Exxon Valdez Oil Spill Trustee Council

February 11, 2011 teleconference

800.315.6338 8205

10:00 a.m. – 12:30 p.m.

Motions

DRAFT 2/8/2011

Motions for February 11, 2011 Trustee Council meeting

Agenda Item 2, Agenda and November 3, 2010 Meeting Notes:
Move to approve the February 11, 2011 meeting agenda.
Move to approve November 3, 2010 Trustee Council meeting notes as prepared.

Agenda Item 5, Agreed Upon Procedures Contact:
Move to approve entering into an Agreed-Upon Procedures Contract for a 2010 audit with Elgee, Rehfeld and Mertz for an amount not to exceed $16,187 which includes 9% General Administration. [$14,850 + $1,336.50 (9% GA) = $16,187]

Agenda Items 6 & 7, FFY 2011 Lingering Oil & Pigeon Guillemot Proposals:
Boufadel Project Funds
Move to approve funding $1,586,785 which includes 9% General Administration for Project 11100836, Boufadel – Pilot Studies of Bioremediation of *Exxon Valdez* Oil in Prince William Sound Beaches.

Re-allocate $50,000 to support Boufadel NEPA
Move to re-allocate the total amount of funds authorized in Resolution 08-10, designating $50,000 (which includes General Administration) to fund a NOAA analysis of the 1994 EVOS Restoration Plan Environmental Impact Statement (EIS), to fund a NEPA review of Project 11100836, Boufadel–Pilot Studies of Bioremediation of *Exxon Valdez* Oil in Prince William Sound Beaches.

Irons/Pigeon Guillemot project funds
Move to approve funding $218,000 which includes 9% General Administration Phase I of Project 11100853, Irons–Pigeon Guillemot Restoration in Prince William Sound.

Irvine/Boulder Armored Beaches project funds
Move to approve funding $178,200 which includes 9% General Administration for Project 11100112, Irvine–Lingering Oil on Boulder-Armored Beaches.

Robertson/Geotextile project funds
Move to approve funding $226,400 which includes 9% General Administration for Project 11100111, Robertson–Evaluation of Polypropylene Geotextile-Based Mechanical Removal Methods.

Agenda Item 8, Habitat, small parcels Saltz, Silver, and Poore:
Move to authorize funding of $43,600 which includes 9% General Administration for due diligence expenses consistent with State and Trustee Council requirements in support of Kenai River habitat protection efforts for three small parcels: Saltz' Island-KEN 3009, Silver Parcel-KEN 3008, and Poore-KEN 3010.

Womac, Cherri G (EVOSTC)

From: Womac, Cherri G (EVOSTC)
Sent: Tuesday, February 08, 2011 11:58 AM
To: Burns, John J (LAW); Campbell, Cora J (DFG); 'Craig O'Connor (Craig.R.O'Connor@noaa.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)'; 'Pat Pourchot (Pat_Pourchot@ios.doi.gov)'; Schorr, Jennifer L (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)'; 'Joe Darnell'; 'Michael Zevenbergen (Michael.Zevenbergen@usdoj.gov)'; 'Ronald McClain (Ronald.McClain@usda.gov)'
Cc: Hsieh, Elise M (EVOSTC); 'Claire Fishwick-Leonard (claire.fishwick@alaska.gov)'; 'Lesia Monson (Lesia_Monson@ios.doi.gov)'; 'Mary Goode'; 'Mary Schlosser (mary.schlosser@alaska.gov)'; 'Nancy Korting (nancy.korting@alaska.gov)'; 'Pat Kennedy '; 'Tauline_Davis@ios.doi.gov'
Subject: Additional and Revised materials for Feb 11 TC teleconference
Attachments: Draft TC Agenda Feb 11, 2011 draft.pdf; draft motion sheet 2-11-2011 rvd.doc; DRAFT Resolution 11-__ Kenai parcels.doc; DRAFT Resolution 11-__ FFY 2011 Work Plan Amendment.doc; FY11 Workplan Addendum2-7-11.pdf; EVOS Habitat nomination 2.11.11.pdf; Brune Studebaker Comments.pdf; Long-Term Spending Scenario Table January 2011 Update 2-8-2011.doc

Hello Trustees, Alternates and Counsel,

Attached please find the latest updates of the following documents for the Council meeting this Friday, February 11th.

1. Latest Draft Agenda
2. Draft Resolutions and Motions sheet
   Note: Steve Zemke may have some suggested language for the Pigeon Guillemot resolution regarding coordinating agencies before beginning to expend funds for a NEPA review, if the Council approves these funds.
3. Amended Workplan with an additional science panel recommendation re: the Irons/Pigeon Guillemot project.
4. Habitat Parcel write ups, including Poore parcel which was not included before.
5. Two comments from the PAC regarding the Habitat program.
6. Revised Spending Scenario chart from Department of Revenue (chart sent with earlier email had an error in the short-term program sections).

We look forward to your participation on Friday. Please let us know if you need any additional information.

Elise

Womac, Cherri G (EVOSTC)

From: Hsieh, Elise M (EVOSTC)
Sent: Monday, January 31, 2011 1:16 PM
To: Burns, John J (LAW); Campbell, Cora J (DFG); Craig O'Connor (Craig.R.O'Connor@noaa.gov); Jim Balsiger (jim.balsiger@noaa.gov); Kim Elton (kim_elton@ios.doi.gov); Hartig, Lawrence L (DEC); Steve Zemke (szemke@fs.fed.us); Pat Pourchot (Pat_Pourchot@ios.doi.gov); Schorr, Jennifer L (LAW); Brookover, Thomas E (DFG)
Cc: Womac, Cherri G (EVOSTC); Dawn Collinsworth (Dawn.Collinsworth@ogc.usda.gov.); Hsieh, Elise M (EVOSTC); Gina Belt (regina.belt@usdoj.gov); Schorr, Jennifer L (LAW); Schorr, Jennifer (EVOSTC); Joe Darnell; Michael Zevenbergen (Michael.Zevenbergen@usdoj.gov); Ronald McClain (Ronald.McClain@usda.gov)
Subject: Council Meeting Materials for February 11th
Attachments: Draft TC Agenda Feb 11, 2011 draft.pdf; EVOS TC AUP COMP 9 30 10 EL .pdf; FY11 Workplan Addendum.pdf; Silver Benefits report.pdf; Saltz benefits report.pdf; Performance Measure 12_31_2010.pdf; Long-Term Spending Scenario.doc; Long-Term Spending Scenario Table January 2011 Update.doc; Draft Nov 3 2010 Trustee Council Meeting notes-emh.pdf

Hello Trustees and Alternates,

There will be a teleconferenced Council meeting on February 11, 10:00 a.m. - 12:30 p.m.. We encourage you to participate in person if you're in town. The call in number is: 1-800-315-6338, Code 8205. The documents below will also be located on your Forum on the EVOSTC website. Draft Resolutions and a draft Motions sheet will also be forwarded to you closer to the date of the meeting.

Attached to this email is a draft agenda, which includes the following items:

2010 Agreed Upon Services Contract: **The attached Engagement Letter details the general outline of services provided at the last meeting and is recommended for approval. Funds were previously approved/re-allocated in November.** At the November meeting, the Council approved a transition from the standardized audit which has been performed for over 20 years to a more efficient AUP contract with the auditor, which is tailored to detail the financial transactions which require the most review and requested provide the engagement letter for review at this meeting. Max Mertz will be online to answer any additional questions the Council may have. As discussed in November, the engagement letter notes a cost of just under $15,000, which the Council authorized in November as a re-allocation from the audit cost of approximately $30,000.

2. FFY'11 Proposal Funding Recommendations: **Please review the attached document**, which contains the abstracts and the recommendations of the Science Panel, Science Coordinator Catherine Boerner, and Elise. The full proposals are on the Forum. Please keep in mind that the full proposals are confidential unless funded by the Council and thus we ask that you limit the circulation of these documents. Catherine Boerner will be on line to answer any questions the Council may have. NOAA's Pete Hagen is also looking into whether a NEPA action will require additional funds from the Council to enable the funding of these proposal(s). **In addition to the attached document, below is a quick pro/con list:**

1. Boufadel: Bioremediation Studies

   Pros
   - Project builds on four years of work
   - Relatively non-invasive
   - Extensive experience of all team members

   Cons
   - High cost if applied to all lingering oil sites

2. Irons – Pigeon Guillemot Restoration in PWS

Pros

- Direct restoration method
- Could potentially jumpstart the restoration of PIGU in PWS
- Only bird listed as not recovering on Injured Resources and Services List
- Project builds on 15 years of data at Naked Island
- PI's are have experience with seabirds in Alaska

Cons

- High cost ($182,306 per nest cost if existing 17 nests are doubled as projected)
- Long timeline for measuring success (10 years on Naked, 15 years Sound-wide)
- Small chance that mink could re-populate the island
- DNA evidence was not conclusive (mink are genetically mixed between native and farmed)
- PIGU were in decline prior to the spill and have continued a 1.2% decline since
- "A precise estimate of the guillemot population response should mink be eradicated is not possible" (proposal page 5)
- "There is some uncertainty about the exact proportion of all nest predation events that are caused by mink" (proposal page 11)

3. Irvine: Lingering Oil on Boulder-Armored Beaches

Pros

- Team has worked on these sites previously
- Experience and qualified team
- May have the potential to lead to mitigation measures

Cons

- Would be first year of a multi-year project before remediation possibility could be assessed

4. Robertson: Evaluation of Polypropylene Geotextile-Based Mechanical Removal Methods

Pros

- Costs are modest
- Methodology is low-tech
- Could be employed by anyone without training

Cons

- Highly invasive method
- Potential for very serious negative impacts on the coastal environment
- Method has been tested in PWS and was not considered feasible
- Percentage of shorelines that this method could be used on are small
- Would require NEPA assessment

3. Habitat documents: **DNR requests approximately $40,000 in due diligence funding for three parcels.** The benefit reports for the Silver and Saltz parcels are also attached for your review; a brief summary of the Poore parcel is below and a benefit report will be forwarded as soon as we receive one. Carol Fries recently retired and we are pleased to welcome Samantha Carroll from DNR, who will be handling habitat transactions. She will be on-line to answer any questions the Council may have.

Poore Parcel: Virginia Poore has nominated her parcel containing approximately 52 acres with approximately 1,250 linear feet of river frontage located at Eagle Rocks on the Kenai River for Trustee Council consideration. The parcel has a small boat ramp and enjoys some recreational use. The majority of the parcel is undisturbed

with several areas of low-lying wetlands. The parcel provides valuable riparian habitat as well as recreational opportunities for anglers. A small creek meanders through the parcel running east to west. This is an exceptional opportunity. DNR has been working with the landowner and her attorney to consider this parcel in a methodical, measured manner. Preliminary due diligence indicated no title issues and the landowner has provided a UASFLA compliant appraisal for agency review.

4. Department of Revenue: **An Updated Spending Scenarios Chart and Investment Performance Summary are attached.**

Over the last couple years, Bob Mitchell of ADOR has helpfully provided charts and graphs to assist the Council in its delibertions and long-term strategic planning. Last November, the Council worked off of a table of spending scenarios to provide funding amounts for the FFY'12 long-term programs invitation. Attached is a newly-revised chart that includes the spending levels decided upon by the Council in the fall. It has also been adjusted for inflation and general administration costs. While all involved acknowledge that these spending and earning estimations are speculative and based upon a market which has recently proven its volitile abilities, the chart lays out the current thinking of the Council and provides for long-term planning. The five-year program contracts allow for spending adjustments as needed over time.

Agenda

DRAFT 2/10/2011

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
February 11, 2011, 10:00 a.m. – 12:30 p.m.
Anchorage, Alaska

Trustee Council Members:

JEN SCHORR
Trustee Alternate/Attorney General
Alaska Department of Law

LARRY HARTIG
Commissioner
Alaska Department of
Environmental Conservation

CORA CAMPBELL
Commissioner
Alaska Department of Fish and Game

CRAIG O'CONNOR
General Counsel
National Oceanic and 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
Federal Chair: _____

1. Call to Order – 10:00 a.m.

2.	Consent Agenda - Approval of Agenda* - Approval of Meeting Notes* November 3, 2010	
3.	Public comment – 10:15 a.m. (3 minutes per person)	
4.	Executive Director's Report (5 minutes)	Elise Hsieh, Executive Director
5.	2010 Agreed-Upon Services Contract* (15 minutes)	Max Mertz Elgee, Rehfeld & Mertz
6.	Review FFY 2011 Lingering Oil Proposals* (30 minutes)	Catherine Boerner
7.	Pigeon Guillemot Project Amendment* (15 minutes)	Dede Bohn, USGS
8.	Habitat*: Silver, Saltz and Poore Parcels (20 minutes)	Samantha Carroll, ADNR
9.	Executive Session, as needed	

Adjourn – by 12:30 p.m.

* Indicates action items

Nov 3 2010 Mtg Notes

DRAFT 11/16/2010

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
November 3, 2010

Chaired by: Craig Tillery
Trustee Council Member

Trustee Council Members Present:

Steve Zemke, USFS *
Kim Elton, USDOI
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 1:23 p.m., November 3, 2010 in Anchorage at the EVOS Conference Room.

1. Approval of the Agenda

APPROVED MOTION: Motion to modify the November 3, 2010 agenda by deleting Items 8 and 9 discussions of the Record of Decision and Restoration Plan Supplement as they are not ready for action

Motion by O'Connor, second by Lloyd

2. Approval of August 26, 2010 meeting notes

APPROVED MOTION: Motion to approve the August 26, 2010 meeting notes

Motion by O'Connor, second by Elton

Public comment opened at 1:25 p.m.

Five public comments were offered.

Public comment closed at 1:55 p.m.

There were no Public Advisory Committee (PAC) comments.

3. Information Technology Services Contract

APPROVED MOTION: Motion to authorize the Executive Director to enter into a contract for Information Technology (IT) support services for the remainder of FFY 11, ending September 30, 2011, with John Wojtacha of Superior Computer Solutions in the amount of $81,750 which includes 9 percent General Administration.

Motion by O'Connor, second by Lloyd

4. Audit

APPROVED MOTION: Motion to approve transitioning from the Audit as authorized in the FFY'11 APDI budget to an Agreed-Upon Procedures Contract for 2010 with Elgee, Rehfeld and Mertz for an amount not to exceed the previously-budgeted and authorized amount.

Motion by Elton, second by O'Connor

5. Habitat Reauthorization of Funds for Jacobs Mutch small parcels

APPROVED MOTION: Motion to approve the reauthorization of funds for Jacobs and Mutch Anchor River Small Parcels in the amount of $175,000; this authorization shall terminate if a purchase agreement is not executed by October 30, 2011.

Motion by Hartig, second by Elton

6. Cordova Community Center

APPROVED MOTION: Motion to approve funding of the Cordova Center, as detailed in the Council's Resolution Regarding the Cordova Community Center $7,008.393 with clarification on the definition of EVOS and EVOS Trustee Council in draft resolution language.

Motion by O'Connor, second by Lloyd

7. FFY 2012 Invitation

APPROVED MOTION: Motion to approve the FFY 2012 Invitation for Proposals for release, with the following inclusion and revisions made by Council staff:

1.) Any necessary housekeeping revisions;
2.) Text in the Herring Program section limiting the focus of that program to Restoration Option Two which is the enhanced monitoring option in the Integrated Herring Restoration Program (IHRP).
3.) Further, there is Inclusion of funding for the five focus areas in the following amounts: Herring Program, $1,000,000 annually for the first five-year contract, to increase annually by 2.75 percent to account for inflation; Long-Term Monitoring, $2,000,000 annually for the first five-year contract, to increase by 2.75 percent

annually to account for inflation; and Storm Water, $1,700,000 total for up to a five-year period; Marine Debris, $1 ,000,000 total for up to a five-year period; and Response, Lessons Learned, $700,000 total for up to a five-year period.

Motion by Lloyd, second by Hartig

8. FFY 2011 Invitation – Lingering Oil

APPROVED MOTION: Motion to approve issuing a FFY 2011 Invitation requesting pilot projects for the 2011 field season building on the work of Michel Boufadel, Al Venosa and Jacqui Michel with funding of up to $1,500,000. Motion by Elton, second by Hartig

9. Adjourn — Motion by Lloyd, second by O'Connor

Off the record 3:20 p.m.

ELGEE REHFELD MERTZ, LLC

CERTIFIED PUBLIC ACCOUNTANTS

9309 Glacier Highway, Suite B-200 • Juneau, Alaska 99801
907.789.3178 • FAX 907.789.7128 • www.ermcpa.com

January 26, 2011
Elise Hsieh, Executive Director
Exxon Valdez Oil Spill Trustee Council
441 W. 5th Avenue, Suite 500
Anchorage, Alaska 99501

We are pleased to confirm our understanding of the nature and limitations of the services we are to provide for *Exxon Valdez* Oil Spill Trustee Council.

We will perform the following services:

1) We will compile, from information you provide:

   (1) The statement of fiduciary assets and liabilities and statement of changes in fiduciary assets and liabilities for the State of Alaska *Exxon Valdez* Oil Spill Investment Fund as of and for the year ended June 30, 2010.

   (2) The statement of assets, liabilities, and trust fund balance arising from cash transactions and statement of receipts, disbursements and changes in trust fund balance for the U.S. Department of Interior, Natural Resources Damage Assessment and Restoration Fund as of and for the year ended September 30, 2010.

   (3) Balance sheet and statement of revenues, expenditures and changes in trust fund balance of the State of Alaska *Exxon Valdez* Oil Spill Settlement Trust as of and of the year ended June 30, 2010.

We will issue accountants' report thereon in accordance with Statements on Standards for Accounting and Review Services issued by the American Institute of Certified Public Accountants. Management has elected to omit substantially all of the disclosures required by accounting principles generally accepted in the United States of America.

The objective of a compilation is to assist you in presenting financial information in the form of financial statements. We will utilize information that is your representation without undertaking to obtain or provide any assurance that there are no material modifications that should be made to the financial statements in order for the statements to be in conformity with accounting principles generally accepted in the United States of America.

You are responsible for:

b) the preparation and fair presentation of the financial statements in accordance with accounting principles generally accepted in the United States of America or other comprehensive basis of accounting.

c) designing, implementing, and maintaining internal control relevant to the preparation and fair presentation of the financial statements.

d) preventing and detecting fraud.

e) identifying and ensuring that the company complies with the laws and regulations applicable to its activities.

f) the selection and application of accounting principles.

g) making all financial records and related information available to us and for the accuracy and completeness of that information.

We will conduct our compilation in accordance with Statements on Standards for Accounting and Review Services issued by the American Institute of Certified Public Accountants.

A compilation differs significantly from a review or an audit of financial statements. A compilation does not contemplate performing inquiry, analytical procedures, or other procedures performed in a review. Additionally, a compilation does not contemplate obtaining an understanding of the company's internal control; assessing fraud risk; testing accounting records by obtaining sufficient appropriate audit evidence through inspection, observation, confirmation, or the examination of source documents (for example, cancelled checks or bank images); or other procedures ordinarily performed in an audit. Accordingly, we will not express an opinion or provide any assurance regarding the financial statements being compiled.

Our engagement cannot be relied upon to disclose errors, fraud, or illegal acts. However, we will inform the appropriate level of management of any material errors, and of any evidence or information that comes to our attention during the performance of our compilation procedures, that fraud may have occurred. In addition, we will inform you of any evidence or information that comes to our attention during the performance of our compilation procedures regarding illegal acts that may have occurred, unless they are clearly inconsequential. We have no responsibility to identify and communicate deficiencies in your internal control as part of this engagement.

