W, SM adjacent to the American River
Agency Sponsor:	Alaska Department of Fish & Game
Appraised Value:	Unknown

Parcel Description. This parcel is located on Middle Bay on the northeast coast of Kodiak Island approximately 15 miles from the town of Kodiak. This relatively flat coastal tract is predominantly vegetated with willow shrubs and beach grasses in the area between the Chiniak Highway and Mean High Tide. The vegetation in the area immediately upstream of the highway is similar with some cottonwood trees. The parcel includes a portion of the flood plain, the meandering river to the mouth and areas adjacent to the intertidal zone. There is a 17(b) public access easement (25 feet wide) from the bridge downstream to the river mouth on the south side of the river.

Linkage to Restoration:

Restoration Benefits.
The parcel has high recreational qualities for the residents of Kodiak because of its proximity to town and road access. The area was regularly used by the public historically and is popular with recreational and subsistence fishermen. The American River has spawning populations of pink, chum and coho salmon and the Alaska Department of Fish

and Game (ADF&G) stocks Chinook salmon. Most of the effort for salmon fishing is downstream of the highway bridge but Dolly Varden, and salmon outside of the closed season, are fished year around upstream.

The parcel is unique because it can provide road-accessible year-round fishing opportunities, which are limited on Kodiak Island. As Leisnoi's conveyances have been resolved, the relatively easy free public access to which Kodiak residents have become accustomed has changed to a permit system administered by Leisnoi.

Potential Threats.
The continued use of this parcel for recreation and the quality and popularity of recreational use are potentially at risk because of the potential for subdivision development of the parcel. Subdivisions and conversion of Lesnoi Corporation land to private use is already occurring nearby along the Chiniak Highway. Development on this parcel has the potential to negatively affect the adjacent intertidal and nearshore habitat. Acquisition of the parcel would ensure that residents of Kodiak would continue to have access to popular fisheries and that riparian habitat remains intact. ADF&G's Chinook stocking program would be jeopardized because existing easements may not allow adequate access for the program.

Proposed Management.
This parcel has been identified as a priority for ADF&G. The conservation easements will be managed by ADF&G.

KAP 3004 Mouth of the Olds River

Owner:	Leisnoi, Inc.
Physical Location:	This parcel is located on Kalsin Bay approximately 25 miles from the town of Kodiak.
Acreage:	Unknown. Preliminary footprint includes approximately 25-40 foot easements on either side of the river for approximately 1 mile upstream from the mouth.
Brief Description:	Downstream of the Chiniak Highway bridge: Portions of sections 10 and 11, T30S, R20W, SM adjacent to the Olds River: Upstream of the Chiniak Highway bridge: Portions of sections 10 and 15, T30S, R20W, SM adjacent to the Olds River
Agency Sponsor:	Alaska Department of Fish & Game
Appraised Value:	Unknown

Parcel Description. This parcel is located on Kalsin Bay on the northeast coast of Kodiak Island approximately 25 miles from the town of Kodiak. This relatively flat coastal tract is predominantly vegetated with willow shrubs and beach grasses in the area between the Chiniak Highway and MHT. The vegetation in the area immediately upstream of the highway is similar with some cottonwood trees. The parcel includes a portion of the flood plain, the meandering river to the mouth and areas adjacent to the intertidal zone.

Linkage to Restoration:

Restoration Benefits.
The parcel has high recreational qualities for the residents of Kodiak because of its proximity to town and road access. The area was regularly used by the public historically and is popular with recreational and subsistence fishermen. The Olds River has spawning populations of pink, chum and coho salmon and ADF&G stocks Chinook salmon. Most of the effort for salmon fishing is downstream of the highway bridge but Dolly Varden, and salmon outside of the closed season, are fished year around upstream. A subsistence fishery for eulachon occurs downstream of the bridge.

The parcel is unique because it can provide road accessible year-round fishing opportunities, which are limited on Kodiak Island. As Leisnoi's conveyances have been resolved, the relatively free easy public access to which Kodiak residents have become accustomed has changed to a permit system administered by Leisnoi.

Potential Threats. The continued use of this parcel for recreation and the quality of recreational use are potentially at risk because of the potential for subdivision development of the parcel. Subdivisions and conversion of Lesnoi Corporation land to private use is already occurring nearby along the Chiniak Highway. Development on this parcel has the potential to negatively affect the adjacent intertidal and nearshore habitat. Acquisition of the parcel would ensure that residents of Kodiak would continue to have access to popular fisheries and that riparian habitat remains intact. ADF&G's Chinook stocking program would be jeopardized because existing easements may not allow adequate access for the program.

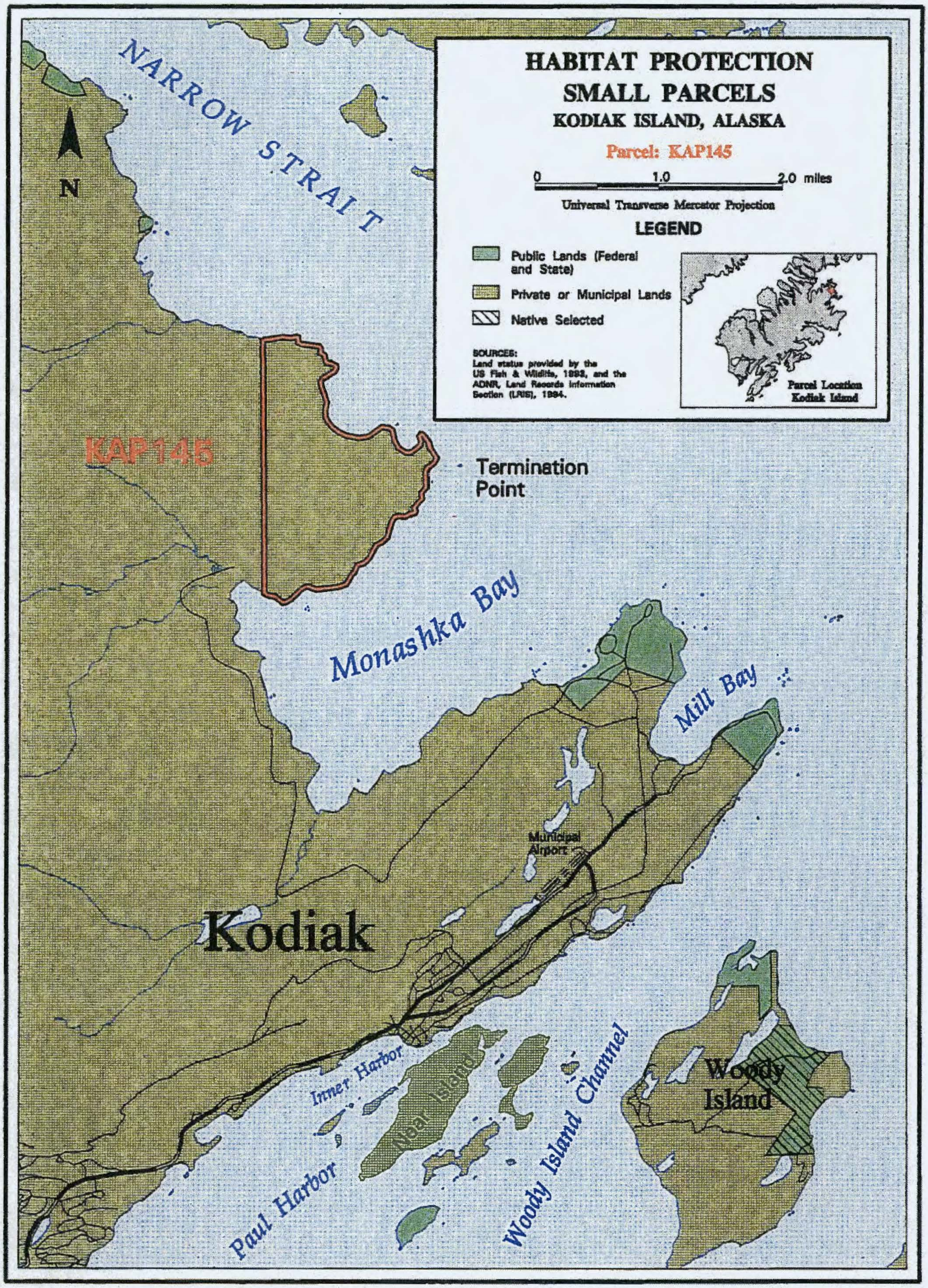
Proposed Management.
This parcel has been identified as a priority for ADF&G. The conservation easements will be managed by ADF&G.

REQUEST.
The State would like to move forward with preliminary due diligence efforts including an appraisal of all three parcels. We will require additional funds in order to complete preliminary due diligence efforts on this parcel as outlined below. Following completion of the appraisal process, additional due diligence expenses such as a Phase I environmental assessment will be required should the parties choose to proceed after obtaining the appraisal information.

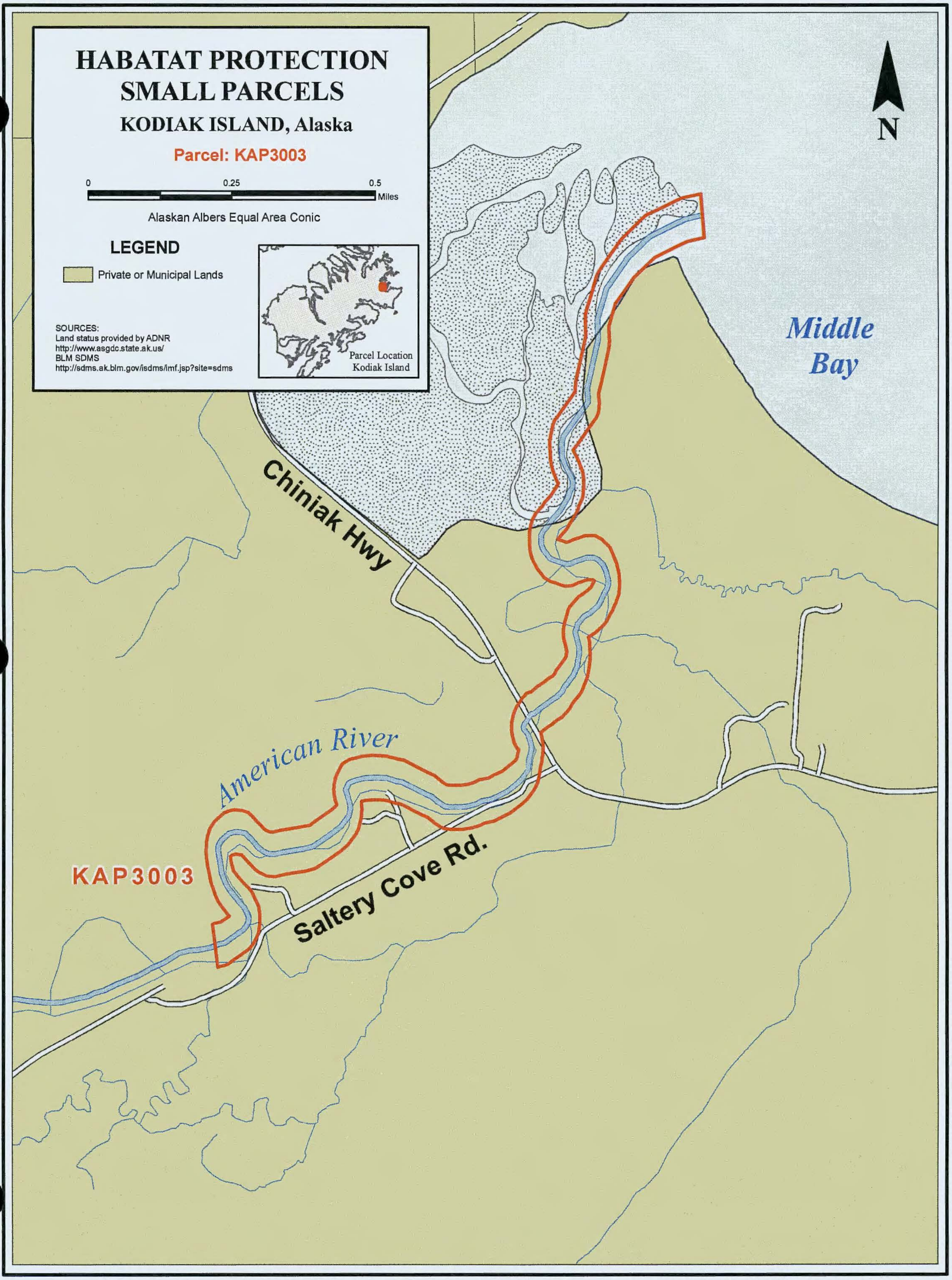
Task	Estimated Cost
Appraisal	$20,000
Timber Evaluation (KAP 145)[1]	$10,000
Appraisal Review	$10,000
Subtotal (Current Request)	$40,000
G&A	$3,600
Total Requested at this time	$43,600

Attachments:
Map of Termination Point
Map of American River Project Area
Map of Olds River Project Area

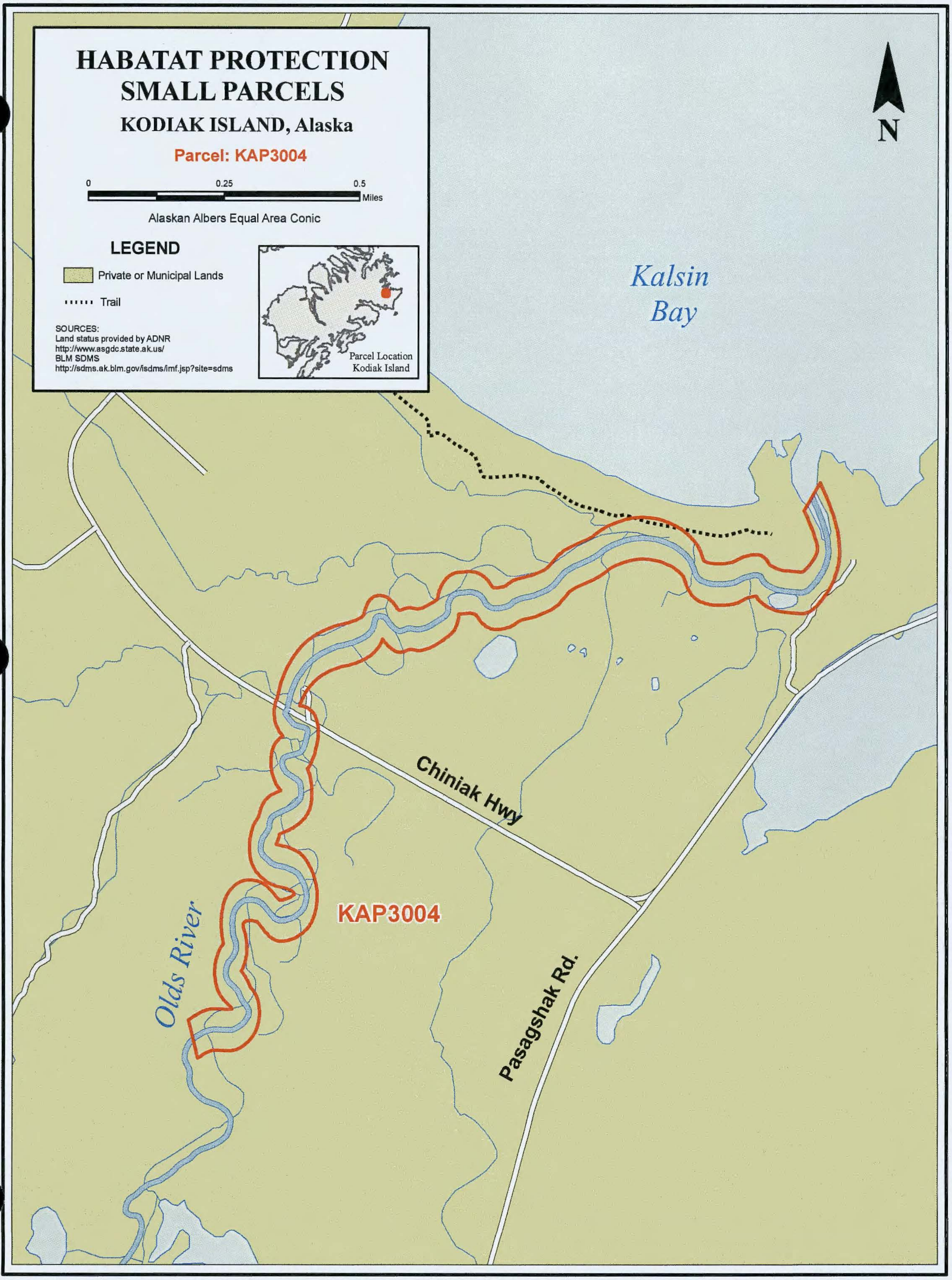
[1] This timber evaluation is not a full timber cruise, but will consist of an update of previous timber evaluation conducted on the Termination Point parcel.



Date printed: January 12, 1995



HABATAT PROTECTION
SMALL PARCELS
KODIAK ISLAND, Alaska
Parcel: KAP3003
0
0.25
0.5
Miles
Alaskan Albers Equal Area Conic
LEGEND
Private or Municipal Lands
SOURCES:
Land status provided by ADNR
http://www.asgdc.state.ak.us/
BLM SDMS
http://sdms.ak.blm.gov/isdms/imf.jsp?site=sdms
Parcel Location
Kodiak Island
N
Middle Bay
Chiniak Hwy
American River
KAP3003
Saltery Cove Rd.


HABATAT PROTECTION
SMALL PARCELS
KODIAK ISLAND, Alaska
Parcel: KAP3004
0
0.25
0.5
Miles
Alaskan Albers Equal Area Conic
LEGEND
Private or Municipal Lands
Trail
SOURCES:
Land status provided by ADNR
http://www.asgdc.state.ak.us/
BLM SDMS
http://sdms.ak.blm.gov/isdms/imf.jsp?site=sdms
Parcel Location
Kodiak Island
N
Kalsin
Bay
Chiniak Hwy
KAP3004
Olds River
Pasagshak Rd.

RESOLUTION 10-13 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL REGARDING SMALL PARCEL KEN 3006

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill Trustee Council ("Trustee Council"), in accordance with the Memorandum of Agreement and Consent Decree entered as settlement of *United States of America v. State of Alaska* No. A91-081 Civil, U.S. District Court for the District of Alaska, and after public meetings, unanimous agreement has been reached to expend funds received in settlement of *State of Alaska v. Exxon Corporation, et al.,* No. A91-083 CIV, and *United States of America v. Exxon Corporation, et al.*, No 91-082 CIV, U.S. District Court for the District of Alaska, for necessary natural resource damage assessment and restoration activities as follows:

1. The owner of small parcel KEN 3006 comprised of Lots 4 and 5, block 1 of Coal Creek Moorage Subdivision, as described in Attachment A, has indicated an interest in selling this small parcel.

2. An appraisal authorized by the Trustee Council has been completed, reviewed and approved establishing one hundred thousand dollars ($100,000) as the Fair Market Value of KEN 3006.

3. KEN 3006 has attributes which if they are acquired and protected will restore, replace, enhance and rehabilitate injured resources and the services provided by those natural resources including important habitat for several species of fish and wildlife for which significant injury resulting from the *Exxon Valdez* oil spill ("EVOS") has been documented.

4. Existing laws and regulations, including but not limited to the Alaska Forest Practices Act, the Alaska Anadromous Fish Protection Act, the Clean Water Act, the Alaska Coastal Management Act, the Bald Eagle Protection Act and the Marine Mammal Protection Act, are intended, under normal circumstances, to protect resources from serious adverse effects caused by activities on the lands. However, restoration, replacement and enhancement of resources injured by the EVOS present a unique situation. Without passing judgment on the adequacy or inadequacy of existing law and regulations to protect resources, scientists and other resource specialists agree that, in their best professional judgment, protection of habitat in the spill area to levels above and beyond that provided by existing laws and regulations will have a beneficial effect on recovery of injured resources and lost or diminished services provided by these resources.

5. There has been widespread public support within Alaska, as well as on a national basis, for the acquisition of lands in the oil spill area.

6. The purchase of small parcels is an appropriate means to restore a portion of the injured resources and services in the oil spill area.

7. The purchase of this parcel is an appropriate means to restore a portion of the injured resources and services in the oil spill area. Acquisition of this parcel is consistent with the Final Restoration Plan.

THEREFORE, we resolve to provide funds for the State of Alaska to purchase all of the Seller's rights and interests in small parcel KEN 3006 as recommended by the Executive Director of the Trustee Council ("Executive Director"), and pursuant to the following conditions:

(a) the amount of funds (hereinafter referred to as the "Purchase Price") to be provided by the Trustee Council to the State of Alaska for the purchase of small parcel KEN 3006 shall be one hundred thousand dollars ($100,000);

(b) authorization for funding for any acquisition described in the foregoing paragraph shall terminate if a purchase agreement is not executed by July 31, 2011;

(c) filing by the United States Department of Justice and the Alaska Department of Law of a Notice, as required by the Third Amended Order for Deposit and Transfer of Settlement Proceeds, of the proposed expenditure with the United States District Court for the District of Alaska and with the Investment Fund established by the Trustee Council within the Alaska Department of Revenue, Division of the Treasury ("Investment Fund"), and transfer of the necessary monies from the Investment Fund to the State of Alaska Department of Natural Resources;

(d) a title search satisfactory to the State of Alaska and the United States is completed, and the Seller is willing and able to convey fee simple title by warranty deed;

(e) no timber harvesting, road development or any alteration of the land will be initiated on the land without the express written agreement of the State of Alaska and the United States prior to purchase of this parcel;

(f) a hazardous materials survey satisfactory to the State of Alaska and United States is completed;

(g) compliance with the National Environmental Policy Act; and

(h) a conservation easement on parcel KEN 3006 shall be conveyed to the United States which must be satisfactory in form and substance to the United States and the State of Alaska Department of Law.

It is the intent of the Trustee Council that the above-referenced conservation easement will provide that any facilities or other development on the foregoing small parcel shall be of limited impact and in keeping with the goals of restoration, that there shall be no commercial use except as may be consistent with applicable state or federal law and the goals of restoration to pre-spill conditions of any natural resource injured, lost, or destroyed as a result of the EVOS, and the services provided by that resource or replacement or substitution for the injured, lost or destroyed resources and affected services, as described in the Memorandum of Agreement and Consent Decree between the United States and the State of Alaska entered August 28, 1991 and the Restoration Plan as approved by the Trustee Council.

By unanimous consent, following execution of the purchase agreement between the Seller and the State of Alaska and written notice from the Executive Director that the terms and conditions set forth herein and in the purchase agreement have been satisfied, we request the Alaska Department of Law and the Assistant Attorney General of the Environment and Natural Resources Division of the United States Department of Justice to take such steps as may be necessary for withdrawal of the Purchase Price for the above-referenced parcel from the appropriate account designated by the Executive Director.

Such amount represents the only amount due under this resolution to the Seller by the State of Alaska to be funded from the joint settlement funds, and no additional amounts or interest are herein authorized to be paid to the Seller from such joint funds.

Approved by the Trustee Council at its meeting of June 23, 2010, held in Anchorage, Alaska, as affirmed by our signatures affixed below.

STEVE ZEMKE
Trustee Alternate
Chugach National Forest
U.S. Department of Agriculture

DANIEL S. SULLIVAN
Attorney General
State of Alaska

KIM ELTON
Senior Advisor to the Secretary
for Alaska Affairs
U.S. Department of Interior
U.S. Department of Commerce

CRAIG R. O'CONNOR
Special Counsel
National Oceanic & Atmospheric
Administration

DENBY S. LLOYD
Commissioner
Alaska Department of Fish and Game

LARRY HARTIG
Commissioner
Alaska Department of Environmental
Conservation

Attachment A - Restoration Benefits Report and Map

KEN 3006, Coal Creek Moorage 2

Owner:	Linda McLane
Physical Location:	This parcel is located immediately adjacent to previously acquired small parcel KEN 19 located on the confluence of Little Coal Creek and the Kasilof River ("Coal Creek Moorage 1").
Acreage:	6.94 acres
Brief Description:	Lot 4 and Lot 5, Coal Creek Moorage Subdivision Part One, T 3N R 12 W Sec 13 SM
Agency Sponsor:	Alaska Department of Natural Resources
Appraised Value:	$100,000

Parcel Description. This parcel, comprised of two lots fronting on Coal Creek, is located at the confluence of Little Coal Creek and the Kasilof River and is part of the Kasilof River Flats on the east shore of the Kasilof River. The lots are approximately 2.5 miles upstream from the mouth of the Kasilof River and the shores of Cook Inlet. The parcel is located immediately adjacent to previously acquired EVOS small parcel KEN 19, which was purchased from Mr. and Mrs. McLane in 1997. Both lots contain important tidally influenced wetlands. Uplands on the parcels are densely wooded with mixed spruce and birch.

The original Coal Creek parcel was considered unique because of the highly productive tidal marshes on and adjacent to this property, due to their limited distribution. The Kenai Peninsula Borough wetlands delineation illustrates the continuation of the marshes on the parcels currently under consideration.

Linkage to Restoration:

Restoration Benefits.
Injured species that will benefit from this parcel acquisition include intertidal resources, pink and sockeye salmon, Dolly Varden, and bald eagles. The parcel also supports species such as chinook and coho salmon; steelhead and rainbow trout; Canada, Tule and lesser snow geese; Sandhill cranes; and numerous other species of waterfowl and shorebirds. Coal Creek is an important wildlife movement corridor for black bear and moose that travel between the adjacent uplands and the Kasilof River Flats. The Cook Inlet Aquaculture Association has used Coal Creek as a release site for sockeye salmon smolts, which contribute to the overall Cook Inlet commercial fishery. The area supports recreational use by fishermen, birdwatchers and hikers.

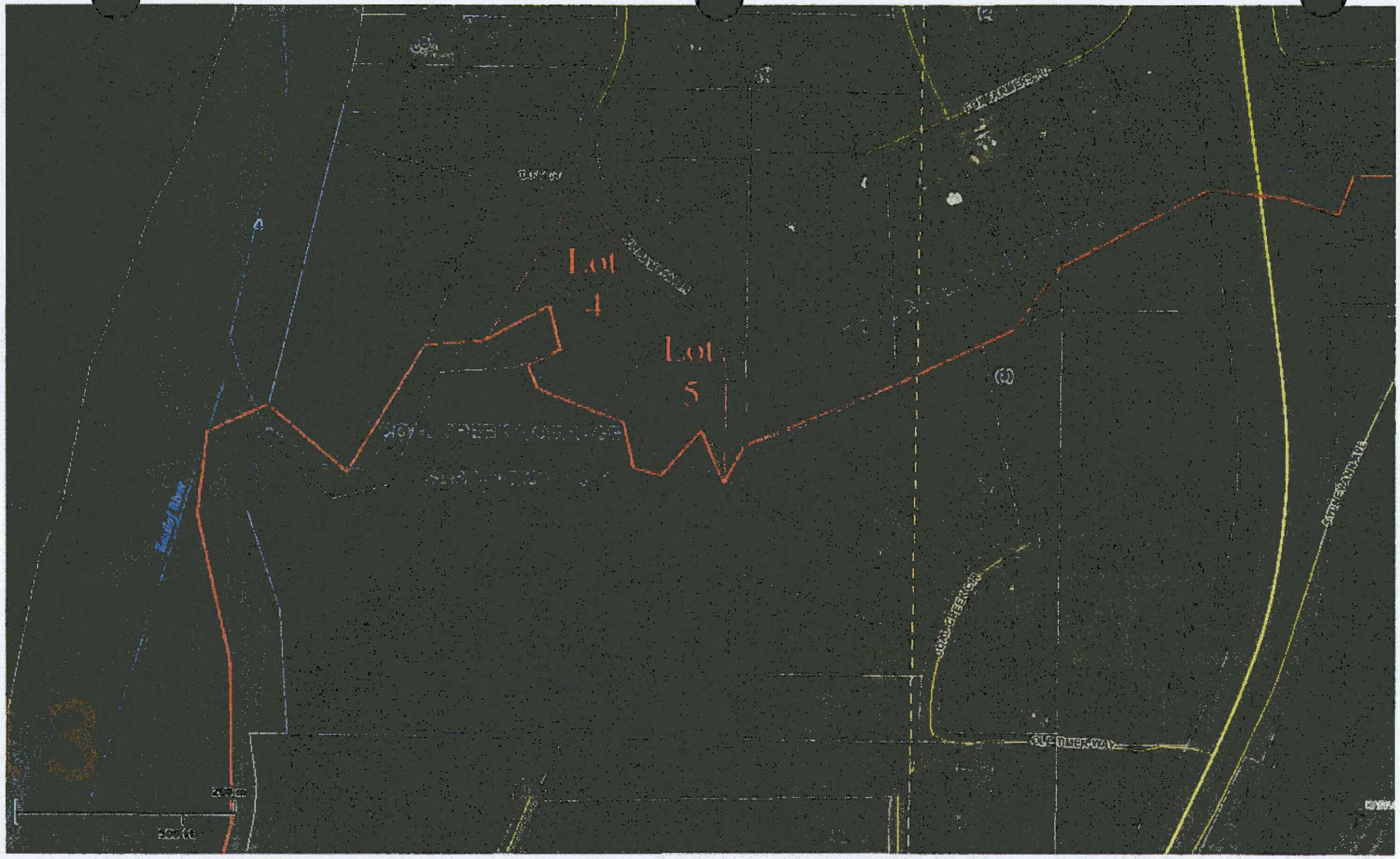
The parcel also has significant cultural values. It includes remnant structures from an early 20th century fox farm, but more importantly it includes house depressions and other features from a prehistoric or early historic Denai'na village site. There is also evidence of early Russian structures with features indicating this may be the site of the first Russian settlement in southcentral Alaska. The site is in relatively pristine condition, with integrity of locations and setting.

The original Coal Creek proposal was strongly supported by the Kenai Peninsula Borough and Kenai Peninsula legislators. In 1997, these parcels were appraised in an effort to include them in the previous transaction. Unfortunately court proceedings prevented further action on the part of the Council. In 2004, Ms. McLane was able to purchase these parcels back from the court in hopes of eventually placing them in public ownership.

Potential Threats.
The owner is very interested in selling this parcel. Adjacent neighbors have expressed interest in the parcel, however, it is the owner's preference that this parcel be acquired by the State and managed consistent with the Coal Creek parcel previously purchased by the Trustee Council. Conversion of this property to home sites has the potential to diminish public access to the upper reaches of Coal Creek, negatively impact valuable cultural resources, and negatively impact estuarine and intertidal areas including KEN 19, Coal Creek Moorage 1. Potential user conflicts could also occur over time.

Proposed Management.
This parcel has been identified as a priority for the Division of Parks and Outdoor Recreation. The State Historic Preservation Officer considers protection of this parcel critical.

This parcel will be managed by the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation, Kenai Area Office in consultation with the State Historic Preservation Officer, consistent with the management of KEN 19, Coal Creek Moorage 1, for the purposes of protecting resources and services injured by the *Exxon Valdez* Oil Spill.

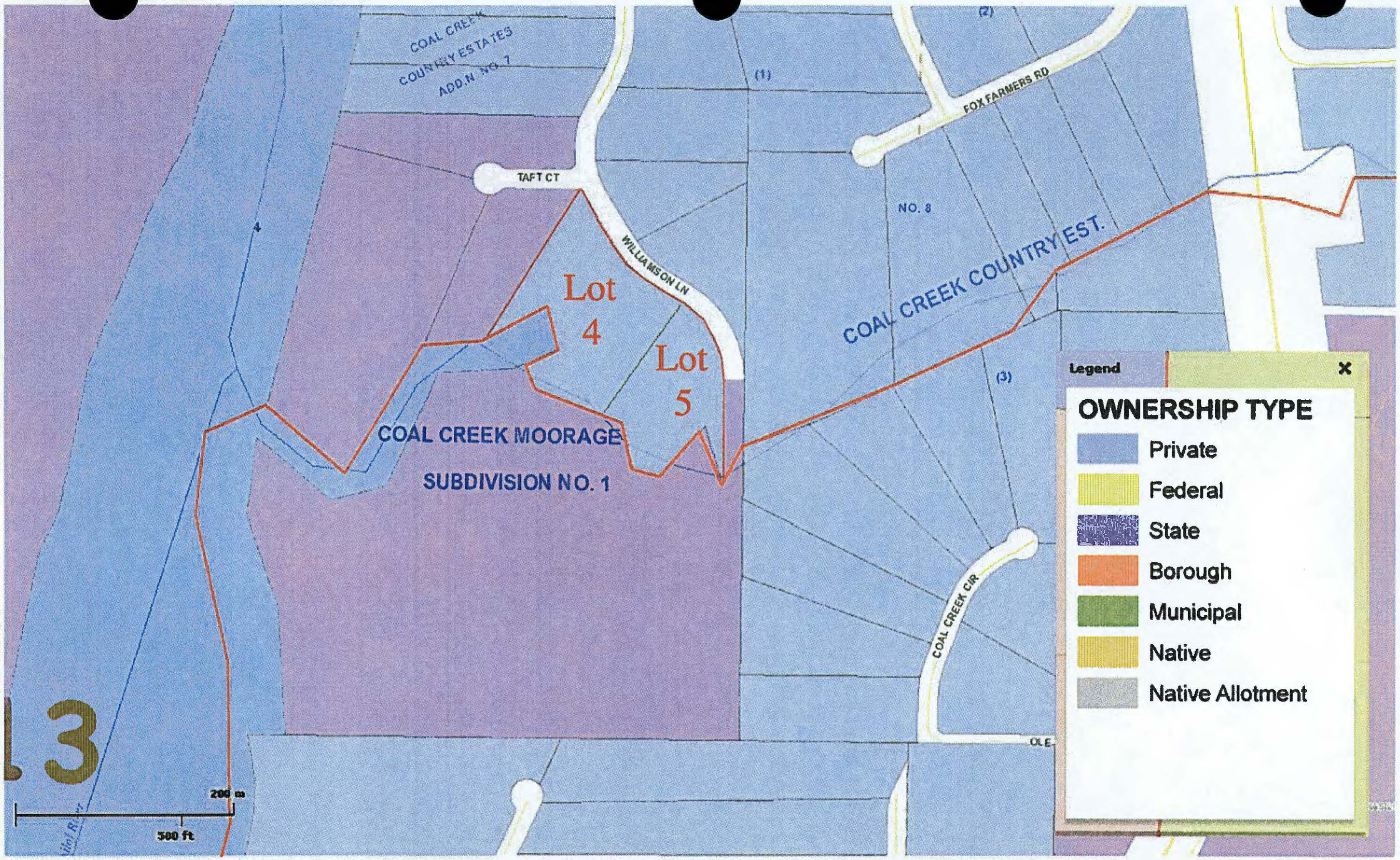


Coal Creek Moorage 2, Imagery

DISCLAIMER: The data displayed herein is neither a legally recorded map nor survey and should only be used for general reference purposes. Kenai Peninsula Borough assumes no liability as to the accuracy of any data displayed herein. Original source documents should be consulted for accuracy verification.

Wed Dec 30 2009 12:59:06 PM

KPB Parcel Viewer



Coal Creek Moorage 2, Land Ownership

Wed Dec 30 2009 12:59:42 PM

KPB Parcel Viewer

DISCLAIMER: The data displayed herein is neither a legally recorded map nor survey and should only be used for general reference purposes. Kenai Peninsula Borough assumes no liability as to the accuracy of any data displayed herein. Original source documents should be consulted for accuracy verification.

Draft 6/17/2010

RESOLUTION 10-14 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL REGARDING AUTHORIZATION FOR ADDITIONAL FUNDS FOR PROJECT 070836-B

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill Trustee Council do hereby certify that, in accordance with the Memorandum of Agreement and Consent Decree entered as settlement of *United States of America v. State of Alaska* No. A91-081 Civil, U.S. District Court for the District of Alaska, and after public meetings, unanimous agreement has been reached to expend funds received in settlement of *State of Alaska v. Exxon Corporation, et al.,* No. A91-083 CIV, and *United States of America v. Exxon Corporation, et al.,* No. A91-082 CIV, U.S. District Court for the District of Alaska, for necessary natural resource damage assessment and restoration activities in the amount of $74,340 plus applicable General Administration (GA) for federal fiscal year 2010. The National Oceanic and Atmospheric Administration waives the project management fees. The monies are to be distributed according to the following schedule:

National Oceanic & Atmospheric Administration (includes 9% GA)	$81,030
TOTAL TO UNITED STATES OF AMERICA	$81,030
TOTAL APPROVED	**$81,030**

By unanimous consent, we hereby request the Alaska Department of Law and the Assistant Attorney General of the Environmental and Natural Resources Division of the United States Department of Justice to take such steps as may be necessary to make available additional funds for Boufadel Project 070836-B, Factors Responsible for Limiting the Degradation Rate of *Exxon Valdez* Oil on Prince William Sound Beaches from the appropriate account designated by the Executive Director.

Approved by the Council at its meeting of June 23, 2009 held in Anchorage, Alaska as affirmed by our signatures affixed below.

STEVE ZEMKE
Alternate Trustee
Chugach Nation Forest
U.S. Department of Agriculture

DANIEL S. SULLIVAN
Attorney General
Alaska Department of Law

KIM ELTON
Senior Advisor to the Secretary
for Alaska Affairs
U.S. Department of the Interior

CRAIG R. O'CONNOR
Special Counsel
National Oceanic & Atmospheric
Administration
U.S. Department of Commerce

DENBY S. LLOYD
Commissioner
Alaska Department of Fish and Game

LARRY HARTIG
Commissioner
Alaska Department of Environmental
Conservation

PROJECT: "Factors responsible for limiting the degradation rate of Exxon Valdez oil in Prince William Sound beaches".

Contract: No. AB133F-07-CN0099

PI: Michel C. Boufadel

boufadel@temple.edu

(215) 204-7871

In 2009 a team from Temple University conducted on Beach EL056C and Beach SM006C measurements of the background concentrations of dissolved oxygen, nutrients (nitrate, ammonia, phosphate) and salinity. These measurements indicated that the concentrations of oxygen and nutrients in pore water are lower than considered necessary for natural biodegradation of lingering oil to occur. Due to the contrasting properties of these two beaches, similar values of nutrients and oxygen are expected to occur throughout the beaches of Prince William Sound. The team had hypothesized that if oil is bioavailable to pore water concentrations, that is if the oil is not sequestered and sheltered from water flow in the beach, then adding oxygen and nutrients would enhance the biodegradation of the oil. The report on this topic as related to Beach EL056C is in the document titled: eco_eleanor.pdf. The document is also located at www.temple.edu/environment/eco_eleanor.pdf. We are finalizing the document containing nutrients and oxygen measurements for Beach SM006C, and it will be at www.temple.edu/environment/eco_smith.pdf

In 2009, means for delivering dissolved chemicals to bioremediate oil from the *Exxon Valdez* Oil Spill were investigated at two beaches: Beach EL056C and Beach SM006C. These investigations revealed that high pressure injection and ambient pressure release, could be used to deliver nutrients and oxygen to the layer of the beaches where lingering Exxon Valdez oil resides. The reports are provided in two files:delivery_eleanor.pdf and delivery_smith.pdf.
The files are located at:
www.temple.edu/environment/delivery_eleanor.pdf
www.temple.edu/environment/delivery_smith.pdf

Nutrients and oxygen measurements on EL056C

Measurements of the background concentrations of nutrients, dissolved oxygen (DO), and salinity were obtained from Beach EL056C, which harbors Heavy Oil Residue from the Exxon Valdez oil spill in 1989. Two transects were set across the beach face; one passed through an oil patch while the other transect was clean. Three pits were dug in each transect and they ranged in depth from 0.9 m to 1.5 m. The DO was less than 1.25 mg/L at oiled pits and greater than 5 mg/L at clean pits. The average nutrient concentrations in the beach were 0.39 mg-NL^{-1} and 0.020 mg-PL^{-1}. Both concentrations are lower than values needed for natural biodegradation (2 to 10 mg-NL^{-1} and 0.40 mg-PL^{-1} to 2.0 mg-PL^{-1}), which suggests that they are both limiting the biodegradation process. The lowest nitrate values were found in the oiled pits, and given the low DO at these pits, we have concluded that either nitrification (i.e., generation of nitrate) is prevented from occurring or removal of nitrate through denitrification is taking place. All factors being equal within the pore water of the beach, either situation would reflect the lack of oxygen. Therefore if oil consumption by microorganisms is occurring, it is probably doing so under anoxic conditions, a process that is extremely slow in comparison with aerobic biodegradation.

Delivery of nutrients and oxygen on EL056C, Eleanor Island and SM006C, Smith Island

Two alternative mechanisms were investigated for delivering nutrients and dissolved oxygen to the oiled zones of Beach EL056C on Eleanor Island and SM006C on Smith Island in Prince William Sound. The delivery technique chosen for EL056C, where the beach is comnposed of sedimentary materials, was High Pressure Injection (HPI) of an inert tracer, lithium, at the approximate depth of 1.0 m into the beach near the mid-tide line. The results revealed that the maximum injection flow rate was 3.0 L/min (around 0.8 gpm) and the associated pressure was around 20 m (30 psi). Therefore, exceeding any of these values would probably cause failure of the injection system. The injected tracer was monitored at multiple depths of four surrounding observation wells, and the results showed that the tracer plume occupied an area of 12 m^2 (around 130 ft^2) within 24 hours. The tracer plume travelled at the average speeds of 10 m/day in the seaward direction and 1.7 m/day in other directions. The rapid movement under HPI and the large diameter of influence (3.0 m) indicated that this method is promising for enhancing biodegradation of the *Exxon Valdez* oil if the biodegradation is limited by nutrient and/or oxygen availability.

The method of delivering nutrients and dissolved oxygen chosen for Beach SM006C, which is underlain by bedrock at a shallow depth, was Ambient Pressure Release (APR). Two transects of wells for tracer application were installed in the beach, one at the right (clean) side of the beach, and one at the left side known to be polluted with heavy oil residue. The tracer delivery occurred under ambient pressure from manifolds 0.60 and 0.45 m deep at the right and left transects respectively. Lithium in a lithium bromide solution made with seawater was used as the inert tracer. The solution was released for 58.5 hours at an average concentration of 82.6 mg/L of lithium at a constant flow rate of 0.23 LPM. The application was then switched to seawater-only for 16 hours at the same flow rate. The tracer was monitored at multiple depths at locations seaward and landward of the manifolds. The results show that the tracer fluctuated with the tidal cycle, moving landward with rising tides, and seaward with falling tides. The plume got deeper as it moved landward and shallower as it moved seaward of the maniford. As the oil is entrapped in the top 10 cm on this beach, applied nutrients and dissolved oxygen by this technique would reach the entrapped oil from beneath as they travel seaward of the manifold. Therefore, if nutrients and/or dissolved oxygen are limiting the biodegradation on this beach, this techniqure of delivery would enhance it. The large travelling speed of the plume in the seaward direction (around 1.5 to 2.0 m/day) suggests that this technique is logistically feasible from a hydraulic point of view.

In summary, our measurements in 2009 have demonstrated that the concentrations of nutrients and dissolved oxygen at oiled locations within Prince William Sound are too low for any significant biodegradation of the Exxon Valdez oil. Our investigation of two techniques to deliver additional nutrients and dissolved oxygen resulted in the following findings: High Pressure Injection (HPI) is advisable for sedimentary beaches, such as EL056C on Eleanor Island, while Ambient Pressure Release (APR) is advisable for beaches with a shallow bedrock, such as SM006C on Smith Island. If the biodegradation of the lingering *Exxon Valdez* oil is limited by the availability of nutrients and oxygen in pore water, then these delivery techniques could enhance the biodegradation process.

Request for Supplementation of Portions of 2009 Field Work and Extension of the Placement of Equipment on Eleanor Island and Smith Island Beaches

We are requesting monies to repeat the tracer delivery investigation at the Eleanor and Smith Island beaches previously studied (EL056C and SM006C). Specifically, we propose to repeat the lithium tracer releases and measurements conducted during the 2009 field season. This would be done using the same lithium release piping and monitoring well piping that was put in place in 2009 and has remained in place since that time. In addition, as in 2009, we propose to take samples of pore water from the previously-installed monitoring wells using the 2009 protocols and to measure those samples for dissolved oxygen, salinity, and temperature. Our 2009 proposal detailed these protocols and is attached for reference.

This proposed additional work will help address two important questions raised by the field work done in 2009. First, there is some question about whether the beaches had been restored to their normal, undisturbed state at the time the 2009 field work was conducted. The lithium tracer investigations conducted in 2009 occurred approximately two months after the excavation and refilling of pits on the beaches in which the delivery equipment was and monitoring wells were installed. Information at that time had led us to conclude that the beaches had resettled to their normal state within two months, and we began delivery and measurement of the tracer thereafter. Using the same protocols employed in 2009 with the equipment installed in 2009, which will have been in place for over a year, would definitively address this question. If the results obtained in 2010 are substantially the same as those obtained in 2009, this would confirm the 2009 data on beach characteristics (including the rate and distance of travel of chemicals through the beach strata) and would add credence to the possibility of delivering bioremediation chemicals to the sequestered lingering oil using this type of equipment. Conversely, if results in 2010 show substantially reduced travel of the lithium tracer through the beach strata, that might suggest that this technology would not be effective for delivery of remediation chemicals to sequestered lingering oil. Any differences between the 2010 data and the 2009 data would be important because we expect that bioremediation using this kind of technology would take place over a matter of months (rather than weeks), possibly in several successive field seasons, post-installation of the delivery systems.

The second important question that the proposed 2010 work would help address is the presence of oxygen in the areas of the beaches where lingering oil is found. Our 2009 work found very low levels of oxygen in these areas, which strongly suggests lack of oxygen as a factor limiting biodegradation of lingering oil. In contrast, work done through studies funded by Exxon Mobil (Atlas and Bragg, 2009a,b) found levels of oxygen much higher than those found in our work. Because the question of oxygen levels in beach areas containing lingering oil is critical to understanding the factors limiting lingering oil biodegradation, additional data from beach areas that undoubtedly have returned to their natural, undisturbed state would be significant.

Finally, we note that our proposal included monies for removing the delivery systems, multiport sampling wells, and sensors that were previously installed in the beaches on Eleanor and Smith Islands. Our intent was to remove them in Summer 2010. However, if pilot testing of bioremediation is adopted on these beaches, these systems could be needed to deliver nutrients and dissolved oxygen. It would be less costly and would cause less disturbance to the beach environments to use these systems rather than remove them and re-placing them at some future date. In addition, even if another method of delivery is explored, the observation wells could be used to monitor the progress of bioremediation. Thus, even if the Trustee Council decides not to fund this proposal for additional field work in 2010, we propose to extend the period within which this equipment would remain on the beaches until their presence is no longer useful to the Trustee Council.

REFERENCES

Atlas, R., Bragg, J.R., 2009a. Evaluation of PAH Depletion of Subsurface *Exxon Valdez* Oil Residues Remaining in Prince William Sound in 2007-2008 and their Likely Bioremediation Potential. AMOP Proceedings, 2009, 2,723-747.

Atlas, R., Bragg, J.R., 2009a. Bioremediation of marine oil spills: when and when not – the *Exxon Valdez* experience. Microbial Biotechnology 2, 213-221.

BUDGET AND BUDGET JUSTIFICATION

	Amount ($)
Travel	7,500
Boat rental (12 days X $2,000/day)	24,000
Summer wage for two graduate students	12,000
Supplies for lithium studies	5,000
Lithium analysis	4,500
Shipping	6,000
Direct cost	59,000
Overhead from Temple University(26%)	15340
Total	74,340
total cost with G&A at 9%	**$81,030**

Five people will travel from Philadelphia to Whittier to take the boat. The airline ticket per person is estimated at $1,000. In each direction, a one night stay in an Anchorage hotel at $200. Per diem for two days is $100. Thus, for five people 5X$1500=$7,500.

The boat Auklet will be rented to house six people during 12 days to conduct the installation. Costs are $2,000/day for 12 days = $24,000.

Two graduate students will be paid for three months (the summer semester) to work on this project. 2 X $2000/monthX 3 months=$12,000.

Cost of conducting the tracer studies on two beaches, $5,000.

Lithium analysis will be conducted. The budget includes 300 samples at the cost of $15 per sample = $4,500.

Shipping of equipment through carrier (e.g., ABF) to Anchorage and transport via rented trucks to Whittier for loading on the boats. Returning the equipment to Philadelphia. Shipping water and sediment samples to Philadelphia. Total costs estimated at $6,000.

The total direct cost is: $59,000. Temple University's overhead rate is 26%, which would result in $15,340. The total cost is $74,340. NOAA receives an additional 9% for G&A which would total to $81,030.

Agenda

DRAFT 6/15/10

Exxon Valdez Oil Spill Trustee Council

441 W. 5th Ave., Suite 500 • Anchorage, AK 99501-2340 • 907 278 8012 • fax 907 276 7178

AGENDA
EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
June 23, 2010, 9:30 a.m. – 12:00 p.m.
Anchorage, Alaska

Trustee Council Members:

DANIEL S. SULLIVAN
Attorney General
Alaska Department of Law

LARRY HARTIG
Commissioner
Alaska Department of Environmental Conservation

DENBY S. LLOYD
Commissioner
Alaska Department of Fish and Game

CRAIG O'CONNOR
Special Counsel
National Oceanic & Atmospheric Administration
U.S. Department of Commerce

KIM ELTON
Senior Advisor to the Secretary for Alaska Affairs
Office of the Secretary
U.S. Department of the Interior

STEVE ZEMKE
Trustee Alternate
Chugach National Forest
U.S. Department of Agriculture

Meeting in Anchorage, Trustee Council Office 441 West 5th Avenue, Suite 500
Teleconference number: 800.315.6338. Code: 8205
State Chair: ___________

1. Call to Order – 9:30 a.m.

2. Consent Agenda
   - Approval of Agenda*
   - Approval of Meeting Notes*
     May 14, 2010

3. Public Advisory Committee comments (9:40)

4. Public comment – 9:50 a.m. (3 minutes per person)

5.	Executive Director's Report - Status of remodel/move - Long-Term Monitoring Work Group - Science Management Contract* - Transition in Admin Budget: AMSS*	(30 minutes)	Elise Hsieh, Executive Director
6.	Habitat (small parcels)*	(20 minutes)	Carol Fries, ADNR Jen Schorr EVOS Deputy Executive Director
7.	Transition in Admin Budget: ARLIS*	(15 minutes)	Carrie Holba, ARLIS
8.	Draft Integrated Herring Restoration Plan* (20 minutes)		Catherine Boerner EVOSTC Science Coordinator
9.	Project 07836-B, Factors Responsible for* Limiting the Degradation Rate of *Exxon Valdez* Oil in Prince William Sound Beaches		Craig O'Connor NOAA
10.	Draft Supplemental Environmental Impact Statement (DSEIS) Update		Craig O'Connor NOAA
11.	Executive Session, as needed		

Adjourn – by 12:00 p.m.

* Indicates action items

May 14 2010
TC Mtg Notes

DRAFT 6/3/10

Exxon Valdez Oil Spill Trustee Council

441 W. 5th Ave., Suite 500 • Anchorage, AK 99501-2340 • 907 278 8012 • fax 907 276 7178

TRUSTEE COUNCIL MEETING NOTES

Anchorage, Alaska

May 14, 2010

Chaired by: Steve Zemke
Trustee Council Member

Trustee Council Members Present:

• Steve Zemke, USFS *
Kim Elton, US DOI
Craig O'Connor, NOAA **
Craig Tillery, ADOL ***
Denby Lloyd, ADF&G
Larry Hartig, ADEC

• Chair
* Steve Zemke alternate for USFS
** Craig O'Connor alternate for James Balsiger
*** Craig Tillery alternate for Daniel Sullivan

The meeting convened at 9:40 a.m., May 14, 2010 in Anchorage at the EVOS Conference Room.

1. Approval of the Agenda

APPROVED MOTION: Motion to approve the May 14, 2010 agenda

Motion by O'Connor, second by Lloyd

2. Approval of April 30, 2010 meeting notes

APPROVED MOTION: Motion to approve the April 30, 2010 meeting notes

Motion by Lloyd, second by O'Connor

Public Advisory Committee (PAC) comments: Stacy Studebaker, PAC Chair

Public comment opened at 9:45 a.m.

There were no public comments offered.

3. Asset Allocation

APPROVED MOTION: Motion to approve Resolution 10-07 Pertaining to the Asset Allocation for Period May 2010-May2011 adopting a median expected return of 7.75% with a standard deviation of 11.96%

Motion by Tillery, second by O'Connor

4. 2010 Update Injured Resources and Services (IRS)

APPROVED MOTION: Motion to approve the April 27, 2010 version of the 2010 Update Injured Resources and Services as written and presented

Motion by Lloyd, second by O'Connor

5. Draft Supplemental Environmental Impact Statement (DSEIS)

APPROVED MOTION: Motion to approve May 13, 2010, 9:00 p.m. Draft Supplemental Environmental Impact Statement with target, not precise, monetary amounts plus or minus 5%, adding potential indicator species to page 15 and non-substantive technical edits by the EVOS executive director

Motion by Elton, second by Tillery

6. May 14, 2010 Agenda Amendment

APPROVED MOTION: Motion to add a discussion about a Long-Term Monitoring Work Group to the previously approved May 14, 2010 Trustee Council meeting agenda

Motion by O'Connor, second by Hartig

7. Long-Term Monitoring Work Group

APPROVED MOTION: Motion to approve Resolution 10-07 Regarding Authorization for Long-Term Monitoring Work Group

Motion by O'Connor, second by Lloyd

Off the record: 11:30 a.m.
On the record: 11:38 a.m.

8. 2010-2012 Public Advisory Committee Charter

APPROVED MOTION: Motion to approve the charter as presented for the 2010-2012 Public Advisory Committee

Motion by O'Connor, second by Elton

9. Amend 2010-2012 Public Advisory Committee membership

APPROVED MOTION: Motion to amend the 2010-2012 Public Advisory Committee membership to 10 members: aquaculture/mariculture, commercial fisher, commercial tourism, recreation user, conservationist/environmental, Native landowner, sport hunter/fisher, subsistence user, science/technologist, and public-at-large

Motion by Tillery, second by Lloyd

10. Adjourn — Motion to adjourn by O'Connor, second by Hartig

Off the record 12:50 p.m.

IHRP Rest Options

Exxon Valdez Oil Spill Trustee Council
441 W. 5th Ave., Suite 500 • Anchorage, AK 99501-2340 • 907 278 8012 • fax 907 276 7178

MEMORANDUM

TO: Elise Hsieh, Executive Director

FROM: Catherine Boerner, Science Coordinator

DATE: June 4, 2010

RE: Summary of IHRP Restoration Options

Restoration Options

Beyond a general agreement that herring are depressed, there has been little consensus over the causes the herring decline, the extent or severity of the decline, the present abundance of herring, or what could, or should, be done to address the problem. However, there are valid reasons for proceeding carefully and cautiously. A formidable reason concerns the issue of scientific validation. Any restoration program involving intervention will be expensive, and could even entail some adverse environmental effects. It is essential that the validity of any approach be monitored and evaluated.

Potential Problems for Restoration

If herring restoration were simple and inexpensive, almost certainly it already would have occurred. There are several fundamental problems related to the objective:

1. **Costs:** Restoration activities can be very expensive, and EVOSTC already has expended significant funds to understand fundamental and practical issues of herring biology.

2. **Scientific limits to understanding or knowledge:** At the present time there is insufficient technical information required for certain restoration options, but this problem can be resolved with additional research. For example, it does not make sense to produce hundreds of millions of juveniles to be released in the late fall if the limiting factor is overwinter survival from starvation. Or, could the production of additional herring result in an increase in predators? A better understanding of these factors will aid in the decisions of intervention strategies and locations.

3. **Logistics and technology:** PWS is remote and when coupled with the realities of harsh winters, all intervention strategies will need to be well-designed and safe for operation. These are solvable issues, but they are not trivial, and their solutions may be costly.

4. **Limited accessible technical skill:** For many activities, people with particular skill sets are required. Even if funds are available, it can be difficult to access specialized technical skill sets to work in remote parts of PWS.

5. **Institutional, procedural and legal issues:** This category represents one of the most difficult and formidable constraints to many potential herring restoration activities. Institutional, state and federal agencies have the legal mandate to protect fisheries and habitat through a series of procedures (e.g., environmental impact statement, permitting process with disease reviews); all of these processes will receive scientific and legal scrutiny, including from different interest groups. There are concerns for putting wild populations at risk, the use of chemicals in mass-marking, permitting, moving live fish, etc.

Eight Restoration Options

It may be possible to promote restoration of herring in Prince William Sound using intervention methods such as increasing over-winter survival of 0+ juveniles by artificial feeding during the late fall or the release of juveniles reared in hatcheries. However, every potential restoration option could be controversial and few have been tried or demonstrated to be technically feasible or cost effective. Further, the use of direct restoration activities may cause unintended adverse environmental outcomes such as the increase in incidence of disease to herring or other fishes. In some instances pilot projects can test the effectiveness and help to understand the factors limiting herring recovery. All potential interventions will benefit from improved knowledge on limiting factors that may affect the success of various intervention options. The following text presents a list and summary of restoration options, starting with the least risky and lowest degree of intervention and progressing to the heaviest intervention.

1. Enhanced Monitoring (no direct action)

A serious restoration option is to take no intervention and wait for natural recovery
This option requires monitoring of the population to determine abundance trends in the adult population. The disadvantage is that it does nothing to restore herring populations.

2. Predator Management

Herring have numerous predators through all life stages. This option considers the possibility of predator hazing or predator removal to increase the amount of herring making it into adulthood. While several predators cannot be removed or hazed, walleye pollock have been identified as a major predator during the over-wintering period. Opening a targeted fishery for pollock may reduce the predation pressure on herring, but this management technique is controversial and will require the complete cooperation of ADF&G who would have to manage the expanded pollock fishery.

3. Altering Carrying Capacity

Herring feed in the winter when food is available, and that winter feeding improves their condition. Overwintering starvation (or predation on nutritionally stressed individuals) is a potentially large source of mortality for herring, particularly for juveniles, so supplying supplemental food to young herring during the winter may lead to improved year-class strength. Advantages of this approach are that cultured herring are known to eat commercial feed, so the cost is likely to be moderate.

Disadvantages include the need to identify appropriate feeding locations, feed the target species without creating more predation or competition, and ensure the fish can metabolize the food.

4. Disease Mitigation

A potentially significant factor limiting PWS herring population is mortality from disease. It has been recommended that we pursue a three tier disease ecology approach which would include establishing infection prevalence; determining the basic relationships between environmental and biological factors influencing disease prevalence and; developing of predictive tools, which will be useful in forecasting the potential for future disease epidemics. The disadvantages of this approach would be the extended timeframe that would be required to complete all three tiers and the fact that it will not add any herring to the system.

5. Managing Competition

Several species of fish occasionally compete with herring for food resources, so competition may be a partial limitation to recovery of herring stocks, particularly at early life stages such as overwintering age-0. Juvenile pollock inhabit the same nursery bays as juvenile herring; the energetic content of pollock tends to increase over the winter, while that of herring declines. If pollock is a significant competitor of herring, removal of that competition has the potential to reduce overwintering mortality. This option relies on the implementation of Option 2, removal of predators. The removal of adult pollock will lower the number of juveniles competing with herring during the over-winter period.

6. Relocation of Stranded Eggs

Two strategies were discussed in the 2008 Cordova meetings: relocating stranded eggs, and relocating spawn to seed underutilized bays. Neither strategy involves impoundment, handling of adults, the lengthy propagation or feeding of larvae and juveniles; hence, the logistics and costs are minimal. Relocation of stranded egg involves moving eggs stranded on the shore back into the water to improve their viability or moving them to another location believed to be more favorable for survival. Advantages of the approach are that the manipulation of eggs may allow them to be marked, handling is relative low, infrastructure is low, and, hence, the cost is relatively low, giving this alternative some attraction. Disadvantages include potential harm to existing eggs during the collection process, the low likelihood of being able to manipulate enough eggs to detect an effect in the population, and it bypasses very few potential bottlenecks (e.g., predations, overwinter survival of age 0) in herring recovery, so it has a low likelihood of success.

7. Improved Management Strategies

The recovery goal outlined in this plan requires a biomass above that currently used to open the fisheries. Therefore, changes to harvest strategies may be needed to allow full rebuilding of the stock. Such changes may include protecting spawning areas from staging and anchoring boats to reduce disturbance to the eggs, changing the fishery threshold, and restricting practices that tend to induce disease. Advantages of the approach include low costs to implement and potentially improved sustainability of the fishery. The disadvantages include not being able to implement until the fishery is reopened and no direct measure of how the changes affect the population.

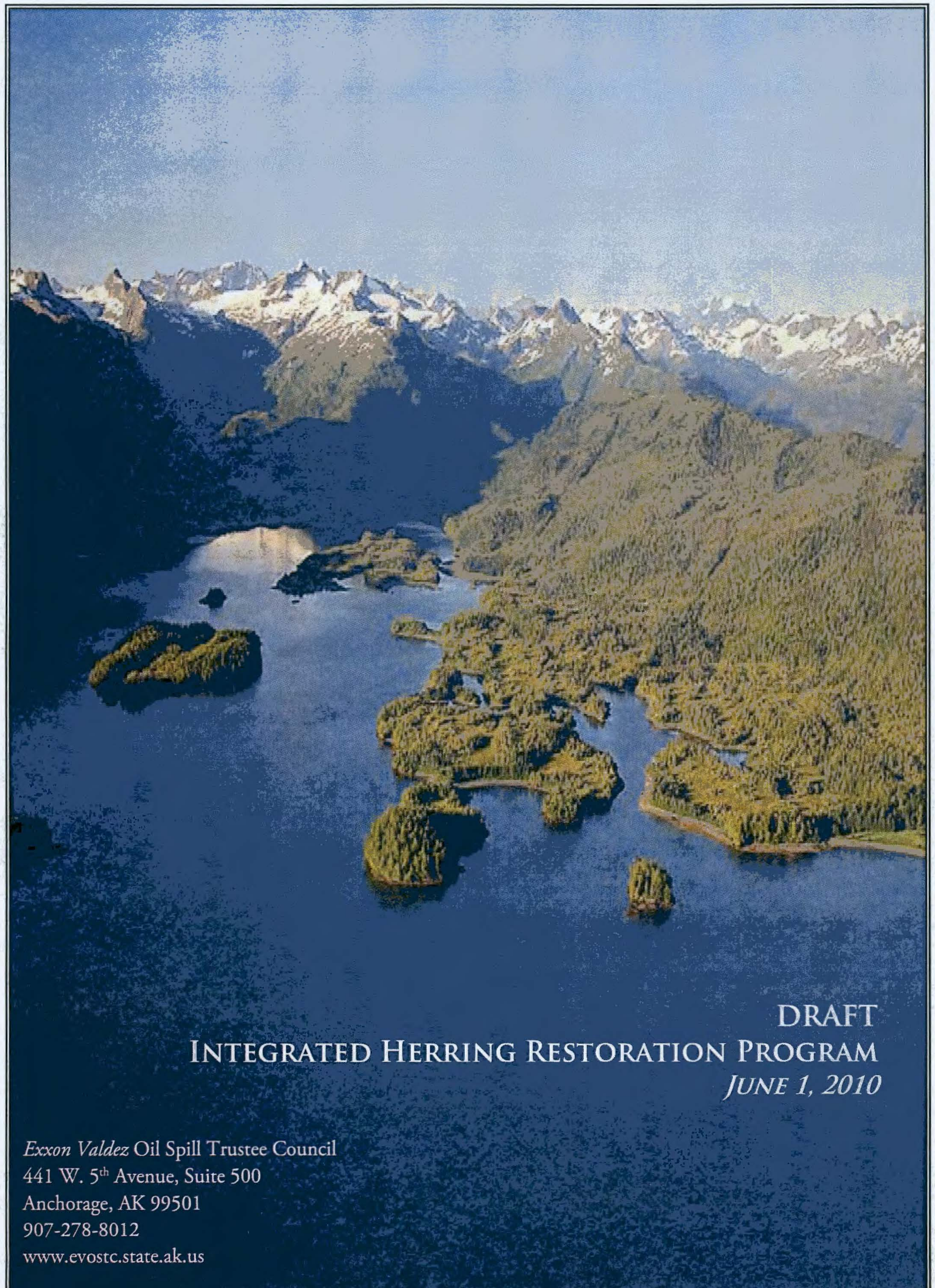
8. Supplemental Production

Supplemental production would release cultured herring to supplement natural recruitment to assist recovery of the population to historical levels. This would be the most intrusive alternative, would require the most infrastructure, probably has the most risk from disease, and would be the most costly of all alternatives. The advantage of this option would be that, in theory, large releases may allow for the direct restoration of herring including the reopening of the fishery.

The following chart summarizes the pros and cons of the eight restoration options that were provided in the IHRP document. I have shaded what I believe to be the two most feasible options for the Council to pursue. While each option has merit, several may be outside of the Council's legal purview or have the potential to harm other species in an effort to help herring.

Option	Pros	Cons
Enhanced Monitoring	• Least expensive option • Would provide more information on herring over the long-term. • No detrimental impact to herring	• No direct addition of herring
Predator Management	• Low cost • Could lower over-winter mortality of herring	• Action can only be taken by ADF&G • May be detrimental to pollock populations • Could be difficult to remove juvenile pollock without also removing juvenile herring.
Altering Carrying Capacity	• Herring are known to eat commercial feed • Cost is likely to be moderate • Could lower over-winter mortality of herring	• Need to identify appropriate feeding locations • May be difficult to feed herring without creating more predation or competition • Would need to ensure the fish can metabolize the food
Disease Mitigation	• No detrimental impact to herring	• No direct addition of herring • Long term program (20+ years)
Managing Competition	• Low cost • Could lower over-winter mortality of herring	• Action can only be taken by ADF&G • May be detrimental to pollock populations
Relocation of Stranded Eggs	• Relatively inexpensive • May allow for marking • Little to no infrastructure required	• Low potential for success • Potential harm to existing eggs during the collection process • Low likelihood of being able to manipulate enough eggs to detect an effect in the population

Option	Pros	Cons
Improved Management Strategies	• Low cost to implement • Potential to improve sustainability of the fishery	• Not able to implement until the fishery is reopened • No direct measure of how the changes affect the population
Supplemental Production	• Would increase populations quickly • May allow for the reopening of the fishery • Would provide a preferred food source to injured seabirds and mammals	• Most expensive of all options • May have detrimental effect on wild herring • Would need the complete cooperation of ADF&G to manage the released fish • Would require the construction of the most infrastructure • Greater risk for disease



DRAFT
INTEGRATED HERRING RESTORATION PROGRAM
JUNE 1, 2010

Exxon Valdez Oil Spill Trustee Council
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Preface

Herring are vital to many different species in North Pacific ecosystems, including humans. Herring transfer energy from zooplankton to upper level predators such as whales, sea birds and larger fish. The complex interactions among herring prey and predators make the examination of herring restoration challenging. Each step in the herring life cycle and the concomitant interaction with either food or predator could be a "bottleneck" point or limiting factor constraining recovery. Prince William Sound herring collapsed in 1993 and have not recovered naturally. It is time to consider potential restoration options that are based on the most likely limiting factors and rigorous science.

Since the 1989 oil spill, scientific research has been conducted on many of the injured species and services in Prince William Sound. Several recovering species have direct links to herring; and thus, herring are a keystone species necessary to support a full recovery of the ecosystem as a whole. Many recovering human services are also linked to the recovery of herring. It is likely that commercial fishing has the most far-reaching implications, with the economic effects of commercial fishing losses felt across entire communities. It is timely that herring restoration be examined now while there is still a viable, remnant stock from which to work. Additionally, the partnership which has developed between scientists and affected communities can carry this effort far.

More than twenty years have passed since the *Exxon Valdez* Oil Spill and herring numbers are still too low to sustain a commercial fishery. Herring are an integral part of every inshore ecosystem on the northwest coast of North America. We cannot consider the Prince William Sound ecosystem recovered from the effects of the oil spill until herring abundance has been restored—even if the collapse of herring cannot be linked directly to the spill.

I am pleased to acknowledge the hard work and dedication of the authors of this program:
Catherine Boerner, Evelyn Brown, Rob Campbell, Doug Hay, Gary Fandrei, Paul Hershberger, Ross Mullins, Vince Patrick, Scott Pegau, Stanley "Jeep" Rice and Doug Woodby. I would also like to extend my thanks to the members of the Herring Steering Committee whose commitment to the restoration of Pacific herring in Prince William Sound has laid the foundation for the future of this important program.

Elise M. Hsieh, Executive Director

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PLEASE COMMENT

You can help the Trustee Council by reviewing this draft program and providing your comments. You can comment by:

Mail:	*Exxon Valdez* Oil Spill Trustee Council 441 W. 5th Avenue, Suite 500 Anchorage, AK 99501 Attn: Integrated Herring Restoration Plan
Telephone:	1-800-478-7745 Collect calls will be accepted from fishers and boaters who call through the marine operator.
Fax:	907-276-7178
E-mail:	elise.hsieh @alaska.gov

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I. Executive Summary and Synopsis of the Restoration Plan

No one knows why herring in Prince William Sound (PWS) collapsed and no one definitively knows how to restore them. The PWS herring population, like all herring populations, fluctuates, but most herring populations rebound after periods of low abundance. This usually follows the suspension of fishing, but PWS herring have not recovered even after fishing has stopped for nearly a decade. It is clear that the present status of the population is severely depressed, but it is less clear if the present state is stable or if the abundance trajectory is improving or declining.