If, for any reason, we are unable to complete the compilations of your financial statements, we will not issue reports on such statements as a result of this engagement.

2) We will also apply the agreed-upon procedures which *Exxon Valdez* Oil Spill Trustee Council has specified, listed in the attached schedule, to the Trustee Council's records and statements as of and for the year ended September 30, 2010, prepared in accordance with the criteria described in the attachment. This engagement is solely to assist the Trustee Council with matters described in the attached schedule. Our engagement to apply agreed-upon procedures will be conducted in accordance with attestation standards established by the American Institute of Certified Public Accountants. The sufficiency of the procedures is solely the responsibility of those parties specified in the report. Consequently, we make no representation regarding the sufficiency of the procedures described in the attached schedule either for the purpose for which this report has been requested or for any other purpose. If, for any reason, we are unable to complete the procedures, we will describe any restrictions on the performance of the procedures in our report, or will not issue a report as a result of this engagement.

Because the agreed-upon procedures listed in the attached schedule do not constitute an examination, we will not express an opinion on the accounting records. In addition, we have no obligation to perform any procedures beyond those listed in the attached schedule.

We will submit a report listing the procedures performed and our findings. This report is intended solely for the use of the Trustee Council, and should not be used by anyone other than these specified parties. Our report will contain a paragraph indicating that had we performed additional procedures, other matters might have come to our attention that would have been reported to you.

You are responsible for the presentation of the applicable schedules and documents in accordance with criteria described in the attached schedule; and for selecting the criteria and determining that such criteria are appropriate for your purposes.

Max Mertz is the engagement partner and is responsible for supervising the engagement and signing the report or authorizing another individual to sign it.

We plan to begin our procedures on approximately March 1, 2011 and, unless unforeseeable problems are encountered, the engagement should be completed by June 30, 2011. At the conclusion of our

engagement, we will require a representation letter from management that, among other things, will confirm management's responsibility for the presentation of the schedule and documents described in the attachment.

We estimate that our fees for these services will be $14,850. You will also be billed for travel and other out-of-pocket costs such as report production, word processing, postage, etc. The fee estimate is based on anticipated cooperation from your personnel and the assumption that unexpected circumstances will not be encountered during the engagement. If significant additional time is necessary, we will discuss it with you and arrive at a new fee estimate before we incur the additional costs. Our invoices for these fees will be rendered each month as work progresses and are payable on presentation. Continuation of services is contingent upon timely payments. A finance charge of 1% per month (12% annually) will be assessed to all accounts over sixty days old. If we elect to terminate our services for nonpayment, our engagement will be deemed to have been completed upon written notification of termination even if we have not completed our report. You will be obligated to compensate us for all time expended and to reimburse us for all out-or-pocket expenditures through the date of termination.

We appreciate the opportunity to assist you and believe this letter accurately summarizes the significant terms of our engagement. If you have any questions, please let us know. If you agree with the terms of our engagement as described in this letter, please sign the enclosed copy and return it to us. If the need for additional procedures arises, our agreement with you will need to be revised. It is customary for us to enumerate these revisions in an addendum to this letter. If additional specified parties of the report are added, we will require that they acknowledge in writing their responsibility for the sufficiency of procedures.

Sincerely,

ERM

RESPONSE:

This letter correctly sets forth the understanding of *Exxon Valdez* Oil Spill Trustee Council.

Signature_____

Title_____

Date_____

Attachment 1
Agreed Upon Procedures Outline for the *Exxon Valdez* Oil Spill Trustee Council
Year Ended September 30, 2010

Natural Resources Damage and Restoration Fund (NRDA&R)

1. We will obtain the necessary information and perform procedures to verify the flow of funds into and out of *Exxon Valdez* Oil Spill Trustee Council's NRDA&R account. Specifically, we will:
    a.) Obtain the annual cash flow plan for the year ended September 30, 2010 from the U.S. Department of Interior. We will inquire of U.S. DOI staff as to the procedures used to prepare/establish the plan and ensure the disbursements to the federal agencies are made in accordance with the Trustee Council work plan.
    b.) Perform procedures to ensure that disbursements from the NRDA&R accounts to each of the federal agencies were made in accordance with the work plan and court notices for the year ended September 30, 2010.
    c.) We will reconcile amounts disbursed from NRDA&R to amounts reported by the agencies.
    d.) We will perform procedures related to *Exxon Valdez* Oil Spill Trustee Council's NRDA&R account for monitoring return of the unspent project funds from the federal agencies.

2. We will perform procedures relative to the process and controls of each of the federal agencies to ensure that unspent project funds are properly and timely returned to *Exxon Valdez* Oil Spill Trustee Council's NRDA&R account. Specifically, we will:
    a.) Contact federal agencies to determine when unspent project funds were last returned and for which projects.
    b.) In order to assist us in these procedures, we will request that each of the agencies prepare a schedule of unspent project funds by project/year.

State of Alaska EVOS Oil Spill Settlement Account

1. We will evaluate procedures in place at the State of Alaska, Department of Fish and Game for monitoring unspent portions of projects to ensure that unspent project funds are identified and reported to the Trustee Council and used to offset future Trustee Council funding.
2. We will evaluate the Restoration Office's process in place to monitor timely return of unspent funds.
3. We will review the Restoration Office's process for determining available unencumbered and unspent EVOS project funds that are available to reduce future Court Notices.

EVOS Restoration Office

1. We will evaluate controls over expenditures by the Restoration Office to ensure that costs incurred are reasonable and within the mission of the EVOS Trustee Council.
2. We will obtain and review a listing of expenditures for EVOSTC internal admin allocation – project 10100.

Performance
Measures

State of Alaska

RATES OF RETURN - Total

Periods Ending December 31, 2010

STATE STREET.

EVOS Investment Report

	EMV	Month	QTR	1 YEAR	3 YEARS	5 YEARS	ITD	Incept Date
AY02 - EVOS RESEARCH INVESTMENT	101,908	4.67	6.35	13.06	1.26	4.59	4.54	11-01-00
EVOSINFI - EVOS INVESTMENT FUND INDEX		4.73	6.55	12.21	1.04	4.56	4.19	
AY02FI - EVOS BROAD MARKET FIXED INCOM	28,744	-1.12	-1.13	7.00	5.90	5.74	6.21	11-01-00
XSL - BC AGGREGATE		-1.08	-1.30	6.54	5.90	5.80	6.10	
AY02IEP - EVOS SOA INT'L EQUITY POOL	21,987	8.05	5.47	9.28	-4.16	4.04	4.19	11-01-00
XCB - MSCI EAFE (NET)		8.10	6.61	7.75	-7.02	2.46	3.41	
AY02MM - EVOS MONEY MARKET FUND	5,809	0.06	0.12	0.26	1.21	2.79	2.77	11-01-00
X11 - 91 DAY T-BILL		0.02	0.04	0.13	0.79	2.43	2.45	
AY02R3K - EVOS RUSSELL 3000 INDEX	45,368	6.71	11.49	16.80	-1.98	2.78	1.56	11-01-00
XF3 - RUSSELL 3000		6.78	11.59	16.93	-2.01	2.74	1.32	
AY2H - EVOS HABITAT INVESTMENT FUND	34,017	4.67	6.34	13.06	1.00	4.46	7.16	11-01-02
EVOSINFI - EVOS INVESTMENT FUND INDEX		4.73	6.55	12.21	1.04	4.56	7.33	
AY2HFI - EVOS SOA2H BROAD MARKET FIXE	10,139	-1.12	-1.12	6.99	5.78	5.65	5.29	11-01-02
XSL - BC AGGREGATE		-1.08	-1.30	6.54	5.90	5.80	5.13	
AY2HIEP - EVOS SOA2H INTL EQUITY POOL	7,758	8.05	5.47	9.28	-4.15	4.05	9.52	11-01-02
XCB - MSCI EAFE (NET)		8.10	6.61	7.75	-7.02	2.46	9.88	

State of Alaska

RATES OF RETURN - Total

Periods Ending December 31, 2010

STATE STREET.

EVOS Investment Report

	EMV	Month	QTR	1 YEAR	3 YEARS	5 YEARS	ITD	Incept Date
AY2HMM - EVOS SOA2H MONEY MARKET FU	125	0.06	0.12	0.50	1.33	2.39	2.13	03-01-03
X11 - 91 DAY T-BILL		0.02	0.04	0.13	0.79	2.43	2.23	
AY2HR3K - EVOS SOA2H RUSSELL 3000 INDE	15,995	6.73	11.52	16.84	-1.68	2.96	7.44	11-01-02
XF3 - RUSSELL 3000		6.78	11.59	16.93	-2.01	2.74	7.34	
AY2J - EVOS KONIAG INVESTMENT FUND	47,839	4.67	6.36	13.09	0.87	4.39	7.10	11-01-02
EVOSINFI - EVOS INVESTMENT FUND INDEX		4.73	6.55	12.21	1.04	4.56	7.33	
AY2JFI - EVOS SOA2J BROAD MARKET FIXED	14,312	-1.12	-1.12	7.00	5.87	5.71	5.32	11-01-02
XSL - BC AGGREGATE		-1.08	-1.30	6.54	5.90	5.80	5.13	
AY2JIEP - EVOS SOA2J INTL EQUITY POOL	10,950	8.05	5.47	9.26	-4.17	4.04	9.51	11-01-02
XCB - MSCI EAFE (NET)		8.10	6.61	7.75	-7.02	2.46	9.88	
AY2JMM - EVOS SOA2J MONEY MARKET FUN	0	0.03	0.08	0.28	1.49	3.13	2.83	12-01-03
X11 - 91 DAY T-BILL		0.02	0.04	0.13	0.79	2.43	2.35	
AY2JR3K - EVOS SOA2H RUSSELL 3000 INDE	22,576	6.73	11.52	16.86	-1.84	2.86	7.42	11-01-02
XF3 - RUSSELL 3000		6.78	11.59	16.93	-2.01	2.74	7.34	

State of Alaska

RATES OF RETURN - Total

Periods Ending December 31, 2010

STATE STREET.

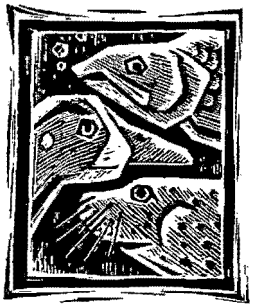
EVOS Investment Report

	EMV	Month	QTR	1 YEAR	3 YEARS	5 YEARS	ITD	Incept Date
AY00A43 - EVOS BROAD MARKET FIXED INCO	53,196	-1.12	-1.13	7.00	5.87	5.71	6.21	11-01-00
XSL - BC AGGREGATE		-1.08	-1.30	6.54	5.90	5.80	6.10	
AY00A45 - EVOS SOA INT'L EQUITY POOL	40,695	8.06	5.48	9.28	-4.61	3.58	4.30	11-01-00
XCB - MSCI EAFE (NET)		8.10	6.61	7.75	-7.02	2.46	3.41	
AY00A42 - EVOS SHORT TERM POOL	5,934	0.06	0.12	0.27	1.59	3.01	2.88	11-01-00
X11 - 91 DAY T-BILL		0.02	0.04	0.13	0.79	2.43	2.45	
AY00A46 - EVOS RUSSELL 3000 INDEX	83,939	6.72	11.50	16.81	-1.90	2.83	1.82	11-01-00
XF3 - RUSSELL 3000		6.78	11.59	16.93	-2.01	2.74	1.32	

Long-Term Spending

Exxon Valdez Oil Spill Trustee Council

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



TO: Trustee Council Members and Alternates

FROM: Elise Hsieh
Executive Director

DATE: January 31, 2011

RE: Long-Term Spending Scenario for Council Research Focus Areas

During 2009-2010, the current Council engaged in intensive discussion with the goal of implementing a strategic and efficient use of the remaining funds. This effort began with informal Council discussions and then continued its development with six public meetings in spill-area communities and multiple Council meetings. This effort culminated in the Fall 2010 release of a FFY'12 Invitation, which requests research in four focus areas, including two 20-year programs. At the request of the Council, this document briefly describes the current Council's intent with regard to future research spending. The attached table should also be updated annually with actual spending updates and to check for needed adjustments. Please refer to the 2010 NEPA update documents for additional information regarding the Council's planning during that time.

Using the Spending Scenarios for Long-Term Planning

While the current Council and the Alaska Department of Revenue (ADOR) acknowledge that the investment funds are based on a market which has very recently proven its volatility, there is also agreement that these spending scenarios, based upon the best information available at this time, allow the Council to plan strategically for the use of the remaining funds into the future and to begin implementing those plans. Thus, the Council considered various spending scenarios before determining to implement long-term research programs based on the scenario in the attached table. It is assumed by the current Council that future councils will respond to market fluctuations with appropriate course-corrections and spending adjustments.

The attached table includes the spending scenario used by the current Council to begin implementing and funding proposals in four research areas, including two 20-year programs. It does not address the Habitat or Koniag sub-accounts, which do not necessarily require the same level of future planning. In addition, the administration costs, which have been reduced from a high of over $2.5

million in 2009, have another planned reduction around 2017, at which time the intent is that only the two long-term programs will remain to administrate. These figures are also estimations and may be able to be further reduced, or may demand an increase if the Council expands its program.

Bob Mitchell at ADOR created the attached table and helpfully produced the materials upon which this document is based, as well as those used heavily by the Council during this planning phase.

The Spending Scenario Model: how the simulations were produced

The attached table was created with a model to estimate the likelihood that the research fund will survive through FFY32, with given assumptions about annual spending and annual investment performance. The investment performance was simulated using Callan's most recent capital market assumptions (developed in early 2010). The research fund is assumed to maintain its existing asset allocation through the end of FFY27, then go to a 100% bond allocation for the remaining 5 years. A Monte Carlo simulation was conducted with 100,000 iterations. The specific assumptions for this iteration of the model are outlined below.

Interpreting the Results

The main table is accompanied by a companion table which analyzes the "probability of ruin" for this spending scenario. The "probability of ruin" is the proportion of model iterations that resulted in the fund balance going negative at some point through the end of FFY32. The terminal value distribution provides a sense of the range of possible outcomes. These figures assume that one takes all 100,000 iterations and orders them by ending market value from the lowest to the highest. The 25^{th} % number indicates the market value of the iteration for which 25% of all iterations lie below that value. Half of the simulations had a terminal market value below the 50^{th} % number and half had terminal market values above that value. About one-quarter of all iterations had a market value above the 75^{th} % number. Notice that the 25^{th} and 50^{th} % numbers are closer to each other than the 50^{th} and 75^{th} % numbers. This indicates that most of the iterations cluster together at a lower terminal market value than would be suggested by looking only at the 50^{th} and 75^{th} % numbers.

Assumptions used in the model:

1. Current asset allocation until end of FFY27, then 100% bonds.
2. Expenses occur evenly throughout each year.
3. Beginning balance = $97.489 million.
4. FFY11 earnings are for .5 year.
5. Adjusted for 2.75% inflation.

Limitations of the model:

The model has some limitations which may underestimate actual downside risk, including:

1. Asset class returns are assumed to be normally distributed, with relatively few extreme returns. Equity returns have historically experienced large negative and positive returns more frequently than is assumed in the distribution incorporated in the model.
2. Asset class correlations tend to vary over time. In particular, the diversification benefits normally associated with incorporating multiple asset classes tend to wane during times of market stress. The model assumes constant correlation relationships between asset classes.
3. The model assumes there is no relationship between returns from period to period. The market may experience periods of strong or weak asset class performance that persist over time. Conversely: the extreme ends of the distribution produced by the model may be the result of a string of either very positive or very negative outcomes. The extremes of the distribution should be interpreted with caution.
4. Inflation is assumed to be constant at 2.75%. Variations in inflation levels over time are not reflected in the model.

Attachment: Long-Term Spending Scenario Table January 2011 Update

Long-Term Spending Scenario: January 2011 Update

Please see Long-Term Spending Scenario Memorandum for additional information

Probability of Ruin and Terminal Market Value Trade

	Terminal Market Value		
Prob Ruin	25th %	50th %	75th %
10.7%	42,882	113,311	210,801

Long-Term Spending Scenario for Council Research Funding

	FFY11	FFY12	FFY13	FFY14	FFY15	FFY16	FFY17	FFY18	FFY19	FFY20	FFY21	FFY22	FFY23	FFY24	FFY25	FFY26	FFY27	FFY28	FFY29	FFY30	FFY31	FFY32	Total
Admin: (9% GA included)		1,700	1,747	1,795	1,844	1,895	1,500	1,541	1,584	1,627	1,672	1,718	1,765	1,814	1,864	1,915	1,967	2,022	2,077	2,134	2,193	2,253	38,627
Lingering Oil Studies*	1,500																						1,500
FFY12-13 Projects*		2,000	2,000																				4,000
Long-Term Monitoring*		2,000	2,055	2,112	2,170	2,229	2,291	2,354	2,418	2,485	2,553	2,623	2,695	2,770	2,846	2,924	3,004	3,087	3,172	3,259	3,349	3,441	55,837
Herring*		1,000	1,028	1,056	1,085	1,115	1,145	1,177	1,209	1,242	1,277	1,312	1,348	1,385	1,423	1,462	1,502	1,544	1,586	1,630	1,674	1,720	27,920
Stormwater*		340	340	340	340	340																	1,700
Marine Debris*		500	500																				1,000
Response*		140	140	140	140	140																	700
9% GA for * Areas listed above	135	538	546	328	336	344	309	318	326	335	345	354	364	374	384	395	406	417	428	440	452	464	8,339
Total Expenses	**1,635**	**8,218**	**8,355**	**5,771**	**5,915**	**6,063**	**5,245**	**5,390**	**5,537**	**5,690**	**5,847**	**6,007**	**6,172**	**6,343**	**6,517**	**6,696**	**6,879**	**7,069**	**7,263**	**7,463**	**7,668**	**7,879**	139,623

Revised 2/8/2011

FFY 2011 Lingering Oil
Proposals

FY11 Proposal Funding Recommendations

Project Number	Principal Investigator	Project Title (abbr.)	Total Requested	FY11 Requested	Total Approved	Science Panel	Science Coord.	PAC	Executive Director	Trustee Council
11100836	Boufadel	Bioremediation Pilot Studies	$1,586,785.00	$1,586,785.00	$0.00	Fund	Fund	Not Reviewed	Fund	**Pending**
11100853	Irons	Pigeon Guillemot Restoration in PWS	$2,434,159.00	$218,000.00	$0.00	Fund	No Consensus	Not Reviewed	No Consensus	**Pending**
11100112	Irvine	Lingering Oil on Boulder-Armored Beaches	$203,800.00	$178,200.00	$0.00	Fund	Fund	Not Reviewed	Fund	**Pending**
11100111	Robertson	Evaluation of Polypropylene Geotextile-Based Mechanical Removal Methods	$226,400.00	$226,400.00	$0.00	Do Not Fund	Do Not Fund	Not Reviewed	Do Not Fund	**Pending**
Total Funds Requested and Approved			**$4,451,144.00**	**$2,209,385.00**	**$0.00**					

Descriptions of New FY11 Proposals

Project Number: **11100836**

Project Title: **Pilot studies of bioremediation of the Exxon Valdez oil in Prince William Sound Beaches**

Principal Investigator: Michel Boufadel

Affiliation: Not Available

Co-PIs/Personnel: Jacqui Michel

Project Location: Prince William Sound

Funding Requested by Fiscal Year:

FY11: $1,586,785.00	**FY12:** $0.00	**FY13:** $0.00
FY14: $0.00	**FY15:** $0.00	**FY16:** $0.00

Total Funding Requested: $1,586,785.00

Abstract:

Oil from the Exxon Valdez persists on initially polluted beaches and contains a considerable fraction of the toxic compounds polycyclic aromatic hydrocarbons (PAHs). The results of the "Oil biodegradation" project by Albert Venosa revealed that more than 80% of the total PAHs (TPAHs) biodegrade within six months when exposed to an environment rich with dissolved oxygen and nutrients. Results from the "Limiting factors" project by Michel Boufadel revealed that the nutrient concentration was an order of magnitude lower than needed for optimal oil biodegradation. It was also found that the dissolved oxygen concentration at oiled pits was, in general, less than 1.0 mg/L. Therefore, anoxic conditions exist, which means that aerobic biodegradation of oil is not occurring. Therefore, both oxygen and nutrient limitations are occurring. While the Venosa study demonstrated oil biodegradability, the actual rate of oil biodegradation in the field when provided with sufficient oxygen and nutrient can be evaluated only through a pilot study of bioremediation, as we are proposing herein. Due to the high dilution for chemicals applied onto the beach surface, we evaluated the delivery of oxygen and nutrient solutions into the beaches subsurface through tracer studies. The tracer experiments revealed that the tracer delivered into the subsurface travelled distances of meters with minimal dilution. Therefore, we are proposing herein to pursue the same approach for delivering solutions of hydrogen peroxide, sodium nitrate, and sodium tripolyphosphate. Sediment samples will be obtained at various times from various locations and will be analyzed for oil composition. Surrogate measures for oil biodegradation include microbial population and the nutrient concentration. The selection of the beaches for the study will be made based on the "Limiting Factor project" and the "Spatial oil distribution" project by Jacqui Michel. Findings from the latter project will be relied upon to upscale the pilot scale results of this study.