There are a number of approaches that might be successful at assisting with recovery of PWS herring, but none has been proven. Each approach invokes implicit biological assumptions that may be misconstrued or simply wrong. These assumptions often concern fundamental issues about factors affecting herring recruitment and interactions of herring with the ecosystem. Some of these uncertainties have been under investigation for more than a century, and probably will remain uncertain for some time. These limitations in knowledge and understanding impede efforts at herring restoration but do not necessarily stop it. A consequence, however, is that any effort at restoration will require careful efforts at validation to ensure that any changes in abundance are a consequence of a restoration activity and not a natural change.

Most approaches at restoration will be complex, expensive, and encounter both technical and procedural problems. Some approaches may actually be deleterious. These comments are not an excuse for inactivity, but they are a reason to proceed carefully and cautiously. Above all, the implicit guideline for an approach to herring restoration is do no harm. This report presents eight types of restoration activities that might be considered. Not all are necessarily feasible and the report includes and comments on the strengths and weaknesses of each. Further, the report outlines the essential scientific and procedural preparations that must be implemented before any restoration activity could be considered.

In distinct sections the report provides a brief background on the *Exxon Valdez* oil spill, basic herring biology, and potential factors limiting herring recovery. These are followed by a description of eight restoration options or activities. The report concludes with a restoration plan that consists of a list of recommended activities to be conducted in the next year prior to the initiation of any of the restoration options. Mainly these recommended activities will provide perspective about the cost and scale of efforts required for each of the options as well as essential information on the implications of the regulatory environment that could affect restoration work.

The restoration plan consists of three phases in time. Phase 1 (2012–2014) would initiate "*enhanced monitoring*" (Restoration Option 1) of the PWS herring population to better understand recruitment, predator impacts, and demographic and biological changes within the herring population. Beginning in 2010, through modest contracts and/or workshops, scoping activities related to the restoration options would provide: (i) an external review of assessment methodology and sensitivity analysis of capability of current methods to detect change; (ii) a report defining the regulatory environment and implications for restoration work; (iii) a report on "scaling" restoration activities that would examine the effort and cost for different options; and (iv) a report defining decision points about when to initiate and suspend restoration activity. All scoping activities could then be synthesized into a single report that would systematically examine the restoration options relative to feasibility of cost.

Phase 2 (2016–2022) would initiate active implementation work on several restoration options, that are deemed feasible by the scoping activities. This includes "*altering carrying capacity by winter feeding*"

(Restoration Activity 3) and research on "*disease mitigation*" (Restoration Activity 4) and, perhaps, work related to "*relocation of stranded eggs*" (Restoration Option 6). In 2014, a decision would be required whether to attempt "*predator and competition management*" (Restoration Activity 2 and 5) by initiating a fishery targeting on pollock in PWS. This option may require a preceding Environmental Impact Statement (EIS) review. The option of possible "*future supplementation activity*" or a "hatchery" approach (Restoration Activity 8) is substantially more expensive that all other options. Its initiation would depend on preliminary contracts to investigate mass-marking technology and pilot-scale hatchery work. Such contracts would not necessarily imply that herring hatcheries are planned. Rather, in the event that they would be considered, this preliminary and relatively inexpensive preparatory work will have been completed. It is recommended that the merits of Restoration Option 7 (*management strategies*) be considered later, in the future, pending results from the "*disease mitigation work*" (Restoration Activity 4) which warrants unequivocal support.

Phase 3 would begin in approximately five to six years. If the schedule of activities outlined above is started, then likely the abundance trend of the PWS herring population will have been carefully monitored and the results of early restoration activity will be known. If PWS herring continue to decline, and other restoration activities have not been effective, then decision makers should be prepared to consider the supplemental production activity (Restoration Activity 8) as a last resort to herring restoration. Based on work in Japan, this approach can successfully produce herring, but the cost of such work in PWS might be prohibitive.

Synopsis of the restoration plan: 2012–2022

This is a three-stage plan that will begin with immediate enhancement of monitoring and a set of scoping activities that are essential to define the regulatory environment, scale of potential activities and costs, and decision points relative to herring stock conditions that might initiate or suspend restoration activity. Stage 2 would begin selective restoration activities.

Stage 1: Monitoring and Scoping – 2012–2014

Enhanced Monitoring. Initiate three types of enhanced monitoring (recruitment, top-down and herring population).

Preliminary Scoping. Through modest contract and/or workshops, conduct five different scoping activities related to the restoration options: (i) external review of assessment methodology and sensitivity analysis of capability of current methods to detect change; (ii) a report defining the regulatory environment and implications for restoration work; (iii) a report on scaling restoration activities relative to effort and cost; and (iv) a report defining decision points about when to initiate and suspend restoration activity. All scoping activities could then be synthesized in to a single report that would systematically examine the restoration options relative to feasibility of cost.

Stage 2: Selected restoration activity – 2014–2016

Restoration activity: Support the research on *disease mitigation* as soon as possible (Restoration Option 4) and initiate work on altering *carrying capacity by winter feeding* (Restoration Activity 3). Pending results of scoping activities, withhold judgment about the *relocation of stranded egg* activity (Restoration Activity 6) because of potentially flawed suppositions and potential for habitat damage. Finalize decisions regarding predator and competition management (Restoration Activity 2 and 5) by initiating a fishery targeting on pollock in PWS. Withhold judgment and of the merits of Restoration Option 7 (management strategies) pending results from the disease mitigation work (Restoration Activity 2).

Pilot-scale work
To support possible future supplementation activity (Restoration Activity 8) initiate contracts to investigate mass-marking and pilot-scale hatchery work. Such contracts do not necessarily imply that herring hatcheries are planned, but in the unlikely event that they would be considered, this preliminary and relatively inexpensive preparatory work will have been completed.

Stage 3: 2016–2022
In approximately five years, be prepared to initiate the supplemental production activity (Restoration Activity 8) if PWS herring continue to decline, and other restoration activities have not been successful.

II. Introduction

The Prince William Sound herring population collapsed in the early 1990's and has not recovered. Annual recruitment (year class strength) has been poor and the incidence of disease has been high. Despite numerous studies directed at understanding the effects of oil on herring, the cause of the collapse and factors constraining population recovery are poorly understood. A combination of factors, including disease, predation and poor recruitment appear to contribute to the continued low population level of herring in the Sound.

The Integrated Herring Restoration Program (IHRP) examines the information and understanding about the complex factors affecting the PWS herring population, and provides a list of potential restoration activities, ranging from no activity to intensive activity. Although there are many scientific and technical complexities, as well as some political implications to overcome, this report tries to provide a decision tree that will aid decision makers in the future with difficult decisions on what can and should be done to restore herring in PWS.

Restoration plans for fish populations usually begin after stock collapse, not before. Awareness of a sustained collapse may not occur until long after it happens, sometimes years later. Pacific herring populations fluctuate naturally, so symptoms of a sustained collapse can be difficult to recognize. In PWS, symptoms of the collapse included reduced annual spawning and poor recruitment for several consecutive years. Sixteen years after the 1993–94 crash, the population has not rebounded as quickly or in the numbers expected.

Fish stock collapses are not rare events and recovery programs are becoming increasingly common. Over the last 20–30 years, rigorous scientific protocols have been established for restoration programs for many fish stocks. The concept is not new and the potential application to PWS herring is not necessarily unique. Usually initial restoration steps involve a curtailment of fishing and implementing of monitoring and assessment programs. Following the 1993–94 crash, the Alaska Department of Fish and Game (ADF&G) took the necessary steps to close the herring fishery and continue to monitor and assess the population on an annual basis. In effect, these were the first stages in an active restoration program.

A fundamental principle of fisheries management, like management of any renewable resource, is that harvested fish populations will increase reproductive output to compensate for removals by a fishery. The same principle applies as the first response for restoration activity: fishery closures. The basic assumption is that depressed fish populations will recover, reaching former levels of abundance when mortality from fishing is stopped. Therefore, fishing closures, especially for a few consecutive years, should have been sufficient to allow the natural recovery of PWS herring, but this has not yet occurred.

In the context of the scientific approach to fish population restoration, the first approach of restricted fishing should be sufficient to promote recovery. If not, an "intervention" step may be considered. This involves some form of environmental manipulation, usually by promoting better survival of fish eggs or juvenile forms, as in a fish hatchery, but there may be other options and approaches. The main PWS herring restoration issue concerns the wisdom of implementing an "intervention" step. Specifically, is intervention warranted? If so, why and how could it be done? If not, why not?

Most, but not all, information necessary to make a decision about intervention is available. Not all of the uncertainties are biological or scientific – some legal and jurisdictional issues must be addressed before a second "intervention" step could begin. Before any intervention option can be attempted, there are unresolved issues of scale and policy that must be answered. For instance, how many "additional" herring would be needed to make a positive difference to PWS herring recruitment and abundance? Also, uncertainty about costs must be resolved, especially for different types of containment facilities that would be required and would require financial support for staff, equipment, etc. There are serious, unresolved questions about legal and management jurisdictions. For instance, it is established that mass-marking of fish produced from restoration work is an absolute requirement for validation. Less certain, however, are the implications for working within the existing legal framework governing use of certain chemicals required for mass-marking. Similarly, legal concerns about disease, genetic issues and the movement of live fish would need to be addressed.

The *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) has taken the issue of herring restoration through intervention seriously and proceeded carefully. The main EVOSTC tasks directed specifically at potential intervention have been: (i) the 2006–2007 preparation of a draft (white paper) report on the feasibility of enhancement based on Norwegian and Japanese herring "hatchery" approaches – t he white paper also identified the requirement for developing "mass-marking" for PWS herring as an essential prerequisite for scientific validation; (ii) a series of EVOSTC-sponsored meetings in Cordova in 2008 that led to a draft report on potential intervention options and a list of important information gaps; (iii) the acknowledgement that mass-marking is a crucial component of any restoration-intervention approach, which led to the development of a "state-of-the-art" workshop on fish marking in Anchorage, October, 2009; and (iv) a new directive for the 2009 Invitation for Proposals that required herring researchers supported with EVOSTC funding to ensure that their project was integrated with other herring projects, plus a requirement that the research addresses fundamental issues concerned with potential PWS herring restoration.

Many of the issues in this report were identified and discussed during the series of meetings in Cordova in 2008 from which a list of potential recommendations was developed. A key recommendation concerned the adequacy of the present herring monitoring system in PWS. The concern was that the current system may not be adequate to establish a reliable baseline of the population, or even to monitor the present trends in abundance. Therefore, a period of "enhanced monitoring" is advisable as a prerequisite to any restoration activity.

A cautious approach is essential. If any restoration option is undertaken, it must follow rigorous scientific guidelines and criteria for evaluation and verification of intervention activities. It will require several more years before a decision to start intervention could, or should, be made. In the meantime, all current herring research activities funded by the EVOSTC have been designed to address basic questions related to intervention and further better understanding of the potential value of various intervention options.

There are four major sections that follow: Section III discusses the necessary herring biology required to understand the factors that limit herring at different life stages described in Section IV. Section V discusses the range of intervention options, beginning with none and ending with intensive. Lastly, Section VI suggests a sequential plan on which to base future program directions and decisions, thus, supplying future decision makers with the informational tools they will need.

III. Development of the IHRP (Integrated Herring Restoration Program)

The collapse and lingering decline of herring populations in Prince William Sound has stimulated discussions on restoration. The first management option, closing the fishery, has not resulted in an increase in the population sufficient to support a commercial fishery, but the fishery closure may have prevented even worse declines. Now, nearly 16 years later, restoration options are being considered, even though some may be controversial and risky. Salmonid restoration is common, but there has been more than 100 years of science and active hatchery operations in many countries to support this group of species. In contrast, the information base on understanding the limitations facing herring and the related restoration science is rudimentary.

Biology and Science of Fish Restoration

The scientific concepts and principles of fish population restoration are well established but often not implemented systematically or successfully (e.g., Caddy and Agnew 2004; Walters and Martell 2004). In contrast to PWS herring, most fish stock collapses occur after periods of overfishing. Therefore, the scientific basis for restoration of commercially important stock has been developed in the context of overfishing. The standard remedy to correct for overfishing is conceptually simple: reduce fishing pressure or suspend fishing completely. In practice, reducing fish catches can be difficult to implement and control, especially when there are multiple political jurisdictions (i.e., two or more states, provinces or countries) or geographically and technologically complex differences in fishing gear, monitoring and enforcement capabilities, etc. Restoration literature is rich on these topics, but these are moot points relative to the issue of the recovery of herring in PWS.

A basic assumption, applicable to nearly all approaches to restoration of fish populations, is that when fishing stops, populations will re-grow naturally, up to an approximate equilibrium level determined by the capacity of their environment – to a theoretical level known as the "carrying capacity". In general, this basic assumption seems to hold for herring: nearly all commercially harvested herring populations in the world have collapsed at some time during the last century and virtually all recovered (Hay et al. 2001).

Restoration through Intervention

Many commercial fisheries have collapsed in the last 50 years. At the same time rapid development in finfish aquaculture technology compelled some scientists to advocate artificial enhancement (i.e., "intervention") for restoring some fish populations. The most common "intervention" technique would be some form of herring hatchery, but there may be other, or additional approaches that might be considered as applicable in PWS, such as food supplementation or predator control.

The issue of restoration through intervention and particularly enhancement of marine fish populations is controversial. Part of the fisheries science community, mainly from the ecological side, is steadfastly opposed to the concept of marine finfish enhancement. There is another component that is comfortable with the concept. However, even the detractors of the concept suggest that enhancement activity may be warranted when all other conventional management procedures fail. Even then, there are reservations about the efficacy of the approach if density-dependent factors regulating recruitment occur after the release of cultured fish.

Restoration options should be seen as a sequential process or "program" where natural recovery options are tried first, followed by intervention techniques – if possible or necessary. Caddy and Agnew (2004) provide a template of generic methodological steps that must be taken to restore depressed (usually overfished) populations. Most of their recommended steps, such as fishery closures and biological monitoring were already in place in PWS. From this perspective, the first response elements of a restoration plan for PWS had already been implemented, beginning at the time when catch quotas were reduced and also when the fishery was suspended in the mid-1990's. It was not considered as a "restoration plan" at that time, but the activities were the same. Therefore, the actions of the responsible management agency (ADF&G) were consistent with the essential "first response" elements of a formal restoration plan. The subsequent work of continued monitoring and assessment also could be viewed correctly as part of a restoration plan.

The main uncertainty of the PWS herring restoration plan concerns the problem of whether or not to take an additional step of intervention. Specifically what types of steps could be taken and how they could be implemented. The basis of that decision is the focus of this report. A chapter in a fisheries ecology textbook by Walters and Martell (2004) provides explicit protocols for the development, implementation and evaluation of a restoration program through supplemental production (Appendix B - Table 1a-c). Although the comments of Walters and Martell (2004) were directed mainly at artificial rearing and release, many of their recommendations apply to some of the other types of potential restoration options that have been considered for PWS.

Restoration Options

A series of community-based meetings in 2008 produced a list of potential intervention options. Participants included community members, scientists, and participants representing non-governmental organizations (NGO's), state and federal government agencies. These meetings were often difficult as participants struggled to find common ground as they considered a wide range of potential restoration options. Beyond a general agreement that herring are depressed, there was little consensus over the causes the herring decline, the extent or severity of the decline, the present abundance of herring, or what could, or should, be done to address the problem. Nevertheless, the meetings produced a preliminary list of options. However, decisions to proceed with any particular option require further information, in addition to the results of scientific work in progress. There are valid reasons for proceeding carefully and cautiously. A formidable reason concerns the issue of scientific validation. Any restoration program involving intervention will be expensive, and could even entail some adverse environmental effects. It is essential that the validity of the approach can be monitored and evaluated.

Beginning in 2009, all EVOSTC-funded research projects concerned with herring were designed to be mutually complementary – hence "integrated" – through the sharing of data and logistical support, etc. More projects were started in 2009 and 2010 and nearly every project will contribute some key information or understanding about either (i) the factors limiting herring recovery or (ii) the feasibility of one or more potential intervention approaches.

Criteria for Successful Restoration

Criteria for restoration have been defined provisionally as a time in the future when the PWS herring population meets the following criteria:

- spawning biomass has been above 43,000 metric tons for 6–8 years;
- two "strong" recruitments of age 3 fish in those 6–8 years (strong is ≥ 220 million fish);
- spawning occurring in 3 or more regions of PWS (e.g., North, East and West).

Meeting these goals means that the population is relatively healthy and stable, with a mix of age classes in the population, as opposed to one dominant age class. Because we do not fully understand the differences in survival of eggs, larvae or juveniles from the different spawning locations, there was consensus that three regional spawning areas within PWS was an important goal. The biomass target of 43,000 metric tons for 6–8 years was a mean of years during a good period, and it was thought these numbers would be more sustainable through tough years (swamping predators for example).

The duration of the program is roughly estimated at about 20 years. Probably it would take two or three years to initiate some of the pre-requisite work for some options, especially those that require mass-marking of herring.

Potential Problems for Restoration
If herring restoration were simple and inexpensive, almost certainly it already would have occurred. There are several fundamental problems related to the objective:

(i) *Costs:* Restoration activities can be very expensive, and EVOSTC already has expended significant funds to understand fundamental and practical issues of herring biology.

(ii) ***Scientific limits to understanding or knowledge:*** At the present time there is insufficient technical information required for certain restoration options, but this problem can be resolved with additional research. For example, it does not make sense to produce hundreds of millions of juveniles to be released in the late fall if the limiting factor is overwinter survival from starvation. Or, could the production of additional herring result in an increase in predators? A better understanding of these factors will aid in the decisions of intervention strategies and locations.

(iii) ***Logistics and technology:*** PWS is remote and when coupled with the realities of harsh winters, all intervention strategies will need to be well-designed and safe for operation. These are solvable issues, but they are not trivial, and their solutions may be costly.

(iv) ***Limited accessible technical skill:*** For many activities, people with particular skill sets are required. Even if funds are available, it can be difficult to access specialized technical skill sets to work in remote parts of PWS.

(v) ***Institutional, procedural and legal issues:*** Surprisingly, this category represents one of the most difficult and formidable constraints to many potential herring restoration activities. Institutional, state and federal agencies have the legal mandate to protect fisheries and habitat through a series of procedures (e.g., environmental impact statement, permitting process with disease reviews); all of these processes will receive scientific and legal scrutiny, including from different interest groups. There are concerns for putting wild populations at risk, the use of chemicals in mass-marking, permitting, moving live fish, etc.

The Role of EVOSTC: Restoration by Intervention
A decision to investigate the feasibility of a particular restoration option does not necessarily mean that EVOSTC is committed to implementing a large-scale intervention program. Instead, the intention is to examine the implications of the concept, as it applies to herring in PWS. Full-scale intervention activities would require several years of preparation, mainly to develop and determine some technological issues, such as mass-marking of fish. Mass-marking and other technological activities are fundamental pre-requisites of any intervention activity. Therefore, because the development of these technological issues will take time, it is important that some investigations begin immediately. It also is important to understand that these investigations also could result in a definitive conclusion that the restoration activities are impractical or far too expensive.

IV. Herring Biology
Research of herring biology, supported by EVOSTC for more than 20 years, provides a foundation for understanding ecological factors affecting the PWS herring population and insight about which restoration options are the most feasible. The following is a brief biological overview relevant to the restoration options.

Distribution
Pacific herring (*Clupea pallasi*) is one of about 180 species within the family Clupeidae (Order Clupeiformes). Pacific herring occur in waters of the continental shelf from northern Baja California to arctic Alaska, westward along shelf waters to Russia and south to Japan and the Yellow Sea. They also occur in some major estuarine areas of Arctic (Hay 1985) (Figure 2).

Life History
Herring have four distinct life stages: eggs, larvae, juveniles and adults. In PWS spawning occurs mainly in April, usually with durations of days or a few weeks. Annual mean spawning time is temperature-dependent and can vary, by a few days or even week. Eggs are adhesive and usually attached to vegetation. Hatching occurs in 2–4 weeks. After hatching, larval herring are small (~6–8 mm long) and are translucent. They move to the surface where they join the ichthyoplankton and thin. At this stage they may be advected over considerable distances, but probably are retained within the Sound. The larvae have yolks that will last a few days, followed by feeding on invertebrate eggs and small zooplankton, especially eggs and nauplii of copepods. As larvae grow, they begin to move and congregate in nearshore areas. By July, or about 10 weeks after hatching, they metamorphose into juveniles, gain silver pigmentation and begin to assume a typical herring shape. In the fall, the juveniles move into deeper water but nearshore habitat remains important for at least the first year, and they may spend up to two years in nearshore areas or bays before joining the adult population residing in deeper waters (Brown and Carls 1998). Copepods remain an important food for all life stages but adults also feed on larger crustaceans and small fish. During winter, as temperature and light decrease, food supply becomes limited and both young and adult year classes stop feeding functionally. Survival of young herring through the winter depends on the amount of food that was available in the preceding summer and their ability to store sufficient lipid reserves to sustain them over the winter. For the older age classes, winter is less limiting on direct survival but may affect their reproductive condition and spawning capacity in the spring (Carls et al. 2001).

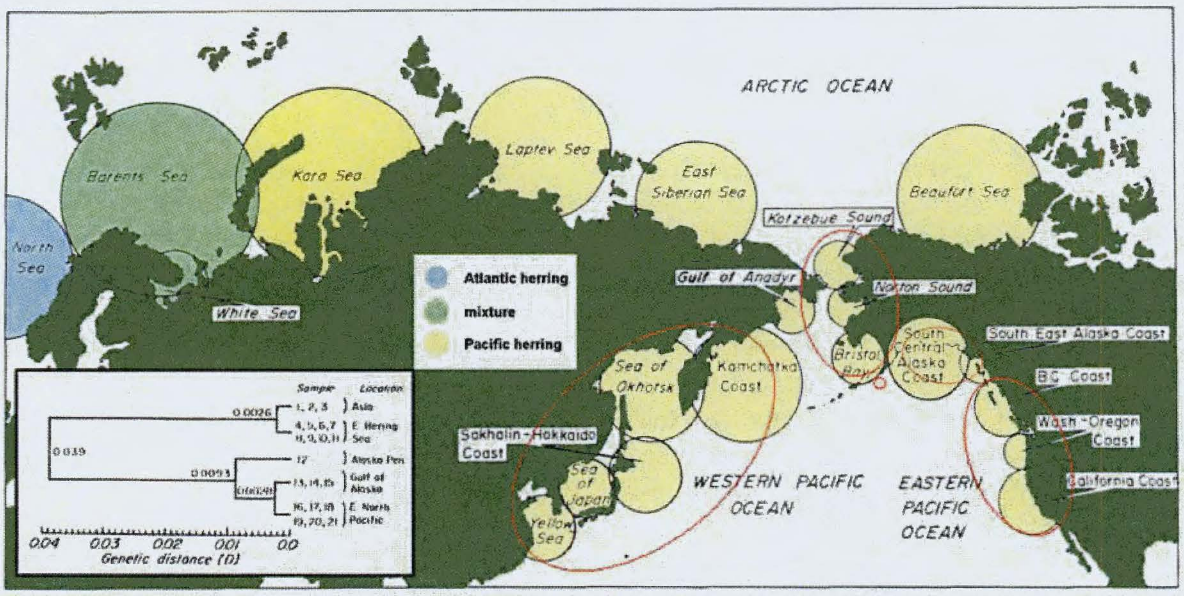

Fig.2. Global distribution of Pacific herring (adapted from Hay 1985)

Spawning Biology
Spawning in PWS typically takes place in April and the spawning season varies from five days to three weeks. Spawning locations may vary, but herring often spawn along the same beaches each year, although the volume of eggs and shoreline distances varies (Brown and Carls 1998; Carls et al. 2002). For example, from 1994 to 1997, the annual spawning beach length ranged from 23.3 to 68.5 km (Willette et al. 1998). Figure 3 shows Pacific herring spawning beds located throughout PWS based upon 1973–2006 data from the Alaska Department of Fish and Game (Moffitt, personal communication, 2006)

During spawning, the eggs attach to eelgrass, rockweed (*Fucus* sp) and kelp in shallow subtidal and intertidal areas. The eggs hatch in May, about 24 days after spawning depending on temperature (Hart 1973; Brown and Carls 1998).

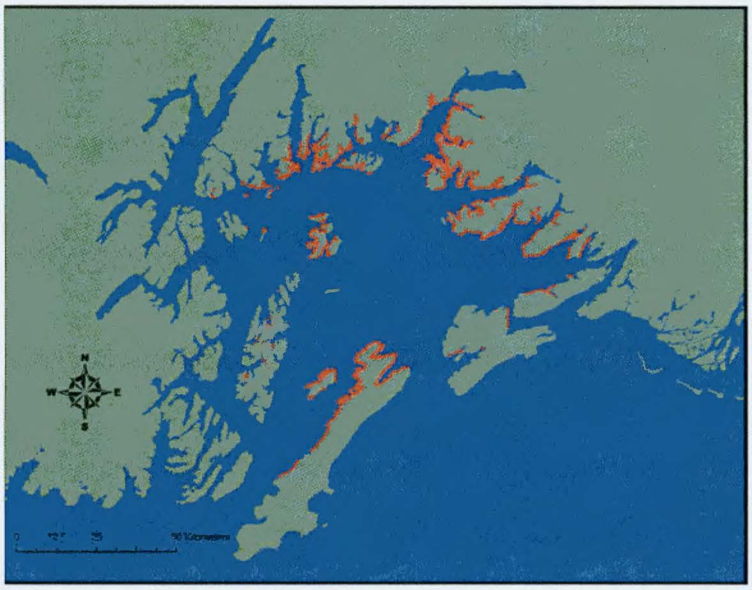

Fig.3 Pacific herring spawning beds located throughout PWS based upon 1973 - 2006 data from the Alaska Department of Fish and Game (Moffitt 2006, pers. comm.)

In PWS, adult Pacific herring rarely spawn before their third year and may live up to 15 years. The average life span of a PWS herring is nine years. After spawning in the spring, adult Pacific herring disperse from the spawning aggregations to multiple schools in deeper waters. The exact distribution of PWS herring in the summer months is uncertain, but in other regions herring typically migrate to open shelf waters to feed and return to sheltered in shore waters, in central and eastern PWS, in the fall to overwinter. The locations of the fall seine catches in the reduction fishery in the early half of the last century often was close to the entrance of PWS (Rounsfell and Dehlgren 1932; Brown and Carls 1998).

V. Potential Factors Limiting Recovery
Ideally, understanding the limiting factors would be a key to the deciding which intervention strategies have the best chance at success. A problem, however, is that this fundamental question has eluded scientific investigators throughout the world, studying herring, and other marine species. Very likely there are many different types of limiting factors (top down factors, bottom up factors), and they each will impact different life stages. One factor may be more effective in limiting recruitment of juveniles (e.g., winter availability of small prey), while another factor may be more limiting to adults (e.g., disease). The understanding is further complicated because the dominance of one factor not only may change with life stage or season, but also may change between years.

Lingering Oil

The PWS herring population was increasing prior to 1989, with record harvests reported just before the spill (Figure 3). After the spill, the 1989 year class of herring was one of the smallest cohorts of spawning adults recorded and by 1993 the fishery had collapsed with only 25 percent of the expected adults returning to spawn. To many it seemed obvious that the poor 1993 recruitment was a consequence of the spill that occurred four years earlier. The population collapse led to the closure of the commercial herring roe fishery, and ignited debate about the cause. Some remain convinced that the spill was the cause; others believe it was caused by natural systems (Rice and Carls 2007). We may never know the cause of the collapse with certainty or when it started because there is a conflict between data interpretations (Hulson et al. 2008; Thorne and Thomas 2008). While the cause of the original decline is clouded with unknowns that we cannot resolve, it is more important to understand why there is a lack of recovery.

Unhealthy fish were detected at the same time as the crash, and multiple stressors (including exposure to PAH's) can exacerbate some chronic infections to epizootic disease. Highly virulent pathogens continue to be present in the current population, and may continue to play a role as a limiting factor on the population. Disease surveillances did not occur in the previous years to the spill. Hydro-acoustic estimates of over-wintering populations were initiated in 1993, after the decline in population was detected. It is clear that the spill had some direct effects on eggs and larvae that were directly exposed to oil in 1989, but it is less certain that such exposure to oil led directly to the 1993 crash, although the 1989 cohort represented one of the poorest recruitments ever observed.

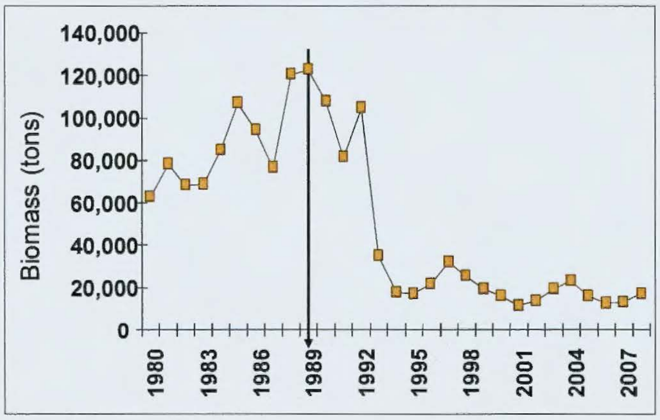

Fig 3. ADF&G ASA Model, 2008

For oil to be a cause of the current population depression, 1) lingering oil must have continued to exert new effects, or 2) the oil exposures of 1989 must have caused a persistent biological effects. There is no evidence of such persistent effects in herring. On the contrary, polynuclear aromatic hydrocarbon loads in the water are very low (Carls et al. 2006). Less than 0.2 percentof the shoreline has evidence of oil contamination (from lingering oil or from human historical habitation sites), and virtually none of that overlaps with the current spawning areas of herring (Boehm et al. 2004). Only trace concentrations of persistent organic pollutants (e.g., pesticides and polychlorinated biphenols) are detectable in intertidal areas.

Lingering oil effects are not suspected as an explanation for the continued depression of herring. There is no evidence of significant herring exposure to oil in PWS after 1990. Unlike the habitat of certain other species (pink salmon, sea otters, and harlequin ducks), oil did not persist in herring habitat (open water and intertidal shorelines); thus, the herring population is not affected by a chronic source of lingering oil. Northeastern spawning areas were not affected by the *Exxon Valdez* oil spill, nor were north-central spawning grounds (which are not currently utilized by the herring). There was little overlap between shoreline oiling and herring spawning on Montague Island and in the Naked Island group (another area not currently utilized by herring).

Spawning Habitat

Pacific herring spawn in shallow sub-tidal and intertidal water (Haegele et al. 1981). On rare occasions thick egg deposition can limit survival (Hay 1985; Taylor 1971), but that it rare in most spawning areas in PWS and elsewhere. Similarly, low oxygen or high temperature may kill or impair development of large numbers of eggs (Purcell and Grover 1990), but this is not an issue in PWS. On the contrary, herring spawning habitat in PWS is not considered impaired by human activity, pollutants, or natural factors. Therefore, there appears to be no credible limitation to herring recovery associated with spawning habitat.

Restricted Genetic Diversity

Genetic diversity in PWS herring, examined in 1995 and 1996 (shortly after the 1993 population collapse) was comparable to that of other healthy Northeast Pacific herring populations (Seeb et al. 1999; Beacham et al. 2008). This is not surprising since herring are a "metapopulation", meaning there is significant gene flow between adjacent herring populations throughout the Pacific west coast. Both gene diversity (heterozygosity) and allelic diversity (the number of alleles per locus) are high in PWS herring. The genetic diversity of PWS herring is similar to that of herring from Cherry Point but significantly higher than that of herring from San Francisco Bay. Both of the latter stocks are stressed. All measurements examined fail to demonstrate evidence of a genetic bottleneck among PWS herring capable of reducing recruitment success. According to observed genetic diversity, the 2.2×104 metric ton minimum spawning biomass threshold needed to conduct a commercial fishery is expected to protect the long-term genetic diversity of PWS herring. Even currently low population levels appear to be at least one thousand times higher than the upper bound on the evolutionarily effective population size of PWS herring. Gene flow is significant between southwest PWS and the Gulf of Alaska as well as within PWS, but subpopulations within PWS cannot be reliably differentiated. Because of large inter-annual genetic variation, further work with neutral DNA markers is unlikely to "resolve the question of whether demographically independent stocks occur within Prince William Sound or even in the northern Gulf of Alaska" (O'Connell et al. 1998). Any restoration option or intervention strategy needs to preserve genetic diversity.

Competition

With depressed population levels it is possible that another species has filled niches in the ecosystem that herring previously occupied. The competition for habitat or food at some life stage may limit the success of herring. Juvenile gadids, such as saffron cod or pollock, are often found in large numbers in the same habitats as juvenile herring. Although the Sound Ecosystem Assessment program found that there was no food competition between age 0 herring and pink salmon smolts (REF), there may be competition between these two species at different life stage or for different resources. At least one recent modeling project suggested that hatchery released salmon smolts are responsible for maintaining the depressed herring populations (Deriso et al. 2008), but the roles of competition as a factor preventing herring recovery remains uncertain.

Recruitment Issues

The net population increase or decrease is the result of factors that take the population down, such as disease, predation, senescence, and how that is balanced against the forces that increase the numbers, such as more food in the summer building up the energy levels to get through the winter. "Recruitment" refers to population increases as juveniles "recruit" into the adult population. After the 1993 crash, recruitment was low in the 1995–1998 cohorts. Years with low recruitment also occur in other Pacific herring populations but consecutive low recruitment events are relatively rare (on the order of once every 50 years). However, 4-year to 6-year runs of low recruitment have occurred at other times in other herring populations, from Washington State to Togiak, Alaska. Strong recruitment from the lowest biomass levels has not been observed at PWS or Prince Rupert, but five of the ten examined herring populations (Togiak, Sitka, Craig, Queen Charlotte Islands, and West Coast of Vancouver Island) have generated extremely strong recruitment events from the lowest biomass levels. While the low recruitments from the 1995 to 1998 year classes are within the range of natural variability, recovery of PWS herring will require further good recruitment events, combined with increased adult survival from disease and other sources.

Oceanographic Conditions
Oceanographic conditions (mixing, temperatures) have a direct effect on primary product, and thus have a fundamental effect on the amount of energy transferred to the zooplankton that herring feed on. PWS oceanographic conditions vary annually (Gay 2007; Gay and Vaghan 2001), but do not explain the 15 years of poor recruitment in PWS herring. Pacific herring respond to climatic changes, with increases in some populations during warm conditions when plankton production is generally better than during cold years. The Gulf of Alaska populations have increased during the positive phase of the Pacific Decadal Oscillation, when the Gulf of Alaska is stormy, warm and the water is well-mixed (Brown 2006). The favorable conditions for these populations appear to be related to higher plankton production, as there are larger fish at equivalent ages when zooplankton are more abundant. However, anomalously cold conditions, detected in PWS beginning in 2006, may have a negative impact on herring populations (Weingartner 2007).

Disease
A potentially significant factor affecting PWS Pacific herring recovery is age-dependent mortality from three pathogens: mesomycetozoan *Ichthyophonus hoferi*, viral hemorrhagic septicemia virus (VHSV), and filamentous bacteria (associated with cutaneous ulcers). A severe outbreak of VHSV began in 1993 and recurred again in 1998. Epidemics of *I. hofer*i peaked in 2001 and 2005. In general, newly recruiting 3-year-olds have the highest VHSV infection rates. VHSV infection rates decrease in older fish. In contrast, *I. hoferi* infection rates increase as herring age, thus affecting the largest and most reproductively capable adults.

The causes for sustained disease problems from 1993 through 2003 are not apparent. Immune suppression can be caused after acute exposure to oil, but no herring living today in PWS were alive and exposed in 1989, and no continuing exposure to lingering oil is suspected. At present, the relationship among disease and other factors, such as the lack of food, is not apparent. The PWS Pacific herring population remains too low to allow commercial fishing and there is no hypothesis to explain the continuing disease or adequate information to predict when disease problems will abate.

Predation
In the PWS ecosystem predation on herring transfers energy from zooplankton to predators, including humpback whales, harbor seals, birds, and other fish. In this role, herring may also significantly influence or control the grazing pressure exerted on lower trophic levels (Cole and McGlade 1998). Of these predator-prey interactions, the relationship between humpback whales and PWS herring has been identified as a factor potentially limiting recovery. Intensive foraging on aggregated winter herring may represent a significant source of mortality to herring, particularly if herring stocks are depressed and humpback whales numbers increase. A whale feeding on herring from October to mid-February (150 d), would consume about 4.5×105 herring. More than 100 whales were observed feeding on herring in

winter 2008/2009 and have been estimated to consume the equivalent of a typical commercial fishery (Rice et al. 2010).

Juvenile herring are heavily predated by multiple species of seabirds, including five species injured by the EVOS (Bishop and Kuletz 2007). Current research is focused on the spatial and temporal abundance of seabird predators in and around juvenile herring schools, as well as the physical and biological characteristics of the schools used for feeding. The estimates of juvenile herring consumption produced by this work will aid in planning future restoration efforts as well as in assessing the role of seabird predation on herring recruitment by providing data to both herring and ecosystem modeling.

Energy Consumption/Food Availability

Juvenile herring diets become more varied as they grow, though they continue to feed on copepods (Hart 1973; Norcross and Brown 2001). The energy content of available food also varies seasonally, lowest in late fall and highest in spring (Norcross 2001). Sufficient energy storage to maintain age 0 and age 1 juveniles over winter is critical to juvenile herring survival in PWS. Food availability declines in winter months (the highest percentage of empty stomachs is in December; Norcross et al. 2001) and fish in cold regions often fast or reduce feeding (Paul et al. 1998). Consequently, whole body energy content drops over winter; YOY juveniles either consumed relatively less energy than adults during this period or only those with the highest energy content in the fall survived (Paul et al. 1998). Based on research results on PWS herring juveniles, energy consumption appears higher than other populations (Sitka, Lynn Canal), and when coupled with food limitations, especially for overwintering age 0 juveniles, may be a limiting factor. Overwinter survival is probably one of the most important limiting factors in the recruitment of juveniles to the adult population for all stocks, and may be disproportionately important for PWS herring.

VI. Eight Restoration Options

It may be possible to promote restoration of herring in Prince William Sound using intervention methods such as increasing over-winter survival of 0+ juveniles by artificial feeding during the late fall or the release of juveniles reared in hatcheries. However, every potential restoration option could be controversial and few have been tried or demonstrated to be technically feasible or cost effective. Further, the use of direct restoration activities may cause unintended adverse environmental outcomes such as the increase in incidence of disease to herring or other fishes. In some instances pilot projects can test the effectiveness and help to understand the factors limiting herring recovery. All potential interventions will benefit from improved knowledge on limiting factors that may affect the success of various intervention options. The following text presents a list and summary of restoration options (summarized in Table 1), starting with the least risky and lowest degree of intervention and progressing to the heaviest intervention.

Table 1. Summary and comparison of eight restoration options. The columns summarize the life stage, potential problems, benefits, start time and duration, cost, likelihood of validation and potential for harm. Costs estimates (in $thousands) are approximations.

Restoration activity	Life stage	Potential problems	Benefits	Start	Duration	Cost	Validation	Potential Harm
1. No restoration action but enhanced monitoring Enhanced monitoring to inform decision makers about choice of intervention options and to obtain supplemental information on recruitment, disease, post-winter YOY survival; comparative bay productivity	All stages	Modest increases in cost	Potentially improved management decisions, enhancement of all science projects	Immediate	Long >10 years	Moderate $250K-$1000K/y, but reduced after several years	Not applicable	Nil
2. Predator management Reduce mortality by controlling the level of predation on herring. Walleye pollock is a potentially major predator (and competitor) of herring during winter. A targeted fishery for pollock is a potential restoration option.	Age 0+ to age 1+ herring, increase survival in winter	Selective removal of predators without impacts on herring	Relatively simple approach utilizing local community support.	1-2 years	Short	Low $10K-$50K/y	Difficult	Moderate
3. Altering carrying capacity Concurrent research investigations would conduct field experiments comparing feed supplemented versus non-supplemented areas, etc.								
(1) Winter food supplementation. During winter, as temperature and light decrease, food supply diminishes and could become limiting for age 0+ juveniles. Food would be added to selected areas in PWS.	Age 0+, December to May	Potential technical challenges - getting food to herring and vice versa	Potentially a relatively simple and inexpensive	1-2 years	Moderate - > 5 years	Moderate Pilot-scale: $50-$100K/y, full scale: $100-$1000K/y	possible but requiring moderate research effort	Nil
(2) Increase productivity in parts of PWS by adding additional nutrients: adding inorganic nutrients to increase fish production has been done successfully in lakes for many years.	All ages - increased nutrition from spring to fall.	Validation, and indirect effect on herring	Improved growth	1-2 years	Moderate - > 5 years	Moderate Pilot-scale: $50-$100K/y, full scale: $100-$1000K/y	difficult and perhaps expensive	Low
4. Disease mitigation A disease ecology approach involves a three tiered process								
(1) Monitor infection prevalence and intensity to anticipate future epizootics and evaluate efficacy of future disease management strategies.	Age 0+ juveniles and all older ages	Normal issues related to fish health research	Potentially improved management, scientific benefits	1-2 years	Moderate - > 5 years	Moderate $100-$200K/y	NA	Nil
(2) Empirical studies to determine epidemiological relationships between environmental/biological factors and disease.	All ages	Normal issues related to fish health research	Potentially improved management, scientific benefits	1-2 years	Up to 5 y	Moderate $200-$400/y	"	"
(3) Develop predictive tools to forecast future disease epidemics.	Age 0+ juveniles and all older ages	Normal issues related to fish health research	Potentially improved management, scientific benefits	1-2 years	3-5 years	Moderate $~$200/y	"	"

Restoration activity	Life stage	Potential problems	Benefits	Start	Duration	Cost	Validation	Potential Harm
5. Managing competition Herring may be out-competed by pollock at the overwintering age-0 stage. If pollock is a significant competitor of herring, removal of that competition has the potential to reduce overwintering mortality.								
Selectively remove pollock by a fishery targeting that species. Targeting juvenile pollock may be difficult because it often co-occurs with herring but a selective fishery for adult pollock is feasible.	Age 0+ juveniles and all older ages	Potential controversy; capture/mortality of non-target species, disposal of pollock catch	Relatively simple approach utilizing local community support.	1-2 years	Short	Low ~$50K/y but additional cost possible for EIS review	Difficult	Low
6. Relocation of stranded eggs Two strategies were identified: relocating stranded eggs, and relocating spawn to seed underutilized bays.								
(1) Relocation of stranded egg involves moving eggs stranded on the shore back into the water to improve their viability or moving them to another location believed to be more favorable for survival.	Eggs and larvae	Basic assumptions may be valid; potential damage to healthy spawn.	Probably none	1-2 years	Short	Low ~$100K/y	Difficult, bordering	Low to moderate
(2) Relocation of spawn, by picking kelp laden with spawn has the advantage of a higher probability of having more viable embryos survive till hatching.	Eggs and larvae	Basic assumptions probably are invalid. There is potential for damage to healthy spawn.	Development of expertise useful for other restoration options (supp. production).	Soon - 2010-2011	Short	Low ~$100K/y	Simple to prove ineffective	Low to moderate
7. Improved management strategies Harvest strategies change may be needed to rebuild the stock. This effort would include a public process involving the Alaska Board of Fisheries, stakeholders, and ADF&G personnel, possibly including a workshop. Changes may include protecting spawning areas from staging and anchoring boats, revising fishery thresholds, and restricting practices that induce disease. This option has a low cost and potentially improved sustainability of the fishery. The disadvantage is delayed implementation until the fishery is reopened and no direct measure of how the changes affect the population.	Spawning adults	No implementation until the fishery is reopened and no effective validation.	Low costs to implement and potentially improved sustainability of the fishery.	Uncertain	Indefinite	Low ~$50K/y (max) - but potential loss of future fishery revenue	Not certain, probably impossible	

Restoration activity	Life stage	Potential problems	Benefits	Start	Duration	Cost	Validation	Potential Harm
8. Supplemental production Supplemental production would release cultured herring to supplement natural recruitment to assist recovery of the population to historical levels. This would be the most intrusive alternative, would require the most infrastructure, probably has the most risk from disease, and most costly of all alternatives.								
(1) Pilot-scale tests	eggs to 0+ juvenile (age 6 months)	High cost, long development and implementation period	Could follow established prototypes from Japan	1-2 years	1-5 years	Moderate-high $300-1000K/y	not applicable to pilot-scale	low
Restoration activity	**Life stage**	**Potential problems**	**Benefits**	**Start**	**Duration**	**Cost**	**Validation**	**Potential Harm**
(2) Herring hatchery or hatcheries - shore based or transportable within PWS	eggs to 0+ juvenile (age 6 months)	High cost, long development and implementation period	Direct addition of fish to the population	> 2years, requiring development of mass marking technology	minimum of 10 years	High-very high $5,000K/y (or higher)	possible, necessary requiring mass marking	unknown potential for disease exacerbation

1. Enhanced Monitoring (with no specific restoration activity)
A serious restoration option is to take no intervention and wait for natural recovery This option requires monitoring of the population to determine abundance trends in the adult population. Keeping tabs on population trends will inform and aid decision makers about choices of intervention options. This option provides supplemental information, such as evaluations of recruitment, trends in disease, post-winter survival by young of the year, and relative productivity of various nursery bays. Enhanced monitoring also might lead to a better understanding of the role of disease, predictability of disease outbreaks, and potential disease management practices that reduce disease impacts. Monitoring of herring populations and quantification and measurement of critical life-history attributes might also allow for the development of better predictive models of herring stocks, more protective fisheries management practices, and longer-term sustainability of the stock.

The tools and understanding developed by monitoring and research would be expected to provide fisheries managers with better predictions of herring populations allowing for more adaptive management practices that will be needed even if active intervention is implemented. The greatest advantage is that no ecological manipulation is required. The disadvantage is that it does nothing to restore herring populations.

2. Predator Management
The goal of predator management is to reduce mortality by controlling the level of predation on herring. Herring are a common prey item of fish, birds, and mammals, and predation is, therefore, a likely factor limiting recovery of herring in PWS. Predator management can be accomplished by altering the behavior of a predator (known as "hazing"), or by outright removal of the predator. Clearly, there are a number of herring predators whose abundance and behavior cannot be manipulated, on legal and moral grounds: Two major mammal predators in PWS (humpback whales and Steller sea lions) currently are listed as endangered species. Moreover, an important consideration for the recovery of herring populations is that they are prey to avian predators still listed as "not recovered" from EVOS. However, there are a number of significant fish predators on herring, including groundfish (walleye pollock, cod and halibut) and salmon. Behavioral modification of fish predators is not possible, but they may be removed by targeted fisheries. Walleye Pollock in particular has been identified as a potentially major predator (and competitor) of herring during the winter period, particularly the juveniles that are struggling for survival in their two years, and a targeted fishery for that species is the most feasible restoration option.

Predator management is a controversial approach. The simplest form of predator control would be fishery for some of the dominant fish predators. More controversial would be the hazing of marine mammals or birds (possible during the spawning events). It has the disadvantages of having no manner to directly test the efficacy, some of the predators are endangered species, and relying on reduction fisheries practices. Probably a directed fishery to reduce the PWS pollock population may be subject to the preparation of an Environmental Impact Statement (EIS) and review.

3. Altering Carrying Capacity
Herring feed in the winter when food is available, and that winter feeding improves their condition (Rice 2007). Overwintering starvation (or predation on nutritionally stressed individuals) is a potentially large source of mortality for herring, particularly for juveniles, so supplying supplemental food to young herring during the winter may lead to improved year-class strength.

Food may be a limiting factor for at least part of the herring life cycle. During winter, as temperature and light decrease, food supply diminishes and could become limiting, especially for age 0 juveniles. Survival of young herring through the winter depends on food availability in the preceding summer and the lipid reserves that sustain herring over the winter (Blaxter and Holliday 1963; Hay et al. 1988; Paul et al.1998; Vollenweider and Heintz 2007). For older age classes, winter survival is less precarious, but food availability may affect their reproductive condition and spawning capacity in the spring (Carls et al. 2001). Therefore, the food environment experienced by herring prior to, and during, winter may influence year class strength and reproductive capacity. These observations indicate that if food supplementation were feasible, especially to juveniles that are concentrated in shallow, nearshore habitats, then it might lead to improved survival.

There is a wide variety of marine feeds that have been developed for aquaculture that could be used towards this end, some manufactured (pellet food and the like), some more natural than others (e.g., *Artemia* eggs and nauplii); each have some advantages and drawbacks in terms of price, simplicity, and nutritional value.

A slightly different approach may promote increased productivity in parts of PWS by adding inorganic nutrients to increase fish production, as has been done successfully in lakes for many years (Hyatt et al. 2004). Fertilization has not been attempted in the coastal ocean, mainly due to problems of residence time (i.e., dilution by tidal flushing) and scale (the vast amount of nutrients required). Even in well-constrained lakes, nutrient additions have usually been of a single, limiting nutrient, and unbalanced nutrient ratios have often lead to unintended consequences (blooms of algae types that are grazer resistant, for instance). Rather than adding allochthonous nutrients (i.e., nutrients that are brought in from an external source), it is also possible to enhance the movement of autochthonous (i.e., local) nutrients by moving deep water to the surface. Deep water is generally nutrient enriched (by the degradation of sinking organic matter); nutrient levels in the deep waters of the North Pacific are among the highest in the world ocean (Reid 1961, 1965).

Nutrients usually are prevented from being transported upwards and mixed to the surface by temperature or salinity gradients. Such gradients are especially pronounced in PWS, where the large amount of fresh water input every spring and summer create a relatively fresh surface layer overlying deeper, nutrient rich water. However, it is possible to move deep water to the surface, which will increase nutrient concentrations and enhance production; the technology has been used for many years for shellfish aquaculture. A series of simple calculations suggest that artificial upwelling may enhance growth in fish stocks (Kirke 2003), though those calculations were done for a low latitude reef ecosystem.

The surface waters of PWS usually are stratified in summer (Vaghan et al. 2001), which tends to reduce nutrient fluxes to the surface. Most primary production occurs in April and May (Eslinger et al. 2001).) Mechanical "upwellers" could be used to enhance late-summer production: the technique has been recently demonstrated in the open ocean (Grabowski et al. 2008). Age-0 and age-1 schools inhabit nearshore areas and by late-July locally enhanced production and increased food availability could then be expected to result in increased energetic reserves in young herring which could lead to a concomitant reduction in overwintering mortality (Norcross et al. 2001).

There are many questions that need to be addressed prior to initiating an overwintering feeding or nutrient enrichment program. Within overwintering bays, it is important to have some understanding of the current winter carrying capacity. Measurements of how much food is available to overwintering herring can be assessed by plankton surveys. It is also important to understand the bioenergetic requirements of herring during winter, in order to determine how much food is required. However, the bioenergetics of herring are fairly well known (Megrey et al. 2007). Finally, surveys to enumerate herring and their competitors are needed, in order to determine how much food would be required.

To assess the effectiveness of an overwintering feeding program, it would be important to monitor winter survival as well as the energetic condition of the fish. A comparative approach, where one bay is manipulated and one is not, would permit testing whether or not food additions improved overwintering survival and by how much. A potential test of the effectiveness of feeding supplementation could be based on fatty acid (FA) profiles. If the FA composition of manipulated bays were different than the profiles of non-affected bays, then this would be reflected in the FA of herring that consume the food. Therefore, FA testing, combined with other tests, could determine if manipulation led to increased feeding of herring, and if the effects of the manipulation were limited to local areas, or whether the possible movements of herring among different bays, obscured any local effects. Similarly, to assess the effectiveness of a late summer nutrient enrichment, it would be important to also monitor the effectiveness of the upwelling system (with measurements of nutrients and productivity), as well as to follow survival and energetic condition of the fish. Again, a bay-to-bay comparison would be required to determine if nutrient additions were effective.

The technological requirements for a feeding program are fairly modest. There is a requirement for technological development of the method used to deliver the food, and evaluation of the nutritive composition of the food. Aquaculture nutrition is a mature science, and there are many aquaculture feeds currently available that might be used for herring. Similarly, a late summer nutrient enrichment program could use existing upweller technology. Some upwellers are powered by waves, others by mechanical pumps; it is likely that an enclosed bay (which receives less wave action) would require the use of the latter. Both of these restoration options would need to be informed by synoptic, broad scale surveys of overwintering bays in PWS; high-speed, cost-effective survey methodologies (optical and acoustic) are required to collect the necessary data at the appropriate scale and at a reasonable cost.

The approach depends on being able to identify the location of overwintering juveniles and providing an appropriate feed for them. It is important that any such program not attract predators or competition for the food resources. A full scale program may require repeated feeding at several locations within Prince William Sound. Advantages of this approach are that cultured herring are known to eat commercial feed, so the cost is likely to be moderate. Also, it may be possible to mark the fish using the feed. Disadvantages include the need to identify appropriate feeding locations, feed the target species without creating more predation or competition, and ensure the fish can metabolize the food.

4. Disease Mitigation

A potentially significant factor limiting PWS herring population is age-dependent mortality from three pathogens: the mesomycetozoan *Ichthyophonus hoferi*, viral hemorrhagic septicemia virus (VHSV), and filamentous bacteria (associated with cutaneous ulcers). A severe outbreak of VHSV and ulcers began in 1993. Epidemics have cycled through the Pacific herring population in PWS about every four years with decreasing severity since 1993. However, epidemics of *I. hoferi* have been observed in more recent years.

The causes of the persistent disease are not apparent. Unfortunately, there are no long-term disease data sets for other herring populations or other species with which to make comparisons. Immune suppression can be caused after acute exposure to oil, but no herring living today in PWS were alive and exposed in 1989, and no continuing exposure to lingering oil is suspected. An original hypothesis was that disease was a sporadic event associated with exceeding carrying capacity (Marty et al. 1998), but the 1998, 2001, 2002, and 2005 disease events occurred when the population was relatively low. How the current levels of disease and their interaction with other factors, such as predation or poor nutrition, affect mortality rates at the different life stages is unknown.

Traditional disease management strategies involve an integration of infection prevalence and intensity monitoring with mitigation strategies, including prevention with prophylactics, treatment with appropriate therapeutics, and adaptive disease management practices that are evaluated by continued disease monitoring. Although this proven process typically works extremely well in hatchery situations, where fish are monitored and manipulated under semi-controlled conditions, the traditional disease management process is not appropriate in situations involving populations of wild marine fish, including Pacific herring in Prince William Sound. For example, administration of prophylactics and therapeutics to populations of wild marine fish are complicated by issues involving ecosystem scale and fish community dynamics, and are typically not considered appropriate for populations of wild fishes. These complications have historically prevented the advancement of disease management in populations of wild fish; however, the field of disease ecology has recently emerged and is offering creative ways to mitigate and manage diseases in wild populations.

A disease ecology approach is similar to that employed by the World Health Organization (WHO) and Centers for Disease Control (CDC), and involves a three tiered process involving:

(1) Establishment and continuation of infection prevalence and intensity monitoring and surveillances. This component is required to monitor changes that signal the emergence of future epizootics and to evaluate the efficacy of future disease management strategies.

(2) Incorporation of empirical studies intended to determine the basic epidemiological relationships between environmental and biological factors influencing infection / disease prevalence.

(3) Development of predictive tools, based on known epidemiological relationships, which will be useful in forecasting the potential for future disease epidemics.

Combined, this three-tiered approach will provide the basic epidemiological information necessary to develop and validate adaptive disease management strategies intended to mitigate the effects of future herring disease outbreaks in PWS; these adaptive management strategies can then be evaluated and adjusted through continued monitoring for infection prevalence and intensity. A very clear advantage of this approach over that employed by the WHO and CDC involves utilization of the natural host (Pacific herring), rather than mammalian surrogates for humans, in empirical manipulation studies.

Interaction between the disease mitigation and supplemental production options
Disease principles, relationships, and adaptive management strategies addressed in the Disease Mitigation option are also critical and intimately tied to the success of restoration option 8: Supplemental Production. Disease is a natural phenomenon inherent to populations of both wild and hatchery fishes, with both groups of fish sharing similar causes, exacerbating factors, and principles of disease. For example, viral hemorrhagic septicemia causes large epizootics among populations of wild Pacific herring (Traxler and Kieser 1994, Meyers and Winton 1995, Meyers et al. 1999, Hedrick et al. 2003), and often causes epizootics in impounded herring used for the closed pound spawn-on-kelp (SOK) fishery that has occurred in PWS (Hershberger et al 1999). As a result of extremely large quantities of infective virus shed into the water during active epizootics (Kocan et al. 1997; Hershberger et al. 1999; and Hershberger et al. In Preparation), some have questioned the impacts of the closed pound SOK fishery on initiating epizootics and deleterious population-level effects to wild, un-impounded herring.

5. Managing Competition
Several species of fish occasionally compete with herring for food resources, so competition may be a partial limitation to recovery of herring stocks, particularly at early life stages such as overwintering age-0. Recent work (Deriso et al. 2008) suggests that competition (and predation) from juvenile salmon released from hatcheries in PWS may be limiting the recovery of herring. However, the importance of salmon hatcheries in the local economy precludes limiting their output.

Juvenile walleye pollock (*Theragra chalcogramma*) is also a significant competitor to herring in PWS (Sturdevant 1999; Purcell and Sturdevant 2001). Juvenile pollock inhabit the same nursery bays as juvenile herring; the energetic content of pollock tends to increase over the winter, while that of herring declines (Paul et al. 1998; Kline 2008). This suggests that herring may be out-competed by pollock during the winter, which would add to overwintering mortality (pollock is also a predator of herring, and predator control is dealt with in another section). If pollock is a significant competitor of herring, removal of that competition has the potential to reduce overwintering mortality.

The removal of pollock may be accomplished by a selective fishery specifically targeting that species. In practice it may not be possible to specifically target juvenile pollock, because it often co-occurs with herring. A selective fishery for adult pollock could be accomplished more easily and would result in a concomitant reduction in the number of juvenile pollock the following year (as well as removing a major predator of herring in PWS). To be successful, some basic knowledge of the biology of pollock in PWS would be required, including estimates of stock size, age structure and distributions. As well, there would be no need to develop specific fishing gear technologies for this option; pre-existing gear and methods could be employed.

6. Relocation of Stranded Eggs

Two strategies were discussed in the 2008 Cordova meetings: relocating stranded eggs, and relocating spawn to seed underutilized bays. Neither strategy involves impoundment, handling of adults, the lengthy propagation or feeding of larvae and juveniles; hence, the logistics and costs are minimal.

Relocation of stranded egg involves moving eggs stranded on the shore back into the water to improve their viability or moving them to another location believed to be more favorable for survival. Some participants in the 2008 Cordova meetings considered stranded eggs to be a waste. They advocated a strategy to salvage the "wasted spawn" to reduce mortality at the egg and through the larval drift stages of life. Some of the assumptions for moving stranded eggs may be challenged, however. In a study that examined the collection and transfer of such eggs to a new location, most of the eggs were found to be viable, even after extended periods on the shore (Hay and Marliave 1988). Further, many of the stranded eggs were naturally re-immersed in water on subsequent tides.

Relocation of spawn, by picking kelp laden with spawn, would be more intrusive, but has the advantage of a higher probability of having more viable embryos survive till hatching. Because the picked kelp could be held in a predator-exclusion structure, such as a herring impoundment, high hatch rates could be expected. This mechanism would permit the possible seeding of bays removed from the current spawn areas. Advocates of this approach, however, should realize that prior work in BC was unsuccessful. Although billions of eggs were collected and transported to a new location, there was no subsequent spawning in the location in the years following the transfer (Hay and Marliave 1988).

Advantages of the approach are that the manipulation of eggs may allow them to be marked, handling is relative low, infrastructure is low, and, hence, the cost is relatively low, giving this alternative some attraction. Disadvantages include potential harm to existing eggs during the collection process, the low likelihood of being able to manipulate enough eggs to detect an effect in the population, and it bypasses very few potential bottlenecks (e.g., predations, overwinter survival of age 0) in herring recovery, so it has a lower likelihood of success.

7. Improved Management Strategies

The recovery goal outlined in this plan requires a biomass above that currently used to open the fisheries. Therefore, changes to harvest strategies may be needed to allow full rebuilding of the stock. Such changes may include protecting spawning areas from staging and anchoring boats to reduce disturbance to the eggs, changing the fishery threshold, and restricting practices that tend to induce disease. Advantages of the approach include low costs to implement and potentially improved sustainability of the fishery. The disadvantages include not being able to implement until the fishery is reopened and no direct measure of how the changes affect the population.

8. Supplemental Production

Supplemental production would release cultured herring to supplement natural recruitment to assist recovery of the population to historical levels. This would be the most intrusive alternative, would require the most infrastructure, probably has the most risk from disease, and would be the most costly of all alternatives.

Rationale and overview

Raising early life stages of herring in captivity avoids high rates of mortality occurring at larval and juvenile stages. This approach appears to be successful in Japan where herring are cultured successfully, released into the natural environment as juveniles, and recovered years later as adults. If this approach were tried in PWS, all fish released must be marked to provide a basis for evaluation of the program. The success of a supplemental program may depend on the duration of the rearing period: longer is better, up to a maximum of a year. Therefore, the duration of the captivity period is uncertain at this time, but a spring release would avoid potential starvation in the winter, and would release juveniles at the time of the spring bloom when wild food abounds.

Mass-marking technology would need to be developed and authenticated before enhancement activities could be considered. Also, a "core" monitoring program to measure natural impacts on the PWS herring population must be in place. Supplemental production approaches could be costly and it is essential to determine valid cost estimates required to ensure success. Uncertainties involve unresolved questions of scale. Specifically, how many juvenile herring would be required to effectively supplement natural recruitment, and what would the program cost? These questions could be addressed in a "white paper" that considers the scale and costs of a supplemental program.

As an approximate guide to the probable scale of a supplemental operation, a 10 percent increase in the present annual recruitment of about 200 hundred million age 3 recruits, would require the addition of 20 million age 3 herring. Probably the mortality between the time when supplemented herring are released (as 0+ herring in their first winter) and the time when they join the spawning population (as age-3 or age 4 recruits) is substantial (>90%). Therefore, it may require the rearing and release of at least 200 million herring juveniles, and perhaps more, to achieve even a modest (10 %) increase in recruitment of 10 percent. Production of this magnitude is in the same ballpark as the hatchery releases of salmon in PWS.

An advantage of supplementation is that it adds fish directly to the ecosystem and technology exists for rearing large numbers of juveniles. Another advantage is that it involves very low impact on the wild population in that relatively small numbers of herring are required as sources of eggs. For instance, a relatively good cohort of herring in PWS at the present time might consist of about two hundred million fish (or 20 thousand tons), about ten times greater than the sizes of most recent cohorts). Even full-scale supplementation would not attempt to rear twohundred million herring, but even if it did, it would require the eggs from only about one ton of herring (or 0.005% of the present population). Probably a more realistic number for potential supplemental production would be the addition of 20 million fish (approximately the same number as the number of released pink salmon released annually). Even allowing for considerable mortality (90%), etc., such supplemental production (20 million additional recruits) would require the gametes (eggs and sperm) from about one ton of herring.

Disadvantages of a supplemental production option include the potentially high costs associated with the duration of the herring rearing period and the potential for the release of diseased or inferior stock. Probably it would require 2–3 years to establish the efficacy of a mass-marking technology, although it is likely that such an approach can be met successfully, provided that permitting issues can be addressed. The time required to conduct pilot-scale experiments is at least several years. Another three years may be needed to implement full-scale supplemental production. Once released it would require 3–4 years before some of this hatchery-produced cohort recruited to the adult population. Therefore, it would take at least six years and probably several more before the success of the project could be evaluated.

Supplementation facilities
The types of containment systems that might be used for mass-rearing of PWS herring require further discussion and innovation. Traditional shore-based facilities, which require massive volumes of pumped sea water, provided to fish housed in large tanks, are probably not the prototype for work in PWS. A drawback from such an approach is that the release site would be confined to the immediate vicinity of the shore-based hatchery. This may be a problem because the optimal locations for release may be elsewhere. It would likely be best to release hatchery-reared herring in multiple sites, especially in habitats that are known to be natural habitats for juvenile herring. Such widely distributed release would be simplified if SP-herring were reared in floating facilities that could be towed to one of more release sites. Experience with herring bait pond operations in British Columbia and Washington State shows that the capture, confinement and movement of live herring can be difficult. Herring do not react favorably to being moved with dip-nets or confined to small net-cages, even for short periods. Often such handling results in abrasion and scale loss followed by disease outbreaks. It follows that such practices must be avoided during the conceptual design phases of any potential herring project.

Validation approaches—the essential requirement for mass-marking
Regardless of the place, duration or larval containment method, all fish released must be marked to allow the efficacy of the program to be determined. This fundamental requirement must be established early in the enhancement schedule of activities. There are positive spin-offs that accompany a well designed mark-recapture programs as they would also provide means to address fundamental questions about factors limiting recovery. There is also the potential for controlling the release site environment in a manner that can inform the efficacy of other restoration alternatives.

Although artificially reared herring can be successfully released to the wild, there is still uncertainty about whether such releases actually increase the population or merely displace naturally produced fish. Similar debates continue about supplemental production of other hatchery-produced species, such as salmon, and the answers are not necessarily clear. A resolution to such a debate involves a marking or tagging program of naturally produced species, done in conjunction with releases from supplemental production. However, the implementation of such a tagging program for wild herring would not need to be initiated until the technology for mass-rearing and mass-marking of hatchery-reared herring is well established. This would require a few years.

Pilot-scale experiments
Any full-scale supplemental production program (i.e., release of herring juveniles reared in captivity) must be preceded by pilot-scale experimental projects that establish a protocol for effective mass-marking. This is not trivial and it took several years of preliminary work before Japanese researchers were able to meet this requirement. Work in PWS can build on Japanese experience, but pilot-scale experimental work is essential because conditions differ. The best pilot-scaled program would provide the information needed for developing a full-scale in situ herring marking and rearing program.

VII. Monitoring and Core Data Collection

Any restoration activity will require basic information about the PWS herring population. Annual assessments of spawning stock biomass (SSB) are essential – both for any intervention activity as well as for the continuity of responsible management. Regardless of which, if any, restoration option is undertaken, monitoring will play an important role in the restoration process. Monitoring will be required as part of any active restoration program to evaluate the efficacy of various active restoration methods, the status of recovery, and the potential occurrence of unintended adverse impacts.

Enhancement of monitoring for stock assessment
Currently, an annual stock assessment is completed by ADF&G. Data requirements for a minimal management plan require samples of the spawning population to determine the age and size structure. These data are supplemented by assessments of the relative abundance of herring spawn (measures as the cumulative distance of spawn along shorelines). Further, these data are often supplemented by acoustic surveys in selected parts of PWS. Due to funding and staffing constraints, the current surveys are not as comprehensive as needed to gain a working understanding of the current state of herring in PWS.

***Top-down process monitoring*:** Predator and disease monitoring need continued monitoring. We understand both processes exist, but we have less understanding of the dynamics of both processes across years and life stages. Both of these processes will continue to occur with wild fish but also come into play with enhanced fish.

Disease monitoring: Regular collection of specimens would be used to test for the presence of pathogens. Further, there must be a capability to evaluate the extent of epizootics as they occur.

Predators/competitors: The abundance and distribution of important predators/competitors to herring is required, particularly as they affect the early life stages and recruitment. In general, this will require a combination of field surveys and subsequent laboratory analysis to evaluation trophic relationships of herring and other species that consume the same prey as herring.

Oceanographic monitoring: Oceanographic monitoring of the physical and biotic environment in PWS must continue. Environmental conditions affect the growth environment for herring, which in turn may affect survival, especially the over-wintering survival of age 0+ juveniles. Further, the amount of planktonic food transfer between PWS and the Gulf of Alaska can impact the ecosystem within the sound (Cooney et al. 2001).

VIII. Implementation Plan

Restoring herring is a complex problem, from scientific, technical, legal, and political perspectives. The path to successful restoration is not obvious or simple. Every path is likely to be controversial, including the speed along the path. Every potential restoration activity will require a sequence of difficult decisions and probably the information available may not be fully satisfactory basis for most decisions. Given this uncertainty, the plan outlined below is designed to make progressive advancements in better understanding of the technical efficacy and limitations, financial costs and legal implications of potential restoration activity.

Moving forward toward the goal of a restored herring population will require time and careful evaluation of the present status of herring and the possible impact of potential activities. A "phased approach" is best, with each of several phases focusing on different stages of the development of the program.

A defensible, scientific approach to herring restoration in Prince William Sound would be to approach the issue in incremental steps, or stages. At the beginning of each step there would be an objective and a set of activities that would be evaluated at the end of the step. We suggest that the earliest steps of a "conceptual phase" that began approximately in 2007, are already completed. We are now at the beginning of a second "scoping stage", but the components of the first stage are described below to provide a context for the subsequent components of a restoration plan.

The initial phase of herring restoration has likely already occurred in the form of four distinct activities: (1) a series of meetings in Cordova in 2008 that developed a list of potential restoration activities; (2) beginning in 2010, a restructuring of EVOSTC-funded research proposals concerned with herring to ensure that all were inter-connected and addressed issues or questions related to one or more of the potential restoration options; (3) in 2007 a report (white paper) that reviewed the efforts of herring restoration, and related activities in other countries; and (4) in 2008–2009 a workshop and report on issues related to mass-marking and tagging of herring, which could be essential components for validation of any herring restoration program.