Science Panel Comments:

This proposal represents a request to conduct a pilot remediation of persistently oiled shorelines, using key scientific information arising from the revealing studies conducted in their previous EVOS trustee-funded project. The approach involves injection of an oxygen source (hydrogen peroxide) and a source of inorganic nitrogen nutrient (Li nitrate) into the oiled subsurface layer at a position on the intertidal beach known from the earlier scientific work to result in transport to the oiled sediments down-shore. This method is based upon their clear demonstration of the role of oxygen limitation, nutrient limitation, and the importance and nature of sub-surface flows in the previous research phase of their EVOS work.

The funds requested for this project are high (1.6 M). The high costs are justified adequately by the budgetary information that is provided, although I do note what appears to be a high overhead rate for one of the consultancies. The remediation process being tested is directly applicable to the most troublesome type of beach where unweathered oil still persists two decades after the EVOS. The approach is relatively non-invasive, requiring only an injection excavation high on the beach and monitoring wells and ports at a few locations lower on shore. The proposal includes exceptionally experienced and technically trained experts in all the necessary disciplines to complete the project with skil

and insight. Boufadel, Michel, Wrenn, Short, and Crodes have complementary skills and have shown evidence of past effective collaboration to integrate their efforts successfully. The review of the large number of publications from the previous EVOS science project supports the conclusion that the knowledge of what limits degradation of the lingering oil is sufficient now to move ahead with this set of remediation trials.

This project is exceptional in its quality, technical expertise, importance, and potential to address a huge lingering impact of EVOS. Funding for this project is supported without reservation. It would be beneficial if there was some projection of costs of actually applying this remediation technique to all the known sites of concern. There is also some question of whether doing quantitative qPCR is justified because it provides molecular biological information on the biodiversity of hydrocarbon-degrading microbes but does not quantify them like more traditional measures of microbial biomass and degradation activity. If inadequately justified, that could save costs because this is an expensive process.
This is a superb proposal, technically sound, well justified, and potentially providing a solution to the perhaps most nagging unsolved problem left by EVOS.

Science Panel Recommendation: Fund

Science Coordinator Comments:

I concur with the science panel's review and recommend funding for this project with no reservations.

Science Coordinator Recommendation: Fund

Public Advisory Committee Comments:

Not Applicable

Public Advisory Committee Recommendation: Not Reviewed

Executive Director Comments:

I recommend funding the Boufadel project. However, I would like the PI to respond with regard to alternatives to the high overhead rate identified by the science panel comments.

Executive Director Recommendation: Fund

Trustee Council Comments:

Not Available

Trustee Council Decision: Pending

Project Number: 11100853

Project Title: Pigeon Guillemot Restoration Research in Prince William Sound, Alaska

Principal Investigator: David Irons

Affiliation: USFWS

Co-PIs/Personnel: Dan Roby

Project Location: Prince William Sound

Funding Requested by Fiscal Year:

FY11: $218,000.00	**FY12:** $580,081.00	**FY13:** $580,081.00
FY14: $360,657.00	**FY15:** $347,670.00	**FY16:** $347,670.00

Total Funding Requested: $2,434,159.00

Abstract:

This amendment to project 070853, Pigeon Guillemot Restoration Research in Prince William Sound, Alaska, provides an opportunity to restore the population of Pigeon Guillemots (Cepphus columba) in Prince William Sound, Alaska, which has declined by more than 90% at the Naked Island group since 1989. A restoration plan for Pigeon Guillemots in PWS was prepared to address the species' lack of population recovery following injury by the 1989 Exxon Valdez oil spill. Predation on nests and adults by mink is now the primary limiting factor for guillemot reproductive success and population recovery at the most important historical nesting site for guillemots in PWS (i.e., the Naked Island group). Mink on the Naked Island group are descended in part from fur farm stock and apparently were introduced to the island group during the 1980s. Eradication of mink at these islands was selected as the preferred restoration alternative because it is feasible and most likely to result in the recovery of guillemots in PWS. Other alternatives are either currently unavailable or unlikely to be effective. An eradication effort is likely to be successful due to both well-developed methods and the low likelihood of re-colonization. Potential negative effects of the preferred alternative are either negligible or largely avoidable. The guillemot population at the Naked Island group would likely double within the first 10 years following mink eradication, and the Sound-wide population of guillemots would likely increase within 15 years of mink eradication at the Naked Island group, once guillemots nesting at the Naked Island group had become a source population for other parts of PWS.

Science Panel Comments:

This proposal has been previously submitted to the EVOS Trustee Council and reviewed by the Science Panel. Support for the work was strong among the Science Panel members. One concern that arose pertained to the question of whether the mink found today on Naked and nearby Islands in the Naked group are descendants of the animals introduced artificially or whether these are fully native mink with an intact natural genome. That question has now been answered with DNA analysis revealing a mixed genome, not reflecting a pure native stock. This answer would appear to satisfy the question of whether these mink are natural (no) and to allow the extermination to move forward, if supportable scientifically by the Science Panel and Trustee staff and if politically and financially acceptable to the Trustee Council.

Here I will provide a review of the adequacy of the science. First, it is noteworthy that PIGUs are the only bird species still listed as Not Recovering after EVOS. Second, the importance of Naked Island and its potential recovery to this species is evident – the Naked Island group held about 25% of the PIGU population in PWS prior to the spill despite representing only 2 % of the PWS shoreline. Third, the inference that mink represent the impediment to PIGU recovery on Naked is strong, based especially on comparison Smith Island where mink are absent and PIGU survival is good. Fourth, the contention that strong recovery of PIGUs on Naked would lead to spread and re-colonization of other suitable sites in PWS is a reasonable expectation, so restoration on Naked pays a wider dividend of recovery elsewhere in PWS. Fifth, we know that the introduced foxes are now gone from Naked so that isn't the problem. Sixth, the alternatives analysis is compelling in showing that no other restoration option would work and that eradication is the only solution. For example, providing more of the now reduced lipid-rich prey would be useless, resulting in feeding mink better not in enhancing PIGU survival and abundance. Culling would be a half-step and require costly intervention

forever, and thus can be rejected as a viable restoration option. Seventh, elimination of predatory mammals on islands is a well-established practice to enhance ground-nesting seabirds and other birds.

Consequently, this proposal makes good sense scientifically and addresses an ongoing restoration failure of importance. The only questions involve the costs and the potential use of dogs, if trapping fails to get every last mink in the eradication process. The costs are 2.4 Million or 1.3 Million if a National Wildlife Foundation match is obtained. We concur that these cost estimates are reasonable because a 3-5 year time frame is needed to complete the removal. So while high, the expenditures are likely justified. The use of dogs in the removal of mink seems to possibly conflict with animal rights as an unacceptably cruel practice.

Science Panel Recommendation: Fund

Science Coordinator Comments:

This proposal is scientifically compelling and builds on four years of work focused on this topic. While the idea of a direct restoration project is appealing, I am concerned that the total project cost is very high in relation to the total number of nests that they project will be added to the island complex.

Science Coordinator Recommendation: No Consensus

Public Advisory Committee Comments:

Not Applicable

Public Advisory Committee Recommendation: Not Reviewed

Executive Director Comments:

I do not have a recommendation for this project. The project is very compelling because it potentially provides active restoration for an injured species. However, the high cost and speculation regarding the longterm outcome needs to be weighed carefully by the Council.

Executive Director Recommendation: No Consensus

Trustee Council Comments:

Not Available

Trustee Council Decision: Pending

Project Number: 11100112

Project Title: **Lingering Oil on Boulder-Armored Beaches in the Gulf of Alaska 22 Years after the Exxon Valdez Oil Spill**

Principal Investigator: Gail Irvine

Affiliation: Not Available

Co-PIs/Personnel: Mark Carls, Dan Mann

Project Location: Prince William Sound

Funding Requested by Fiscal Year:

FY11: $178,200.00	**FY12:** $25,600.00	**FY13:** $0.00
FY14: $0.00	**FY15:** $0.00	**FY16:** $0.00

Total Funding Requested: $203,800.00

Abstract:

We want to continue long-term monitoring of lingering oil at six Gulf of Alaska sites where we have tracked the fate and persistence of stranded Exxon Valdez oil over the last 22 years. It has been six years since our last survey revealed that relatively unweathered oil still persisted at some sites. Interestingly these sites have less weathered oil (e.g., contains more n-alkanes) than similarly aged oil from Prince William Sound. All five of our monitoring sites on the Katmai National Park coast are boulder beaches with high wave energies. Accepted knowledge predicted that rapid natural weathering of stranded oil would occur in such settings. This was not the case, and we are still figuring out why. We think it is because the boulder armors that cover these shorelines protect the underlying oil. In addition to resampling our monitoring plots, we will be testing to see if oil is leaking out from these beaches. By extending our long term study of oil stranded on this little understood shoreline type, we will contribute important new data useful for predicting the geographic distribution of lingering oil, assessing its potential for continued pollution, and designing methods for its remediation.

Science Panel Comments:

This proposal represents a plan to return to oiled shorelines in the Kenai Fjords and Katmai National Parks and re-sample to determine the degree of oil persistence and its state of weathering so as to provide an updated record of the degree of persistence of oil and toxicity. Five of the historically sampled (on three previous dates) sites fall within Designated Wilderness. The project will also deploy passive samplers to assess whether oil is escaping into the sea waters and thus the ecosystem from the sub-surface reservoirs of lingering contamination. The last such survey occurred 6 years ago.

Costs of this project are relatively modest (178K in 2011 and 26K in 2012). This team has conducted identical surveys and related research in the past so the cost estimates presented in the detailed budget are likely accurate. The team produces partners from 3 different organizations, the National Park Service, the University of Alaska, and NOAA-Auke Bay lab. They each are experienced and well qualified for this work. This project examines beaches that differ from those already assessed in PWS in that these are high-energy beaches that would have been anticipated to promote oil weathering and degradation but surprisingly did not. The sequestering of oil in the sub-surface sediments of these beaches is thought to result from armoring by large boulders. In addition to repeating the surveys, this project proposes to assess the stability of the interlocking boulder assemblies as a mean of assessing whether that stability is involved in creating protection of buried oil from oxygen that could induce normal weathering. If true, this could suggest remediation procedures that could be subsequently tested.

On balance, this project has merit and would contribute useful observations on the extent of oil disappearance and chemical weathering over the past 6 years on troublesome sites. It would also advance to some degree our understanding of how oil sequestration pe3rsists in these energetic environments. The study lacks the detailed engineering, chemistry, and process-oriented science evident in the Buofadel proposal, yet this one does have merit and is far less expensive. The PIs have done a responsible job of writing up and publishing results of the previous surveys

and participated in the EVOS process broadly. The fact that these problems persist in Designated Wilderness and shores of National Parks gives special urgency to progressing towards remediation. This proposal is of value but would not be rated as high in priority as the Boufadel proposal. There is some question as to whether the 30-d strip deployment used to detect any oil release from the sub-surface pools of lingering oil is to be done for and usually only a single 30-d period, in which case the weather and wave conditions could well make the outcome non-representative. Also would repeated-measures ANOVA provide more powerful tests and more insights? Furthermore, non-parametric tests like the Wilcoxon tests proposed are typically less capable of detecting differences than normal-based statistics and usually an arcsin transformation serves well to render variances equal and thus normality-based testing justifiable. But these are just quibbles in an otherwise well designed study plan.

Funding of this project is supported, which is reasonably priced with compelling budget justification, addresses an ongoing contamination issue, has potential to lead to mitigation (clean-up) measures, differs from the PWS beaches on which oil lingers in substantive ways, and affects a NPS which requires some special consideration.

Science Panel Recommendation: Fund

Science Coordinator Comments:

I concur with the science panel's review of this project.

Science Coordinator Recommendation: Fund

Public Advisory Committee Comments:

Not Applicable

Public Advisory Committee Recommendation: Not Reviewed

Executive Director Comments:

This project has merit and is of interest. However, this project examines the where and why of lingering oil, while the Boufadel project squarely addresses the more immediate Council concern of what should be done. Thus I would prioritize funding of the Boufadel project.

Executive Director Recommendation: Fund

Trustee Council Comments:

Not Available

Trustee Council Decision: Pending

Project Number: 11100111

Project Title: **Evaluation of Polypropylene Geotextile-Based Mechanical Removal Methods for Lingering Oil on Gravel Beaches in Prince William Sound, Alaska**

Principal Investigator: Tim Robertson

Affiliation: NUKA Reserach

Co-PIs/Personnel: David Janka

Project Location: Prince William Sound

Funding Requested by Fiscal Year:

FY11: $226,400.00	**FY12:** $0.00	**FY13:** $0.00
FY14: $0.00	**FY15:** $0.00	**FY16:** $0.00

Total Funding Requested: $226,400.00

Abstract:

This proposal describes the scope of work, methodology, and estimated costs associated with a pilot project that will evaluate lingering oil removal methods using oleophilic geotextiles in combination with sediment washing and reworking. The study builds on both the early work of EVOS volunteer cleanup workers at Mars Cove involving geotextiles and the more recently published literature suggesting that sediment washing shows promise as a lingering oil treatment method for certain types of beaches. Investigators will a conduct series of small-scale field trials that evaluate and compare the potential for several geotextile-based mechanical removal methods to enhance total recovery and limit adverse environmental impacts to shoreline areas where lingering oil persists. The removal techniques to be evaluated in this pilot project represent basic low-technology manual methods that, if successful, provide simple, practical, scalable and relatively inexpensive field treatment techniques that may be the best available treatment options for at least some of the lingering oil sites along the spectrum of beaches in need of further treatment. The geotextile-based sediment treatment methods will be evaluated for the removal efficiency, cost, logistical feasibility, secondary pollution of water column and sediments, and impacts to sediment grain size of treated sediments. The results will be compiled in oral and written reports to the Trustee Council, public outreach materials, and a manuscript for submission to a peer-reviewed journal.

Science Panel Comments:

This project is designed as a pilot study to test an oil removal method based upon digging up oiled sediments on a certain type of beach, placing them in containers made of oleophylic geotextile material, exposing them to wave action for 7 days, and then testing the efficacy of hydrocarbon removal. The project also intends to test some of the inadvertent environmental impacts that are likely associated with this invasive process.

The funds requested for this study are modest (226 K). The methodology is indeed low-tech and could be employed by anyone without training. The process did come into play on at least one beach immediately after the EVOS. The procedure does have potential to speed up disappearance of oil, based upon what we now know about limitations to the weathering of buried oil. Lack of oxygen and nutrients (nitrate) limits the rate of degradation of buried oil, as shown well by recent EVOS-funded research by Boufadel. Consequently, excavating oiled sediments and exposing them to wave turbulence and mixing of oxygenated waters with normal nutrient levels would enhance weathering and remove it from under the sediments where degradation can be slow.

Although the project has a relatively low cost, it should not be supported because of many critical deficiencies. First, the invasive nature of this method would lead to potentially very serious negative impacts on the coastal environment. Excavating the entire oiled substrate can and will kill massive numbers of benthic invertebrates, including clams of importance as prey for shorebirds, seaducks, and sea otters. The removal of cobbles and any larger rocks will in itself disrupt the natural beach sedimentology and granulometry. Not all the oil will be retained by the geofabric, such that new releases will move into the water column. The finest sediments will pass through the geofabric materials adding to turbidity. By placing these bags on the intertidal shore, they can damage the underlying ecology by smothering the

benthic invertebrates directly and through induced sedimentation. It is doubtful that the EVOS trustees would endorse such an invasive method with attendant potential for unintended environmental damages. Indeed, this approach has much similarity with a method tested 20 years ago by the NOAA Auke Bay lab that involved digging trenches on beach and exposing the buried oil and sediments to wave action, sunlight, oxygen, and dissolved nutrients. This approach was deemed unacceptable by the trustees in part because of the attendant damages to the environment and because doing it on the large scale required to remediate the oiled shorelines was impractical.

The approach proposed for pilot testing here can only be applied to shorelines lacking armor of larger cobbles and boulders. The applicable shorelines thereby do not constitute a large fraction of oiled shores. Furthermore, we know from EVOS studies of Irvine and colleagues that armoring of beaches is important to the process of sequestering lingering oil. Consequently, this approach is inapplicable to those sites where oil removal is most urgent.

The proposal as presented reflects some serious naivete and/or lack of effort to provide a complete assessment of uncertainties. For example, the conduct of this research would likely depend upon receipt of a FONSI decision after a NEPA review, which could require preparation of and EIS. This would seriously delay the work, perhaps by years, and add costs not now included in the budget. The proposers do not identify a hydrocarbon analytic laboratory willing and able to perform those analyses and may such labs are fully engaged now with samples from the Gulf oil spill. Many of the procedures are vague – eg, barrels may or may not be used to suspend the geotextile and oil booms may or may not be used to prevent escape of hydrocarbons. The choice of only a single treatment period (7 days) is not defended, nor is treatment period included as a factor in the pilot testing as it should be in the absence of sound scientific knowledge that 7 days is sufficient. The use of SPMDs around the geotextile locations will potentially detect oil presence but cannot be used to quantify the magnitude and mass balance of oil releases. Choice of a Van Veen grab for benthic sampling is inappropriate in the intertidal zone because it does not lead to a repeatably sized and shaped sample. Coring is the preferred approach and that can be done in intertidal sediments. Use of multiple pairwise t-tests for assessing significance of results is insufficient because it fails to take into account all results in a single analysis and thus will have compromised power to detect differences. The PIs do not display from their record of education, work experience, and publication sufficient technical skills to provide confidence that they can conduct and publish rigorous science of the sort required here.

In summary, this project has too many problems to justify its support.

Science Panel Recommendation: Do Not Fund

Science Coordinator Comments:

I concur with the science panel's review of this project.

Science Coordinator Recommendation: Do Not Fund

Public Advisory Committee Comments:

Not Applicable

Public Advisory Committee Recommendation: Not Reviewed

Executive Director Comments:

I concur with the science panel's review of this project and do not recommend funding.

Executive Director Recommendation: Do Not Fund

Trustee Council Comments:

Not Available

Trustee Council Decision: Pending

Boufadel

PROPOSAL FORM

THIS FORM MUST BE SUBMITTED BY THE PROPOSED PRINCIPAL INVESTIGATOR (S) AND SUBMITTED ALONG WITH THE PROPOSAL.