Although there is a list of eight herring restoration options (summarized in Table 1), none is fully developed to the point of implementation. Mainly, the uncertainties concern factors that can be examined in the first year or two (2012–2014).

Stage 1 – Monitoring and scoping stage: strategies and feasibilities (2012–2014)

The preliminary steps taken in stage 1 helped to define and understand the potential options, but it also led to the understanding that there are other aspects that must be addressed prior to initiating any active restoration intervention or activity. This stage should begin in 2012 and be completed in 2013 or 2014 and consists of ensuring that all of the technical, scientific, legal and administrative components are in place prior to any active restoration work. It also includes specific requirements, to begin as soon as possible, to enhance monitoring.

Enhancement monitoring is essential, so that recruitment factors are better understood. Three types of monitoring can be distinguished:

(1) Recruitment monitoring, mainly associated with contract research directed at the pre-recruitment life stages of herring biology and ecology. This includes oceanographic monitoring, sampling for juvenile herring in bays, and other work, some of which is currently in progress as part of contract work funded by EVOSTC for the years 2010-2013. This specific monitoring should be re-evaluated after three field seasons (in 2012) with the intention of reducing the effort (perhaps by half) and selecting and retaining the most productive and informative monitoring measures on recruitment, to be continued for the next 4–20 years but at a reduced level.

(2) Top-down monitoring, mainly associated with predation on all life stages, but with particular emphasis on bird, mammal and fish predation of older juveniles and adult herring. Enhanced "top-down monitoring" should begin in the next 1–2 years, and continue for about five more years, followed by a longer period when it is re-examined, reconfigured and conducted at a reduced level.

(3) Herring population monitoring, with special emphasis on age composition, geographic distribution, and spatial and temporal variation in size and age within PWS.

Five scoping tasks are defined, each of which should result in a stand-alone report. The completion of this scoping stage would be an assessment and evaluation of all of the information that would provide essential details about cost and scale of effort related to each potential restoration option.

Scoping Task One: Monitoring evaluation.

The first scoping task is to ensure that the present monitoring systems for herring can adequately detect change in abundance, either for increases or declines. This can be done best in a small workshop of scientific and technical experts, mainly from ADF&G and NOAA. The workshop would culminate in a written report, that will review present and past monitoring and assessments. The workshop report would compare procedures used for herring assessments in PWS and (i) comment on the relative strengths or weaknesses relative to assessments done elsewhere, especially in the northeast Pacific, (ii) estimate the sensitivity of the present approach, in terms of the ability to detect changes in recruitment or abundance, or other demographic or ecological changes in herring, such as spawning location; and (iii) recommend specific changes, as required that might be essential for the restoration options. This work could be done within the next 12 months.

Scoping Task Two: Defining the regulatory environment.

A different but concurrent preparation task is to develop a stand-alone report that would describe the implications of restoration activity relative to the regulatory environment in PWS. For instance, most restoration activities involve movement of live fish, and this aspect falls under jurisdiction of the State of Alaska. There also are regulatory implications of fish disease, etc. Prior to initiating any restoration work there must be a well-defined method for determining the regulatory implications for specific restoration activities. This report could be done by contract, or perhaps by a short-term secondment (1–2 weeks) of state or federal personnel who understand the broad range of regulations that might affect any of the potential restoration activities. This work could be done within the first 12 months.

Scoping Task Three: Scaling restoration activities.

A third concurrent task, relevant to some, but not all, potential restoration activities, is to determine the "scale" of changes that must be made to make a significant impact. For instance, some restoration activities attempt to improve survival of young herring entering the adult population – or the technical term is "recruitment". It is necessary to estimate the level of increase in recruitment that would be required to make (1) a detectable difference and (2) a significant increase, so that the PWS herring population could be restored. Similarly, if the objective of a restoration activity were to decrease predation rates (i.e., increase survival) of adult herring, then there is a requirement to know how much activity is required to make a detectable difference. Completing this preparation activity could be done in a small workshop or some short-term contracts that would prepare a definitive report on the scale required for each of the potential restoration activities. This work could be done within the first 12 months.

Scoping Task Four: Defining key biological decision points.

A fourth preparation activity is to examine and define criteria and "decision points" for guiding restoration work. It is essential to have defined criteria that would provide a quantitative basis for (1) deciding when to initiate any restoration activity and (2) when to suspend restoration activity, if the population is recovering. Changes in abundance, although probably the primary factor affecting restoration work, are not the only criteria. For instance, restoration activity might also be based on changes in spatial distribution (especially if all herring were confined to specific areas) or pronounced changes (voids) in demographics (i.e., missing several cohorts in the age composition). This "pre-restoration" activity could be initiated in a workshop, held within a year that would produce a set of workable criteria and restoration points.

Scoping Task Five: Costs and directions.

This activity concerns issues of scale and cost and the temporal duration of potential restoration activities. Many restoration activities would be very expensive, especially if conducted at a scale that would impact the entire PWS. Some would require nearly a decade or more to be fully implemented and evaluated. The costs of such work could be prohibitive, requiring more than the EVOSTC budget. Prior to initiating any restoration activity, it is essential that the approximate costs of each activity be examined, both for the implementation of pilot-scale work and the potential start of full-scale restoration. This preparation task follows as a logical outcome of the four other tasks (monitoring, regulation, scaling and decision points). It will require about one year to complete all of the other preparation tasks. At that time, during the spring or summer of 2013, the information from each of the four preparation tasks would be assembled and examined by a small team of specialists representing skill sets that could establish a credible evaluation of the costs and time associated with each of the potential restoration activities. The composition of this team could be decided during the coming year and could include some of the same people who contributed to the four other preparation tasks reports.

Stages 2 and 3 – Implementation and monitoring (2014–2022)
Stage 3 is not fully defined and must wait for the full development of stage 2 (enhanced monitoring and scoping tasks). The recommendation is to pursue the restoration options that (i) do no harm; (ii) are the least expensive, and (iii) appear to have some chance of success that can be validated.

The list of options (Table 1) begins with "no action" as Restoration Activity 1. The choice of this option would depend on recent trend in PWS herring abundance between 2009 and 2014. If herring abundance appears to be increasing, this may be an acceptable option. If the trend were for continuing deterioration of herring, then the no-action option should be dropped in favor of one or more active intervention options. A key decision point concerns the level of herring abundance that is deemed to warrant sufficient concern to lead to the implementation of restoration work. This decision point should be defined in a scoping workshop in (see Scoping Task Four above).

Of all of the restoration options, the simplest and least expensive would be predator management – in the form of a target fishery for pollock (Restoration Activity 2). This specific option also addresses the "managing competition" option (Restoration Activity 5). The predation hypothesis is that pollock predation on herring has led to some reduction of the PWS herring population, so that elimination of the predator biomass would lead to enhance herring survival. The competition hypothesis is that juvenile pollock may compete for similar zooplankton food as juvenile herring ; therefore, reducing adult pollock would lead to a reduction of juvenile pollock, hence, reduced competition. The main problem with this option is that it would be difficult to verify its success because herring populations might have increased even if a pollock fishery did not occur. In contrast, it would be relatively simple to confirm that restoration by pollock removal failed, and this would occur if herring has not increased after fisheries targeting on pollock. The advantage of this approach is that the work is relatively inexpensive, but the public reaction could be mixed, especially if there were no market for the captured pollock (i.e., wasted) or if there were significant bycatch, especially of herring. The conceptual basis for the competition-reduction hypothesis may require more attention. The premise is that the reduction of adult pollock would eventually lead to a reduction of juvenile pollock that compete with herring for limited food. This premise requires more scrutiny.

Two options to alter carrying capacity through altering carrying capacity or food supplementation (Restoration Activity 3) also could be conducted for a moderate cost, although there are some technical details that remain uncertain. The key hypothesis is that survival of age 0+ herring may be restricted by food limitation. The addition of relatively small amounts of food could stem the over-wintering mortality that may limit herring recruitment in PWS. Although technical uncertainties exist, this option is relatively inexpensive and addresses interesting and important hypotheses based on early work by Norcross, Brown, Paul and others (see references). It would be difficult to confirm the hypothesis that herring recruitment improved following feeding (the evidence would only be circumstantial), but if there were no marked improvement in recruitment following feeding supplementation, corroborated by sampling of herring juvenile nutritional condition, then this option could be discarded as ineffectual. The attractive aspect of this option is that the work is experimental, addresses key scientific issues and is relatively inexpensive. There may be opportunities to develop tests that monitor unique natural chemical signal in supplemented food (such as fatty acid profiles) that would provide a basis for tracking the fate of supplemented food, and whether it is utilized effectively by herring.

The disease mitigation activity (Restoration Activity 4) does not involve active restoration activity, but it seeks to determine if there are any underlying relationships between environmental factors and the incidence of herring disease. In general, this approach involves leading edge, technically sophisticated and rigorous scientific research. It is relatively modest in cost and has negligible impact on herring with potential to provide significant benefits.

The premise for the relocation of stranded eggs (Restoration Activity 6) may be flawed, because stranded eggs are not necessarily doomed, and tidal actions may re-immerse some stranded eggs. Also, herring eggs can develop normally for extended periods in air provided that temperatures are not extreme and the eggs do not become desiccated. Although the cost of relocating eggs is relatively low, there could be deleterious impacts on normally developing eggs. Perhaps a redeeming aspect of this activity is development of egg acquisition protocols for possible herring hatchery work (Restoration Activity 8), if that were to develop. There is virtually no way to evaluate the efficacy of egg relocation, but it is possible, and likely, that the approach could be ruled unsuccessful, or the implicit assumptions about herring stock structure were incorrect, if herring did not establish or re-establish in the transplanted locations (Hay and Marliave 1988).

The improved management strategies activity (Restoration Activity 7) is based on the assumption that flaws in herring fishery management may has contributed to the 1993 collapse,, but hard evidence for this is lacking. Perhaps the major concern is that some impoundment operations may have led to the spread of disease. This issue warrants further attention, but it is not especially relevant until the PWS herring population is recovered.

The final restoration activity of supplemental production (Restoration Activity 8) or herring hatchery(s) is the most difficult and expensive and has the longest duration. Ironically, it is the one activity that has a successful prototype, based on Japanese work. This concept and details of this approach have been examined elsewhere, but the main reservation about proceeding with this approach is that the cost could be very high and the role of disease transmission from such hatcheries environments is unknown. If this approach were attempted, it must be preceded with pilot-scale work on mass-marking (recommended) and pilot-scale rearing facilities (perhaps recommended but not immediately). Even with the successful completion of preliminary mass-marking and pilot-scale work, this supplemental production option should only be undertaken as a "last resort", if and when there has been demonstrable failure of the preceding approaches to increase herring abundance and a deterioration of natural production.

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Appendix A - Terminology

Recovery – Recovery is the return of the PWS herring population to some defined level. This can occur naturally or through restoration activities.

Restoration – Restoration is the recovery of the PWS herring population through human actions.

Intervention – Intervention describes the activity that attempts to either increase PWS herring birth rates or reduce PWS herring mortality.

Enhancement – The goal of restoring the herring population in a habitat that is capable of sustaining it.

Integrated program – An ecosystem based program organized around common goals/hypotheses determined and implemented through involvement by impacted communities and scientists to develop a teamwork that creates efficiencies, open communication, and inter-related activities that inform each other to achieve the program goals.

Supplemental production – the release of cultured herring to increase the existing herring population.

Intensive aquaculture – Rearing of herring using traditional hatcheries and artificial environments.

Extensive aquaculture – using natural habitats (bays) to rear herring

Recruitment - the process of older juveniles becoming sexually mature and joining the adult population. This definition is specific to Northeast Pacific herring.

Gamete - sperm or unfertilized ova, prior to release from adult fish

Egg – fertilized ovum, adhesive and sessile, within the inter-tidal and shallow sub-tidal zone, with developing embryo, and hatching in ~ 3 weeks

Larva – recently hatched embryo, living off yolk sac (~5 days) and feeding on small (~100 µm) zooplankton, living in surface waters (mainly top 20 m) and part of the zooplankton community, although most abundance in nearshore habitats. In general, larvae are long and thin, with little resemblance to adult forms.

Metamorphic – process of change between larval and juvenile forms (pigmentation beginning, physical change)

Juvenile – the stages between the larvae and sexually mature adult. Young juveniles begin to assume the adult form and develop silvery-colored scales. In general separate cohorts begin to aggregate together and form schools. In general the young juvenile stages are retained in nearshore habitats, but may venture into offshore (continental shelf areas) during their second or third years. The duration of the juvenile stages usually ends at age 3 or 4 when the fish are sexually maturing and joining adult schools.

Adult – the sexually mature stage, beginning at age 3 or 4 (36–48 months of age). Adults may form sub-populations that may, or may not migrate to shelf waters for summer feeding. In general adult herring form dense aggregations during winter months and remain relatively immobile and feed opportunistically.

Mass-marking – the ability to place a physical or chemical mark on large numbers of fish in order to determine their place of origin

In-situ – taking place in the original environment; not moved

Carrying capacity - The maximum population of a particular organism that a given environment can support without detrimental effects

Otolith - Calcareous particles found in the inner ear

Appendix B – Critical Steps In Program Design

Table 1a - Critical steps in program design – (adapted from Chapter 13, Walters and Martell, 2004). The discussion of development steps in a generic marine fish enhancement program was adapted to and Excel sheet. The comments in the right column indicate the present state of PWS herring relative to an enhancement program.

Critical steps in program design		Comment
Step 1	**Make management priorities and trade-offs clear and acceptable**	Tradeoffs could be difficult if the cause of low herring abundance was related to the pink salmon hatchery programs. This critical step asks "what if the Prince William Sound herring stock cannot co-exist at high levels of abundance with other stocks?"
Step 2	**Demonstrate recruitment overfishing or unsuccessfully rearing in the wild**	This step is fully met. Annual stock assessments are done annually. There is no fishery, so there is no concern with recruitment-overfishing, unless herring are taken in significant quantities and bycatch (or killed by collateral damage) in other fisheries. This seems unlikely.
Step 3	**Show that enhanced fish can successfully recruit in the wild**	This has been shown by Japanese work.
Step 4	**Show that total abundance is increased by the enhancement contribution**	This step has NOT yet been shown by Japanese work. Although potential restoration methods used in Prince William Sound may resemble those used in Japan, the objectives are not necessarily the same. The best way to meet this objective is to extend the culture time as long as necessary to reduce, or eliminate, density-dependent competition with wild juveniles.
Step 5	**Prevent continued overfishing**	This step is not applicable at the present time. The fishery is closed. This step is only relevant if and when the stock "recovered" to a level that supported a fishery. If that happened restoration efforts should cease. If they continued, then management rationale for restoration would have changed – from a "conservation and restoration" program to a "production" program.
Step 6	**Ensure that fishery regulations are adequate to prevent continued overfishing of the wild population (unless there has been a policy decision to 'write-off' the wild population**	This step is not applicable at the present time. The fishery is closed. This step is only relevant if and when the stock 'recovered' to a level that supported a fishery.
Step 7	**Show that the hatchery production system is sustainable over time, if it is to be permanent.**	This step is not applicable at the present time. The fishery is closed so enhancement is being considered for purposes of restoration, not production.

Table 1b - Critical steps in monitoring– (adapted from Chapter 13, Walters and Martell, 2004). The discussion of development steps in a generic marine fish enhancement program was adapted to and Excel sheet. The comments in the right column indicate the present state of PWS herring relative to an enhancement program.

Monitoring and experimental requirements		**Comment**
Step 1	**Mark a high proportion of all released fish**	First, marking methods need to be established. Then broad marking programs should assess the survival of enhanced and wild herring. Probably the Japanese ALC marking procedure may be a guide.
Step 2	**Mark some wild fish in addition to hatchery fish**	See comment above: Marking methods need to be established.
Step 3	**Vary the releases among years, including the number released, time of release and release areas.**	This step applies more to species such as salmonids. For herring it may be advisable to monitor success of releases among different areas.
Step 4	**Monitor changes in recruitment**	This should be possible with routine bio-sampling of the PWS herring population.
Step 5	**Monitor changes in fishing mortality**	This would depend on the re-establishment of a fishery. If stocks recovered to the level that would support a fishery, then enhancement would be unnecessary.
Step 6	**Monitor changes in reproductive success of released fish**	One way this could be done is sampling of maturing adults in the fall and winter, prior to spawning. Monitoring also could include fecundity analyses, quantification of ovarian atresia (counting atretic oocytes) and egg size of spawning fish.

Table 1c - Things that can go wrong– (adapted from Chapter 13, Walters and Martell, 2004). The discussion of development steps in a generic marine fish enhancement program was adapted to and Excel sheet. The comments in the right column indicate the present state of PWS herring relative to an enhancement program.

Things that can go wrong		**Comment**
Step 1	**Failure to produce fish that successfully recruit to the spawning population**	Japanese work indicates that cultured herring can survive and spawn but it is essential to develop a mass-marking system for any released fish in PWS.
Step 2	**Direct exploitation of wild fish to provide hatchery seed stock**	This is a real, but relatively small concern with the assumption that, following Japanese practices, there can be relatively good survival from hatching to the juvenile stage.
Step 3	**Post-release competition between hatchery and remaining juvenile fish**	This may be the most pressing concern. Monitoring and research should attempt to determine the optimal release time. Based on the information in this report, later releases of larger juveniles may reduce possible competition for scarce food resources in the late fall and early winter.
Step 4	**Increase in predation and disease risk for remaining wild fish**	This is a major concern, given the present high incidence of disease in Prince William Sound herring. It is especially troubling that the viral disease (VHS) tends to break out in crowed conditions.
Step 5	**Selection under enhancement conditions for traits that are inappropriate**	This is only a concern if enhancement activities had a long duration.
Step 6	**Attraction of fishing effort by unregulated fisheries**	Probably this is not an issue.

A DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE *EXXON VALDEZ* OIL SPILL RESTORATION PLAN

MAY 2010

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OFFICE OF THE SECRETARY, U.S. DEPARTMENT OF THE INTERIOR

ABSTRACT:
NOAA, as a member of the *Exxon Valdez* Oil Spill Trustee Council (Council), has prepared a draft supplement to the existing environmental impact statement (EIS) on the Council's restoration efforts, in accordance with the National Environmental Policy Act of 1969, (NEPA). This supplemental EIS (SEIS) is necessary to respond to significant new circumstances bearing on the Council's restoration efforts as assessed in the original EIS. Specifically, as the restoration funds remaining from the *Exxon Valdez* settlement diminish, the Council seeks a more discrete and efficient funding mechanism by which to direct the remaining funds. The SEIS assesses the environmental impacts of the Council's proposal to narrow and refine the scope of the Council's restoration efforts to five defined restoration categories: herring; lingering oil; long-term monitoring of marine conditions and injured resources; harbor protection, marine restoration, and lessons learned/outreach; and habitat acquisition and protection.

PUBLIC COMMENTS ON THE DRAFT SEIS MUST BE RECEIVED BY MONDAY JULY 19, 2010

EXECUTIVE SUMMARY

NOAA, as a member of the *Exxon Valdez* Oil Spill Trustee Council has prepared this Draft Supplemental Environmental Impact Statement. It presents and analyzes alternative proposals for the *Exxon Valdez* Trustee Council's management of the remaining joint trust funds resulting from the civil settlement of civil claims brought as a result of the 1989 *Exxon Valdez* Oil Spill. Following a required 30-day period of no action, the three federal trustees (U.S. Departments of Interior, Agriculture and Commerce) are expected to sign a Record of Decision in October 2010. This Record of Decision will represent the conclusion of the planning process and provide guidance for the Trustee Council's future actions.

The Council, recognizing that the remaining joint trust funds are limited and that is it becoming increasingly difficult to distinguish between spill impacts and other effects in measuring recovery, is considering a strategic and organized transition to a more modest restoration program, which would focus the remaining funds on a few specific programs and reduce administrative costs. Specifically, the Council proposes to narrow and refine the scope of the Council's monitoring efforts to five defined restoration categories: herring, lingering oil, long-term monitoring of marine conditions and injured resources, harbor protection, marine restoration, and lessons learned/outreach, and habitat acquisition and protection. Under this approach, the remaining Council funds would be expended with an emphasis on producing information to support the future management and natural restoration of the injured species and, thus, the human services that depend upon them. In addition, the information produced by such activities can enable management consistent with long-term restoration.

This SEIS assesses the environmental impacts of the Council's proposal. In 1994, the Council adopted a Restoration Plan and an EIS was issued that analyzed the Council's actions under that Plan. The five focus areas the Council currently proposes to pursue are consistent with the existing EIS and the 1994 Restoration Plan.

In developing its proposed action alternative of focused restoration, the Council issued a Notice of Intent summarizing its proposals and subsequently held public meetings in six spill-area communities to encourage public comment. Throughout this deliberative process, the Council and its staff also consulted with scientists, Trustee Agency Liaisons, counsel, the Council's Public Advisory Committee, and reviewed numerous public comments received through the public meetings and those submitted directly to the Council.

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CHAPTER 1 – INTRODUCTION

1.1 Background

More than twenty years ago, on March 24, 1989, the tanker *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska, causing the largest tanker oil spill in U.S. history. Approximately 11 million gallons of North Slope crude oil subsequently moved through southwestern Price William Sound and along the western coast of the Gulf of Alaska, causing injury to both natural resources and services (the functions performed by a natural resource for the benefit of another natural resource and/or human uses) in the area. During the summer of 1989, oil from the spill was found as far away as 600 miles from Bligh Reef.

The State of Alaska and the United States brought claims against Exxon Corporation and related companies for the natural resources damage resulting from the spill and the resolution of the civil claims resulted in a $900 million civil settlement. The *Exxon Valdez* Oil Spill Trustee Council (EVOSTC or Council) was formed in 1991 to oversee the use of these funds to work to restore the natural resources and ecosystem damaged by the 1989 spill. The Council consists of three state (AK Departments of Law, Environmental Conservation and Fish and Game) and three federal trustees (U.S. Departments of the Interior, Agriculture and NOAA) (or their designees) and is advised by members of the public and by members of the scientific community. As part of their efforts, the Council adopted a Restoration Plan (Plan) in 1994 to guide restoration through research and monitoring, habitat protection and general restoration.

The *Exxon Valdez* Oil Spill Trustee Council originally approved and released a *Draft Restoration* Plan in 1993, followed by a *Draft Environmental Impact Statement* in June 1994, which reviewed the potential effects of implementing the plan. In September 1994, the Council issued a *Final Environmental Impact Statement*, followed by their signing of a Record of Decision in October 1994 and adoption of the *Restoration Plan* in November 1994. The Council has prepared this supplement to the existing environmental impact statement (EIS) issued in 1994, in accordance with the National Environmental Policy Act of 1969, 42 U.S.C. § 4321 *et seq.* (NEPA).

1.2 Proposed Action

Of the approximately $780 million of joint trust funds initially managed by the Council, which consisted of payments by Exxon Companies and interest and earnings on those payment, more than $180 million has been used for research, monitoring and general restoration and more than $375 million has funded habitat protection. Council annual program development, implementation and administration costs have totaled more than $45 million Approximately $15 million will be needed to fund the ongoing and final stages of EVOSTC administration. Approximately $65 million is currently contractually-committed to multi-year projects, habitat purchases and other previously approved projects. Therefore, as of spring 2010, approximately

$81 million remain available for research, monitoring and general restoration, and $25million remain available for habitat acquisition and protection. These joint trust funds are invested in State of Alaska investment accounts which have produced additional income for restoration activities. The proposed funding of future restoration activities must allow for annual flexibility in order to respond to market fluctuations which affect the income produced by these investment accounts. Accordingly, the monetary amounts proposed by the Council are approximate figures and represent proportional allocations of remaining restoration funds.

Recognizing that funding for future restoration is limited and that it is becoming increasingly difficult to distinguish between spill impacts and other effects in measuring recovery, the Council is considering an organized and strategic transition to a modest program which would focus the remaining funds on a few specific programs and habitat protection. Long-term management of species and resources initially injured by the spill lies with the agencies and entities that have the mandate and resources to pursue these long-term goals. To advance long-term resource management of injured resources, the Council has increasingly directed funds toward research that provides information critical to the support of and healthy functioning of the spill ecosystem.

The Council proposes to narrow the scope of its future restoration work. Building on its past efforts, the Council has identified five areas of focus for its remaining work: (1) herring; (2) lingering oil; (3) long-term monitoring of marine conditions and injured resources; (4) harbor protection, marine restoration, and lessons learned/outreach; and (5) habitat acquisition and protection.

1.3 Purpose and Need

The purpose of the proposed action analyzed in this Supplemental Environmental Impact Statement (SEIS) is to continue to restore the injured natural resources and services affected by the spill. The Federal and State governments, acting as Trustees for natural resources, are responsible for taking actions necessary to restore resources and the services they provide that were injured by the spill. The Federal Water Pollution Control Act (Clean Water Act) (33 U.S.C. § 1321[f] and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)(42 U.S.C. § 9607[f]) provide the legal basis for these responsibilities. This SEIS also responds to significant new circumstances bearing on the Council's restoration efforts as assessed in the original EIS. Specifically, as the restoration funds remaining from the *Exxon Valdez* settlement diminish, the Council seeks a more discrete and efficient funding mechanism by which to direct the remaining funds. This SEIS assesses the environmental impacts of the Council's proposal to narrow and refine the scope of the Council's restoration efforts to five defined restoration categories: 1) herring; 2) lingering oil; 3) long-term monitoring of marine conditions and injured resources; 4) harbor protection and marine restoration; and 5) habitat acquisition and protection. Each of these focus areas falls within the original 1994 *Restoration Plan. See Restoration Plan* at pp. 19 – 28.

1.4 Action Area

The spill area is located in Southcentral Alaska, including the northern and western portions of the Gulf of Alaska, and encompasses a surface area of approximately 75,000 square miles. The spill area is divided into three regions: Prince William Sound, Cook Inlet/Kenai Peninsula, and the Kodiak Archipelago and the Alaska Peninsula. *See also*, The *Exxon Valdez* Oil Spill Area General Land Status Map, 1994 Restoration Plan at pg. V.

1.5 Public Participation Process

1.5.1 Notice of Intent

As part of the process to develop the Draft Supplemental Environmental Impact Statement, NOAA, on behalf of the Council, solicited the input of stakeholders and the public on the scope and scale of the Draft SEIS. NOAA began the formal scoping process by publishing a Notice of Intent (NOI) in the *Federal Register* on Friday January 22, 2010 (75 FR 3706).

1.5.2 Scoping Process

NOAA also released public notices of six public meetings in February and March 2010 in the following locations:

Table 1: Scoping Process, Public Meeting Locations and Times

February 16, 2010 - Homer, Alaska 6:00 PM - 8:00 PM Alaska Islands and Oceans Visitor Center 95 Sterling Highway Homer, AK 99603	**March 16, 2010 - Seward, Alaska** 6:00 PM - 8:00 PM K.M. Rae Building 125 Third Avenue Seward, AK 99664
February 17, 2010 - Anchorage, Alaska 6:00 PM - 8:00 PM Dena'ina Civic & Convention Center- Kahtnu Room #1 600 West 7th Ave. Anchorage, AK 99501	**March 17, 2010 - Valdez, Alaska** 6:00 PM - 8:00 PM Valdez Civic Center 110 Clifton Drive Valdez, AK 99686
February 18, 2010 - Cordova, Alaska 7:00 PM - 9:00 PM Cordova Public Library 622 First Street Cordova, AK 99574	**March 18, 2010 - Kodiak, Alaska** 6:00 PM - 8:00 PM Kodiak Refuge Visitor Center 402 Center Street Kodiak, AK 99615

These notices were sent though email distribution lists, posted on the Council website, mailed to municipalities and tribal governments, and published in local and state newspapers. Through both the NOI and the public meetings, NOAA requested comments from the public regarding potential environmental concerns or impacts, additional categories of impacts to be considered, measures to avoid or lessen impacts, and suggestions on restoration priorities and projects.

At the six public meetings a representative from NOAA, as the Lead Administrative Trustee, gave an overview of the NEPA process and discussed the direction the Council plans to take with regard to streamlining its administrative structure. The Council website was updated so that it contained much of the same information released through the NOI and the public meetings.

For more information on the comments gathered through the scoping process, visit the EVOSTC website at http://www.evostc.state.ak.us/NEPA/Comments.cfm

1.6 Environmental Justice

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. While not a part of NEPA itself, EO 12898 (Environmental Justice, 59 FR 7629 [1994]) requires each federal agency to achieve environmental justice by addressing "disproportionately high and adverse human health and environmental effects on minority populations and low-income populations." The Council will take these matters into consideration when making decisions with regard to future restoration activities. This type of determination is further described in Chapter 4, sections 4.1 and 4.2 for this case.

CHAPTER 2 – ALTERNATIVES, INCLUDING THE PROPOSED ACTION

2.1 Introduction

This chapter describes the management alternatives considered by the Council in their proposal to narrow and refine the scope of their restoration efforts and concurrently to implement a more discrete and efficient funding mechanism by which to direct the remaining funds. The Council has considered two management alternatives: (1) no action – a continuation of the current program; and (2) a narrowing of the Council's scope to five defined restoration categories. The analysis in this SEIS pertains to the broadly defined alternatives, and as such, does not consider specific restoration projects. Project- and site-specific analyses will be conducted by the appropriate agencies for all future actions.

2.2 Program Elements Common to both Alternatives

Both alternatives share the common elements outlined in the September 1994 *Final Environmental Impact Statement* (FEIS, Ch. 2, pg. 2-5). These elements include policies that:

- take an ecosystem approach to restoration;

- require that restoration projects designed to restore or enhance an injured service must have a sufficient relationship to an injured resource;

- encourage competition and efficiency in restoration efforts;

- require that restoration projects be subject to open, independent scientific review before Council approval;

- require that restoration must include meaningful public participation in planning, project design, implementation and review; and

- specify that government agencies will be funded only for restoration projects that they would not have conducted had the spill not occurred.

2.3 Alternative 1: No Action

The "no action" alternative consists of the Council continuing its activities in research, monitoring, general restoration and habitat protection, as it has done for the last twenty-one years, pursuant to the Preferred Alternative (5) in the FEIS. This current practice involves approximately $2 million in administrative costs annually for funding of Trustee Agency Liaisons, science support, Restoration office administration, Public Advisory Committee operations, and project management. These funds also support numerous meetings by the Council, researchers, stakeholders and the public to review and approve individual projects of a limited length, typically one to three years.

As outlined in the September 1994 *Final Environmental Impact Statement* (FEIS, Ch. 2, pg. 6-7), agency monitoring of natural recovery would remain at present levels and agency responsibility would remain unchanged. In addition, under this alternative, the remaining funds from the civil settlement would be spent as they have in the past until they were fully depleted. This includes the Council considering individual projects under their own project management and current methods of Council administration, as described above. Under this scenario, it is likely the administrative costs would remain similar or slightly below their present levels, despite the diminishing expenditures on restoration by the Council.

2.4 Alternative 2: The Proposed Action - Focused Restoration

This alternative addresses the same policies, locations, restoration goals, assumptions used for impact assessment, as outlined for the FEIS Proposed Action Modified Alternative 5: FEIS, Ch. 2, pg. 14-16. However, the General Restoration list of FEIS Alternative 5 is supplanted by the Council's proposed five focus areas: herring, lingering oil, long-term monitoring of marine conditions and injured resources, harbor protection, marine restoration, and lessons learned/outreach; and habitat acquisition and protection, which are discussed in detail below. In addition, instead of considering individual, discrete projects that were typically one year in length, the Council proposes to fund longer-term, integrated programs. The Council would also shift many of its current administrative functions, such as scientific and technical review and planning, peer review, and the solicitation and management of individual projects, to the entity responsible for the funded focus area. By narrowing its focus areas and by delegating many of its existing administrative functions to a select number of entities, the Council would streamline and reduce administrative functions and allow the funded entities to design and implement longer-term, integrated programs supporting restoration goals and objectives.

2.4.1 Herring

The Council has classified the Prince William Sound (PWS) population of Pacific herring (*Clupea pallasi*) as a resource that has not recovered from the effects of the 1989 oil spill. The PWS herring population was increasing prior to 1989 with record harvests reported just before the spill. The 1989 year class was one of the smallest cohorts of spawning adults recorded and by 1993 the fishery had collapsed with only 25 percent of the expected adults returning to spawn. The PWS fishery was closed from 1993 to 1996, but reopened in 1997 and 1998, based on an increasing population. Numbers again declined in 1999, and the fishery remains closed today. The 1993 collapse can be explained by several competing hypotheses; however, data uncertainties make it unlikely that the true reasons will ever be known.

The Council recognizes the uncertainty with regard to the role of the 1989 spill and the current depressed state of the PWS herring population. However, herring are considered a keystone species in the marine ecosystem and play a vital role in the food chain of many injured species. Thus, rebuilding the herring population has the potential to support the restoration of these injured species. In addition, supporting a healthy herring population may compensate for some of the losses in fishing opportunities that resulted from the spill and its damage to salmon and species other than herring. In April 2006, prompted by public comments about the continuing impacts to human communities and commercial fishermen from herring losses, the Council convened scientists and researchers, commercial and subsistence fishermen, and natural resource managers for a herring workshop. One of the most important outcomes of the workshop was the consensus that a long-term strategic herring restoration program was needed if viable herring recovery activities were to be implemented. From 2006 to 2008, Council representatives met with natural resource managers, commercial fishers, scientists, the Public Advisory Committee (PAC) and Alaska Native residents of spill area communities to gain sufficient input to draft a cost-efficient, scientifically credible, and coordinated program. This effort produced the first draft of the Integrated Herring Restoration Program (IHRP) in December 2008. The IHRP is currently undergoing its final revision and will inform the final *Invitation for Proposals FY 2012* that may be issued by the Council in October 2010 if Alternative 2 of this SEIS is chosen for implementation.

The goal of the IHRP is to determine what, if anything, can be done to successfully restore PWS herring; to determine what steps can be taken to examine the reasons for the continued decline of herring in the Sound; to identify and evaluate potential recovery options; and to recommend a course of action for restoration. The Council is currently funding a package of multi-year proposals that are focused on factors limiting recovery.

The Council proposes funding a long-term herring program that focuses on core monitoring at a level that allows detection of population change, at a precision meaningful to restoration objectives, and that focuses on identifying limiting factors for the continued decline of herring in Prince William Sound (PWS), to identify and evaluate potential recovery options and to recommend a course of action for restoration of PWS herring.

The Council has proposed to use approximately 11% to 21% of the available funding for research in this area over a twenty-year period. The program would conduct studies that may include monitoring of herring population, disease, predators, habitat and related oceanographic conditions.