By submission of this proposal, I agree to abide by the Trustee Council's data policy (*Trustee Council Data Policy**, adopted March 17, 2008) and reporting requirements *(Procedures for the Preparation and Distribution of Reports***, adopted June 27, 2007).

PROJECT TITLE: Pilot studies of bioremediation of the Exxon Valdez oil in Prince William Sound beaches

Name of PI: Michel C. Boufadel
Email: boufadel@gmail.com Phone: (610) 608-2281
Mailing Address 1947 N. 12th Street,
City, State, Zip Philadelphia, PA 19122

Name of PI: Jacqui Michel
Email: jacquimichel@resesarchplanning.com Phone: 803-256-7322 x 329
Mailing Address Street Address is 1121 Park Street
City, State, Zip Columbia, South Carolina, 29201

Name of PI:
Email: Phone:
Mailing Address
City, State, Zip

* www.evostc.state.ak.us/Policies/data.cfm
** www.evostc.state.ak.us/Policies/reporting.cfm

FY11 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Pilot studies of bioremediation of the Exxon Valdez oil in Prince William Sound Beaches

Project Period: 2011-2012

Primary Investigator(s): Michel Boufadel, Temple University, Jacqui Michel, Research Planning Inc

Study Location: EL056C, SM006B, Montague Island

Abstract:
Oil from the Exxon Valdez persists on initially polluted beaches and contains a considerable fraction of the toxic compounds polycyclic aromatic hydrocarbons (PAHs). The results of the "Oil biodegradation" project by Albert Venosa revealed that more than 80% of the total PAHs (TPAHs) biodegrade within six months when exposed to an environment rich with dissolved oxygen and nutrients. Results from the "Limiting factors" project by Michel Boufadel revealed that the nutrient concentration was an order of magnitude lower than needed for optimal oil biodegradation. It was also found that the dissolved oxygen concentration at oiled pits was, in general, less than 1.0 mg/L. Therefore, anoxic conditions exist, which means that aerobic biodegradation of oil is not occurring. Therefore, both oxygen and nutrient limitations are occurring. While the Venosa study demonstrated oil biodegradability, the actual rate of oil biodegradation in the field when provided with sufficient oxygen and nutrient can be evaluated only through a pilot study of bioremediation, as we are proposing herein. Due to the high dilution for chemicals applied onto the beach surface, we evaluated the delivery of oxygen and nutrient solutions into the beaches subsurface through tracer studies. The tracer experiments revealed that the tracer delivered into the subsurface travelled distances of meters with minimal dilution. Therefore, we are proposing herein to pursue the same approach for delivering solutions of hydrogen peroxide, sodium nitrate, and sodium tripolyphosphate. Sediment samples will be obtained at various times from various locations and will be analyzed for oil composition. Surrogate measures for oil biodegradation include microbial population and the nutrient concentration. The selection of the beaches for the study will be made based on the "Limiting Factor project" and the "Spatial oil distribution" project by Jacqui Michel. Findings from the latter project will be relied upon to upscale the pilot scale results of this study.

Estimated Budget:
EVOS Funding Requested: $1,586,785
(breakdown by fiscal year and must include 9% GA)

Non-EVOS Funds to be used:
(breakdown by fiscal year)

Date: 01/07/2011

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

PI: Michel C. Boufadel

Contract: No. AB133F-07-CN0099

It is customary for PIs to have a section summarizing the work that was done in prior funding. However, as this proposal is closely related to our prior work, and we are citing the prior work extensively in this proposal, we would be providing the summary in the body of the proposal. Therefore, the summary will not be provided herein to minimize redundancy.

Thirteen journal publications have resulted so far from this project, and all of them acknowledged support from the EVOSTC. Two additional articles are submitted, and five are in preparation for submission by April 01, 2011.

The papers that are published/in press/accepted are:

1) Li, H. (Postdoctoral Fellow), **M. C. Boufadel**, Long-term persistence of oil from the Exxon Valdez spill in two-layer beaches, ***NATURE geosciences***, *3*, 96-99, 2010.
2) **Boufadel, M. C.**, Y. Sharifi, B.Van Aken, B. A. Wrenn, and K. Lee, Nutrient and oxygen concentrations within the sediments of an Alaskan beach polluted with the *Exxon Valdez* oil spill, ***Environmental Science and Technology***, *44* (19), p 7418–7424, 2010.
3) Xia, Y.(Graduate Student), H. Li., and **M. C. Boufadel**, Factors affecting the persistence of the Exxon Valdez oil on a shallow bedrock beach, ***Water Resources Research***, 46, W10528, 17 PP., 2010 doi:10.1029/2010WR009179.
4) Guo, Q. (Graduate Student), H. Li., **M. C. Boufadel**, and Y. Sharifi, Hydrodynamics in a gravel beach and its impact on the Exxon Valdez oil spill, ***Journal of Geophysical Research, Oceans,*** 115, C12077, doi:10.1029/2010JC006169, 2010.
5) Sharifi, Y. (Graduate Student), B. V. Aken, and **M. C., Boufadel**, The effect of pore water chemistry on the biodegradation of the Exxon Valdez oil spill , ***Journal of Water Quality, Exposure and Health***, Springer, DOI 10.1007/s12403-010-0033-4, 2010.
6) **Boufadel, M. C.** and A. D. Bobo, High pressure delivery of tracer simulating nutrients for the bioremediation of the Exxon Valdez oil, ***Groundwater Monitoring and Remediation***, in press, 2011.
7) Xia, Y. (Graduate Student) and **M. C. Boufadel**, Beach geomorphic factors for the persistence of subsurface oil from the Exxon Valdez spill in Alaska, ***Environmental Monitoring and Assessment,*** in press, 2011.
8) Bobo, A. (Graduate Student), H. Li, and **M. C. Boufadel**, Groundwater flow in a tidally influenced gravel beach in Prince William Sound, Alaska, ***Journal of Hydrologic Engineering, ASCE***, accepted, 2011.
9) **Boufadel M. C.**, A. Bobo, and Y. Xia, Feasibility of deep nutrients delivery into a Prince William Sound beach for the bioremediation of the Exxon Valdez oil spill, ***Ground Water Monitoring and Remediation***, accepted, 2011.
10) Li, H. (Postdoctoral fellow), A. D. Venosa, and **M. C. Boufadel**, A universal nutrient application strategy for the bioremediation of oil polluted beaches, ***Marine Pollution Bulletin,*** 54, 1146-1161, 2007.
11) Li, H.(Postdoctoral fellow), **M. C. Boufadel**, and J. W. Weaver, Tide-induced seawater-groundwater circulation in shallow beach aquifers, ***J. of Hydrology***, 211-224, 2008.

12) Li, H. (Postdoctoral Fellow), **M. C. Boufadel**, and J. W. Weaver, Numerical simulations of the bank-storage effects of unconfined aquifers abutting open water bodies with rising water level, ***Ground Water***, 46(6), 841-850, 2008.
13) Abdollahi-Nasab, A. (Graduate Student), **M. C. Boufadel**, Li, H., and J. W. Weaver, Saltwater flushing by freshwater in a laboratory beach, ***Journal of Hydrology***, 386,1-12, 2010.

Journal articles 10 through 13 provided a foundation for the numerical simulations of our field results from the PWS. In other words, they allowed us to "build our case", to validate our approach.

The following two articles reporting field results from Prince William Sound are already submitted:
14) Abdollahi-nasab, A. (Graduate Student), H. Li, and **M. C. Boufadel**, The role of freshwater for the persistence of the Exxon Valdez oil in a wave-exposed beach in Alaska, ***Journal of Environmental Engineering, ASCE***, submitted
15) Li, H., and **M. C. Boufadel**, A tracer study and its implications for the persistence of oil from the Exxon Valdez in a gravel beach in Prince William Sound, Alaska, USA, ***Marine Pollution Bulletin***, submitted 2011.

I. NEED FOR THE PROJECT

A. Problem Statement

The 1989 Exxon Valdez oil spill polluted around 800 km of intertidal shorelines within Prince William Sound, Alaska (Bragg et al. 1994; Neff and Stubblefield 1995; Neff et al. 1995). Recent studies by scientists from the National Oceanic and Atmospheric Administration (NOAA) (Short et al. 2004; Short et al. 2006) estimated that between 60 and 100 tons of subsurface oil persists in many initially-polluted beaches in Prince William Sound (PWS). The persistence of oil was noted by other studies (Li and Boufadel 2010; Michel and Hayes 1999; Page et al. 2008; Taylor and Reimer 2008). Short et al. (2004) found that the oil contains a relatively high percentage of Polycyclic Aromatic Hydrocarbons (PAH) known to be toxic to the fauna and flora (Carls et al. 2001). Short et al. (2006) reported that sea otters and harlequin ducks foraging the beaches in northern Knight Island would encounter subsurface lingering Exxon Valdez oil.

The Exxon Valdez Trustee Council funded three projects in relation to the lingering oil. They are: 1) "Distribution of Subsurface Oil from the *Exxon Valdez* Oil Spill", led by Dr. Jacqui Michel, 2) "Factors responsible for limiting the degradation rate of Exxon Valdez oil in Prince William Sound beaches" led by Dr. Michel Boufadel, and 3) Oil biodegradability led by Dr. Albert Venosa.

The "oil distribution" project (Michel et al., 2010) provided a detailed assessment on the oil distribution at various beaches in PWS, and a probabilistic model on the areal distribution of oil. The work also provided correlations between oil persistence and geomorphic and hydrologic parameters (slope of beach, freshwater, armoring, etc.). The "oil distribution" project would be used as a basis for scaling up the results of the pilot study that we are proposing herein.

Our work (Boufadel and coworkers) investigated the factors affecting the persistence of oil in six beaches in PWS (Fig.1). Four of the beaches were lentic and the remaining two were lotic (i.e., exposed to waves). On each beach, they set up a transect passing through the oiled area of the beach and a transect in the clean area. The publications explaining the hydrologic-geomorphic factors on each beach are as follows: Beach 1 (Li and Boufadel, 2010), Beach 2 (Bobo et al., 2010), Beach 4 (Xia et al., 2010 and Guo et al., 2010), Beach 5 (Xia and Boufadel, 2010). We found that, with the exception of Beach 2, all the beaches that we studied are heavily polluted, with oil content varying between moderate oil residue (MOR) to heavy oil residue (HOR). The oil content at Beach 2 was light oil residue (LOR).

We found that, in general, the beaches can be viewed as consisting of two layers: an upper layer that has a high permeability underlain by a layer that has a permeability that is 100 to 1,000 folds smaller than that in the upper layer. Oil was present in the lower layer just a few inches (0.10 m) below the interface of the two layers (Fig. 2). In addition, on four of the six beaches (Beach 1, 2, 4, and 6, Fig. 1), the water table remained above the interface of the two layers in the clean transect while it dropped into the lower layer in the oiled transect. The water table remained above the interface of the two layers due to a large freshwater groundwater flow into the beach especially during low tide.

At Beach 5 (Fig. 1), no freshwater was found. But the clean transect had a steep slope (11%) in comparison with the oiled transect (7%). In addition, the armor on the clean transect was much weaker than that on the oiled transect. Xia and Boufadel (2010) argued that these two factors enhanced water exchange between the sea and the pore water in the beach causing either the washout of the oil or its accelerated weathering and biodegradation (in comparison with the oiled transect). The role of armoring and its effect on oil weathering was thoroughly discussed in Michel and Hayes (1999), Hayes and Michel (1999), Hayes et al., (2009, and Michel et al. (2010).

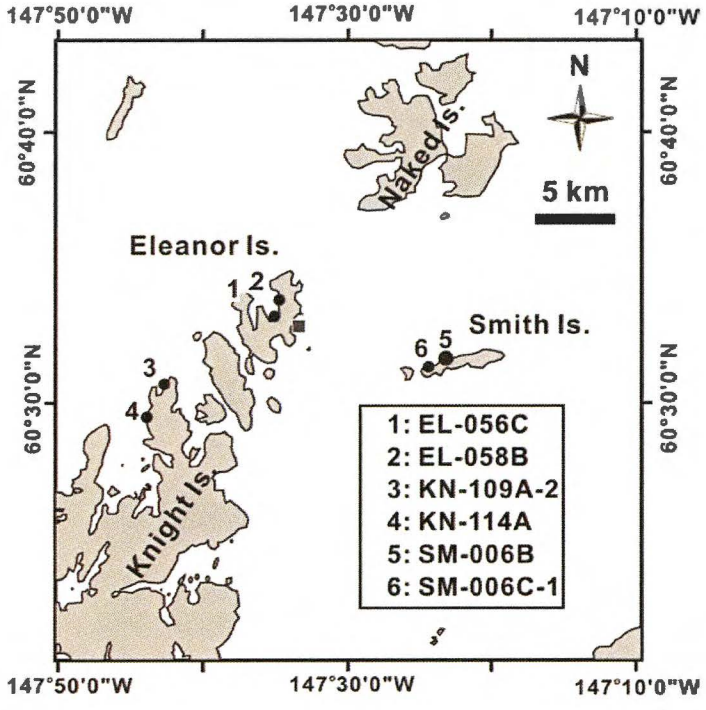


Figure 1: Location of beaches (filled circles with numbers next to them) in Prince William Sound investigated in the Limiting Factor Study by Boufadel. Sites 1 through 4 were in sheltered areas whereas sites 5 and 6 were exposed to waves from a 60 km fetch. For the Oil Biodegradation project by Albert Venosa, oiled sediments were taken from sites 4, 5, and from PWS3A4 (the square symbol on the west side of Eleanor Island).

The data at Beach 3 suggest a random distribution of oil at the 1.0-m scale- in other words, there is no clear correlation between the large-scale hydrology or geomorphology and oil persistence (manuscript in preparation).

In Summer 2009, we measured the concentration of nutrients and dissolved oxygen (DO) in the lower layer of two beaches: Beach 1 (Boufadel et al., 2010) and Beach 6 (Sharifi et al., 2010), Fig. 1. We found that the levels of nitrogen and phosphorous were approximately 0.40 mg-N/ L and 0.033 mg-P/L, respectively. Our nitrogen value is similar to that found by Bragg et al., (1994) and Atlas and Bragg (2009). The optimal values for nitrogen are 2.0 to 10 mg-N/L

(Venosa et al., 1996; Boufadel et al., 1999; Du et al., 1999, Zhu et al., 2001), and those for phosphorus vary from 0.2 to 1.0 mg/L. Thus, the measured concentration of both nitrogen and phosphorus are approximately an order of magnitude lower than the optimum.

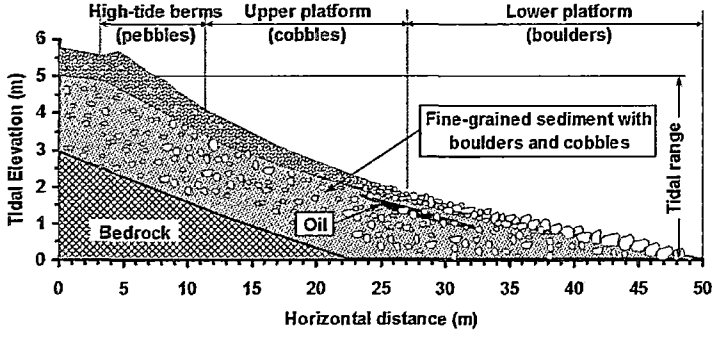


Fig. 2: Persistence of oil in the lower layer of beaches in Prince William Sound. Copyright Nature Publishing Group, from Li and Boufadel (February, 2010).

To accurately measure the oxygen concentration in the lower layer, we placed sensors in the pits and filled the pits and awaited 9 weeks before conducting measurements. Driving sensors into the beach is almost an impossible task (Page et al., 2008). We found that the DO varied from higher than 3 mg/L in the clean locations to less than 1 mg/L in the oily pits (Li and Boufadel, 2010; Boufadel et al., 2010; Sharifi et al., 2010). In addition, while the ammonia concentration was more or less uniform in the beach (at about 0.25 mg-N/L), the nitrate concentration at oily pits was around 0.04 mg/L, an order of magnitude smaller than the average, which suggests that nitrification of ammonia to nitrate was not occurring, a situation due to the low DO. This indicates that anoxic conditions exist in the oiled areas and they prevent the aerobic biodegradation of oil (or slow it down tremendously).

Pore water moving within the beach loses its dissolved oxygen due to biochemical oxygen demand from biogenic material and the oil. The pattern of pore water flow within tidally influenced beaches is very dynamic with water from the sea filling the beach near the high tide line and propagating seaward within the beach (Attai-Ashtiani et al., 1999, 2001; Boufadel, 2000; Li et al., 2008). Thus, the DO tends to decrease going seaward, as illustrated in Figure 3.

In our work on Beach 1 (Boufadel et al., 2010) and Beach 6 (Sharifi et al., 2010), we found the DO to vary from 3.0 mg/L to 9.0 mg/L in the clean transects. The latter value being the same as the DO value measured in the open water near the beaches, which indicates that the 3.0 mg/L can only result from the consumption of oxygen by biodegradation (i.e., oxidation) of biogenic matter (as no oil was present there). Therefore, for the low DO values at the oiled areas, one cannot rule out a combination of biodegradation of biogenic matter and of the hydrocarbons.

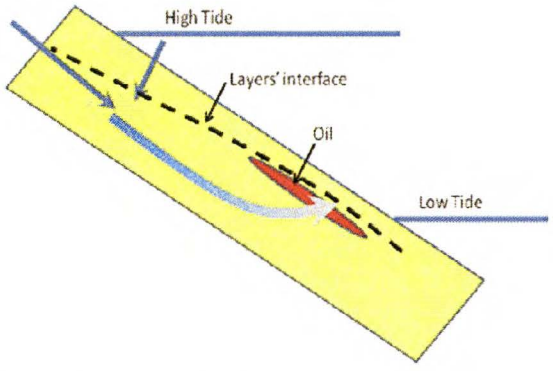


Figure 1: Schematic of water flow within an oiled transect. The beach fills from the landward side and from the sea near the high tide line (large blue arrows). As water moves seaward within the beach (curved arrow), it loses its dissolved oxygen and nitrate. Measurements above the oil layer in the upper layer would provide high dissolved oxygen values due to the large permeability of the upper layer. Copyright American Chemical Society (from Boufadel et al., 2010).

The biodegradation of the Exxon Valdez oil under oxygen-rich (i.e., aerobic) nutrient-rich conditions was demonstrated in Venosa et al. (2010) where more than 80% of the total PAHs (TPAH) degraded within 170 days. In that study, oiled sediment samples were taken from Beach 1, Beach 4, and PWS3A4 (see Figure 1) and they were put in microcosms and supplied with nutrients whenever the nitrogen concentration dropped below 5.0 mg/L. The excavation of the sediments from the beaches, their transport from Alaska to Ohio (where the experiments were conducted), and their mixing in large 55 gallons drums to homogenize them (Albert Venosa, personal communication) made the oil more physically accessible to the ambient water in the microcosm and its abundant content of DO and nutrients (i.e, the mixing minimized mass-transfer resistance). Venosa et al (2010) addressed this point and stated that the microcosm results could be viewed as upper limits for field biodegradation. In other words, the extent of biodegradation in the field would be, most likely, smaller than that found in the microcosms. Unfortunately, the extent of field biodegradation cannot be inferred from that of the microcosms and can be obtained only through a pilot study, which is the objective of this proposal.

The main objective of this proposal is to conduct pilot studies of bioremediation of the EVOS through delivery of hydrogen peroxide and nutrients.