2.4.2 Lingering Oil

One of the most surprising revelations from two decades of research and restoration efforts since the 1989 spill is the persistence of subsurface oil in a relatively unweathered state. This oil, estimated to be around 97.2 metric tons (or 23,000 gallons), is contained in discontinuous patches across beaches that were initially impacted by the spill. The patches cannot be visually identified on the beach surface, but their presence may be a source for continued exposure to oil for sea otters and birds that seek food in sediments. The survey work completed to date indicates that the oil is decreasing at a rate of zero to four percent per year, with only a five percent chance that the rate is as high as four percent. As a result, it may persist for decades.

Subsistence, recreational, commercial fishing and passive uses were significantly impacted by the spill and this has affected the overall health of the communities in Prince William Sound.

Lingering oil may also discourage the public from resuming full use of some natural resources, in part to avoid patches of oil that still persist and, probably, in part due to uncertainty about exactly where oil patches remain (and, conversely, where the oil has fully degraded) and the extent to which it continues to affect edible aquatic organisms and other resources. It may be appropriate to devote additional resources to evaluate, monitor, and redress the impact of lingering oil on recreational and subsistence uses in the spill area. An important function of this effort would be to pass this information back to the communities and the general public.

In an effort to address the issue of lingering oil, the governments developed a restoration plan in 2006 under the terms of the Reopener provision in the Consent Decree with Exxon (http://www.evostc.state.ak.us/facts/reopener.cfm). Efforts to date include the development of a spatial probability model to identify beach segments with a high likelihood of persistent oil, and investigations of the reasons for the persistence of oil as a means to consider options that may accelerate the oil degradation. The Council has also funded a number of studies to determine the effects of lingering oil on the nearshore environment and the species that forage there, including sea otters, harlequin ducks and Barrow's goldeneyes.

It is possible that the results of currently funded and ongoing projects, or information developed by the research of other entities, will identify information gaps that will need to be filled. Under the lingering oil initiative, the Council envisions completion of the studies underway to reach a decision point on further efforts for active remediation. Upon receiving additional lingering oil information from these current lingering oil studies and the resolution of the Reopener, the Council will evaluate the need for restoration of services that may be affected by lingering oil, and thus no prospective funding amount has been proposed. If there is a need for additional projects, these may include proposals to measure the exposure of recovering or not recovered resources to lingering oil and the effects of such exposure, in addition to direct restoration of impacted services if practical and feasible, particularly in the nearshore ecosystem.

2.4.3 Long-term monitoring of marine conditions and injured natural resources

In the twenty-one years since the *Exxon Valdez* oil spill, it has become apparent that the ocean ecosystem can undergo profound changes naturally and such changes likely preclude a return to pre-spill conditions. The 1994 *Restoration Plan* (Plan) recognized that recovery from the spill would likely take decades. A Restoration Reserve was created from the Plan in part to provide for long-term observation of injured resources and services and provide for appropriate restoration actions into the future. To further this effort, in 1999 the Council also supported the development of a long-term research and monitoring program, which did not progress to implementation.

Long-term monitoring has two components: monitoring the recovery of resources from the initial injury and monitoring how factors other than oil may inhibit full recovery or adversely impact recovered resources. This second type of monitoring collects data on environmental factors that drive ecosystem-level changes. Monitoring factors such as temperature, salinity, turbidity, and zooplankton availability can play an important role in determining the overall health of the ecosystem. Data produced from this type of monitoring is increasingly valuable in illuminating the larger ecosystem shifts that impact and influence a broad variety of species and resources injured by the spill. In addition, by monitoring such changes, agencies and interested parties may be able to adjust their own activities and management strategies to adapt to what may lie ahead and to further support injured resources in these quickly-shifting marine ecosystems. The Council has a history of supporting oceanographic monitoring by helping to establish and fund long-term data collections.

With regard to the monitoring of individual species, the Council also proposes to monitor some key indicator species. While it would be virtually impossible to monitor every injured resource and service in the entire geographic area of the oil spill, it is possible to select key indicator species that will provide an overview of the health of the ecosystem. Examples of these key species may include forage fish, killer whales, seabirds, bivalves, and sea otters. Monitoring these indicator species in two trophic levels (pelagic and benthic) as well as the environmental drivers (oceanographic conditions) of the system can provide a combination of data that can greatly contribute to an understanding of the state of recovery in the spill areas.

In this initiative, the Council envisions seeking partnerships with scientific entities or consortiums able to maintain those collections, demonstrate an ability to leverage this support, and develop science-based products to inform the public of environmental changes and the impacts of these changes on injured resources and services. The Council proposes to fund this effort with approximately 15% to 25% of the available funding, to be spent over a twenty-year period. As a part of this effort, the Council seeks to monitor ocean and nearshore conditions such as current, temperature, and the climate of those areas that influence the spill area, as well as injured resources.

2.4.4 Harbor protection, marine restoration, and lessons learned/outreach

a. Waste disposal and harbor projects

Many coastal communities in the spill area have a limited ability to collect and properly dispose of waste, such as oily bilge water, used engine oil, paints, solvents, and lead-acid batteries. Improper disposal of these wastes in landfills adversely affects the quality of nearby marine waters through runoff and leaching. In some cases, these wastes are discharged directly into marine waters. Chronic marine pollution stresses fish and wildlife resources, possibly delaying recovery of resources injured by the oil spill. For example, with regard to the worldwide mortality of seabirds, the effects of chronic marine pollution are believed to be at least as important as those of large-scale spills.

The Council has approved the funding of several projects to prepare waste management plans and has contributed to their implementation. These projects resulted in the acquisition of waste oil management equipment and the construction of environmental operating stations for the drop-off of used oil, household hazardous waste and recyclable solid waste in Cordova, Valdez, Chenega Bay, Tatitlek and Whittier, Kodiak and lower Cook Inlet. The Council seeks to further reduce pollution in the marine environment to facilitate the recovery of injured natural resources or services and is considering funding this effort with approximately 3% to 13% of the available funding.

b. Marine debris removal

Marine debris is an issue in the marine and near-shore environment in Alaska, where it is likely that thousands of tons of marine debris exist within three nautical miles of the Alaska coastline. Marine fish and wildlife become entangled in and ingest debris from foreign and domestic sources that may be a day or decades old and that range from small plastic items to very large fishing nets. Approximately 175 metric tons of debris was collected from Alaska coasts by citizen cleanup projects in 2007. Marine debris removal projects can result in an immediate improvement to the coastal habitat.

Coastal communities are effective in marine debris cleanups due to their intimate knowledge of the locations of debris accumulation. In addition, when communities participate in marine debris cleanups, they often alter the common practices that led to marine debris as their awareness of the effects of the debris on their coastline and the fisheries upon which they depend increases. Marine debris removal reduces marine pollution affecting injured resources and services and, thus, further supports natural restoration. The Council proposes to fund marine debris removal with up to 7% of the available funding.

c. Lessons Learned/Outreach

Damage to natural resources occurs not only with an initial oil spill, but also potentially through spill response efforts. Damage assessment from the 1989 spill has yielded information that can assist in mitigating damage from spill response activities in future spills. Skilled damage assessment also quantifies the extent of injury and allows for the accurate monitoring and measurement of restoration after a spill. Organizing, preserving, and passing on such information will help responders and those conducting future damage assessments. These efforts ensure that restoration efforts are truly effective. Outreach efforts could include a conference or series of papers sharing information to be used by future responders, including natural resource assessment, the long-term costs of high-pressure washing, use of dispersants in the near-shore, sub-arctic environment, and the effects of potential burning scenarios. The Council proposes to fund this effort with up to 5% of the available funding.

2.4.5 Habitat acquisition and protection

The protection of habitat is an important component of the *Exxon Valdez* oil spill restoration program. The acquisition of private lands or partial interests in private lands promotes the natural recovery of spill-injured resources and associated services by removing the threat posed by additional development impacts. The program is implemented by state and federal resource agencies, often in partnership with non-governmental organizations. The habitat program has protected approximately 650,000 acres of valuable habitat through a variety of purchases of various property rights, ranging from fee simple acquisition to conservation and timber easements. The goals of the habitat protection program remain viable. Resource and land management agencies, such as the Alaska Department of Natural Resources, Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, National Park Service and U.S. Forest Service, continue to receive parcel nominations for Council consideration. Approximately $25 million remains within the habitat subaccount for future habitat protection efforts. The Council is considering alternatives for allocation of these funds. For example, half of the funds remaining may be allocated to protect large parcels within a period of two to three years, and the remaining half to a program spanning a 12-year period focused on the protection of small parcels less than 1,000 acres or $1 million in price. The Council proposes to utilize the approximately $25 million remaining to continue the habitat program. A variety of administrative options, funding allocations, time frames, and management strategies will be considered.

2.5 Other Alternatives Considered and Rejected

In their deliberations, the Council has considered alternatives that consisted of expending the remaining funds in a short time frame, transferring the monies to agencies to administer, and reallocating habitat monies to other restoration uses. Each of these alternatives was rejected without detailed consideration, as noted below.

2.5.1 Expending funds in the immediate future

Expending the funds in a very short time frame, for example within three years, as a method to decrease the overall expenditure in administrative costs that accrue over time was rejected. While it could possibly achieve some measure of purely economic efficiency with regard to overall administrative expenditures and might be appropriate for some projects, e.g. marine debris removal, it would not necessarily represent the most effective way to pursue restoration of injured resources and services. For example, it would not serve the considerable long-term scientific needs of monitoring and long-term herring research; nor would it benefit habitat protection, where taking the time to develop sensitive negotiations with willing sellers are required.

2.5.2 Funds Transferred to Agencies

Transferring the remaining funds to agencies to be expended as limited and required by the *Exxon Valdez* settlement, was rejected as unnecessary and inhibits the opportunity to allow non-governmental organizations to propose creative collaborations and participation that could result in an efficient and creative use of resources.

2.5.3 Reallocation of Habitat Funds:

Reallocating habitat monies to other restoration uses was rejected because the Council supports using the remaining funds (approximately $24 million) currently designated for habitat protection for that valuable use. In addition, the Council noted that this allocation of funds is mandated by federal law. *See*, Public Law 106-113, 113 Stat 1501A-207 (1999). An effort to amend the legal requirement would entail an additional and unnecessary use of administrative resources and time.

2.5.4 Funds used for an Endowment

Using the remaining funds for a permanent endowment was rejected without detailed consideration due to legal issues which could hinder a permanent endowment.

2.6 Comparison of Alternatives

2.6.1 Alternative 1

This alternative would vary in terms of the scope of restoration activities proposed, as it would not be limited to the five focus areas. Without reducing the array of restoration activities, restoration efforts for species that would benefit from activities under one of the five focus areas could experience diminished benefits or benefits of a shorter duration than they would under Alternative 2, as Alternative 1 allows the remaining funds to be spent on a broad variety of proposals without a strategic focus or comprehensive plan to guide the spending. In addition, under this alternative, the Council would remain the sole administrator of the funds, thus requiring funds that could be used for restoration activities to be allocated toward administration (approximately an additional $10–$25 million, depending upon the duration of the Council). This alternative also does not envision an organized or strategic end to the expenditure of funds, thus potentially creating an abrupt end to the Council's funding of restoration activities when the funds are fully depleted.

2.6.2 Alternative 2

This option envisions actions focused on the five proposed restoration areas that would aid in the recovery of a broad spectrum of injured resources and services. Focus areas such as long-term monitoring of oceanographic conditions and injured resources and herring research can also produce information that can be used by a wide variety of researchers, members of the public, stakeholders, state and federal agencies. Under this approach, the remaining Council funds would be expended in a strategic and organized manner, with an emphasis on producing information to support the future management and natural restoration of injured species and, thus, the human services that depend upon them. In addition, the information produced by such activities can enable management consistent with long-term restoration. This important data can assist those agencies and entities that have the mandate and resources to pursue long-term restoration goals for these injured species and services and which will exist beyond the life of the Council.

The Council's restoration effort has been evolving over time and the current proposal represents this progression. With regard to research and restoration proposals, this alternative refines the Council's efforts in these five areas, rather than funding individual projects that typically lasted for one year and typically focused on a singular injured resource. The single-species perspective has been driven largely by the original listing of injured resources and species. Consistent with this, the September 1994 FEIS and the 1994 Plan were largely organized by individual species. The 1994 Plan also acknowledged the importance of the ecosystems in the spill area, and this perspective has grown with time and as science has illuminated the complex and interdependent relationships of ecosystems.

Under Alternative 2, the Council contemplates restoration activities for specific species which serve the focus areas. For example, the Council includes herring as a single-species focus area in its current proposed alternative. However, this species is considered a keystone species in the marine ecosystem and herring play a vital role in the food chain of many injured species. Thus, rebuilding the herring population has the potential to support the restoration of a broad range of injured species. Supporting a healthy herring population also has the potential to compensate for some of the losses in fishing opportunities that resulted from the spill and its damage to species other than herring. In this way, the Council's focus on this single species may serve a broad range of injured species and services. In addition, as discussed with regard to long-term monitoring, the Council contemplates monitoring a number of key species in the spill-affected ecosystems in order to contribute to the overall understanding of the spill-affected ecosystem.

Alternative 2 also emphasizes an effort to reduce administrative spending through funding long-term proposals administered largely by third parties which have exiting infrastructure that can accommodate administering such a program and therefore potentially allowing a higher allocation of funds (approximately an additional $10–25 million, depending upon the duration of the Council) to be used for restoration activities. By narrowing its focus to provide benefits for a broad range of injured species over the long-term, the Council increases the opportunity for continuing research to support the future management and long-term restoration goals for individual species and benefit the ecosystems hosting numerous species originally injured by the spill.

Chapter 3 – Affected Environment

3.1 Introduction

This Chapter provides a current summary of the status of the environment affected by the spill. As discussed above, the Council's research has been largely organized by individual injured species, consistent with the *Injured Resources and Services List* (List) which it adopted in November 1994 as part of its *Restoration Plan* and updated in 1996, 1999, 2002, 2006 and 2010. The List served three main purposes in the Restoration Program:

1. Initially, the List identified natural resource and human service injuries caused by the oil spill and clean-up efforts.

2. The List helped guide the Plan and was especially important in 1994 when the plan was first adopted. The List was created as guidance for the expenditure of public restoration funds under the Plan, and assisted the Council and the public to ensure that money was expended on resources that needed attention. The List continues to serve that purpose today.

3. Finally, the status of injured resources on the List provides the Council and the public a way to monitor recovery of individual species, and the related ecological functions and human services that depend on those resources.

Although the fish and wildlife resources that appear on the List experienced population-level or chronic injury from the spill, not every species that suffered some degree of injury was included. For example, carcasses of about 90 different species of oiled birds were recovered in 1989, but only 10 species of birds were included on the List.

Moreover, it should be noted that the analysis of resources and services in relation to their recovery status only pertains to amelioration of effects from the 1989 oil spill. When the Plan was first drafted, the distinction between effects of the oil spill and the effects of other natural or anthropogenic stressors on affected natural resources was not clearly delineated. At that time, the spill was recent; the impact to the spill area ecosystem was profound and adverse effects of the oil on biological resources were apparent. As time passes, the ability to distinguish effects of oil from other factors affecting fish and wildlife populations diminishes. Currently, natural and human perturbations may be hindering recovery of some resources initially injured by the spill. However, the passage of time and the evolution of science from the listing of species to an ecosystem approach have shifted the purpose and utility of the Injured Resources and Species List. The Council recognizes that the complexities and the difficulties in measuring the continuing impacts from the spill result in some inherent uncertainty in defining the status of a resource or service through a specific list and the Council's focus has accordingly expanded to a more ecosystem approach. The 1994 Plan also outlined an ecosystem approach to restoration and this more integrated view has become increasingly recognized as essential and the original organization of efforts through a list of species in the Update is no longer a viable approach.

Recognizing that funding for future restoration is limited and that it is becoming increasingly difficult to distinguish between spill impacts and other effects in measuring recovery, the Council's efforts are now focused on making an organized and strategic transition to a modest program which focuses the remaining funds on a few specific programs. Building on its past efforts, the Council has identified the following areas of focus: (1) herring; (2) lingering oil; (3) long-term monitoring of marine conditions and injured resources; (4) harbor protection, marine restoration, and lessons learned/outreach; and (5) habitat acquisition and protection.

The Council also recognizes that long-term management of species and resources initially injured by the spill lies with the agencies and entities that have the mandate and resources to pursue these long-term goals. To support natural restoration and to enable management consistent with this long-term restoration, the Council has increasingly directed funds toward research that provides information that is critical to monitor and support the healthy functioning of the spill ecosystem.

3.2 Ecosystem Perspective and Recovery

Recognizing the difficulties inherent with the listing of individual species, as discussed above, the Council has moved towards an ecosystem approach. In practice, and through the Plan, the Council has increasingly adopted an ecological approach to restoration, and, consistent with this, the studies and projects the Council sponsors have been progressively more ecologically-based.

The 1994 Plan defines ecosystem recovery as follows:

Full ecological recovery will have been achieved when the population of flora and fauna are again present at former or pre-spill abundances, healthy and productive, and there is a full complement of age classes at the level that would have been present had the spill not occurred. A recovered ecosystem provides the same functions and services as would have been provided had the spill not occurred.

Although significant progress has been made using this definition of recovery, some of the coastal and marine ecosystems in the oil spill region have not fully recovered at this time from the effects of the oil spill. For example, harlequin ducks still show signs of oil exposure and may be negatively affected by such exposure. A number of other species and communities are showing signs of recovery, but are still not fully recovered from the effects of the oil spill. Although full ecological recovery has not been achieved, the spill area ecosystem is making progress towards recovery 21 years after the *Exxon Valdez* oil spill.

Consistent with the Council's shift from individual species to an ecosystem approach, in this chapter we will discuss each injured resource and service as part of its larger system, including the nearshore, offshore, and human services.

3.3 Recovery Status Determination

The information contained in this Chapter, drawn from the Injured Resources and Services List, also provides the List's recovery status for each species.[1] The recovery goal for injured resources is a condition that would exist in the absence of the *Exxon Valdez* oil spill (EVOS). It is important to understand that ecosystems are dynamic and the spill-affected area would have changed even without the spill. Given the limited ability to predict multi-year changes in marine ecosystems, it is difficult to know precisely what changes were inevitable had the spill not occurred. However, it is still possible to assess the recovery status of a particular resource by reviewing multiple sources of applicable information.

Types of information that were used to assess the recovery status of a particular resource or service included:

- initial magnitude of oil impacts to a population in the spill area
- comparisons of population demographic in oiled and reference areas
- survey data of community members in oiled and reference areas
- continued exposure to residual oil in the spill area as measured by the biomarker cytochrome P450 or tissue concentrations of petroleum hydrocarbons
- exposure potential as evaluated by the distribution of lingering oil; overlap in spatial distribution of lingering oil and a resource; and identification of an exposure pathway
- persistence of sublethal or chronic injuries
- intrinsic ability of the population to recover
- other natural or human-caused stressors

Even with such an evaluation, direct links cannot always be drawn between effects from the oil spill and the observed, current condition of a particular resource: in most cases the amount or type of data is insufficient to complete a cause and effect relationship. Specifically, there is little pre-spill data for many of the injured resources. Moreover, the physiological effects of oil on key species of wildlife and subsequent population consequences were not well understood at the time of the spill. As a result, few species exist for which there is complete knowledge of the impacts of the oil spill.

[1] The *Exxon Valdez* Oil Spill Trustee Council 2010 Update of Injured Resources and Services (May 14, 2010), available on the Council's website at http://www.evostc.state.ak.us, provides the information presented in this Chapter and may be consulted for additional detail and annotations.

3.3.1 Uncertainties in Evaluating Recovery Status

To mitigate the uncertainties inherent in evaluating recovery the Council reviewed current, relevant scientific information while acknowledging the limitations of assigning an ultimate cause and effect relationship using the existing data. The current List combines the available literature and limitations of data into one document using best professional judgment. The types of uncertainty found in the published literature include:

1. Variability in population estimates. Because the patterns of animal distribution present challenges in getting accurate counts (especially of highly mobile fish, birds and marine mammals), most estimates of population size have wide ranges of variability associated with the data.

2. Lack of pre-spill data. For many of the resources affected by the spill there was limited or no recent data on their status in 1989. Additionally, some of the available pertinent data were the result of limited sampling, which consequently produced wide confidence intervals around the population estimates.

3. Interaction of spill and natural factors. It is increasingly difficult to separate what may be lingering effects of the spill from changes that are natural or caused by factors unrelated to the oil spill.

4. Scale and scope. The geographic scale and scientific scope of studies conducted over the years has varied among resources and this disparity must be considered when interpreting data and applying results to recovery status. Some studies were conducted at the large spatial scale to address population and ecosystem concerns, while other studies focused on localized exposure and effects of oil. In addition, some studies examined one characteristic over multiple species while other studies investigated many characteristics in a focused number of species.

For some species, no further actions have been taken with regard to future funding of studies to assess recovery. This may be based upon the factors discussed above and may also include a consideration of the following:

1. Additional studies are expensive. More study, with sufficient effort and scope to achieve powerful tests of the impacts of lingering oil, would be relatively expensive.

2. Unable to definitively demonstrate an effect. Natural variability, confounding effects, and lack of tools to estimate important metrics make it unlikely that an effect could be detected with a high degree of confidence.

3. Effects are likely undetectable. Based on available data, mechanistic principles, and knowledge of past spill impacts on processes of recovery, the likely effects are deemed to be minimal.

4. Effects unlikely to be of ecological importance. Based on available data, understanding of ecological interactions, and the expected small size of lingering impacts, it is unlikely that the effect (if any) will impair function of the ecological system.

5. No effective restoration options available. Even if a demonstrated need exists, there are no reasonable options for restoration of the injured resource.

6. More effective uses of funds. Other projects provide promise of more definitive results, greater significance to the ecosystem, or more potential for restoration.

More information on the recovery status of impacted species is available in the following section. The species listed are separated by nearshore and offshore designations but many can traverse the designations during life stages, time of year, or in response to predation.

3.4 Nearshore: Recovering

More than 1,400 miles of coastline were oiled by the spill in Prince William Sound, on the Kenai and Alaska peninsulas, and in the Kodiak Archipelago. Heavy oiling affected approximately 220 miles of this shoreline. It is estimated that 40–45 percent of the 11 million gallons of crude oil spill by the *Exxon Valdez* washed ashore in the intertidal zone. For months after the spill in 1989, and again in 1990 and 1991, both oil and intensive clean-up activities had significant impacts on the flora and fauna of this environment.

Initial impacts to the nearshore occurred at all tidal levels and in all types of habitats throughout the oil spill area. Direct assessment of the spill effects included sediment toxicity testing, documenting abundance and distribution of nearshore organisms and sampling ecological parameters of community structure. Dominant species of algae and invertebrates directly affected by the spill included common rockweed, speckled limpet, several barnacle species, blue mussels, periwinkles, and oligochaete worms. At lower elevations on gravel and mixed sand/gravel beaches, the abundance of sediment organisms and densities of clams declined. Large numbers of dead and moribund clams were documented on treated beaches, but these effects were likely due to a combination of oil toxicity and hot water washing. Nearshore fish were also affected. In a study conducted in different habitats, density and biomass of fish at oiled sites showed declines relative to reference sites in 1990.

The Nearshore Vertebrate Predator (NVP) project was a six-year study (1995-2001) of factors limiting recovery of four indicator species that use the nearshore environment. The possible factors included: food availability, continued damage from oil, and population demographics. The $6.4 million project focused on two fish-eaters, river otters and pigeon guillemots, and two species that feed on shellfish and other invertebrates, harlequin ducks and sea otters. Nearshore areas were the hardest hit by the *Exxon Valdez* oil, which clung to beaches and polluted waters on each succeeding tide. When this project was designed, all four predators exhibited signs of stress in oiled areas. For sea otters and harlequin ducks, long-term effects continued in the oiled areas, as shown by the lack of population recovery in these areas, and symptoms of oil exposure in harlequin ducks. At the time, researchers predicted that food was the most likely factor limiting recovery, but their studies proved that it was not. When large quantities of lingering oil were discovered in 2001, it became clear that there was linkage between known effects and the remaining oil.

3.4.1 Bald Eagles: Recovered

Productivity (or reproductive success as measured by chicks per nest) was back to pre-spill levels in 1990 and 1991, and an aerial survey of adults in 1995 indicated that the population had returned to or exceeded its pre-spill level in the Sound. In September 1996, the Council classified the bald eagle as recovered from the effects of the oil spill.

3.4.2 Barrow's Goldeneyes: Recovering

Prince William Sound is an important area for this species as the area is within their wintering range and supports between 20,000 and 50,000 wintering individuals. Survey data from the U.S. Fish and Wildlife Service indicated that winter numbers of goldeneyes on oiled areas were stable from 1990–1998, in contrast to significantly increasing numbers on unoiled areas during that same time period That was interpreted as evidence of lack of recovery, as the prediction would be that lack of continued injury would result in parallel population trajectories and that recovery would be indicated by more positive trajectories on oiled areas. In the most recently published survey (through March 2007), slopes were parallel and stable over time, although this was due primarily to a decrease in goldeneye abundance on unoiled areas. A study of Barrow's goldeneye habitat use in oiled and unoiled portions of Prince William Sound found that densities of birds in oiled areas were at expected levels, given the habitat; food limitations in the intertidal are not restraining recovery. Lingering oil still remains in intertidal habitats used by Barrow's goldeneyes, maintaining the possibility of continued exposure and chronic effects.

Interpretation of surveys and habitat selection is constrained by lack of full understanding of Barrow's goldeneye demography, particularly rates of site fidelity and dispersal. These values have important implications for understanding the process of population recovery. Lack of elevated CYP1A measured in oiled areas in 2009 relative to unoiled areas suggests that exposure to lingering oil has ceased in the Barrow's goldeneyes, and thus, that at least part of the recovery objective has been met. Barrow's goldeneyes are considered to be recovering from the effects of the oil spill.

3.4.3 Black Oystercatchers: Recovering

Black oystercatchers are long-lived (15+ years) and territorial, occupying nests in rocky areas close to the intertidal zone and returning in successive years to nest again in the same vicinity. In the early 1990s, elevated hydrocarbons in feces were measured in chicks living on oiled shorelines. Deleterious behavioral and physiological changes including lower body weights of females and chicks were also recorded. Because foraging areas are limited to a few kilometers around a nest, contaminations of mussel beds in the local vicinity was thought to provide a source of exposure. In 1998 the Council sponsored a study to reassess the status of this species in Prince William Sound. The data indicated that oystercatchers had fully reoccupied and were nesting at oiled sites in the Sound. The breeding phenology of nesting birds was relatively synchronous in oiled and unoiled areas, and no oil-related differences in clutch size, egg volume, or chick growth rates were detected. However, a higher rate of nest failure occurred on oiled Green Island: at the time this was thought to be the result of predation, not lingering effects of oil. Because the extent of shoreline with persistent contamination was limited and lingering oil was patchy, it was concluded that the overall effects of oil on oystercatchers in the Sound had been minimal. However, the reasons that predation was higher at oiled Green Island than at Montague were not investigated. It is not clear whether predation was higher because there were higher numbers of predators, lower number of nests initiated or a behavioral change in the parents that would have led to lower nest protection.

Based on this study and one year of boat-based surveys (2000) of marine birds in Prince William Sound indicating that there were increases in numbers of oystercatchers in both the oiled and unoiled areas for that year, the black oystercatcher was identified as recovered. Since 2002, however, additional information has come to light indicating that designation may have been premature. A long-term (1989–2007) evaluation of marine bird population trends suggest that populations of black oystercatchers in the Sound have likely not recovered to pre-spill conditions.

Further, ongoing oil exposure to oystercatchers was documented in 2004 using a biochemical marker of exposure, cytochrome P450IA. Given the more recent understanding of the persistence of oil in sediments along shorelines that initially received heavy or moderate oiling, it is likely that black oystercatchers in oiled areas have suffered chronic exposure as has been shown for sea otters and harlequin ducks. Hydrocarbon exposure in 2004 is likely considerably less than in the early 1990's, but at this time, we do not know if there are any significant physiological or population level consequences from chronic exposure.

Black oystercatchers will have recovered when population levels, reproduction rates, productivity and oil exposure biomarkers have reached levels that would have existed without the spill. Evidence, however, still shows a high rate of nest failure and the continued exposure to oil. Population trends indicate a continued status of "recovering."

3.4.4 Clams: Recovering

Studies have indicated that abundances of some species of clams were lower on treated beaches through 1996. Densities of littleneck and butter clams were depressed through 1997 on cleaned mixed-sedimentary shores where fine sediments had been washed down the beach during pressured water treatments.

As part of an investigation of sea otter populations conducted from 1996-1998, researchers compared clam densities between oiled sites on Knight Island and unoiled sites on Montague Island. They reported an increase in mean size of littlenecks and butter clams at Knight Island, where numbers of sea otters, a major predator of clams were significantly reduced. Absolute densities of littlenecks and butter clams were not different between oiled and unoiled sites; however, oiled sites had fewer juvenile clams and lower numbers of other clam species. In 2002, differences in species richness, diversity and abundance of several species were still measurable between cleaned (oiled and treated) and untreated (oiled but untreated) beaches. Moreover, as of 2007, several wildlife species that use the intertidal zone and feed on clams (e.g., harlequin ducks and black oystercatchers) are still being exposed to oil. These resources are included on the List and although the exact route of oil contamination has not been established for these birds, it is likely they are ingesting oil with their prey.

Some overlap occurs between areas where lingering oil and populations of littleneck and butter clams co-exist. Given the burrowing behavior of these animals, it is likely they would be exposed to oil as they dig into the subsurface sediments known to contain oil. In fact, it has been demonstrated that littleneck clams exposed for a year to the surface layer of contaminated sediments did not accumulate oil, but if the clams were buried in sediments mixed with oil, accumulation did occur.

Clam populations found on oiled but untreated beaches have likely recovered from the effects of the spill. However, several factors continue to impact clam populations on oiled and treated beaches: abundances and distribution differences are still measurable between cleaned and untreated sites; a lingering oil occurs in habitats with clams, and exposure of clams to oil could result in upper trophic level predators eating contaminated prey; and other species on the List are still being exposed to oil and are known to forage on clams.

Clams are continuing to recover in the Sound, but there still exists a difference in abundance between oiled and washed, oiled and unwashed, and unoiled sites. Data have suggested that disturbance of the rock armor of beaches continues to impede recovery. If this is true then recovery may require geological re-armoring processes that operate on decadal scales. Current population trends indicated a status of recovering.

3.4.5 Common Loons: Recovered

Boat-based surveys of marine birds in Prince William Sound give some insight into the recovery status of the loons affected by the oil spill. Pre-spill counts of loons exist only for 1972–1973 and 1984–1985. After the spill, contrasts between oiled and unoiled areas of the Sound indicated that loons as a group were generally doing better in unoiled areas than in oiled areas. Thus, the survey data suggested that the oil spill had a negative effect on numbers of loons (all species combined) in the oiled parts of the Sound.

Common loons exhibited declines in population numbers and habitat usage in oiled areas in 1989 but not in 1990. There was a weak negative effect of oiling on population numbers again in 1993, but not in 1996 or 1998. Based on the boat surveys carried out through 2000, there were indications of recovery, because in that year the highest counts ever recorded for common loons in PWS. In addition, July 2000 counts were the third highest of the 11 years since 1972, although these increases were limited to the unoiled portion of the Sound. Loons are a highly mobile species with widely variable population numbers and the pre-spill data were limited, thus this one year of high counts in the unoiled areas was insufficient to indicate that recovery had started.

Population surveys conducted from 1989–2007 found increasing winter population trends in common loon densities in oiled areas. The summer counts do not show a consistent positive relationship, however the summer counts of loons are usually low and variable because they are predominately found on their breeding grounds in other areas during the summer. Common loons have an intrinsically low population growth rate and relatively large numbers of carcasses were recovered after the spill, yet post spill winter population counts of common loons have met or exceeded available pre-spill counts for all years measured since the spill, except 1993. Given the long-term positive changes in winter population information, common loons are considered recovered from effects of the oil spill.

3.4.6 Common Murres: Recovered

Post-spill monitoring at the breeding colonies in the Barren Islands indicated that productive success was within normal bounds by 1993, and it has stayed within these bounds each breeding season since then. During the period 1993–1997, the murres nested progressively earlier by two to five days each year, suggesting that the age and experience of nesting birds were increasing, as might be expected after a mass mortality event. By 1997, the numbers of murres at the Barren Island had increased, probably because three- and four-year old nonbreeding sub-adult birds that were hatched there in 1993 and 1994 were returning to their natural nesting colony. Although counts were low in 1996, the counts in 1997 at this index site brought the colony size to pre-spill levels. The population size coupled with normal reproductive success (productivity), indicate that recovery has been achieved for common murres.

3.4.7 Cormorants: Recovered

Marine bird surveys were conducted during ten of the 16 years during1989–2005. For cormorants, trends for both summer and winter populations were increasing in the oiled area of Prince William Sound. Moreover, population estimates for cormorants in summer 2004 ranged from 9,000–11,000 birds, which falls within the range of 10,000–30,000 estimated in 1972. Therefore, although population estimates of cormorants are highly variable throughout their range, the recovery objectives have been met and cormorants are considered to be recovered.

3.4.8 Cutthroat Trout: Very Likely Recovered

Limited information exists regarding the current status of cutthroat trout. Recent exposure to lingering oil is unlikely, because most of the bioavailable oil appears to be confined to subsurface intertidal areas, and not dissolved in the water column. Distribution of cutthroat trout is patchy throughout the Sound,however populations are known to occur in areas directly impacted by the spill The Sound is the northern edge of cutthroat trout range and dispersal during marine migration is restricted, thereby increasing their susceptibility to habitat alteration and pollution. Resident cutthroat trout populations in the Sound are small and geographically isolated from each other: These characteristics suggest that recovery of a population would depend less on mixing with nearby aggregates than on the productivity of the endemic population and the extent to which it was injured by the spill. However, anadromous forms are also present. Confounding factors such as sport fishing and habitat alteration of spawning streams (e.g., through logging) may also inhibit successful recruitment of young into a population and subsequent increase in numbers.

Given the ecological similarities in summer diet and foraging ecology along shorelines between cutthroat trout, and Dolly Varden, and the absence of ongoing injury to Dolly Varden, further research would be very unlikely to demonstrate any evidence of continuing differences due to the spill between oiled and unoiled areas. Thus, funding the additional research necessary to provide current growth rate and abundance data for this species is not a cost-effective scientific priority.

The Council considers cutthroat trout to be very likely recovered. Additional study, with sufficient effort and scope to achieve powerful tests of the impacts of lingering oil, would be relatively expensive, would likely be unable to definitively demonstrate an effect, and any effects would likely be minimal. For these reasons, it is unlikely that additional research will clarify this species' injury status.