B. Relevance to the 1994 Restoration Plan Goals

The proposed research will consist of the field trials to confirm the factors limiting natural recovery and demonstrate the effectiveness of the proposed technologies to speed natural recovery through addition of oxygen and nutrient.

If this the technology that we are proposing is effective, it would lead to development of a comprehensive bioremediation plan that will restore habitats that are adversely impacted by the lingering oil. The benefits of this research to the evaluation and implementation of bioremediation in PWS is consistent with the EVOSTC objective of determining whether remediation of specific shorelines would protect or restore injured resources.

Michel et al. (2006) evaluated various cleanup technologies for the EVOS, and ranked bioremediation highest amongst the active technologies. Natural attenuation was ranked highest due to a high penalty assigned to the disruption of the environment. In comparison with mechanical removal of the oiled sediments, bioremediation has three salient advantages: 1) It is not too disruptive to the environment and does not increase the exposure of sensitive species during remedial operations, 2) It does not require locating the oil accurately (say to within centimeters), as the delivery methods (if done properly) would ensure complete coverage of the oiled areas, and 3) unlike mechanical removal where large volumes of contaminated sediments would need to be transported out of the PWS, bioremediation occurs in-situ.

The primary beneficiaries of this research would be natural resources in PWS that have not yet fully recovered from the EVOS due to exposure to the lingering oil and the human communities that depend on these resources for their livelihood and quality of life.

II. PROJECT DESIGN

A. Objective:

The main objective of this proposal is to conduct pilot studies of bioremediation of the EVOS through delivery of hydrogen peroxide and nutrients.

We propose to conduct pilot studies of bioremediation on beaches with oil content that is moderate oil residue (MOR) to heavy oil residue (HOR), and we will ensure that the oiled areas receive sufficiently high concentrations of oxygen and nutrients. The method of delivery and the chemical composition of the solutions are key parameters and are discussed next.

B. Procedural and Scientific Methods

Method of Delivery

With the exception of the zone near the high tide line, the net movement of pore water applied onto the beach surface is seaward in any beach subjected to tide (Boufadel et al., 2006, Li et al., 2007, Brovelli et al., 2007). Therefore, solutions applied onto the beach surface would tend to be washed out to sea. Due to the two layers configuration in the beaches of PWS, where the upper layer has a permeability that is 100 to 1,000 times that of the lower layer, solutions applied onto the surface tend to dilute and wash out to sea rapidly. This was indeed noted by Xia et al. (2010) who conducted numerical simulations (based on field results) and found that 1% of the hypothetical applied nutrient concentration reaches the oil after 2 days. Therefore it is highly likely that surface application is not promising except in situations where the oil layer is very shallow and the surface application is in localized form (i.e. placing the solution directly on the oil).

Based on the findings in the field studies in 2007 and 2008, we conducted tracer studies in 2009 at two beaches in PWS (Beach 1 and Beach 6), where a conservative tracer (lithium in a lithium bromide solution) was delivered directly into the lower layer. We found that, in comparison with

the surface application, subsurface delivery result in much lower dilution due to two factors: 1) The porosity of the lower layer is 5 to 10% of the total volume while that of the upper layer is more than 30% (Bobo et al., 2011). This implies that in the absence of any pore water movement, the dilution in the upper layer is 3 to 6 times that in the lower layer. 2) As the permeability is proportional to the cube of the porosity, e.g., the Kozeny-Carmen equation (Bobo et al., 2011) a ratio of 3 to 6 in porosity results in a difference of 30 to more than 200 folds in the permeability (the modeling gave a ratio of 1,000 folds in permeability in some cases). Therefore, subsurface delivery is considerably superior to surface application. Air sparging (i.e, injecting air) is not promising due to the shallow depth of the bedrock. Thus, injected air would float by buoyancy to the surface near the injection well and the impact will be very limited (Wong et al., 1997).

For the reasons mentioned above, we propose to follow the same approach that we conducted in Summer 2009, which is to deliver the solutions to the lower layer of the beaches. We will report our prior findings on the topic as we present our approach (below) to minimize redundancy.

Chemical Composition

We will ensure that the chemical solutions delivered into the beaches (subsurface injection or release) have the maximum concentrations of oxygen and nutrients permissible by the logistics, environmental concerns, and safety. Using seawater from the Sound near the beach of interest, the delivered solution will have a concentration of hydrogen peroxide H_2O_2 of 100 mg/L, and will be amended with the compounds lithium nitrate ($LiNO_3$) and sodium tripolyphosphate ($Na_5P_3O_{10}$) to obtain concentrations of 50 mg/L of nitrogen and 5.0 mg/L of phosphorous. This ratio of N:P meets the expected stoichiometric requirements for hydrocarbon degradation and has been shown to support rapid biodegradation of phenanthrene, whereas lower N:P ratios (i.e., higher phosphorus concentrations) resulted in slower biodegradation of PAHs (Garcia-Blanco, 2004). Other cations would be considered for the nutrient compounds based on cost. Examples include sodium nitrate ($NaNO_3$) or potassium nitrate (KNO_3).

Hydrogen peroxide was selected as the source of oxygen for this study because it is water soluble, decomposes to oxygen and water as the only products (Pardieck et al., 1992), and is an efficient source of oxygen (0.47 grams of O_2 are produced per gram of H_2O_2). Other alternative oxygen sources, such as calcium and magnesium peroxides (e.g., PermeOx® and ORC®), produce less oxygen per gram of compound and produce insoluble residual products (e.g., calcium and magnesium hydroxide), which may reduce the permeability of the formation and make subsequent treatment more difficult. Hydrogen peroxide has been widely used to provide oxygen to support bioremediation of hydrocarbon-contaminated groundwater and subsurface sediments (API, 1987; Fogel et al., 1988; Piotrowski, 1989). Although hydrogen peroxide decomposition can be catalyzed by common minerals and enzymes that are likely to be present in the beach subsurface, it is reasonably stable in the absence of sediments (Lawes, 1990). The concentration that will be used (100 mg/l) was selected because the maximum solubility of oxygen in seawater at 15°C is about 40 mg/l (Metcalf and Eddy, 1991). Higher concentrations

may lead to the formation of oxygen gas bubbles that could reduce the permeability of the formation (Spain et al., 1989; Fiorenza and Ward, 1997).

Table 1: Chemical and hydraulic parameters for the bioremediation study	
Concentration of peroxide in solution	100 mg/L
Concentration of nutrients in solution	50 mg/L of N and 10 mg/L of P
Injection flow rate. Type D Beach	1.0 liter per minute
Pressure in injection well. Type D Beach	Less than 7.0 m (of water)
Release Flow Rate. Type S Beach	0.20 liter per minute

C. Description of the Pilot Studies

A main parameter for the selection of beaches for the bioremediation study is the depth of the bedrock. This is because beaches with deep bedrock allow high pressure injection of chemicals into the beach while shallow beaches require slow release (Boufadel and Bobo, 2011; Boufadel et al.,2011, GWMR, Submitted Manuscript). For this reason, we classify (for the purpose of this proposal) beaches as belonging to Type D (for Deep bedrock) or Type S (for Shallow bedrock). We consider a beach to be of Type D if the bedrock is at least 1.5 m deep, and we consider a beach to be of Type S if the bedrock is less than 0.80 m deep. Evidently, these criteria are only for the purpose of this proposal as a bedrock depth of 1.5 m is viewed by a variety of researchers as "shallow". Examples of type D beaches include (Figure 1): Beach 1, Beach 2, the left transect of Beach 4 (Guo et al., 2010), and Beach 3 (Boufadel et al., manuscript in preparation). Examples of type S beaches include the right side of Beach 4 (Xia et al., 2010), Beach 5 (Xia and Boufadel, 2011), and Beach 6 (Sharifi et al., 2010). Readers interested in a detailed analysis of the geomorphology of the Prince William Sound Shorelines are urged to consult the works of Michel and Hayes (1999), Owens et al. (2008), Hayes et al. (2009), and Michel et al. (2010).

Type D: Deep bedrock (i.e., the bedrock is at least 1.5 m deep).

On this type of beaches, high pressure injection (HPI) of the solutions (Table 1) into the lower layer will be pursued. Boufadel and Bobo (2011) found that within 24 hours, the 10% contour of the solution's concentration covers an approximate area of 12 m^2 elongated in the seaward direction (Figure 4). Therefore, at beaches where the oil coverage is larger than 12 m^2, multiple injection wells will be used. The advantage of HPI is two folds: 1) It accelerates the movement and therefore the delivery of the solutions to the oiled areas and 2) It spreads the solutions laterally (i.e., along the shore), as the natural hydraulic gradient is negligible in the along shore direction (Li and Boufadel, 2010; Xia et al., 2011). However, the combination of the HPI with the tidal hydraulics result in a comet shape of the plume (note at 21 hour, the "tail of the comet" extends seaward). Therefore, one could explore bioremediating a large area seaward of the injection well provided the solutions are not too diluted. In other words, the HPI acts as a manifold spreading the solutions along the shore which subsequently travel seaward due to tidal hydraulics. The installation of each injection well would mimic the approach adopted by

Boufadel and Bobo (2011), with the difference that an engineering firm will be hired to conduct the installation.

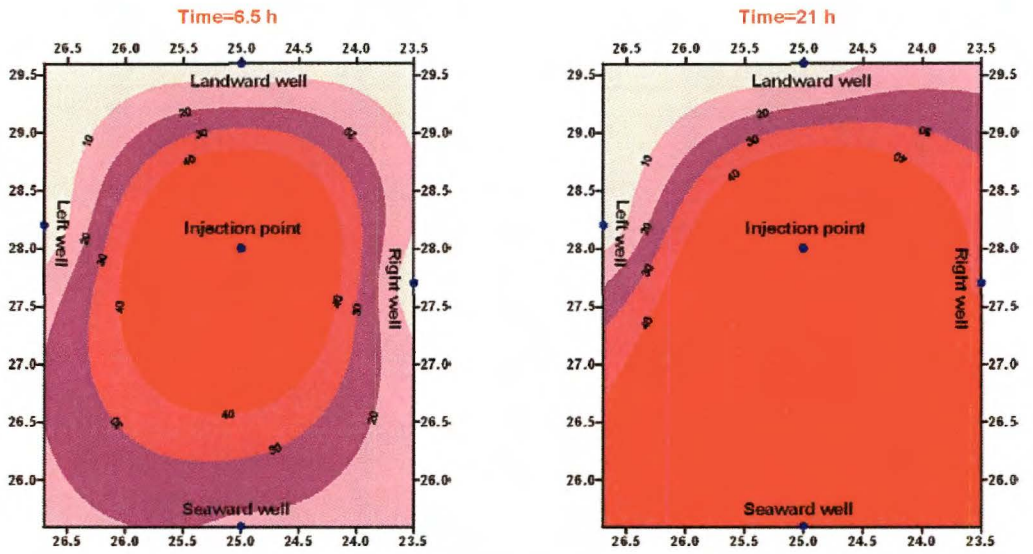


Figure 4: Empirical contours of lithium concentration as percentage of the maximum after 6 hours and 21 hours of high pressure injection (HPI) at Beach 1 (Figure 1). The edge of the plume was delineated where the concentration is 10% of the maximum. The figure indicates that at t=21 hours, the injected plume occupies an approximate area of 12 m^2 (4.0 m cross shore X 3.0 m along shore). Copyright Groundwater Monitoring and Remediation, Boufadel and Bobo (2011).

The approach is as follows: a pit will be excavated down to a depth of 1.50 m while minimizing the disturbance of the beach during the excavation. Then, a well, screened at the bottom 0.30 m will be placed into the pit (Figure 5). The pit will then be filled until the depth of 0.60 m and then a 0.10 m-thick layer of bentonite (clay) will be placed, after which, the pit will be completely filled with the excavated sediments. The primary role of the bentonite layer is to create a sealing "blanket" to keep the injection from short- circuiting around the pipe and upwelling to the surface. Another added benefit would be to "anchor" the pipe into the ground during injection. Based on our experience with excavation in Type D of beaches, we expect the pit diameter at the surface to be less than its depth, and thus the diameter of the bentonite layer to be less than 1.0 m.

The design injection flow is 1.0 liter per minute (0.26 GPM) and the maximum operating pressure in the injection well should be less than 7.0 m of water. Note that the maximum injection flow and the maximum pressure are 3.0 liters per minute and 20.0 m (Boufadel and Bobo, 2011), so our selection (one third of the maxima) provides a sufficient safety factor. These are the same conditions under which Boufadel and Bobo (2011) conducted their tracer study.

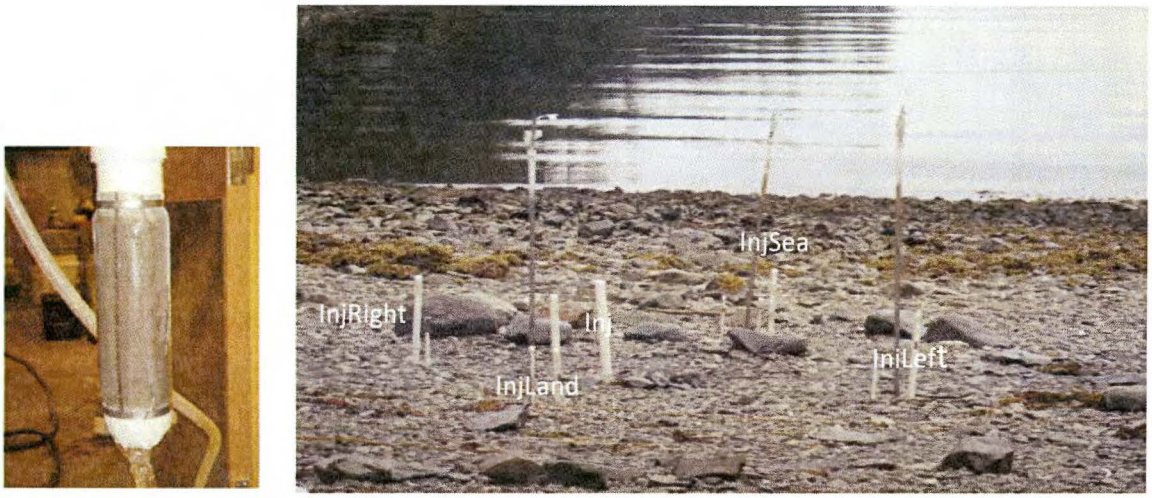


Figure 5: Left panel. The screen that covers the tip of the injection well (length of screen is approximately 0.30 m long, a foot). Right panel: Photograph of the HPI at Beach 1 (Figure 1). Copyright Groundwater Monitoring and Remediation, From Boufadel and Bobo (2011).

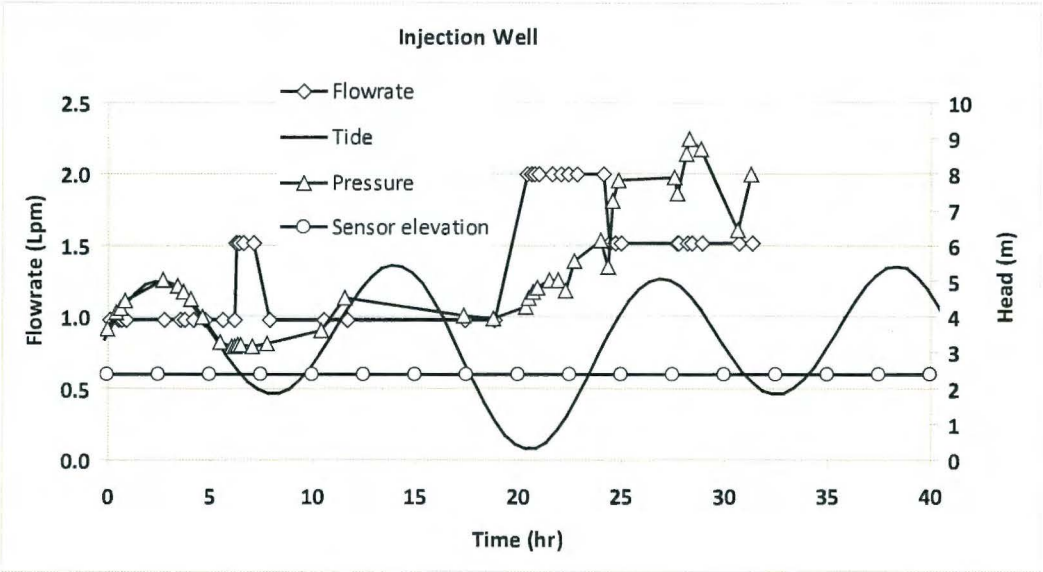


Figure 6: Variation of the pressure as function of time and the flow rate (liter per minute, LPM) for the high pressure injection (HPI) of solution. The pressure remained less than 4 m of water when the injection flow rate was set at 1.0 LPM. For this reason, a design flow rate of 1.0 LPM is proposed. Copyright Groundwater Monitoring and Remediation, from Boufadel and Bobo (2011).

Type S: Shallow bedrock (i.e., the bedrock depth is less than 0.80 m).

The installation would emulate the installation reported in Boufadel et al. (2011, Ground Water Monitoring and Remediation, Submitted Manuscript) for the delivery of lithium bromide under ambient pressure condition. The approach was termed ambient pressure release (APR). Trenches will be dug parallel to the shoreline down to the maximum possible depth. They would be 1.0 to 2.0 m landward of the oiled areas, and thus, the trenches could a few meters long.

Then, HDPE manifolds (Figure 6) will be placed at the bottom of the trenches and the pits will be filled with the excavated material.

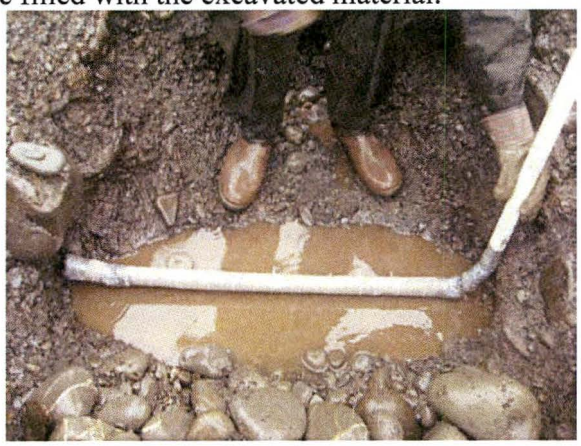


Figure 6: Photo of a 1.0 m trench with the manifold placed parallel to the shoreline before refilling the trench. A more rigid system is being proposed for the delivery of chemicals in this study.

Figure 7 reports the results of the tracer of the APR conducted by Boufadel et al. (2011, GWMR, submitted manuscript). The figure indicates that the applied tracer moved upward (towards the beach surface) as it moved seaward and downward as it moved landward. Considering that the delivery would be done into the lower layer and that the oil is in the top part of the lower layer (see Figure 3 for illustration), it is best to apply the bioremediation solution deep into the beach landward of the oil and rely on the tide to bring it to the oil layer from below. This is an important point as all the studies (e.g., Atlas and Bragg, 2009) dealing with the Exxon Valdez oil spill considered only the downward movement of solutions into the beaches (i.e., did not account for the upward movement).

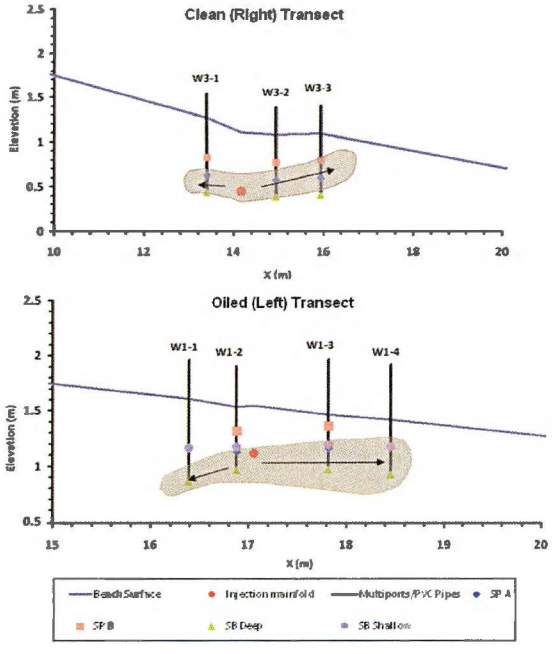


Figure 7: Empirical contours of lithium concentration as percentage of the maximum after 60 hours of ambient pressure release (APR) at Beach 6 (see Figure 1). The manifolds are represented by the filled circle at approximately x=14 m in the top panel and x=17 m in the lower panel. The edge of the plume was delineated where the concentration is 10% of the maximum. The figure indicates that the released plume upwells as it moves seaward and downwells as it moves landward. From Boufadel et al. (2011, submitted manuscript to GWMR).

Beach Selection

We will conduct the pilot studies on four beaches. Two in the northern PWS and two in the southern PWS. Those in the northern PWS would be, most likely, the ones we worked with before: EL056C (147° 34' 17.42" W, 60° 33' 45.57" N) and SM006B (147° 23' 6.41" W, 60° 31' 39.10" N). The selection of the beaches in the southern part of the PWS is made to allow generalization (i.e., scale up) of the results. The southern beaches would, most likely, contain oil that is more weathered than those in the north of the PWS due to the larger travel distance of the spill in open water prior to impact on shorelines.

For the estimation of volumes and masses of nutrients, we consider that each beach that we are going to treat contains oil patches that have a combined area of 25 m^2 and thickness of 0.10 m, a volume of oiled sediments of 0.25 m^3. This is what we observed at Beach 1 (Boufadel and Bobo, 2011). (Beach 5, has much more than that, more like 100 m^2 in areal coverage). Consider that we need to get the oxygen to the lower layer to occupy that volume in the subsurface. The porosity of the lower layer was estimated to be between 0.05 and 0.1 (Bobo et al., 2011). We will consider it to be 0.1. Thus, the volume of pore water would be 2.5X0.1=0.25 m^3.

Assuming a H_2O_2 concentration of 100.0 mg/L, filling the 0.25 m^3 requires:

$$0.25m^3 X 100{,}000\frac{mg}{m^3} = 25{,}000mg = 25\ g$$

This amount of hydrogen peroxide would produce 11.8 g O_2 (0.47 grams O_2 are produced per gram of H_2O_2). Hydrogen peroxide is available at a concentration of 30%, which has a density of 1.11 g/ml. So, 75 ml (83.3 g) of 30% hydrogen peroxide would provide 25 g of pure hydrogen peroxide. We can consider that this is the volume that needs to be added to a beach per day. For a duration of 90 days for one beach, the needed volume of hydrogen peroxide (H_2O_2) 30% solution is: 0.075L/day X 90days=6.75 L. As the hydrogen peroxide is delivered in 55 gallon drums, we would distribute the hydrogen peroxide into 10-liter bottles, and provide one 10-L bottle to each beach. (Note that a 55 gallon of hydrogen peroxide from FMC costs around $500).

Using the same argument for the nutrient mass computation, we have that the total volume of water to replenish per beach is : 0.25 m^3/day X90 days=22.5 m^3, which gives around 100 m^3 for the four beaches. Based on the delivery concentration of 50 mg/L and 10 mg/L for nitrogen and phosphorus, respectively, the needed mass is 100X0.05=5 kg of N and 100X0.01=1.0 kg of phosphorus. These are small numbers that reflect the low porosity in the lower layer in the beaches. Nevertheless, the "safety factors" would consist of purchasing more peroxide and nutrients and would not affect the operation.

Metrics for evaluating the performance

Piezometers and multiport sampling wells used extensively in the Limiting Factors study (Li and Boufadel, 2010; Xia et al., 2010; Guo et al., 2010, Sharifi et al., 2010) will be used herein at locations far from the oiled area (at least 4.0 m from the edge of the oiled area). The piezometers reading will provide the water table within the beach and the tide level. The multiport sampling wells will be used to draw pore water samples for the measurement of the concentration of nutrients, salinity, and lithium, as done before.

We will establish a sampling grid in association with each delivery method. The nodes of the grid will be spaced approximately 1.0 m and will be randomly sampled without replacement. . (We will also explore combining samples to minimize field variability).

Collection of Sediment Samples (around 75 sediment samples per beach).
Sediment samples will be collected at one-month intervals (starting with time zero) by digging a pit through the oil-contaminated region during low tide and obtaining a 10 cm thick sample from the elevation that the oil is encountered. This is because it would not be possible to sample at various depth without downward contamination. Duplicate sediment samples will be collected to measure three parameters: (1) the concentration and composition of oil, (2) the concentrations of nutrients and the conservative tracer, and (3) the concentration of oil-degrading bacteria. Samples for oil analysis will be collected in clean, solvent-rinsed glass jars. Samples for nutrient analysis will be collected in clean, acid-washed plastic bottles. Samples for microbial analysis will be collected in sterile 50-ml plastic centrifuge tubes. Appropriate procedures will be used to decontaminate or disinfect all other equipment used to collect samples. The oil and nutrient

samples will be stored frozen and shipped back to Temple University for analysis. One of the duplicate microbiological samples will be analyzed on board the research vessel by most-probable number analysis (MPN) as described below, and the second will be frozen and shipped to Temple University for molecular biological analysis of the microbial community.

Chemical Analytical Procedure for Oil

The most important response variable for this study will be the concentrations of oil and specific oil components in the treated sediments. These concentrations will be measured by collecting sediment samples from the oil-contaminated zone (without replacement) and extracting the oil with dichloromethane (DCM). The mass of extracted oil will be measured gravimetrically by evaporating an aliquot of the solvent to dryness and weighing the residue, and its composition will be measured by gas chromatography with detection by mass spectrometry (GC-MS). The GC-MS analysis will target 17α(H),21β(H)-hopane and alkyl-substituted and unsubstituted 2- through 4-ring polycyclic aromatic hydrocarbons (PAH). Because these compounds represent a relatively small fraction of the oil mass, thin-layer chromatography with flame ionization detection (TLC-FID) using an Iatroscan instrument will also be used to analyze the four main fractions of the extracted oil (aliphatics, aromatics, resins, and asphaltenes). The combination of gravimetric analysis, GC-MS, and Iatroscan will provide information on the concentration and composition of the oil at varying levels of detail. Biodegradable constituents will be normalized to hopane to minimize variability. All oil analyses will be conducted at the Auke Bay lab, which has an extensive expertise in dealing with oil from the Exxon Valdez.

Chemical Analysis of the Nutrients in Sediment Samples
Measurement of the nutrient concentrations is essential to ascertain whether the nutrient are reaching the oiled sediments. When normalized to the lithium values, nutrient concentrations could a surrogate measure for oil biodegradation within the sediment.

The sample containers used to collect nutrient samples will be preweighed to allow estimation of the relative amounts of water and dry sediments for every sample. Each sample bottle will also be weighed after the sample is collected to determine the total mass of sample collected. Ammonium and nitrate will be extracted from one of the duplicate sediment samples from each location by adding 50 grams of a 2 M potassium chloride solution to the entire sample, mixing for 1 hour, allowing the sediments to settle for 10 minutes, and then filtering the supernatant solution through 0.45-micron filters. The other duplicate sample will be used to measure the concentrations of adsorbed and total phosphorus using a sequential extraction procedure involving 1 M ammonium chloride (exchangeable phosphates), sodium hydroxide (iron and manganese adsorbed), and hydrochloric acid (calcium phosphates). The extracts will be filtered and analyzed as described below. After extraction, the samples will be dried and reweighed to determine the total mass of dry sediments.

The nutrient compounds will be measured using AutoAnalyzer3 (Seal Analytical, Mequon, WI). The frozen samples will be defrosted and kept in the fridge (below 4 °C) in batches of 76 samples, at the time of analysis the samples will be taken out of the fridge, hand shaken for 15

seconds and passed through 0.45 micron PTFE membrane filters (Puradisc™, Whatman, Florham, NJ) into the AutoAnalyzer3 cups. The segmented flow method will be used in Autoanalyzer3 and the concentrations will be detected by colorimetric analysis. Ammonia will be measured using the Berthelot reaction where a blue-green colored complex forms and gets measured at 660 nm wavelength. Nitrate in the solution will be reduced to nitrite by a copper-cadmium reactor column (Grasshoff et al., 1999; Seal Analytical, 2008).The nitrite will then react with sulfanilamide under acid condition to form a purple azo dye. The color will be detected in 550 nm wavelength (Grasshoff et al., 1999; Seal Analytical, 2008). Phosphate will be measured following the Murphy and Riley method until a blue color is formed by reaction of orthophosphate, molybdate ion and antimony ion followed by reduction with ascorbic acid at a pH<1. The blue complex is read at 880 nm wavelength (Grasshoff et al., 1999; Seal Analytical, 2008). The soluble silicate is determined in this method based on reduction of siliconmolybdate in acidic solution to molybdenum blue by ascorbic acid. The complex will be read at 820 nm wavelength (Grasshoff et al., 1999; Seal Analytical, 2008).
The salinity of the same pore-water samples will be measured using a digital refractometer (Salinity-300035, Sper Scientific, Scottsdale, AZ). The samples will be filtered and about 1.5 mL of sample will be poured into the measuring cup of the instrument and the salinity will be determined based on the refraction index of the sample. The refractive index of the samples is affected by the density of each sample which would be different depending on the salinity.

Measurement of Microbial Activity (Sediment and pore water samples)

Two microbiological factors in the beach sediments will be evaluated to characterize oil biodegradation:

1. The size of the alkane- and PAH-degrading microbial communities by most-probable number (MPN) analysis.
2. The structure of the microbial community in different beach layers, which will provide information about the specific pathways and potential of oil biodegradation, e.g., aerobic, denitrification, sulfate reduction, and methanogenesis.

MPN: The size of the alkane- and PAH-degrading microbial communities will be determined using the most-probable number procedure that was developed by Wrenn and Venosa (1996). Because this is a viable counting procedure, the samples must be analyzed as quickly as possible after collection to minimize the potential for the community structure to change during storage. Therefore, the samples will be analyzed on board the research vessel.

The samples will be analyzed by aseptically transferring 5 g of sediment to a sterile 50-ml centrifuge tube followed by addition of 40 ml of sterile phosphate-buffered saline (PBS) solution. The sediment slurries will be mixed by shaking at 200 rpm on a bench-top shaker for 1 hour, the sediments will be allowed to settle, and the supernatant will be used to prepare a dilution series for inoculation into replicate tubes containing selective culture medium. The diluted samples will be incubated for two (alkane degraders) or three (PAH degraders) weeks,

and the number of positive wells per dilution will be scored based on color formation. The only difference between this method and that described by Wrenn and Venosa (1996) is that, instead of 96-well microtiter plates, the diluted samples will be inoculated into sterile screw-cap test tubes that can be more easily shipped back to Temple University for incubation and scoring.

D. Coordination and Collaboration with Other Efforts

The personnel in this project have diverse and complementary backgrounds as one notes from their attached biographies.

Dr. Boufadel is a Professional Engineer (environmental engineering) with expertise in hydraulics and and fate and transport of contaminants, especially in tidally influenced beaches. He will be responsible for the overall management of the project. Dr. Jacqui Michel is a geochemist with extensive expertise in oil spill work. She is arguably one of the foremost experts on remediating oil spills. She will provide input on the selection of the beaches for the pilot study and will make recommendation for the scaling up of the results to other beaches (i.e. to provide guidelines on the applicability of the results to other beaches). Dr. Brian Wrenn is an environmental engineer with extensive expertise in chemical and biological processes. He is the author of numerous articles on the bioremediation of hydrocarbons through nutrient amendment. He will be the lead person on the experimental techniques in this study and will supervise the lab studies for ATP quantification and MPN. Mr. Rich McManus is a Professional Engineer, and brings to the group more than three decades of practical experience in remediating hazardous material. He will contribute to the technological aspect of the pilot study. Dr. Jeff Short was the supervisory research chemist at the Alaska Fisheries Science Center, National Marine Fisheries Service from 1982 through November 2008. He has worked on the Exxon Valdez oil spill until his retirement and has published numerous seminal papers on the spill. He will provide input on various aspect of the study, especially on oil chemistry analysis. Dr. Erik Cordes is a microbial ecologist. He has been working on oil seeps in the Gulf of Mexico and is currently leading research on the Gulf Spill. He will provide technical input on the microbial analysis and the ecological impact of bioremediation. Dr. Benoit van Aken will explore using qPCR to quantify hydrocarbon degraders. All chemical analyses of oil will be conducted at the Auke Bay lab (NOAA) whose personnel (e.g., Dr. Jeep Rice) have been conducting oil analysis for the EVOS since 1989.

E. Budget Justification

A major part of the budget is going to subcontracts to setup the field studies (Glacial Alaska), to assist in the engineering design (Rich McManus, Farallon consulting), to allow scale-up of the results (Jacqui Michel, Research Planning Inc), and to analyze the oil (Auke Bay lab). The personnel at Temple University was budgeted at $281k due to the "short fuse" of the project where junior personnel (e.g., students) cannot produce within such a short period. The breakdown of the budgets of the subcontractors are attached.

MICHEL C. BOUFADEL, Ph.D.

Professional Engineer (PE)
Professional Hydrologist (PH)
Professor of Environmental Engineering
Professor of Earth and Environmental Science
Director, Center for Natural Resources Development and Protection
Chair, Department of Civil and Environmental Engineering
Temple University
1947 N. 12th Street, Philadelphia, Pennsylvania 19122
(215) 204-7871 (Ph.): (215) 204-4696 (Fax)
boufadel@gmail.com | http://www.temple.edu/environment

Education: 1998, Ph.D., Environmental Engineering, University of Cincinnati
1992, M.S., Environmental Engineering, University of Cincinnati
1988, B.S., Hydraulic Engineering, Jesuit University at Beirut,Lebanon.

Professional Activities (partial list)

Member: Committee on "The Deep Well Horizon oil spill impacts on the Gulf Ecosystem Services", National Research Council of the National Academies, 01/2011-present.
Member: Science Advisory Board Hydraulic Fracturing Research Plan Panel, US EPA, 12/10-present.
Vice President, Groundwater Quality Committee, American Society of Civil Engineers. (2010-2012).
Panelist, National Science Foundation, Water Sustainability and Climate (Earth Science Division), 2010.
Panelist, National Science Foundation, Water Resources and Soils (Environmental Engineering Division), 2010.

Five Closely Related Publications:

1) Li, H. (Postdoctoral Fellow), **M. C. Boufadel**, Long-term persistence of oil from the Exxon Valdez spill in two-layer beaches, ***NATURE geosciences***, *3*, 96-99, 2010.

2) Xi, Y.(Graduate Student), H. Li., and **M. C. Boufadel**, Factors affecting the persistence of the Exxon Valdez oil on a shallow bedrock beach, ***Water Resources Research***, VOL. 46, W10528, 17 PP., 2010 doi:10.1029/2010WR009179

3) **Boufadel, M. C.**, Y. Sharifi, B.Van Aken, B. A. Wrenn, and K. Lee, Nutrient and oxygen concentrations within the sediments of an Alaskan beach polluted with the *Exxon Valdez* oil spill, ***Environmental Science and Technology***, *44* (19), p 7418–7424, 2010.

4) Guo, Q. (Graduate Student), H. Li., **M. C. Boufadel**, and Y. Sharifi, Hydrodynamics in a gravel beach and its impact on the Exxon Valdez oil spill, ***Journal of Geophysical Research, Oceans,*** 115, C12077, doi:10.1029/2010JC006169, 2010.

5) Sharifi, Y. (Graduate Student), B. V. Aken, and **M. C., Boufadel**, The effect of pore water chemistry on the biodegradation of the Exxon Valdez oil spill , ***Journal of Water Quality, Exposure and Health***, DOI 10.1007/s12403-010-0033-4, 2010.

Five Significant Publications:

1) **Boufadel, M. C.** and A. D. Bobo, High pressure delivery of tracer simulating nutrients for the bioremediation of the Exxon Valdez oil spill, ***Groundwater Monitoring and Remediation***, in press.

2) Xia, Y. (Graduate Student) and **M. C., Boufadel**, Beach geomorphic factors for the persistence of subsurface oil from the Exxon Valdez spill in Alaska, ***Environmental Monitoring and Assessment,*** in press.

3) Abdollahi-Nasab (Graduate Student), A., **M. C. Boufadel**, Li, H., and J. W. Weaver, Saltwater flushing by freshwater in a laboratory beach, ***Journal of Hydrology***, 386,1-12, 2010.

4) Li, H. (Postdoctoral fellow), Q. Zhao, A. D. Venosa, and **M. C. Boufadel**, A universal nutrient application strategy for the bioremediation of oil polluted beaches, ***Marine Pollution Bulletin,*** 54, 1146-1161, 2007.

5) Ryan, R. J. (Postdoctoral fellow), and **M. C. Boufadel**, Lateral and longitudinal variation of hyporheic exchange along a mountain stream, ***Environmental Science and Technology***, 41, 4221-4226, 2007.

Current Projects.

Project Title: "Factors affecting the lingering of the Exxon Valdez oil in the beaches of the Prince William Sound, Alaska"
Exxon Valdez Trustee Council 05/2007-05/2011
Sole Principal Investigator $1,620,000

Project Title: "Evaluation of the ecology at the banks of the Delaware River"
Department of Environmental Protection, Pennsylvania 10/2010-09/2012
Principal Investigator, 66% effort $50,000

Project Title: "Evaluation of the persistence of the Deep Well Horizon oil in the beaches of the Gulf of Mexico"
United States Coast Guard 12/2010-12/2011
Principal Investigator, 90% effort. $250,000

Project Title: "Delineating the floodplains in the Wissahickon Watershed"
Commonwealth of Pennsylvania 01/2011-01/2013
Co-Principal Investigator, Dr. Featherstone is PI.
Amount of Funding to Boufadel is: $50,000

Project Title: "Regulations and laws related to the Marcellus Shale exploitation and their impact on public health"
Robert Woods Johnson Foundation 01/2011-01/2012
Principal Investigator, 85% effort. $100,000

JACQUELINE MICHEL, Ph.D.
Geochemist, President of Research Planning, Inc.
1121 Park Street, Columbia, SC 29201
(P) 803-256-7322; (F) 803-254-6445; email: jmichel@researchplanning.com

EDUCATION

Ph.D., Department of Geology, University of South Carolina (USC), Columbia (1980).

M.S., Department of Geology, USC, Columbia (1976).

B.S., Department of Geology, USC, Columbia (1974).