3.4.9 Dolly Varden: Recovered

The growth differences between Dolly Varden in oiled and unoiled streams did not persist into the 1990–91 winter, but no growth data have been gathered since 1991. In addition, by 1990 the concentrations of hydrocarbons in bile had dropped substantially and a biochemical marker of oil exposure had a diminished.

In a 1991 restoration study sponsored by the Council, some tagged Dolly Varden moved considerable distances among streams within Prince William Sound, suggesting that mixing of overwintering stocks takes place during the summer in saltwater. Follow up studies indicate that Dolly Varden are abundant throughout the Sound, and genetically similar among geographically different aggregates. Frequent genetic exchange among groups of fish implies that mixing occurs, and outside populations are available to enhance depleted stocks. Moreover, fishing pressure on Dolly Varden is likely not as intense as that on coastal cutthroat trout. Populations are larger, the fish are more widely spread throughout the Sound and larger numbers can better tolerate harvest. Finally, current exposure to lingering oil is unlikely because most of the bioavailable oil is confined to subsurface intertidal areas and not dissolved in the water column. The recovery status of Dolly Varden is recovered.

3.4.10 Harbor Seals: Recovered

Harbor seal populations in the Sound were declining before the oil spill and the decline continued after the spill occurred. Factors contributing to this decline may involve environmental changes that occurred in the 1970s in which the amount and quality of prey resources were diminished. It is possible that the changes in the availability of high quality forage fish such as Pacific herring and capelin altered the ecosystem such that it may now support fewer seals than it did prior to the late 1970s. Other sources of mortality that may be contributing to lower seal numbers could include predation, subsistence hunting, and commercial fishery interactions (e.g., entanglement and drowning in nets).

Satellite tagging studies sponsored by the Council and genetic studies carried out by the National Marine Fisheries Service indicate that harbor seals in the Sound are largely resident throughout the year and have limited movement and interbreeding with other subpopulations in the northern Gulf of Alaska. This suggests that recovery must come largely through recruitment and survival within resident populations.

Based on annual counts from haulouts concentrated in the south-central region of the Sound, seal numbers stabilized from 1996–2005 and likely increased between 2001–2005. From 1990–2005, seal numbers at sites that were not oiled decreased at a greater rate than oiled sites, indicating no localized effects of the spill. However, the entire spill zone was not surveyed, and trends may have been influenced by movements of seals from oiled to unoiled sites after the spill and a return to more oiled sites in recent years. This hypothesis has not been studied directly. Harbor seals are considered recovered due to collective evidence from the last ten years indicating that harbor seal population numbers are stabilizing or increasing.

3.4.11 Harlequin Ducks: Recovering

Winter populations of harlequin ducks in Prince William Sound have ranged from a high of 19,000 ducks in 1994 to a low of around 11,000 ducks in March of 1990, one year after the spill. The 2000 estimate of wintering harlequin ducks in the Sound was approximately 15,000.

Several post-spill studies were designed to measure the extent and severity of injuries to the Prince William Sound harlequin duck population from the oil spill and assess recovery. Through 1998, oil spill effects were still evident although the extent and magnitude of the injury remained unclear. Supporting studies provided evidence of continuing injury to harlequins through the following mechanisms: 1) invertebrate recovery in upper intertidal and subtidal areas remained incomplete for some species, thereby impacting potential prey base for harlequins; 2) oil persisted in intertidal areas of Prince William Sound where it was identified as a source of contamination of benthic invertebrates; 3) the possibility of external oiling of feathers remained due to lingering surface oil; 4) a biochemical marker of oil exposure (cytochrome P450) was greater in tissues of harlequin ducks captured in oiled areas than in reference areas and 5) overwinter female survival was lower in oiled than reference areas.

More recent studies indicate improving conditions. From 1997–2007, age composition and population trends were compared in harlequin ducks between oiled and unoiled areas of the Sound. No difference in population trends was observed between areas. Although populations in the oiled area were no longer declining as they were in the mid 1990s, a positive trend was not observed. Overall, more males than females occurred Sound-wide which is consistent with other Pacific populations of harlequin ducks. The ratio of immature to adult males was similar between areas, thus indicating similar recruitment into both populations. However, there remains a disproportionately lower number of female ducks in the oiled areas. From 2000–2002, measurements of cytochrome P450 activity and female survival rates were converging between oiled and unoiled areas. However, in 2005 through 2009 the P450 biomarker was elevated in ducks from the oiled areas. Finally, lingering oil still remains in habitats used by harlequins, thereby maintaining the possibility of chronic effects related to continued exposure.

Recent analyses still show a pattern of higher cytochrome P450 induction in oiled than unoiled areas. A temporal trend towards convergence between oiled and unoiled populations in over-winter survivorship indicate that harlequin ducks are in the process of recovering. However, a sustained increase in abundance numbers is needed in oiled areas for full recovery. Harlequin ducks are considered to be recovering, as indications of negative effects (reduced survival and declining numbers) in oiled areas have abated, although the recovery objective has not been fully realized.

3.4.12 Mussels: Recovering

The primary route by which mussels accumulate oil is through ingestion of petroleum hydrocarbons in the water. Much of the lingering oil in the Sound and the Gulf of Alaska is sequestered in the subsurface sediments. Mussels are found both as epibiota, attached to the surface substrates, and also partially embedded in coarse sediment, where they could come into close contact with oiled sediments. It is possible that mussels could filter particulate and dissolved hydrocarbons from the water if the oil is re-suspended during storm surges, wave action or when underlying sediments are disturbed by predators. The current distribution of oil within a mussel bed is determined by water flow, amount of oil present, sediment grain size, and disturbance history.

After the spill, hydrocarbons accumulated in mussels for about a decade at sites where oil was retained in sediments. Remaining oil was biologically available for many years after the spill, but the frequency of occurrence and average hydrocarbon concentrations in mussel tissue has declined with time. In most instances concentrations of oil in mussels from the most heavily oiled beds in Prince William Sound were largely indistinguishable from background by 1999. However, concentrations in sediment underlying the mussel beds remained elevated.

Recent data indicate that hydrocarbon concentrations in mussels are declining, even in armored beaches where elimination has been slow, and at many sites concentrations are not different from background. While a decrease in tissue concentration addresses part of the recovery objective, in order to be fully recovered mussels must provide uncontaminated food to top predators, including human subsistence users. As recently as 2008, some bird species which rely exclusively on the intertidal zone (harlequin ducks, Barrow's goldeneye and black oystercatchers) were still being exposed to hydrocarbons. The route of oil exposure has not been established for these birds, however, it is possible that they are consuming contaminated prey or foraging in contaminated sediment during feeding. For many of these species mussels are a known prey item, and they could be foraging in contaminated sediments underlying mussel beds. Because it cannot be verified that predators are not being exposed to oil while foraging in mussel beds, mussels are considered to be recovering from the effects of the oil spill.

3.4.13 Pink Salmon: Recovered

In the years preceding the spill, returns of wild pink salmon in Prince William Sound varied from a maximum of 23.5 million fish in 1984 to a minimum of 2.1 million in 1988. Many factors, such as the timing of spring plankton blooms and changes in water circulation patterns throughout the Gulf of Alaska are likely to have a great influence on year-to-year returns in both wild and hatchery stocks of pink salmon. Since the spill, returns of wild pinks have varied from a high of about 12.7 million fish in 1990 to a low of about 1.9 million in 1992. In 2001 the return of wild stock fish was estimated to be 6.7 million fish.

The decade preceding the oil spill was a time of peak productivity for pink salmon in the Sound. In 1991 and 1992, it appears that wild adult pink salmon returns to the Sound's Southwest District were reduced by 11 percent; however wild salmon returns are naturally highly variable. Furthermore, the methods used to estimate this decrease could not be used to produce reliable injury estimates across multiple generations of salmon. An analysis of escapement data from 1968-2001 did not show any differences in annual escapements between oiled and unoiled parts of the Sound. Therefore, population-level effects from the spill did not impact wild pink salmon or were short-lived.

Sound-wide population levels appear to be within normal bounds. In addition, reduced juvenile growth rates in Prince William Sound occurred only in the 1989 season. Since then, juvenile growth rates have been within normal bounds. Higher embryo mortality persisted in oiled streams when compared to unoiled streams through 1993: these differences were not detected from 1994–1996, but higher embryo mortality was again reported in 1997. It could not be determined if the reemergence of elevated embryo deaths was due to the effects of lingering oil (perhaps newly exposed by storm-related disturbance of adjacent beaches), or due to other natural factors (e.g., differences in the physical environment). Although patches of lingering oil still persist in or near intertidal spawning habitats in a few of the streams used by pink salmon in southwestern Prince William Sound, the amounts were considered negligible based on 1999 and 2001 studies. In 1999, dissolved oil was measured in six pink salmon streams that had been oiled in 1989. Only one of the six streams had detectable concentrations of oil, and they were about a thousand times lower than concentrations reported as toxic to developing pink salmon embryos.

Based on these results, continuing exposure of pink salmon embryos to lingering oil is negligible and unlikely to limit pink salmon populations. Given the fact that pink salmon population levels and indicators such as juvenile growth and survival are within normal bounds, pink salmon were considered recovered from the effects of the oil spill in 1999.

3.4.14 River Otters: Recovered

Although some of the differences (e.g., values of blood characteristics) between river otters in oiled and unoiled areas in Prince William Sound were apparent through 1996, they did not persist in 1997 and 1998. In 1999, the Council considered river otters to be recovered, because the recovery objectives had been met and indications of possible lingering injury from the oil spill were not present.

3.4.15 Sea Otters: Recovering

No apparent population growth occurred for Prince William Sound sea otters through 1991. After 1993, the population in the western Sound began increasing at a rate approximately one-half of the pre-spill rate of increase. From 1993–2000, the number of otters increased by 600 animals which represents an annual growth rate of 4 percent. However, in areas that were heavily oiled, such as northern Knight Island, sea otter populations have remained well below pre-spill numbers, and population trends continued to decline through 2005.Moreover, the demographics within this group apparently are not stable as many of the females are below reproductive age and young non-territorial males have moved into and out of the population.

The lack of recovery may reflect the extended time required for population growth for a long-lived mammal with a low reproductive rate, but likely reflects the effects of chronic exposure to hydrocarbons, or a combination of both factors. Food limitation does not appear to be a factor limiting recovery in the Knight Island group, because food resources are at least as plentiful there as they are at unoiled Montague Island. Productivity is also similar between oiled and unoiled sites. Exposure of sea otters to lingering oil is plausible because their foraging sites and prey species occur in habitats harboring oil. Additionally, biochemical responses (cytochrome P450) of oil exposure were elevated in animals from oiled sites through 2002. By 2004–2005, the response of this biomarker was similar in animals from oiled and unoiled areas. However, additional years of data are needed to determine if the similarity is true convergence, and the apparent diminishing exposure to oil is a long-term trend.

Sea otters will have recovered when population levels, reproduction and productivity are within normal bounds in oiled and unoiled areas and have reached levels that would have existed without the spill. Recovery will also be substantiated when the biochemical indicators of hydrocarbon exposure are similar within the oiled and unoiled areas.

Although there has been a slow increase since 2005 in the sea otter population within the heavily-oiled areas, there has been a greater rate of overall increase in the population within Prince William Sound. Therefore, sea otters are considered to be recovering.

3.5 Sediments: Recovering

Approximately ten acres of *Exxon Valdez* oil remains in surface sediments of Prince William Sound, primarily in the form of highly weathered, asphalt-like or tar deposits. In 2003, it was estimated that 20 acres of unweathered, lingering oil may still be present in subsurface, intertidal areas of the Sound, which could represent up to 100 tons of remaining oil. Most of this oil is found in protected, unexposed bays and beaches. Subsurface oil was not subjected to the original clean-up activities, and because this oil is trapped beneath a matrix of cobbles, gravel and finer sediments, it is not easily exposed to natural weathering processes.

The most recent studies documenting residual oil occurred on those beaches that were considered heavily or moderately oiled in 1989: beaches reported as lightly oiled were not surveyed. Moreover, beaches outside of the Sound were not included, so the amount and extent of residual oil in the entire spill zone is not known, but one estimate suggests as much as 200 tons of oil may still exist. Several studies have evaluated the extent of lingering oil on armored oiled beaches along the outer Kenai Peninsula coast, the Alaska Peninsula, and Kodiak Archipelago: These studies looked at the same sites repeatedly at intervals from 1992–2005. By 1995, little visible oiling was observed in the study area on Kodiak. Overall, by 1995, hydrocarbon concentrations in sediments at the Gulf of Alaska sites were generally lower than for sites in Prince William Sound, but at some locations substantial concentrations persisted. Through 2005, surface oil was not frequently observed in these areas, and subsurface oil was present as mostly unweathered mousse.

In 1989, chemical analysis of oil in subtidal sediments was conducted at a small number of index sites in Prince William Sound. In the subtidal areas, petroleum hydrocarbon concentrations were highest at depths of 1– 60 feet (below mean low water) and diminished out to depths of 300 feet. It is likely that oil in subtidal sediments have decreased substantially since the spill. In 2001, several sites that were sampled after the spill were revisited, and no oil was found in the subtidal sediment from these locations.

Twenty-one years after the spill, lingering oil has persisted in the intertidal zones of Prince William Sound and on northwest shorelines of the spill area. The presence of subsurface oil continues to compromise wilderness and recreational values, expose and potentially harm living organisms, and offend visitors and residents, especially those who engage in subsistence activities along still-oiled shorelines. Although much of the oil has diminished over time, pockets of unweathered oil exist, and natural degradation of this oil is very slow. Moreover, some obligate intertidal foraging bird species are still being exposed to oil. Therefore, sediments are considered to be recovering.

3.6 Offshore - Recovering

Subtidal habitats encompass all of the seafloor below the mean lower low water tide line to about 800 meters, although deeper habitats are often referred to as the deep benthos. For purposes of evaluating oil spill effects, the impacted subtidal zone generally ranges from the lower intertidal zone to a depth of about 20 meters. Communities in the near subtidal areas are typically characterized by dense stands of kelp or eelgrass and comprise various invertebrate species, such as amphipods, polychaete worms, snails, clams, sea urchins and crabs. Subtidal habitats provide shelter and food for an array of nearshore fishes, birds, and marine mammals.

It is estimated that up to 13 percent of the oil that was spilled deposited in the subtidal zones. The direct toxicity of the oil, as well as subsequent clean-up activities caused changes in the abundance and species composition of plant and animal populations below lower tides. Initial injuries were evident for several oil-sensitive species. Infaunal amphipods, a prominent prey species in subtidal communities, were consistently less abundant at oiled than at unoiled sites. Reduced numbers of eelgrass shoots and flowers were also documented and may have resulted from increased turbidity associated with clean-up activities. Two species of sea stars and helmet crabs also were less abundant at oiled sites when compared to oiled areas. However, stress tolerant organisms, including polychaete worms, snails and mussels were more abundant at oiled sites. It has been suggested that these species may have benefited from organic enrichment of the area from the oil or from reduced competition or predation because other, more sensitive species were depleted.

3.6.1 Killer Whales: Recovering (AB Pod), Not Recovering (AT1 Population)
From 1990–1995 seven calves were born within the AB pod: however, additional mortalities occurred and by 2005, the number of whales was only 27. Killer whales are long-lived and slow to reproduce. Female killer whales give birth about every five years, and are likely to produce only four to six calves throughout their life. Moreover, a disproportionate number of females were lost at the time of the spill, and population modeling has demonstrated that the spill impacted the AB pod primarily through the loss of young and reproductive females. Unexpected mortalities in the years since the spill have also impacted this group. These factors indicate that the recovery rate of this population after a large loss of individuals will be slow.

Transient killer whales, such as the AT1 population, largely prey on marine mammals, especially harbor seals. From data collected at haul-outs in the south-central region of the Sound, it appears that harbor seals numbers may have increased over the past five years. It is unclear how the population dynamics of harbor seal influence transient whale populations, but changes in the availability of such an important prey species could impact survival of individuals and reproductive success within groups. Research sponsored by the Council on contaminants in killer whales in the Sound indicates that individuals of the AT1 population are carrying elevated levels of PCBs, DDT, and DDT metabolites in their blubber. Although the presence of these contaminants is not related to the oil spill, the high concentrations found in these transients are comparable to levels that cause reproductive problems in other marine mammals. Accordingly, it is likely that the population dynamics of this population are being influenced by factors other than residual oil which may further hinder their ability to rebound from the initial injury from the spill.

Killer whales will have recovered when population levels, reproduction and productivity are within normal bounds in spill-affected pods of killer whales, as would have existed without the spill. The weighted average annual productivity rate of the AB resident pod is 3.3 percent. This pod is considered recovering. The AT1 transient population of killer whales, however, continues to decline, and therefore, is considered not recovering. The progress toward recovery is slow as key breeding females have been lost. The AB killer whale pod is considered to be recovering due to the stabilized reproduction rate of the pod. The recovery status of the AT1 killer whale population is considered to be not recovering due to the population's continuing decline.

3.6.2 Pigeon Guillimot: Not Recovered

As of 1999, adult pigeon guillemots in the oiled areas were still being exposed to oil as indicated by elevation of a biochemical marker of exposure, cytochrome P450. No differences were found between P450 activity in chicks from oiled and unoiled sites. The difference in P450 activity between adults and chicks is probably due to the fact that pigeon guillemot chicks are fed primarily fish, while adults eat a combination of fish and invertebrates. Invertebrates are more likely to sequester petroleum compounds, whereas fish metabolize them. Data collected in 2004 indicated that there was no difference in P450 activity in adult pigeon guillemots collected in oiled and unoiled parts of the Sound.

Lingering oil occurs in habitats used by pigeon guillemots. They feed on fish and invertebrates by diving and probing the substrate with their bills. Because their diet includes benthic organisms living in the intertidal zone, they could encounter subsurface oil while foraging. However, guillemots do not use the intertidal zone exclusively and can travel several miles offshore to feed. Thus, their exposure to lingering oil is likely intermittent.

Reduction in forage fish, specifically herring and sand lance, has been implicated in declines of pigeon guillemots. The extent to which the oil spill resulted in the depletion of these species could indirectly injure guillemots and other seabirds by removing the food resources on which they depend. Other factors, such as predation and interactions with commercial fisheries, might be contributing to the negative population trend; however comprehensive studies including these variables have not been conducted.

The pigeon guillemot population continues to decline in both oiled and unoiled areas of Prince William Sound. Nest predation is a potential source of mortality that may be limiting recovery in some areas, implying that predator removals could prove an effective restoration option. To establish the recovery of this species to the recovery objective of increasing levels of abundance and productivity that would have existed without the spill, additional data on productivity needs to be gained to form a reasonable estimate. Pigeon guillemots are considered to be not recovered from the effects of the spill.

3.6.3 Rockfish: Very Likely Recovered

From 1989–1991, higher petroleum hydrocarbon concentrations were measured in rockfish from oiled areas when compared to unoiled areas. Interpretation of these data is limited, however, because oil accumulation differs by species and by age of the fish, and these variables were not fixed across sites. Other Council-funded studies have been conducted on rockfish since the spill, including 1) an examination of larval growth of fish, (including rockfish) in 1989; 2) a genetics investigation designed to identify species of rockfish larvae and young in the Gulf of Alaska and 3) a microscopic examination of fish tissues to identify lesions associated with oil exposure. These studies were inconclusive as none of them directly linked exposure of *Exxon Valdez* oil to any of the endpoints that were measured.

It is unlikely that adult rockfish are currently being exposed to lingering oil because known pockets of lingering oil rarely occur in their preferred habitat. Documented lingering bioavailable oil is in the subsurface sediments of the intertidal zone, and adult rockfish mostly occur in differing habitats of subtidal areas and in pelagic environments. From 1999–2000, no differences were measured in physiological responses to oil in rockfish from oiled and unoiled areas. Nearshore environments, however, provide important rearing habitat for young-of-the-year and juvenile rockfish of a number of species. Since lingering oil is present in the intertidal zone, the risk of exposure is present during early life history stages for those species.

Although it is unlikely that most species and life-stages of rockfish are currently being exposed to lingering oil, the original extent of injury was not documented and the potential for continued exposure by young-of-the-year and juveniles of some species is present. Since the spill, few studies have provided information about rockfish abundance, species composition and the impacts of commercial fisheries. Therefore, the current understanding of the long-term effects of the original spill cannot be determined and the Council considers the status of rockfish to be very likely recovered. Based on the available data, understanding of ecological interactions and the expected small size of lingering impacts, it is unlikely that an effect, if any, will impair function of the ecological system and thus there are likely more effective uses of research funds than on further study of this species.

3.6.4 Sockeye Salmon: Recovered

Although sockeye freshwater growth tends to return to normal within two or three years following an overescapement event, there are indications that the populations are less stable for several years. The overescapement following the spill resulted in lower sockeye productivity, (as measured by return per spawner) in the Kenai River watershed from 1989–92. However, production of zooplankton in both Red and Akalura lakes on Kodiak Island quickly rebounded from the initial effects overgrazing. By 1997, Red Lake had responded favorably in terms of smolt and adult production and was at or near pre-spill production of adult sockeye. At Akalura Lake there were low juvenile growth rates in freshwater during the period 1989–92, and these years of low growth correspond to low adult escapements during the period 1994–97. Starting in 1993, however, the production of smolts per adult increased sharply and the smolt sizes and age composition suggested that rearing conditions had improved. It is possible that overescapement also affected lakes on Afognak Island and on the Alaska Peninsula. However, analysis of sockeye freshwater growth rates of juveniles from Chignik Lake on the Alaska Peninsula did not identify any impacts associated with a 1989 overescapement event. On the basis of catch data through 2001 and in view of recent analyses of return per spawner estimates presented to the Alaska Board of Fisheries in 2001, the return-per-spawner in the Kenai River system is within historical bounds. Therefore, it is highly unlikely that the effects that reverberated from the overescapements in 1989 continue to affect sockeye salmon. In 2002, this species was considered to be recovered from the effects of the oil spill.

3.6.5 Kittlitz's Murrelet: Unknown

Few studies have been conducted on Kittlitz's murrelets, however they are known to nest in areas of glacial outcroppings, and they are thought to reside within the Sound from May until September/October. Kittlitz's murrelets have an intrinsically low population growth rate, thus recovery from an acute loss is likely to be slow.

The Kittlitz's murrelet is a candidate species for listing as threatened or endangered under the federal Endangered Species Act. They declined 99 percent from 1972 to 2004 and 88 percent from 1989–2004. While this decline likely started prior to the spill, the rate of decline was 18 percent per year from 1972, but beginning in 1989 that rate increased to 31 percent.

Natural recovery has not restored this resource to pre-spill levels or levels that would have existed had the spill not occurred. What little evidence is available reveals possible predator limitation, within their feeding areas, and impacts due to a shifting climate. While it is likely that basic biological studies would be useful to understand what may be limiting recovery, it is unlikely, due to these confounding effects, that further study will clarify whether there are still residual effects of the spill. In addition, the rarity of this species makes it difficult and expensive to study.

The recovery status for the Kittlitz's murrelet remains unknown. Further, due to the small populations and the confounding effects discussed above, it is likely that additional studies would be both relatively expensive and unable to demonstrate an effect of the spill or to clarify this species' injury status.

3.6.6 Marbled Murrelets: Unknown

Marbled murrelets were declining in the Sound before the oil spill, and the decline has continued since the spill. It is listed as a threatened species in Washington, Oregon, California and British Columbia. Marbled murrelets have low intrinsic productivity and a slow population growth rate. Therefore, recovery from an acute loss will likely take many years.

Marbled murrelets rely on forage fish such as Pacific herring and Pacific sand lance, which may be declining in the spill area due to various reasons including a potential link to EVOS. Their dietary preferences and foraging areas make significant contact with lingering oil unlikely. Exogenous factors such as climatic factors, decreases in habitat availability, and shifts in forage fish populations are the most likely drivers of murrelet population dynamics. Marbled murrelets do not meet their original recovery objective of increasing or stable populations. Moreover, their decline could be attributable in part to a decline in a primary food source; high-lipid forage fish, particularly sand lance and Pacific herring. Based on available data and scientific understanding, the mechanistic linkage between the oil spill, reduction in high-lipid forage fishes and the decline in marbled murrelets remains uncertain. Because of the great variability in the marbled murrelet annual census in the years after the spill, it is unlikely that the loss of even as much as 7–12 percent of the PWS population (the estimated spill mortality) would have been detectable by census techniques.

The recovery status for marbled murrelets remains unknown due to conflicting information and a lack of critical data. Further, due to the confounding effects discussed above, additional studies would likely be unable to definitively demonstrate an effect of the spill with a high degree of confidence or to clarify this species' injury status.

3.6.7 Pacific Herring: Not Recovered

The herring fishery in the Sound has been closed for 15 of the 21 years since the spill. The population began increasing again in 1997 and the fishery was opened briefly in 1997 and 1998. However, the population increase stalled in 1999, and recent research suggests that the opening of the fishery in 1997 and 1998 stressed an already weakened population and contributed to the 1999 decline. The fishery has been closed since then and no trend suggesting healthy recovery has occurred.

One of the primary factors currently limiting recovery of herring in the Sound seems to be disease. Two pathogens, a virus and a fungal infection are prevalent in herring populations among several age classes. Conditions which made herring susceptible to these two diseases (viral hemorrhagic septicemia and Icthyophonus hoferi infection) are unknown, but it appears they have been impacting herring for over a decade. These diseases do not usually distress fish populations for such a long duration, and this cycle seems to be unique to the herring of Prince William Sound.

Lingering oil exists in the Sound, however there does not appear to be much overlap between current herring spawning areas and sites known to harbor residual oil. In 2006, some herring spawn was observed in areas of the Sound that were oiled however, the spatial extent was limited, and this was the first year in decades that it has been reported. Therefore, it is not likely that lingering oil is directly affecting spawning adults, eggs or larvae.

Low genetic diversity does not appear to be a limitation within herring populations. It was suggested that historic overfishing coupled with the population crash of 1993 could have resulted in a population with low genetic diversity. Similar genetic structure could limit a population's ability to tolerate disease or recover from acute losses, but the genetic diversity of Prince William Sound herring is no different from other northwest populations.

Multigenerational toxicity and effects from original contact with oil does not seem plausible, however this hypothesis has not been directly investigated. Other factors may have contributed to the crash of 1993. Some evidence implies that zooplankton production in the 1990s was less than in the 1980s, thereby causing food to be limited at the time of a peaking population. This hypothesis is offered some support by the fact that the average size-at-age of herring had been decreasing since the mid-1980s as population numbers were rising. Poor nutrition may also increase susceptibility of herring to disease.

Predation also plays a role in herring population dynamics, as they are a primary forage fish within the Prince William Sound ecosystem. It is plausible that the small herring population is fighting an on-going disease problem and is further being kept in check by predators such as whales, seals, sea lions and seabirds.

Despite the numerous studies directed at understanding the effects of oil on herring, the causes constraining population recovery are not well understood. A combination of factors, including disease, predation and poor recruitment appear to contribute to the continued suppression of herring populations in the Sound. In summary, Prince William Sound Pacific herring have not met their recovery objective. No strongly successful year class has been recruited into the population and health indices suggest that herring in the Sound are not fit. Therefore, the Pacific herring are considered to be not recovering from the effects of the spill.

3.7 Human Services

The Spill had significant negative impacts, both culturally and economically, on the people who live in the spill area. The lives of the people who live, work, and recreate in the areas affected by the spill were completely disrupted in the spring and summer of 1989. The Council recognized those impacts. In an effort to address those impacts, the Council has devoted a major portion of restoration funds to the restoration of the fish, birds, marine mammals, and archaeological resources that support human communities in the spill area.

3.7.1 Recreation and Tourism: Recovering

Recreation and tourism accounted for 26,000 jobs, generated $2.4 billion in gross sales and contributed $1.5 billion to Alaska's economy in 2003. The number of visitors to Alaska has increased in the years since the spill and it is expected that the recreation and tourism industry in south-central Alaska will grow approximately 28 percent per year through 2020. By 2001, more than $10 million had been spent on repair and restoration of recreational facilities in the spill area, and damage caused by the spill or clean-up efforts at the Green Island cabin and Fleming Spit campsites were repaired.

Telephone interviews conducted in 1999 and 2002 of people who used the spill area for recreation before and after the spill, indicated that, although oil remained on beaches, it did not deter them from using the area. However, they continued to report diminished wildlife sightings in Prince William Sound, particularly in heavily oiled areas such as around Knight Island. They also reported seeing fewer seabirds, killer whales, sea lions, seals, and sea otters than were generally sighted before the spill, but also reported observing increases in the number of seabirds over the last several years. Key informants with experience along the outer Kenai coast reported diminished sightings of seabirds, seals, and sea lions. However, they indicated that the possible presence of residual oil has no effect on recreational activities along the outer Kenai coast, the Kodiak Archipelago, and the Lake Clark and Katmai national park coastlines. Changes in the amount of wildlife observed could be due to a variety of factors, including the spill.

Recreation and tourism rely on both consumptive and non-consumptive uses of natural resources. Although these activities have increased since the spill, several resources have not yet recovered from the spill and beaches used for recreation contain lingering oil. Resources that are important to recreation and tourism, but are still not considered recovered from the spill or their recovery is unknown include harbor seals, Kittlitz's and marbled murrelet, pigeon guillemot, clams, mussels, harlequin ducks, sea otters and killer whales. Sportfishing resources for which the recovery status is unknown are cutthroat trout and rockfish. However, the salmon species that were injured (pink and sockeye salmon) are recovered from the effects of the spill.

Even though visitation has increased since the oil spill, Council's recovery objective requires that the injured resources important to recreation be recovered and recreational use of oiled beaches not be impaired. Lingering oil remains on beaches and in some localized areas this remains a concern for users. Moreover, several natural resources have not recovered from the effects of the spill. Therefore, Council finds recreation and tourism to be recovering from the effects of the spill, but not yet recovered.

3.7.2 Passive Use: Recovering

The Council determined that passive use injuries occurred as a result of the oil spill because natural resources including scenic shorelines, wilderness areas, and popular wildlife species, from which passive uses are derived, were injured. The key to the recovery of passive use is providing the public with current information on the status of injured resources and the progress made towards their recovery.

Passive use is the service provided by natural resources to people that will likely not visit, contact, or otherwise use the resource. Thus, injuries to passive use are tied to public perceptions of injured resources. Passive use is the appreciation of the aesthetic and intrinsic values of undisturbed areas and the value derived from simply knowing that a resource exists. The oil spill occurred in what many Americans viewed as an undisturbed area and caused visible injury to shorelines, fish and wildlife.

Two vital components of the Council's restoration effort are the research, monitoring, and general restoration program and the habitat protection and acquisition program. Extensive work has been done to restore and monitor resources and communicate these findings to the public. The research, monitoring, and general restoration program is funded each year through the annual work plan, which documents the projects that are currently funded to implement restoration activities for injured resources and services. The habitat protection program preserves habitat important to injured resources through the acquisition of land or interests in land. As of 2006, the Council has protected more than 630,000 acres of habitat, including more than 1,400 miles of coastline and over 300 streams valuable for salmon spawning and rearing.

Other public information efforts in which the Council is currently engaged include:

- The Council's website (www.evostc.state.ak.us) offers detailed information regarding past, current, and future restoration efforts
- The Council prepares a number of documents for distribution to the public including:
  - The *Invitation for Proposals*, which solicits restoration project ideas from the scientific community and the public
  - The Annual Work Plan (described above)
  - Updates to the *Restoration Plan* (1996, 1999, 2002, & 2006) which periodically provides new information on the recovery status of injured resources and services.
- Project final reports are available to the public at the Council's website, through the Alaska Resource Library and Information Services (ARLIS) in Anchorage, as well as at several other libraries in the State, the Library of Congress, and through NTIS (National Technical Information Service). In addition, the Council supports researchers in publishing their project results in peer-reviewed scientific literature, which expands their audience well beyond Alaska.
- The Council supports an annual marine science symposium, which is open to the public that provides a venue in which to report the progress of restoration in the spill area.
- Public Input: The Public Advisory Committee (PAC) is an important means of keeping stakeholders and others informed of the progress of restoration and providing the public's opinions to the Council as they make decisions. Additionally, public meetings are held periodically throughout the spill area. All meetings of the Council are widely advertised and opportunity for public comment is always provided.

Until the public no longer perceives that lingering oil is adversely affecting the aesthetics and intrinsic value of the spill area it cannot be considered recovered. Because recovery of a number of injured resources is incomplete, the Council considers services related to passive use to be recovering from the effects of the spill.

3.7.3 Subsistence: Recovering

After the spill, subsistence harvest declined between 9–77 percent in 10 villages within Prince William Sound, Cook Inlet and Kodiak. Villages in Tatitlek and Chenega reduced their harvest by 56 and 57 percent, respectively. Outside of the Sound, harvest declined in Akhiok (on the lee side of Kodiak Island) by nine percent, but by 77 percent in Ouzinkie, which is on the northern side of the island. The primary reason that harvest declined so dramatically was the fear that oil had contaminated the resources and made them unfit to eat.

Harvest levels have generally increased in many communities since the spill, but results of harvest surveys have been variable. By 2003, they were generally higher than pre-spill levels in the communities in Cook Inlet, but lower in Kodiak and Prince William Sound (except for Cordova). Even though the harvest levels in the PWS communities were not as high as pre-spill estimates, they were within the range of other Alaska rural communities. Harvest composition was also altered by the spill. In the first few years following the spill, people harvested more fish and shellfish than marine mammals because of the reduced number of marine mammals and the perception that these resources were contaminated and unsafe to eat.

Both safety concerns and the reduced availability of shellfish contributed to a decline in harvest levels. From 1989–94, subsistence foods were tested for evidence of hydrocarbon contamination, with no or very low concentrations of petroleum hydrocarbons found in most subsistence foods. However, concerns about oil contamination remained, and there was a belief that the increase in paralytic shellfish poisoning (PSP) was linked with *Exxon Valdez* oil. By 2003, most subsistence users expressed confidence in foods such as seals, finfish and chitons. However, the safety of certain shellfish, such as clams was still met with skepticism.

Subsistence use is a central way of life for many of the communities affected by the spill, thus the value of subsistence cannot be measured by harvest levels alone. The subsistence lifestyle encompasses a cultural value of traditional and customary use of natural resources. Following the oil spill, there was concern that the spill disrupted opportunities for young people to learn cultural subsistence practices and techniques, and that this knowledge may be lost to them in the future. In a 2004 survey of the spill area communities, 83 percent of respondents stated that their "traditional way of life" had been injured by the oil spill and 74 percent stated that recovery had not occurred.

Many factors may contribute to the changes observed in subsistence harvests and the lifestyle surrounding this tradition. Demographic changes in village populations, ocean warming, increased competition for subsistence resources by other people (e.g., sport fishing charters), predators (e.g., sea otters), and increased awareness of PSP and other contaminants may play a role in resource availability, food safety, and participation in traditional practices.

Fears about food safety have diminished since the spill, but it is still a concern for some users. Additionally, harvest levels from villages in the spill area are comparable to other Alaskan communities. However, many subsistence resources injured by the spill, including clams and mussels, have still not recovered from the effects of the spill. For these reasons, subsistence is considered to be recovering from the effects of the oil spill.

3.7.4 Commercial Fishing: Recovering

In the 1994 *Restoration Plan*, the Council specifically recognized the declines in pink salmon and Pacific herring populations, and considered the reduction in these two fisheries as the biggest contributors to injury of the commercial fishing service in the spill area. Therefore, many restoration activities were focused towards these resources. The strategy for restoring commercial fishing included funding projects that accelerated fish population recovery, protected and purchased important habitat and monitored recovery progress. By 2002, the Council considered pink salmon and sockeye salmon to be recovered from the oil spill. However, recovery was not considered complete for Pacific herring and the recovery status of this resource remains 'Not recovering' (see individual resource accounts).

Income from commercial fishing dramatically declined immediately after the spill, and for a variety of reasons, disruptions to income from commercial fishing continue today, as evidenced by changes in average earnings, ex-vessel prices and limited entry permit values. Natural variability in fish returns and a number of economic changes in the commercial fishing industry since 1989 probably mean that many of these changes in income are not directly attributable to the spill. However, these factors also make discerning spill-related impacts difficult. Economic changes confronting the industry include the increased world supply of salmon (due primarily to farmed salmonids) and corresponding reduced prices, entry restrictions in certain fisheries (such as Individual Fishing Quotas, for halibut and sablefish), allocation changes (e.g., a reduction in the allocation of Cook Inlet sockeye salmon to commercial fishermen), reduction in processing capacity, and spatial limitations of groundfish fisheries in the spill areas in conjunction with sea lion management. Finally, competition among commercial, recreational, and subsistence fishers influence management decisions of these shared resources.

Since 1989, there have been no non-herring, spill-related, district-wide fishery closures related to oil contamination and populations of pink and sockeye salmon are considered recovered from the effects of the spill. The Prince William Sound herring fishery has been closed for 15 of the 21 years since the spill and herring are not considered recovered. Commercial fishing, as a lost or reduced service, is considered to be recovering from the effects of the oil spill.

3.7.5 Archeological Resources: Recovered

Assessments of 14 sites in 1993 suggested that most of the archaeological vandalism that can be linked to the spill occurred early in 1989, before adequate constraints were put into place over the activities of oil spill clean-up personnel. Most vandalism took the form of "prospecting" for high yield sites. Once these problems were recognized, protective measures were implemented and successfully limited additional injury. Although some cases of vandalism were documented in the 1990s, there appears to be no spill-related vandalism at the present time.

From 1994–1997, two sites in Prince William Sound were partly documented, excavated, and stabilized by professional archaeologists because they had been so badly damaged by oiling and erosion. The presence of oil in sediment samples taken from four sites in 1995 did not appear to have been the result of re-oiling by *Exxon Valdez* oil. Residual oil does not appear to be contaminating any known archaeological sites.

In 1993, the Council provided part of the construction costs for the Alutiiq Archaeological Repository in Kodiak (www.alutiiqmuseum.com). This facility now houses Kodiak area artifacts that were collected during spill response. In 1999, the Council approved funding for an archaeological repository and local display facilities for artifacts from Prince William Sound and lower Cook Inlet. Local displays are open to the public in Port Graham, Cordova, Seward, Seldovia, and Tatitlek. The facility in Seward serves as the repository for the Chugach region.

Based on the apparent absence or extremely low rate of spill-related vandalism and the preservation of artifacts and scientific data on archeological sites, archaeological resources are considered to be recovered.

3.7.6 Designated Wilderness Areas: Recovering

Six moderately to heavily oiled sites on the Kenai and Katmai coasts were surveyed in 1994, at which time some oil mousse persisted in a remarkably unweathered state on boulder-armored beaches at five sites. These sites were visited again in 1999, and oil was found along park shorelines of the Katmai coast. Surveys carried out in 2001 and 2003 to determine the surface and subsurface distribution of oil in Prince William Sound found lingering oil on shorelines within designated wilderness study areas. Finally, in 2005 the sites surveyed in 1999 were again sampled. Although surface cover of oil had declined, the subsurface oil persisted in amounts similar to those found in 1999. Moreover, the oil at those sites was compositionally similar to samples collected 11days after the spill.

However, in many areas, the amount of oil has diminished since 1990. Therefore, designated wilderness areas are considered to be recovering.

CHAPTER 4 – ENVIRONMENTAL CONSEQUENCES

This chapter contains the analysis of the environmental consequences that could result from implementing the two alternatives described. As with the September 1994 Final Environmental Impact Statement, this supplemental environmental impact statement (SEIS) differs from many EISs in that this analysis focuses on the two alternatives for creating increases in populations or services from some existing level, rather than the degree of loss or gain to natural resources from implementation of alternatives.

4.1 Alternative 1: No Action

If the Alternative 1: No Action was implemented, the current practices of the Council would continue and the scope of present Council activities or programs would not change. Similarly, agency monitoring of natural recovery would remain at present levels, and their responsibilities would remain unchanged. The remaining funds from the civil settlement would be spent on a broad range of restoration activities in an annual cycle through Council administration, as it is at present.

The analysis of Alternative 1 in the SEIS is consistent with that presented in the FEIS for Alternative 5. FEIS, Ch. 4, pg. 111–136. In addition, the efforts the Council had initially implemented to achieve environmental justice will be continued so that future work continues to be fair and equitable. FEIS, Ch. 2, pg. 2–4.

4.2 Alternative 2: The Proposed Action

In this alternative, the Council focuses on five defined areas of restoration: herring, lingering oil, long-term monitoring of oceanographic conditions and injured resources and services, harbor protection, marine restoration, and lessons learned/outreach, and habitat acquisition and protection. The analysis of Alternative 2 is consistent with that presented in the FEIS for Alternative 5, with the following analysis categorized by focus area and detailed below. FEIS, Ch. 4, pg. 111–136. Although the focus of future restoration projects will be on the restoration of injured species and services, other considerations will be made. Specifically, environmental justice issues will be considered, analyzed, and determined on a case-by-case basis as future projects are decided upon, consistent with the Council's policies. FEIS, Ch. 2, pg. 2–4. The Council strives for fairness in all impacts of these future projects, however the location of projects are largely determined by the geographic location of each species' preferred habitat.

4.2.1 Long-Term Herring Research

The September 1994 FEIS preferred Alternative (5) contemplated the natural recovery of Pacific herring through habitat protection and acquisition, found in FEIS, Ch. 4, pg. 134. Alternative 2 envisions long-term monitoring and research of herring to examine the reasons for the continued decline of herring in Prince William Sound (PWS), to identify and evaluate potential recovery options and to recommend a course of action for restoration of PWS herring.

The activities contemplated by this proposed action are consistent with the research and monitoring activities outlined in the 1994 Plan analyzed by the FEIS. *Exxon Valdez* Oil Spill *Restoration Plan*, Ch. 3 at pg. 25 (November 1994). As noted in the FEIS, long-term monitoring and research activities could result in projects that would be only informational in nature but extremely beneficial to the restoration of injured resources or the services they provide. These benefits either depend on the results of research that is not yet completed or require an agency management action that is outside the jurisdiction of the Council. Therefore, the impact of ongoing research and management actions by other agencies will not be analyzed in this SEIS. *See also*, FEIS, Ch. 1, pg. 22.

4.2.1.1 Environmental Consequences

The environmental consequences of long-term research and monitoring of Pacific herring populations on the offshore ecosystem were evaluated for the short-term and the long-term. With respect to long-term monitoring, "short-term" pertains to a four-year period after these research and monitoring activities begin, i.e., one herring spawning cycle. "Long-term" pertains to the period over four years after these research and monitoring activities begin.

Short-term: <u>Negligible benefits.</u> Although some benefits, such as but not limited to a better understanding of life-cycle changes, herring population make up, and geographic distribution, may accrue quickly, it is not reasonable to expect substantial results that can then be applied within one lifecycle of herring as this time frame is too short to expect scientifically substantial results.

Long-term: <u>Uncertain level of benefits</u>. These actions may assist in the recovery and long-term management of herring populations, as more detail of herring life cycles, genetics, distribution, and population sizes could be determined which will inform management decisions. However, the long-term recovery of Pacific herring is unknown because, although there is evidence to suggest that the spill had an effect on Pacific herring reproduction, it is not possible to attribute their population declines solely on the spill.

4.2.1.2 Social and Economic Impacts

The impacts of long-term research and monitoring of Pacific herring populations on social and economic uses, such as subsistence, sport and commercial fishing, and wilderness, which are dependent upon the resource were evaluated for the short-term and the long-term. With respect to long-term monitoring, "short-term" pertains to a four-year period after these research and monitoring activities begin, i.e., one herring spawning cycle. "Long-term" pertains to the period over four years after these research and monitoring activities begin.

Short-term: <u>Negligible benefits.</u> Although some benefits may accrue quickly, it is not reasonable to expect substantial results that can then be applied within one lifecycle of herring.

Long-term: Uncertain level of benefits. These actions may assist in the recovery and long-term management of herring populations which could contribute to an increase in these uses. However, the long-term recovery of Pacific herring is unknown because, although there is evidence to suggest that the spill had an effect on Pacific herring reproduction, it is not possible to blame their population declines solely on the spill and thus a projection of benefits is speculative.

4.2.2 Long-Term Monitoring of Oceanographic Conditions and injured resources
The activities contemplated by this proposed action are consistent with the research and monitoring activities outlined in the 1994 Plan analyzed by the FEIS, but rather than focusing on a list of species, the Council proposes to focus on broader oceanographic conditions and key indicator species. *Exxon Valdez* Oil Spill *Restoration Plan*, Ch. 3 at pg. 25 (November 1994); NOI, Fed. Reg. Vol. 75, No. 14 at pg. 3708 (Jan. 22, 2010).

The Council contemplates monitoring a number of key species in the spill-affected ecosystems including forage fish, killer whales, seabirds, bivalves, and sea otters. The Council also realizes the importance of changing oceanographic conditions in the Sound as playing a vital role in the recovery of many injured resources and services. Monitoring factors such as temperature, salinity, turbidity, and zooplankton availability will play an important role in determining the overall health of the ecosystem.

As noted in the FEIS, long-term monitoring and research activities could result in projects that would be only informational in nature but extremely beneficial to the restoration of injured resources or the services they provide if the information were used or acted upon by the Council or other relevant agencies. The realization of these benefits may require an agency management action that is outside the jurisdiction of the Council. Therefore, the impacts of such potential specific management actions are not analyzed in this SEIS. *See also*, FEIS, Ch. 1, pg. 22. Rather, the impacts of implementing long-term monitoring projects are evaluated.

4.2.2.1 Environmental Consequences
The environmental consequences of long-term monitoring of oceanographic conditions and biological resources in nearshore and offshore ecosystems were evaluated for the short-term and the long-term. With respect to long-term monitoring, "short-term" pertains to a five-year period after monitoring begins. "Long-term" pertains to the period over five years after monitoring begins.

Short-term: Uncertain or Low benefits. Depending on the nature and design of the long-term monitoring, some benefits could be experienced within five years after the start of implementation, such that information learned during the study may be made available for the Council or other relevant agencies to enhance impending restoration or management activities. The benefit of this type of long-term monitoring would be low as studies that rely on a compilation of multiple years of new data have to factor in that the maximum potential benefits will not likely be realized within five years as it takes considerable time to analyze and compile data. Unless the Council is committed to implementing activities based on the findings of the long-term monitoring, any benefits generated by long-term monitoring will rely on action being taken by the agencies which have responsibility for managing these natural resources. Since such action is beyond the control of the Council, the actual realization of restoration benefits is uncertain.

Long-term: Uncertain to Moderate benefits. It can be expected that these actions will produce information that may illuminate the larger ecosystem shifts that impact and influence a broad variety of species and resources injured by the spill. The increase in information will be a benefit to resource managers and scientists, and thus enable management strategies and long-term restoration that will support spill area marine ecosystems. Unless the Council is committed to implementing management activities based on the findings of the long-term monitoring, any benefits generated by long-term monitoring will rely on action being taken by the agencies which have responsibility for managing these natural resources. Since such action is beyond the control of the Council, the actual realization of restoration benefits is uncertain.

4.2.2.2 Social and Economic Impacts

The impacts of long-term monitoring of oceanographic conditions for nearshore and offshore ecosystems on social and economic uses, such as subsistence, wilderness, recreation and tourism, sport and commercial fishing, which depend on these marine ecosystems were evaluated for the short-term and the long-term. With respect to long-term monitoring, "short-term" pertains to a five-year period after monitoring begins. "Long-term" pertains to the period over five years after monitoring begins.

Short-term: Low benefits. Although some benefits, such as use of real-time oceanographic conditions data, may accrue quickly, it is not reasonable to expect substantial results within a five-year period.

Long-term: Moderate benefits. It can be expected that these actions will produce information that may illuminate the larger ecosystem shifts that impact and influence a broad variety of species and resources injured by the spill. This information can be used to support these uses, as well as supporting management strategies and long-term restoration that will support spill area marine ecosystems and thus further facilitate additional social and economic use of these resources.

4.2.3 Lingering Oil

The Council previously provided funding to studies that would determine the extent, distribution and biodegradability of lingering oil in the nearshore marine environment. Current research is also underway to quantify the degree of injury caused by the remaining lingering oil, evaluate the feasibility of additional remediation activities, and evaluate whether additional remedial activities would adversely affect the environment.

Lingering oil research activities may also result in projects that would be only informational in nature but potentially beneficial to the restoration of injured resources or the services through either informing the active removal of lingering oil or producing information indicating that removal of the oil would increase the injury to affected species. As discussed above, the nature of the benefits from lingering oil research depend on the results of research that is not yet completed or require an agency management action that is outside the jurisdiction of the Council. Since it is not currently known if additional remedial activities are warranted, the impact of potential remedial actions will not be analyzed in this SEIS.

4.2.3.1 Environmental Consequences

Environmental Consequences of lingering oil research With respect to lingering oil research, "short-term" pertains to a five-year period after research activities begin. "Long-term" pertains to the period over five years after research activities begin.

Short-term effects: Unknown effects. For direct restoration actions, effects are unknown because these potential actions are still being tested.

Long-term effects: Unknown effects. For direct restoration actions, effects are unknown because these potential actions are still being tested.

4.2.3.2 Social and Economic Impacts

The impacts of lingering oil research on social and economic uses, such as subsistence, sport and commercial fishing, wilderness, recreation and tourism and archeological/cultural resources, were evaluated for the short-term and the long-term. With respect to lingering oil research, "short-term" pertains to a five-year period after research activities begin. "Long-term" pertains to the period over five years after research activities begin.

Short-term effects: Unknown to Low effects. For direct restoration actions, effects are largely unknown because these potential actions are still being tested. There has been some moderate benefit as the current activities which have employed some spill-area personnel and equipment to conduct these research activities.

Long-term effects: Unknown effects. For direct restoration actions, effects are unknown because these potential actions are still being tested.

4.2.4 Harbor protection, marine restoration, and lessons learned/outreach

4.2.4.1 Waste disposal and harbor projects

The Council seeks to further reduce pollution in the marine environment to contribute to the recovery of injured natural resources or services with actions to reduce the improper disposal of waste, such as oily bilge water, used engine parts, paints, solvents and lead-acid batteries. Improper disposal of these wastes in landfills adversely affects the quality of nearby marine waters through runoff and leaching. Chronic marine pollution stresses fish and wildlife resources, possibly delaying recovery of resources injured by the spill. In the past, the Council has approved the funding of several projects to prepare waste management plans and has contributed to their implementation. The proposed alternative envisions similar actions, such as the acquisition of waste oil management equipment and the construction of environmental operating stations for the drop-off of used oil and other hazardous waste in spill area coastal communities.

4.2.4.1.1 Environmental Consequences

The environmental consequences of waste disposal and harbor projects on nearshore and offshore marine ecosystems near coastal communities in spill area were evaluated for the short-term and the long-term. With respect to these projects, "short-term" pertains to a ten-year period after such projects begin. "Long-term" pertains to the period over ten years after these projects begin.

Short-term: High benefits. The proposed actions may substantially benefit associated marine ecosystems in areas of implementation in the short-term after implementation of the activities as waste products would no longer be introduced into the marine environment.

Long-term: Low benefits. The initial benefits of the proposed actions to areas in which they are implemented may gradually lessen with the passage of time, being that the protection measures have succeeded in reducing or eliminating waste from entering the environment. In addition, a continuation or increase in sources of pollution in these areas would overwhelm the measures and cause a lowering of benefit to the area.

4.2.4.1.2 Social and Economic Impacts

The impacts of waste disposal and harbor projects on social and economic uses, such as subsistence, wilderness, recreation and tourism, sport and commercial fishing and archeological/cultural resources were evaluated for the short-term and the long-term. With respect to these projects, "short-term" pertains to a ten-year period after research activities begin. "Long-term" pertains to the period over ten years after the project begins.

Short-term: High benefits. The proposed actions may substantially benefit human services associated with the marine ecosystems in areas of implementation in the short-term after implementation of the activities.

Long-term: Low benefits. The initial benefits of the proposed actions to social and economic uses which depend upon the areas in which they are implemented may gradually lessen with the passage of time and a continuation or increase in sources of pollution in these areas.

4.2.4.2 Marine Debris Removal

The Council proposes to fund marine debris removal that affects the spill area marine ecosystem. Marine debris is an issue in the marine and near-shore environment, where it is likely that thousands of marine debris exist within three nautical miles of the Alaska coastline. Marine debris removal projects can result in an immediate improvement to the coastal habitat, reduces entrapment hazards for marine wildlife, and reduces marine pollution affecting natural resources injured by the spill and thus further supports restoration.

4.2.4.2.1 Environmental Consequences

The environmental consequences of marine debris removal on nearshore and offshore marine ecosystems in the spill area were evaluated for the short-term and the long-term. With respect to these projects, "short-term" pertains to a five-year period after such activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: High benefits. The proposed actions may substantially benefit associated marine ecosystems in areas of implementation in the short-term after implementation of the activities as threats from derelict fishing gear, plastics, and chemical leaching would be removed. However, some marine debris may provide habitat for marine organisms. For example, old fishing gear can provide substrate for barnacle or algae attachment and may provide shelter for crustaceans. Removing such "habitat" will have an immediate adverse effect on the microcosm of organisms using it, but the positive effect of debris removal is thought to outweigh the adverse effect.

Long-term: Low benefits. This restoration activity only removes deposited marine debris. To reduce marine debris in the long-term would require education and a change in human waste generation activities. In the absence of such behavioral shifts, new marine debris will continue to be deposited in areas that were previously cleaned. Thus, the initial benefits of the proposed actions to areas in which they are implemented may gradually lessen with the passage of time and a continuation or increase in sources of pollution in these areas.

4.2.4.2.2 Social and Economic Impacts

The impacts of marine debris removal on social and economic uses, such as subsistence, recreation and tourism, wilderness, sport and commercial fishing and possibly archeological/cultural resources, were evaluated for the short-term and the long-term. With respect to these projects, "short-term" pertains to a five-year period after activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: High benefits. The proposed actions may substantially benefit the uses associated with the marine ecosystems in areas of implementation in the short-term after implementation of the activities. Depending on how a marine debris removal program is structured, the program could offer immediate local employment opportunities.

Long-term: Low benefits. The initial benefits of the proposed actions on social and economic uses which depend upon the areas in which they are implemented may gradually lessen with the passage of time and a continuation or increase in sources of pollution in these areas. Depending on how a marine debris removal program is structured, the program could offer long-term local employment opportunities.

4.2.4.3 Lessons learned/outreach

Damage to natural resources can occur not only with the initial spill, but additional damage can also be caused by spill response efforts. The Council proposes to organize, preserve and pass information regarding skilled damage assessment and how to mitigate damage from spill response activities in future spills. Activities envisioned in this effort include outreach efforts such as a conference or series of papers sharing information to be used by future responders, including natural resource assessment, the long-term costs of high-pressure washing, use of dispersants in the near-shore, sub-arctic environment and the effects of potential burning scenarios. The level of environmental and socioeconomic benefits likely to be generated by sharing of information on response, damage assessment, and restoration will depend on the location, frequency and magnitude of future oil spills.

4.2.4.3.1 Environmental Consequences

The environmental consequences of sharing information on response, damage assessment and restoration on nearshore and offshore ecosystems were evaluated for the short-term and the long-term. With respect to these activities, "short-term" pertains to a five-year period after such activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: Moderate benefits. Depending upon the incidence of future spills and similarity of conditions, it can be expected that these actions, if a spill occurs, will assist in mitigating harm from spill response activities as the future responders could learn from lessons gained during earlier spills.

Long-term: Low benefits. It can be expected that these actions assist in mitigating harm from spill response activities in future spills. Unless funded at higher levels that could sustain future activities in this area with the passage of time and the development of additional knowledge in this area, the utility of the information organized, preserved and developed with this effort will diminish as the information, technologies, and methods become more and more out of date.

4.2.4.3.2 Social and Economic Impacts

The impacts of response, damage assessment and restoration implications on the social and economic uses, such as subsistence, sport and commercial fishing, wilderness, recreation and tourism and archeological/cultural resources, which are located near or depend upon nearshore and offshore ecosystems were evaluated for the short-term and the long-term. With respect to these activities, "short-term" pertains to a five-year period after activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: Moderate benefits. Depending upon the incidence of future spills, it can be expected that these actions, if a spill occurs, will assist in mitigating harm from spill response activities and thus support related social and economic uses.

Long-term: Low benefits. It can be expected that these actions assist in mitigating harm from spill response activities in future spills and thus support related social and economic uses.

Unless funded at higher levels that could sustain future activities in this area, with the passage of time and the development of additional knowledge in this area, the utility of the information organized, preserved and developed with this effort will diminish.

4.2.5 Habitat Acquisition and Protection

At the time of the September 1994 FEIS, the Habitat Acquisition and Protection program was a primary component that was to receive the largest portion of remaining settlement funds. In both the proposed alternative and the no action alternative, this program remains a fundamental component, allotted approximately 25% of remaining funds, see FEIS, Ch. 4, pg. 111.

As discussed in the FEIS, parcels available for protection are still being developed and cannot be individually analyzed in this SEIS.

4.2.5.1 Environmental Consequences

The environmental consequences of habitat acquisition and protection on upland, nearshore and offshore ecosystems were evaluated for the short-term and the long-term. With respect to these activities, "short-term" pertains to a five-year period after such activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: Unknown level to high level of benefits. Depending upon the expected usage of parcels if they were not protected, the short-term effects of land acquisition could be of varying benefit ranging from unknown to high. Benefits include, but are not limited to, preventing the intertidal and subtidal areas from being altered by the actions that may occur on the parcels and reducing the disturbances caused by increased human activity.

Long-term: Moderate benefits. The long-term effects of habitat protection actions for reducing disturbance or preventing additional injury to injured species and spill-affected ecosystems are moderately beneficial and with the type of benefit to various injured species and spill-affected ecosystems vary among parcels.

4.2.5.2 Social and Economic Impacts

The impacts of habitat acquisition and protection on social and economic uses, such as wilderness, subsistence, sport and commercial fishing and recreation and tourism and archeological/cultural resources, were evaluated for the short-term and the long-term With respect to these activities, "short-term" pertains to a five-year period after such activities begin. "Long-term" pertains to the period over five years after such activities begin.

Short-term: Unknown. Depending upon the expected usage of parcels if they were not protected, the short-term effects of land acquisition could be of varying benefit to related social and economic uses.

Long-term: Moderate benefits. The long-term effects of habitat protection actions for reducing disturbance or preventing additional injury to related social and economic uses are moderately beneficial and with the type of benefit to various injured human services vary among parcels.

4.3 Cumulative Effects

The CEQ regulations for implementing NEPA define cumulative effects as: "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). It is critical to evaluate past and present actions as well as those that will happen in the foreseeable future in the action area. For the purposes of this SEIS, past and present actions include both human controlled events and natural events. Events taking place in the foreseeable future are thought of as actions that have been proposed or that are in the process of being deliberated on and debated on and are on the way to being formally proposed. Such actions may indeed be said to be "reasonably foreseeable."

Actions that may affect EVOSTC restoration include the list of projects and environmental influences below. Many of these projects were identified and discussed at length in the 1994 FEIS (Chapter 4, pages 152-163). Where there is additional information to supplement the original discussion in the 1994 FEIS, it is included below the table.

Table 2: Projects that may impact EVOS restoration efforts

ACTIVITY	PAST	PRESENT	FUTURE	COMMENT
Whittier Road Access and Whittier Harbor Expansion	X			(see below for additional information)
Trans-Alaska Gas Pipeline Terminal	X			
Institute for Marine Science at Seward	X			(Completed as Alaska SeaLife Center)
Child's Glacier Tourism Development	X			(see below)
FY 1992-1994 EVOSTC Projects	X			
Cordova Road Access	X			
Lower Cook Inlet Oil		X		(see below)

Development				
Yakutat Oil Development		X		
Shepard Point (Nelson Bay) Dredging		X		
Coastal Development in Cook Inlet		X		(see below)
Tankering from the Trans-Alaska Pipeline Terminal at Valdez			X	
FY 2010-2012 EVOSTC Projects			X	(see below)
Cordova Center			X	(see below)
Global Climate and Ocean Regime Changes		X	X	(see below)
Mortality			X	(see below)
Government Administration			X	(see below)

4.3.1 Project Management and Government Administration

FY10 – FY12 EVOSTC Projects: Projects funded during these fiscal years are scientific in nature and will not have any significant impact on the environment of the spill area. Each funded project has received a Categorical Exclusion (Section 6.03.c.3 (a)) from the National Environmental Policy Act.

Government Administration: External factors that potentially impact Council management and administration are new legislation, annual budgets, new leadership, and litigation.

Potential Impacts of the Alternatives on Management and Administration

Alternative 1 would not change the way EVOSTC projects are selected or funded, the same methods used to select projects and research objectives in the past would be implemented again. However, Alternative 2 would allow for a focused and narrowed approach to project selection, . Neither alternative would impact administration, as government administration is beyond the Council's control.

Potential Cumulative Impacts of Management and Administration

Government administration could significantly impact the Council's ability to meet its restoration goals in that pressures of time, personnel, and workload impact the staff's ability to meet work requirements. New leadership or other administrative changes at levels higher than the Council will impact current and future work, as it may require time necessary for adjustment. Projects selected by the Council for the future fiscal years will be a positive impact on the restoration goals of the Council; they will help ensure the goals and objectives are met.

4.3.2 Area Development

Lower Cook Inlet Oil Development: MMS lease sales were discussed in 2007 and one sale was proposed for Cook Inlet (#211). However, it was canceled due to lack of industry interest. A second special interest sale was mentioned in the Federal Register (73 FR 39032), but a sale number was not identified, it is assumed to still be under consideration.

Coastal Development in Cook Inlet: Port facilities improvements and expansions in the towns of Anchorage, Kenai, and Homer are ongoing.

Whittier Road Access and Whittier Harbor Expansion: This project has largely been completed. A Notice of Intent has been issued to prepare an Environmental Impact Statement for Whittier Harbor Navigation Improvements Feasibility Study. This study would consider the feasibility of expanding the existing moorage capacity for vessels at Whittier. A final EIS for this project is scheduled no sooner than January 2011. If this project were to be finalized, potential cumulative impacts of the past, present and reasonably foreseeable future actions include impacts resulting from harbor construction and resultant increase in vessel traffic. *See Notice of Intent*, Fed. Reg. Vol. 74, No. 127 (July 6, 2009).

Child's Glacier Tourism Development: Child's Glacier recreational area improvements have been completed. In addition, the Child's Glacier Lodge may be completed in Summer 2011, with overnight capacity for twelve and recreations activities including jet boat, glacier and kayak tours.

The Cordova Center: This project, for which the Council has approved partial funding, will be required to complete an Environmental Impact Statement (EIS) prior to construction. Specific impacts will be discussed at length in that document.

Potential Impacts of the Alternatives on Area Development

With respect to Alternative 1, the potential impacts to area development would be minimal, as this option does not emphasize these activities. In development areas where marina work is proposed, harbor protection, marine restoration, and lessons learned/outreach focus of Alternative 2, would be beneficial. Funding would be available for work within certain areas and expertise and guidance could be shared with interested parties. Regional development work could be carried out with a focus on water protection, marine debris removal, and restoration implications with new support.

Potential Cumulative Impacts of Area Development

As the spill-affected area continues to become more developed there is less habitat available for species survival and less opportunity for recovery at an ecosystem level. Development not only impacts land use but also the air and water quality of the area. This multi-dimension impact can be lessened with project design and engineering, but careful thought and planning needs to take place at every level to achieve minimal impacts to sensitive species and resources.

4.3.3 Large Scale Factors

Global Climate and Ocean Regime Changes: Global climate change and ocean regime changes will likely impact restoration projects in the future. These outcomes cannot yet be determined but impacts to restoration will be considered and analyzed at the time of future project selection.

Mortality: Death due to predation, disease and animal stranding are likely to occur in the action area in the next ten years.

Potential Impacts of the Alternatives on large-scale factors

Neither of the two alternatives will have an impact on the large-scale items discussed above as these factors are larger than either alternative. The decisions the Council makes to benefit impacted resources will be in response to, not due to, the factors of ocean and climate change, fluctuations in administration, and species mortality among other considerations. The data collection and interpretation within the long-term monitoring focus of Alternative 2 would assist the Council and others in determining the scope and scale of the large-scale ecological factors in regional habitats, however the work being performed in Alternative 2 would not be significant enough to contribute to or impact these large occurrences.

Potential Cumulative Impacts of large-scale factors

The cumulative consequences of these large-scale factors could be significant in both the short and long term. The Council is already working with these factors in mind, as new projects are being designed and funded researchers are considering what the habitat will be like in changing conditions, how disease and other sources of mortality can be minimized, and how to incorporate resiliency in projects. If the timing and potentially additive nature of these large-scale factors were to combine, the work of the Council would be very difficult and improvements to injured species and resources would be slowed.

CHAPTER 5 – DOCUMENT PROCESSING

5.1 List of Preparers

The following persons were primarily responsible for preparing the environmental impact statement or significant background papers.

Catherine Boerner, Science Coordinator, EVOSTC Restoration Office, 10 years experience in natural resource management and wildlife biology, prepared Chapter 3 on the Affected Environment.

Elise Hsieh, Executive Director and Attorney, EVOSTC Restoration Office, thirteen years of experience in Environmental Law, prepared the DSEIS in conjunction with EVOSTC staff and Trustee Agency Liaisons, excluding the process and public process sections in Chapter 1 and Chapter 3, the Affected Environment.

Laurel Jennings, NEPA Coordinator, NOAA Restoration Center, NW Region, three years of experience in federal environmental compliance and habitat restoration, prepared the format for the SEIS and assisted with other sections, including the Public Participation Process sections in Chapter 1.

5.2 Distribution of the draft SEIS

Below is a list of the Agencies, Organizations, and Persons to whom a notice of the availability of the draft SEIS was sent.

5.2.1 Agencies

U.S. Department of the Interior

U.S. Department of Agriculture

Alaska Department of Law

Alaska Department of Environmental Conservation

Alaska Department of Fish and Game

Alaska Department of Natural Resources

5.2.2 Organizations

Native Village of Afognak, Nancy Nelson, President

Native Village of Chenega, Pete Komkoff, President

Native Village of Chignik Lagoon, Clemens Grunert, President

Chignik Lake Village Council, John Lind, President

Native Village of Eyak, Bruce Cain, Executive Director

Native Village of Karluk, Alicia Reft, President

Larsen Bay Tribal Council, Susan Aga, Manager

Nanwalek IRA Council, Wally Kvasnikoff, Chief

Port Lions Traditional Tribal Council, Arnold Kewan, President

Native Village of Tatitlek, Roy Totemoff, President & CEO

Old Harbor Tribal Council, Emil Peterson, President

Native Village of Ouzinkie, Daniel Ellanak, President

Seldovia Village Tribe IRA and Seldovia Native Assn., Crystal Collier, CEO and Fred Elvsaas

Chenega Corporation, Brian Fox

Chugach Alaska Corporation, John F.C. Johnson

English Bay Corporation

Grouse Creek Corporation, Esther Ronne

Knikatnu, Inc, Paul Theodore

Native Village of Port Graham, Eleanor McMullen

Ninilchik Village Traditional Council, Bruce Oskalkoff

Tatitlek Corporation, Carroll Kompkoff

YAK-TAT-KWAAN INC., Donald Bremner

Chickaloon Native Village, Alan Larson

Eyak Corporation, Dan McDaniel and Rod Wohl

Kenaitze Indian Tribe, Rose Tepp

Salmatof Native Association, Jim Segura

Tyonek Native Corporation, Ted Kroto

Eklutna, Inc.

Ninilchik Native Association, Inc.

Valdez Native Tribe, Brenna Hughey

Cook Inlet Region, Inc

5.2.3 Persons

Public Advisory Committee Members:

- Patience Anderson Faulkner
- Torie Baker
- Amanda Bauer
- Jason Brune
- Kurt Eilo
- Larry Evanoff
- Gary Fandrei
- John French
- Jennifer Gibbins
- Lori Polasek
- John Renner
- Bill Rosetti
- Stacy Studebaker
- David Totemoff

Leaders of Municipalities:

- City of Soldotna, Peter A. Micciche, Mayor
- City of Valdez, Bert Cottle, Mayor
- City of Whittier, Lester Lunceford, Mayor
- City of Ouzinkie, Zack Chichenoff, Mayor

City of Seldovia, Keith Gain, Mayor

City of Seward, Willard Dunham, Mayor

City of Old Harbor, Rick Berns, Mayor

City of Port Lions, Steve Andresen, Mayor

City of Akhiok, Linda Amodo, Mayor

City of Chignik, Richard Sharpe, Mayor

City of Cordova, Tim Joyce, Mayor

City of Homer, James C. Hornaday, Mayor

City of Kodiak, Carolyn Floyd, City Clerk

Kodiak Island Borough, Jerome Selby, Mayor

City of Larsen Bay, Valen Norell, Mayor

CHAPTER 6 – REFERENCES

Final Environmental Impact Statement for the *Exxon Valdez* Oil Spill Restoration Plan September 1994).

Notice of Intent, Fed. Reg. Vol. 75, No. 14 at pg. 3708 (Jan. 22, 2010).

Exxon Valdez Oil Spill *Restoration Plan* (November 1994).

Exxon Valdez Oil Spill Trustee Council 2009 Status Report

Exxon Valdez Oil Spill Trustee Council. http://www.evostc.state.ak.us/NEPA/http://www.evostc.state.ak.us/NEPA/

Exxon Valdez Oil Spill Trustee Council 2010 Update of Injured Resources and Services (May 14, 2010)

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