PROFESSIONAL CREDENTIALS

Adjunct Faculty, School of the Environment, USC (2005-present)

Phi Beta Kappa

First in graduating class (August 1974), USC

Carolina Geological Society (1975-present)

Distinguished Alumni Achievement Award, College of Science and Mathematics, USC (2002)

Member, Ocean Studies Board, National Academies (2001-2004)

Chair, NRC Committee on Spills of Emulsified Fuels: Risks and Response (2002)

Chair, NRC Committee on Dispersants Effectiveness and Effects (2005)

Member, NRC Committee on Oil in the Sea III (2003)

Member, NRC Committee on Spills of Nonfloating Oils: Risks and Response (1999)

Lifetime Associate, National Academies

Member, Science Advisory Panel to the U.S. Commission on Ocean Policy (2004-2005)

Co-creator of the concept of Environmental Sensitivity Index (ESI) mapping; has mapped many shorelines, including Prince William Sound, Southeast Alaska, Southern Alaska Peninsula, Cook Inlet and Kenai Peninsula, and Bristol Bay

Wrote the Shoreline Assessment Manual (three versions) for NOAA, which includes SCAT procedures and recommended cleanup methods for all shoreline types

Has responded to hundreds of oil spills, providing recommendations for shoreline cleanup, including manual, mechanical, chemical, *in-situ* burning, and biological technologies

Has been the NOAA SCAT Coordinator for the Deepwater Horizon oil spill since April 2010

FIVE RECENT PUBLICATIONS RELATED TO THE PROPOSED PROJECT

Michel, J., Z. Nixon, M.O. Hayes, J. Short, G. Irvine, D. Betenbaugh, C. Boring, and D. Mann. 2010. Distribution of Subsurface Oil from the *Exxon Valdez* Oil Spill. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 070801), National Oceanic and Atmospheric Administration, Juneau, AK. 121 pp. + app.

Hayes, M.O., J. Michel, and D.V. Betenbaugh. 2010. The intermittently exposed, coarse-grained gravel beaches of Prince William Sound, Alaska: Comparison with open-ocean gravel beaches. J. Coastal Research 26(1):4-30.

Michel, J., Z. Nixon, and L. Cotsapas. 2006. Evaluation of oil remediation technologies for lingering oil from the *Exxon Valdez* oil spill in Prince William Sound, Alaska. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 050778), National Marine Fisheries Service, NOAA, Juneau, AK, 47 pp. + appendices.

Michel, J. and M.O. Hayes. 1999. Weathering patterns of oil residues eight years after the *Exxon Valdez* oil spill: Marine Pollution Bulletin 38: 855-863.

Hayes, M.O. and J. Michel. 1999. Factors determining the long-term persistence of *Exxon Valdez* oil in gravel beaches: Marine Pollution Bulletin 38: 92-101.

FIVE OTHER SIGNIFICANT PUBLICATIONS

Michel, J., Z. Nixon, J. Dahlin, D. Betenbaugh, M. White, D. Burton, and S. Turley. 2009. Recovery of interior brackish marshes seven years after the Chalk Point oil spill. Marine Pollution Bulletin 58: 995-1006.

Michel, J., Dunagan, H., Boring, C., Healy, E., Evans, W., Dean, J.M., McGillis, A. and Hain, J. 2007. Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the Outer Continental Shelf. U.S. Department of the Interior, Minerals Management Service, Herndon, VA, MMS OCS Report 2007-038, 254 pp.

Michel, J., M.O. Hayes, C.D. Getter, and L. Cotsapas. 2005. The Gulf War oil spill twelve years later: Consequences of eco-terrorism. Proc. 2005 International Oil Spill Conference, American Petroleum Institute, Washington, DC. (CD-ROM).

Michel, J., D. Etkin, T. Gilbert, J. Waldron, C. Blocksidge, and R. Urban. 2005. Potentially Polluting Wrecks in Marine Waters: An Issue Paper Presented at the 2005 International Oil Spill Conference. American Petroleum Institute, Washington, D.C. 76 pp.

Wolfe, D. A., M. J. Hameedi, J. A. Galt, G. Watabayashi, J. Short, C. O'Clair, S. Rice, J. Michel, J. R. Payne, J. Braddock, S. Hanna, and D. Sale. 1994. The fate of the oil spilled from the T/V EXXON VALDEZ. Environmental Science and Technology 28(13): 560A-568A.

Brian A. Wrenn, Ph.D.
500 Gabriel Dr.
Kirkwood, MO 63122
ph: (314) 909-6853
cell: (314) 608-2417
e-mail: bawrenn@att.net

Educational Background:

Ph.D. 1992. Environmental Science in Civil Engineering. University of Illinois at Urbana-Champaign.

M.S. 1984. Biological Oceanography. University of Miami, Coral Gables, FL.

B.S. 1980. Biochemistry/Chemistry. University of Illinois at Urbana-Champaign.

Professional Experience:

Temple University, Philadelphia, PA — 2010 to present
Senior Scientist

Southern Illinois University Edwardsville, National Corn-to-Ethanol Research Center (NCERC), Edwardsville, IL — 2007 to 2010
Research Director

Washington University, Department of Civil Engineering / Environmental Engineering Science Program, St. Louis, MO — 1998 to 2007
Assistant Professor

Environmental Technologies & Solutions, Inc., Rochester, NY — 1995 to 1997
Vice-President

University of Cincinnati, Dept. Civil & Environmental Engineering — 1992 to 1995
Postdoctoral Research Associate

Professional Activities:

- National Academy of Sciences (National Research Council): Understanding Oil Spill Dispersants - Efficacy and Effects (2005)
- American Society of Civil Engineering: Natural Attenuation Task Committee (1999-2000)

Publications:

(1) Five Closely Related Publications

Boufadel, M.C., Y. Sharifi, B. Van Aken, **B.A. Wrenn**, and K. Lee. 2010. Nutrient and oxygen concentrations within the sediments of an Alaskan beach polluted with the *Exxon Valdez* oil spill. Environmental Science & Technology 44: 7418-7424.

Wrenn, B.A., K.L. Sarnecki, E.S. Kohar, K. Lee, and A.D. Venosa. 2006. Effects of nutrient source and supply on crude oil biodegradation in continuous-flow beach microcosms. J. Environmental Engineering 132: 75-84.

Wrenn, B.A., M.T. Suidan, K.L. Strohmeier, B.L. Eberhart, G.J. Wilson, and A.D. Venosa. 1997. Nutrient transport during bioremediation of contaminated beaches: evaluation with lithium as a conservative tracer. Water Research 31: 515-524.

Wrenn, B.A. and A.D. Venosa. 1996. Selective enumeration of aromatic and aliphatic hydrocarbon degrading bacteria by a most-probable-number procedure. Canadian J. Microbiology 42: 252-258.

Venosa, A.D., M.T. Suidan, **B.A. Wrenn**, K.L. Strohmeier, J.R. Haines, B.L. Eberhart, D. King, and E. Holder. 1996. Bioremediation of an experimental oil spill on the shoreline of Delaware Bay. Environmental Science & Technology 30: 1764-1775.

(2) Five Significant Publications

Mukherjee, B. and **B.A. Wrenn**. (in press). Effects of physical properties and dispersion conditions on the chemical dispersion of crude oil. Environmental Engineering Science

Wrenn, B.A., A. Virkus, B. Mukherjee, and A.D. Venosa. 2009. Dispersibility of crude oil in fresh water. Environmental Pollution 157:1807-1814.

Yan, B., **B.A. Wrenn**, S. Basak, P. Biswas, and D.E. Giammar. 2008. Microbial reduction of Fe(III) in hematite nanoparticles by *Geobacter sulfurreducens*. Environmental Science & Technology 42: 6526-6531.

Li, Z., **B.A. Wrenn**, and A.D. Venosa. 2005. Effect of iron on the sensitivity of hydrogen, acetate, and butyrate metabolism to fatty-acid inhibition in vegetable-oil-enriched freshwater sediments. Water Research 39: 3109-3119.

Li, Z., **B.A. Wrenn**, and A.D. Venosa. 2005. Anaerobic biodegradation of vegetable oil and its metabolic intermediates in oil-enriched freshwater sediments. Biodegradation 16: 341-352.

RICHARD W. MCMANUS, P.E.
Principal Engineer

B.S. Civil Engineering, 1975
University of Massachusetts, Amherst
M.B.A. University of California, Berkeley, 1984

Mr. McManus serves as Farallon Consulting's Principal Engineer overseeing all engineering design and remediation project management performed by the firm. He is a senior engineer with over 35 years of experience in environmental engineering design, remediation program management, work plan development, remediation engineering and cost estimating, cleanup construction management, and environmental investigations.

Specific to the EVOS Lingering Oil pilot scale remediation program, Mr. McManus has experience in the design and implementation of full-scale in situ bioremediation in Alaska, and has designed and directed remediation projects in remote locations in Alaska. He has also designed and implemented cleanup projects at sites in Alaska and around the United States involving a variety of in situ technologies, including bioremediation, air sparging, soil vapor extraction, chemical oxidation, ozone injection, resistive electric heating, and hot water/steam injection. Mr. McManus has also served as a design engineer for remediation projects in Washington, Oregon, Texas, and California. On these projects he has been responsible for remediation approach development, cost estimating, drawing and specification development, project bidding, construction oversight, and project closure documentation. His relevant project experience is summarized below.

PROJECT EXPERIENCE

- Developed detailed design for implementation of in situ bioremediation of diesel-contaminated soil at a remote Aleutian Island project site that was inaccessible to standard construction equipment. The project involved performance of treatability studies to determine an appropriate reagent injection approach, and design and construction of a treatment equipment building, pumps, controls, piping, and injection wells. Treatability studies determined that bioremediation of the diesel fuel could be accelerated by injection of hydrogen peroxide to stimulate indigenous bacteria. Treatment was implemented over one treatment season and reduced diesel contamination concentrations to below target cleanup levels.
- Directed the remediation design for petroleum hydrocarbon remediation at a tank farm in Sand Point, Alaska at the scene of a 164,000-gallon diesel fuel spill. The project design included recycling of treated waste to avoid the cost of off-site disposal and significantly reduced project costs. Prepared cost estimates for alternative remediation approaches for client and insurance company review. Implemented an organic waste stabilization process to convert oil-contaminated soil into structural fill for use in tank farm reconstruction. Treated material was used to reconstruct berms around the tank farm and bring the facility up to current codes and standards

- Developed remediation design for cleanup of contamination at remote logging camp sites in Southeast Alaska. Prepared drawings and contract specifications for cleanup construction. Managed bidding and contractor selection and directed construction oversight.
- Directed source determination investigation to locate source of benzene in city of Fairbanks water supply. Set up onsite laboratory to measure contaminant concentrations in groundwater samples during monitoring well drilling program Real-time data was used to determine well placement as drilling progressed. Drilling program conclusively established contamination source to be fuel storage tanks associated with adjacent power generating plant.
- Directed remedial investigations and cleanup design of abandon military facilities on St. Lawrence Island, Alaska. Project design called for asbestos abatement, building demolition, fuel spill cleanup, and site restoration. Design was done on fast track basis to meet federal funding deadlines.
- Designed, prepared cost estimates, and directed implementation of waste segregation and minimization approach for remediation of auto recycling yard in Anchorage, Alaska. Innovative approach involved the use of screening and soil washing to separate PCB contaminated fine soil fractions from less contaminated coarse fractions and debris. The approach reduced off-site disposal requirements and minimized project costs.
- Served as lead on-site technical representative in managing response to 160,000-gallon fuel spill at Alaskan fish cannery. Coordinated initial response activities with US Coast Guard Emergency Response On Scene Coordinator. Directed response activities to limit contaminant migration and associated impacts. Developed and implemented sampling plan to document extent of spill impact. Developed site cleanup work plan that incorporated innovative on-site treatment technologies to greatly reduce site cleanup costs.
- Served as the Program Manager for the City of Saint Paul, Alaska in a large municipal utilities upgrade program that involved moving of a city-owned fuel farm, municipal dock improvements, road improvements, and water and waste water service improvements. Directed the design, bidding, and construction oversight of a new and relocated municipal fuel farm. The facility held over one million gallons of fuel, and included a transfer line and dock distribution equipment.
- Directed the design, bidding, and construction management of water storage, treatment, and supply systems upgrade for the North Slope community of Wainwright, Alaska. The program included replacing a 300,000 gallon insulated water storage tank that had been damaged in an overfilling incident, upgrading water treatment facilities, and constructing a utilidor to serve running water to buildings in the community center.

PROFESSIONAL CERTIFICATIONS AND REGISTRATIONS

Registered Civil Engineer, Alaska (CE-5067), 1981, Washington (Reg. 35032), Oregon (72394PE), Utah (5336093-2202)
40-Hour OSHA Health & Safety Certification (29 CFR 1910.120)
8-Hour OSHA Health & Safety Annual Update Certification
8-Hour OSHA Supervisor Training

ENVIRONMENTAL TECHNOLOGY PATENTS

Volatile Organic Compound Monitoring – Patent Number 7,281,439
Passive Acid Tar Neutralization Process – Patent Number 5,814,206
DCR Transportable Treatment Unit – Patent Number 5,609,836

Jeffrey W. Short
19315 Glacier Highway
Juneau, Alaska 99801
(907) 789-0579 (h)
(907) 789-6065 (w)
(907) 209-3321 (cell)
jshort@oceana.org

Professional Experience:

Pacific Science Director, Oceana (November 17, 2008 to December 30, 2010). My main focus was to foster and coordinate the collaborative development and articulation of the scientific rationale for ocean policy recommendations of the Pacific Team of Oceana. My responsibilities included ensuring that policy recommendations have a firm scientific basis, identifying the most compelling scientific arguments for these recommendations, and providing scientific advice regarding advocacy and litigation priorities. As supervisor of the Pacific Team's scientific staff, I was also responsible for the scientific defense of Oceana's advocacy positions at scientific, litigation and policy venues relevant to Pacific and Arctic Ocean issues, including their articulation in media ranging from op/ed articles and news releases to peer-reviewed scientific manuscripts, and for supporting these activities through grant writing. Finally, I promoted our contacts with the scientific community engaged in ocean and climate research, with relevant government agencies and with other environmental organizations.

Supervisory Research Chemist, Alaska Fisheries Science Center, National Marine Fisheries Service (1982 through November 2008). My four basic responsibilities include acting as principal investigator (PI) on research projects, managing the Center's marine chemistry laboratory, advising the government's legal team on the long-term fate and effects of the1989 *Exxon Valdez* oil spill, and reviewing research products that touch on the environmental chemistry of oil for the Center and for numerous peer-reviewed environmental journals.

- **Research Project Principal Investigator.** This includes conceiving, designing, securing funding, executing, analyzing and publishing results for environmental research projects, usually in collaboration with numerous colleagues and support staff. Most of my work has been on the *Exxon Valdez* oil spill. Major projects included: (1) assessment of the initial distribution and persistence of the spilled oil in seawater; (2) discovery and elucidation of a cryptic toxicity mechanism through which oil pollution is nearly 1,000-fold more toxic to fish eggs than previously thought; (3) definitive refutation of alternative hydrocarbon pollution sources advanced by scientists employed by Exxon Corp. as plausible causes of biological effects in the *Exxon Valdez* impact area; (4) discovery of a natural hydrocarbon trophic tracer in the marine food web of the northern Gulf of Alaska; and (5) quantitative measurement of the amount and loss rate of *Exxon Valdez* oil lingering in beaches 12 years or longer after the incident. Each of these was funded at $500K to $5M, and I played the leading role on all but the second. A summary of these projects appeared in *Science* as a review article I co-authored in 2003 (See Peterson, C.H et al.). A list of salient publications from these efforts is attached.

- **Manager, AFSC Marine Chemistry Laboratory.** I presided over a major expansion of the AFSC marine chemistry laboratory in the aftermath of the *Exxon Valdez*

spill, when the government urgently needed additional capacity capable of meeting the stringent standards imposed by impending litigation. Staff increased nearly tenfold from two, and successfully qualified as one of only three such facilities nationally to participate, generating revenues of $500K - $1M annually. Today the facility is internationally recognized, specializing in the environmental analysis of hydrocarbons, biogenic lipids in support of nutritional ecology studies, and high-precision characterization of the marine carbonate buffer system in support of incipient studies on ocean acidification.

- **Scientific Advisor to the *Exxon Valdez* Legal Team for the Governments of Alaska and the United States.** The civil settlement between Exxon Corp. and the governments of Alaska and the US created a $900M fund administered by the *Exxon Valdez* Trustee Council that supported scientific studies, habitat acquisition and other impact offsets. I was one of four scientists selected to design the Council's scientific review policy and administrative structure, and I have since provided policy guidance on request on numerous occasions. Other implemented advice includes publication of the 1993 symposium presenting the initial findings of the Exxon Valdez oil spill impacts as a book, establishment of and support for the annual Alaska Marine Science Conference begun in 1993, and (until recently) retention of the peer-review system for proposal evaluation.

Education:

- Bachelor of Science, Biochemistry and Philosophy, University of California at Riverside, 1973
- Master of Science, Physical Chemistry, University of California at Santa Cruz, 1982
- Doctor of Philosophy, Fisheries Biology, University of Alaska at Fairbanks, 2005

Selected Activities and Honors:

- Bronze Medal, U. S. Department of Commerce, "For scientific research and publications describing the long-term, insidious effects of oil pollution on fish embryos at parts per billion levels"
- Appointment as Visiting Professor for the Key Laboratory of Oil Spill Identification and Damage Assessment Technology, State Oceanic Administration, Qingdao, People's Republic of China
- Appointment to the Governor's Sub-Cabinet Adaptation Advisory Group on Climate Change in Alaska
- Coordinating scientist for an on-going, privately-funded $470K study of the impacts of polycyclic aromatic hydrocarbons and toxic metals on the Athabasca River system from tar sands mining, in conjunction with the University of Alberta and Queen's University in Canada

Biographical Sketch - Dr. Erik E Cordes

Professional Preparation

- Southampton College, Marine Science / Biology, B.S. 1993
- Moss Landing Marine Laboratories, Marine Science, M.S. 1999
- Penn State University, Biology, Ph.D. 2004

Appointments

- 2008-present Assistant Professor, Biology Department, Temple University
- 2005-2008 Postdoctoral Fellow (NSF Ridge2000), Harvard University. Microbial ecology of Juan de Fuca Ridge hydrothermal vent chimneys.
- 2005-2008 Postdoctoral Researcher, Penn State University. Supported on MMS contract to investigate the biology and ecology of *Lophelia pertusa* in the Gulf of Mexico
- 2000-2004 Research Assistant, Penn State University. Supported as NOAA Nancy Foster Scholar, Penn State University Graduate Fellow, Center for Environmental Chemistry and Geochemistry Fellow, as well as NSF, NOAA/NURP, OE, and MMS funding.
- 1999-2000 Research Associate, Moss Landing Marine Laboratories. Supported as senior personnel on North Pacific Research Initiative grant to study *Primnoa reseadiformis*.
- 1999-2000 Biological Consultant, ABA Consulting, Moss Landing CA
- 1998-2000 Adjunct Faculty, Hartnell College, Salinas CA
- 1998-1999 Museum Curator, Moss Landing Marine Labs
- 1995 Research Assistant, Moss Landing Marine Labs. Supported on Navy contract to assess the impact of trawl disposal on deep-sea soft-bottom communities.

Current Research

- 2010-2011: NSF Rapid program (P.I.): *Collaborative Proposal: Acute response of benthic hardbottom communities to oil exposure in the deep Gulf of Mexico*
- 2010-2011: NOAA Natural Resources Damage Assessment (co-P.I.): *Mississippi Canyon 252 Incident NRDA Tier 1 for Deepwater Communities*
- 2008-2012: Minerals Management Service and NOAA Office of Ocean Exploration Contract Award (co-P.I.): *Deepwater Program: Exploration and Research of Northern Gulf of Mexico Deepwater Natural and Artificial Hard Bottom Habitats with Emphasis on Coral Communities: Reef, Rigs and Wrecks*

Publications – 5 most relevant (* indicates undergraduate co-author)

Cordes EE, Becker EL, Fisher CR. (2010) Temporal shift in nutrient input to cold-seep food webs revealed by carbon, nitrogen, and sulfur stable-isotope signatures of associated communities. Limnol Oceanogr 55: 2537-2548.

White HK, Reimers CE, Cordes EE, Dilly GF, Girguis PR. (2009) Examining the relationship between power production and community ecology in plankton-fed microbial fuel cells. ISMEJ 3: 635-646. doi:10.1038/ismej.2009.12

Cordes EE, Arthur MA, Shea K, Fisher CR (2005) Modeling the mutualistic interactions between tubeworms and microbial consortia. PLoS Biol 3: 497-506. doi:10.1371/ journal.pbio.0030077.

Cordes EE, Bergquist DC, Shea K, Fisher CR (2003) Hydrogen sulfide demand of long-lived vestimentiferan tube worm aggregations modifies the chemical environment at deep-sea hydrocarbon seeps. Ecol Lett 6: 212-219. doi:10.1046/j.1461-0248.2003.00415.x.

Andrews AH, Cordes EE, Mahoney MM, Munk K, Coale KH, Cailliet GM, Heifetz J (2002) Age, growth and radiometric age validation of a deep-sea, habitat-forming gorgonian (*Primnoa resedaeformis*) from the Gulf of Alaska. Hydrobiologia 471: 101-110. doi: 10.1023/A:1016501320206

Publications – 5 other significant (* indicates undergraduate co-author)

Cordes EE, Cunha MM, Galeron J, Mora C, Olu-Le Roy K, Sibuet M, Van Gaever S, Vanreusel A, Levin L. (2010) The influence of geological, geochemical, and biogenic habitat heterogeneity on seep biodiversity. Mar Ecol 31: 51-65. doi:10.1111/j.1439-0485.2009.00334.x

Olu K, Cordes EE, Fisher CR, Desbruyeres D (2010) Biogeography and potential exchanges among the Atlantic Equatorial Belt cold-seep faunas. PLoS ONE 5: e11967. doi:10.1371/journal.pone.0011967
Cordes EE, Bergquist DC, Fisher CR (2009) Macro-ecology of Gulf of Mexico cold seeps. Ann Rev Mar Sci 1: 143-168. doi:10.1146/annurev.marine.010908.163912
Cordes EE, Carney SL, Hourdez S, Carney RS, Brooks, JM, Fisher CR (2007) Cold seeps of the deep Gulf of Mexico: Community structure and biogeographic comparisons to Atlantic equatorial belt seep communities. Deep-Sea Res I 54: 637-653. doi:10.1016/j.dsr.2007.01.001
Cordes EE, Hourdez S, Predmore BL*, Redding ML*, Fisher CR (2005) Succession of hydrocarbon seep communities associated with the long-lived foundation species *Lamellibrachia luymesi*. Mar Ecol Prog Ser 305: 17-29.

Synergistic Activities

1. Member of the Steering Committee of the Census of Marine Life Chemosynthetic Ecosystems (ChEss) project, and Chair of the advisory committee for the Rutledge Marine Lab on the Isles of Shoals, New Hampshire. This marine lab is targeted at public education, primarily for elementary school children.
2. Advisor for 4 graduate students (including an NSF Bridge to Doctorate Fellow and an NSF Students as Teachers Fellow) and 6 undergraduates at Temple University. Also served as the mentor for a total of 8 undergraduate students during graduate studies while at Penn State, 5 undergraduates during post-doc at Harvard, and 8 different undergraduates are included as co-authors on publications.
3. Reviewer for 18 different journals, 12 proposals to NSF and NOAA as well as proposals to the scientific funding agencies of the U.K. and Chile.
4. Serving as the "Expert Scientist" for GLOBE's FLEXE Forum program including leading a workshop for 20 High School teachers titled "Bringing Deep-sea Science into the Earth Science Classroom" in Ocean Springs, MS in July 2009.
5. Involved with public outreach by contributing content for websites (NOAA's "Ocean Explorer", "Deep-Sea News", WHOI "Dive and Discover") and having research on the Gulf oil spill featured on television (CNN, Dan Rather Reports, FOX Philadelphia), radio (NPR, BBC), print articles (Associated Press, New York Times, Philadelphia Inquirer, Science), and websites (Nature, Science, Discovery, National Geographic).

Graduate and Post-doctoral Advisors

M.S. Advisor	James Nybakken (MLML)
Ph.D. Advisor	Charles Fisher (PSU)
Post-doctoral Advisor	Peter Girguis (Harvard)

Recent Collaborators and Co-authors

Monika Bright (University of Vienna, Austria), Jim Brooks (TDI Brooks), Robert Carney (LSU), Maria Cunha (University of Aveiro, Portugal), Daniel Desbruyeres (IFREMER, France), Nicole Dubilier (MPI Bremen, Germany), Joelle Galleron (IFREMER, France), Chris German (WHOI), Stephane Hourdez (CNRS, France), Mandy Joye (U. Georgia), Deborah Kelley (U. Washington), Lisa Levin (Scripps Insitution of Oceanography), Ian MacDonald (Florida State University), Steve Macko (University of Virginia), Camillo Mora (Scripps Institution of Oceanography), Karine Olu-Le Roy (IFREMER, France), Harry Roberts (LSU), Steve Ross (UNC Wilmington), Tim Shank (WHOI), Myriam Sibuet (IFREMER, France), Paul Tyler (Southampton University), Saskia Van Gaever (Ghent University, Belgium), Ann Vanreusel (Ghent University, Belgium).

Benoit Van Aken, Ph.D.
Assistant Professor, Department of Civil and Environmental Engineering
Temple University
1947, N. 12th Street, Philadelphia, PA 198122
215-204-7087 - bvanaken@temple.edu

Education

1989 Master in Economics (MS), **Catholic University of Louvain, Louvain, Belgium**
1995 Engineer in Chemistry and Biochemistry (MS), **Catholic University of Louvain**
2000 Ph.D. in Biological Engineering, **Catholic University of Louvain**

Professional Activities

Professional Experience:

08/2009 - present	**Assistant Professor:** Civil and Environ. Eng., Temple University
08/2005 – 08/2009	**Assistant Professor:** Civil and Environ. Eng., West Virginia University
06/2003 – 08/2005	**Associate Research Scientist:** Civil and Environ. Eng., Univ. of Iowa.
06/2002 – 08/2002	**Visiting Scholar:** Biochemistry, Univ. of Washington.
09/2000 – 06/2003	**Postdoctoral Research Assistant:** Civil and Environ. Eng., Univ. of Iowa.
08/1997 – 12/1997	**Visiting Scholar:** Division of Microbiology, Univ. of Helsinki, Finland.
09/1998 – 04/1999	**Visiting Scholar:** Chemistry and Biochemistry, Utah State Univ., Logan, UT.
09/1995 – 10/2000	**FDS Graduate Research Assistant:** Biological Eng., Univ. of Louvain.

Significant Awards and Projects:

2010 - 2012	**PA Department of Environmental Protection:** Evaluation of the ecology at the banks of the Delaware River
2010 - 2015	**NIEHS Superfund Basic Research Program:** Phytoremediation to Degrade Airborne PCB Congeners from Soil and Groundwater Sources
2009 - 2010	**NASA WV Space Grant Consortium:** Photocatalytic Reactor for the Removal of Pharmaceuticals, Pathogens, and Resistance genes in Recycled Wastewater
2007 - 2009	**DoE:** Selenium Removal from Mine Influenced Water (MIW) using Nano-Magnetite.
2005 - 2010	**NIEHS Superfund Basic Research Program:** Phytoremediation to Degrade Airborne PCB Congeners from Soil and Groundwater Sources
2005 - 2008	**SERDP Grant:** Phytoremediation for the Containment and Treatment of Energetic and Propellant Material Releases on Testing and Training Ranges
2003 - 2005	**NSF Grant:** Involvement of an Endosymbiotic *Methylobacterium* sp. in the Biodegradation of Explosives RDX and HMX inside Poplar Tree
2002 - 2006	**MW Keck Foundation Grant:** Catabolic Enzymes and Metabolic Pathways in Phytoremediation
2002 - 2005	**SERDP Grant:** Metabolic Routes and Catabolic Enzymes Involved in Phytoremediation of the Nitro-Substituted Explosives
1996	**Prize for the Best University Studies:** Ass. of Engineers – Univ. of Louvain
1995 - 2000	**FDS Graduate Fellowship:** Fund for Scientific Development, Univ. Louvain

Professional Affiliations:

American Society for Microbiology (ASM)
American Society of Plant Biology (ASPB)
American Chemical Society (ASC)
Association of Environmental Engineers and Science Professors (AEESP)
American Society for Engineering Education (ASEE)

Reviewing Activities:

Associate Editor: West Virginia Academy of Sciences
Panelist: National Science Foundation (NSF), Environmental Engineering – Biological
Journal reviewer: Environmental Science and Technology, Applied and Environmental Microbiology

Closely Related Publications

Boufadel MC, Sharifi Y, **Van Aken B**, Wrenn BA, Lee K (2010). Nutrient and oxygen concentrations within the sediments of an Alaskan beach polluted with the *Exxon Valdez* oil spill. *Environ. Sci. Technol.* **44**:7418-7424

Sharifi Y, **Van Aken B**, Boufadel MC (2010). The effect of pore water chemistry on the biodegradation of the Exxon Valdez oil spill. *J. Wat. Qual. Exp. Health.* doi: 10.1007/s12403-010-0033-4

Correa PA, Lin L., Just CL, Hu D, Hornbuckle KC, Schnoor JL, **Van Aken B** (2010). The effects of individual PCB congeners on the soil bacterial community structure and the abundance of biphenyl dioxygenase genes. *Environ. Int.* **36**:901-906

Van Aken B, Peres CM, Lafferty-Doty S, Moon Yoon J, Schnoor JL (2004). *Methylobacterium populi* sp. nov.: A novel aerobic, pink-pigmented, facultatively methylotrophic, methane-utilizing bacterium isolated from poplar trees (*Populus deltoides* x *nigra* DN34). *Int. J. Sys. Evol. Microbiol.* **54**:1191-1196

Van Aken B, Moon Yoon J, Schnoor JL (2004) Biodegradation of Nitro-Substituted Explosives TNT, RDX, and HMX by a Phytosymbiotic *Methylobacterium* sp. Associated with Populus (*Populus deltoides* × *nigra* DN34). *Appl. Environ. Microbiol.* **70**:508-517

Significant Publications

Van Aken B (2009). Transgenic plants for the enhanced phytoremediation of explosives. *Curr. Opin. Biotechnol.* **20**:1-6

Brentner LB, Mukherji ST, Merchie KM, Yoon JM, Schnoor JL, **Van Aken B** (2008). Expression of glutathione *S*-transferases in poplar trees (*Populus trichocarpa*) exposed to 2,4,6-trinitrotoluene (TNT). *Chemosphere.* **73**:657-662

Van Aken B (2008). Transgenic Plants for Phytoremediation: Helping Nature to Clean-Up Pollution. *Tr. Biotechnol.* **26**:225-227

Flokstra BR, **Van Aken B**, Schnoor JL (2008). Microtox® toxicity test: Detoxification of TNT and RDX contaminated solutions by poplar tissue cultures. *Chemosphere.* **71**:1970-1976

Van Aken B, Moon Yoon J, Just CL, Schnoor JL (2004). Metabolism and mineralization of hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) inside poplar tissues (*Populus deltoides* × *nigra* DN34). *Environ. Sci. Technol.* **38**:4572-4579

Collaborators & Co-Authors

Agathos, Spiros, Catholic Univ. of Louvain, Belgium; **Boufadel, Michel**, Temple Univ.; **Doty, Sharon**, Univ. of Washington; **Hornbuckle, Keri**, Univ. of Iowa; **Hu, Dinfei**, Univ. of Iowa; **Just, Craig**, Univ. of Iowa; **Lee, Kenneth**, Bedford Institute of Oceanography, Fisheries and Oceans, Canada; **Lin, Lianshin**, West Virginia Univ.; **Schnoor, Jerald**, Univ. of Iowa, Iowa City; **Vesper Dorothy**, West Virginia Univ.; **Wrenn Brian**, Southern Illinois Univ.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

National Marine Fisheries Service
Alaska Fisheries Science Center
Auke Bay Laboratories
Ted Stevens Marine Research Institute
17109 Point Lena Loop Road
Juneau, Alaska 99801-8344
Fax (907) 789-6094

January 3, 2011

Dr. Michel Boufadel
Professor and Chair
Department of Civil and Environmental Engineering
Center for Natural Resources Development and Protection
1947 North 12th Street
Philadelphia, PA 19122

Re: GCMS Analyses of Sediment Samples from EVOS Prince William Sound Remediation Studies

Dear Dr. Boufadel:

Our chemistry laboratory will support your proposed EVOS remediation study with the supporting analytical chemistries that you need, estimated earlier by you to be in the 150-sample range, possibly more.

For sediment analyses we will provide the following services:

1. State of the art GCMS analyses for 44 PAH including the 2-5 ring compounds along with important methylated isomers.
2. State of the art GCMS analyses for biomarkers (including terpanes, hopanes, steranes, and isoprenoids). These biomarkers are among the most recalcitrant compounds to degrade, making them useful in source identification, but more importantly, useful in evaluating degradation/weathering from various treatments.
3. GC/FID analyses for 30 alkanes including C9 to C36. Like the biomarkers, these compounds can be very useful in evaluating weathering/degradation over time or by treatment.
4. Quality assurance procedures, including standards and inter-laboratory comparisons of samples provided by NIST.
5. Archiving of the GCMS and collection site data (from chain of custody forms) into the EVOS hydrocarbon database.
6. Modeling of the data for determination of weathering status and comparison to previous sediment samples from the Exxon Valdez spill area. If some sites have

all ready been analyzed from earlier collections, these will be definitely be compared across time prior to and post treatment.

7. Interpretations and a report will be provided of the chemistry as needed, in support of EVOS reporting requirements and scientific publications.
8. FOIA ready package will be prepared for response to expected FOIAs (100% of all chemistry data produced in our laboratory has been subject to previous FOIAs, and this data would be expected to be subject to FOIA also).
9. We will provide the chem-clean collection jars that receive the samples in the field, along with shipping containers.

We will charge $750 per environmental sample provided and provide the services listed above. We will not charge for standards or quality assurance samples that are run in the various strings of samples; those costs are part of the $750 fee per sample. If biomarkers and alkanes (#2 and #3 above) are NOT desired, the price will be lowered to $600 per sample. There are little additional sample preparation costs for these analyses, but they do require additional GC runs (and different standards) to be made for the biomarker and alkane analyses. No charges will be made for any full-time, permanent staff salary that participate in the analyses, reporting, FOIA response, or participation in future publications. The charges above will provide for the operating costs of conducting the analyses and reporting. In addition to the samples provided by you, we would require a chain of custody sheet with appropriate collection data completed. If a field staff person is needed to aid in collection of samples, travel costs would be in addition, but not salary.

In addition, we discussed briefly the possibility of passive samplers. These sample the water, and are a measure of "bioavailability". The cost for passive sampler analyses is $300 each for un-armored and $350 each for armored samplers. Passive samplers are analyzed for PAH only. We would clean the passive samplers (and armored carriers), ship samplers with shipping containers, and provide chemical analyses as above. We would provide training in deployment, if needed, or possibly provide a staff person to aid if this becomes a sampling tool needed by your project.

We look forward to servicing your project needs. More information on remediation of contaminated beaches in Prince William Sound is a worthy project supported by our agency. We appreciate the opportunity to be a part of the project. I can be reached at 907-789-6020 (jeep.rice@noaa.gov).

Sincerely,

Stanley D Rice 13 Jan 2011

Stanley Rice, Ph.D.
Program Manager, Habitat and Marine
Chemistry Studies

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 11

Budget Category:	Proposed FY 11	TOTAL PROPOSED
Personnel	$281,160.0	$281,160.0
Travel	$37,600.0	$37,600.0
Contractual	$803,610.0	$803,610.0
Commodities	$33,000.0	$33,000.0
Equipment	$0.0	$0.0
Indirect *(will vary by proposer)*	$ 300,396.2	$300,396.2
SUBTOTAL	$1,455,766.2	$1,455,766.2
General Administration (9% of subtotal)	$131,019.0	$131,019.0
PROJECT TOTAL	$1,586,785.2	$1,586,785.2
Other Resources (Cost Share Funds)	$0.0	$0.0

COMMENTS: In this box, identify non-EVOS funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY11

Project Title:Pilot studies of bioremediation
Lead PI: Michel Boufadel

FORM 4A
NON-TRUSTEE AGENCY SUMMARY

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Project Title					
Michel Boufadel	Project director		4.0	19000.0		76,000.0
Brian Wrenn	Senior Scientist		5.0	14880.0		74,400.0
Postdoctoral fellow			12.0	5580.0		66,960.0
Two graduate students			24.0	2200.0		52,800.0
Eric Cordes	Assistant Professor		1.0	11000.0		11,000.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		46.0	52660.0	0.0	
					Personnel Total	$281,160.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Travel from Philadelphia to PWS of four personnel	600.0	16	120	200.0	33,600.0
Travel to present the results at a national conference	800.0	2	12	200.0	4,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$37,600.0

FY11

Project Title:
Lead PI:

FORM 4B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11

Contractual Costs: Description	Contract Sum
Treatment system construction, mobilization, installation, and removal by Glacial Alaska (or equivalent)	446,965.5
Research Planning Inch (Jacqui Michel)	82,532.0
Rich McManus, Farallon Engineering	49,112.5
Oil analysis, Auke Bay lab, 300 samples @ $700 a sample	210,000.0
Jeff short, one month	15,000.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$803,610.0

Commodities Costs: Description	Commodities Sum
Shipment of material through land carrier (e.g., ABF) from philadelphia to anchorage	15,000.0
Rental of trucks and cars for transportation	4,000.0
Publications of articles	8,000.0
Purchase of two computers for conducting simulations for data interpretation	6,000.0
Commodities Total	$33,000.0

FY11

Project Title:
Lead PI:

FORM 4B
CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
No equipment purchase			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY11

Project Title:
Lead PI:

FORM 4B
EQUIPMENT DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11

Research Planning, Inc.
Budget for subcontract with Temple University
EVOS Remediation Trials
AB133F-11-RP-0016
16-Dec-10

2011

Personnel	Hours	Rate	Total	
J. Michel	240	104	24,960.00	
Z. Nixon	192	52	9,984.00	
Total Salary Cost			34,944.00	
Overhead (125%)			43,680.00	
Total Personnel Cost			78,624.00	
Travel				
Air Transportation			1,900.00	JM - 1 rt Al
Lodging/Per diem			1,408.00	2 days AK,
Ground Transportation			300.00	
Total Travel Cost			3,608.00	
Other Direct Cost				
Prt/Reproduction			100.00	
Communications			50.00	
Mailing/Shipping			50.00	
Misc			100.00	
Total ODC			300.00	
Total 2011			82,532.00	

laska, 2 rt Philadelphia
4 days Phil.

Table 1
Pilot Treatment System Design Cost Estimate
Lingering Oil Removal Pilot Project
Prince William Sound, Alaska
Farallon PN: 506-002

Task 1: Pilot Treatment System Design

Labor	Unit	Rate	Cost
Principal I Engineer/Geologist/Scientist	50 hour @	$180 per hour =	$9,000
Senior I Engineer/Geologist/Scientist	25 hour @	$150 per hour =	$3,750
Project I Engineer/Geologist/Scientist	180 hour @	$93 per hour =	$16,740
Clerical Level 1	10 hour @	$70 per hour =	$700
Drafter	36 hour @	$75 per hour =	$2,700
		Task 1 Estimated Total	**$32,890**

Task 2: Pilot Treatment System Fabrication and Mobilization Coordination

Labor	Unit	Rate	Cost
Principal I Engineer/Geologist/Scientist	40 hour @	$180 per hour =	$7,200
Project I Engineer/Geologist/Scientist	95 hour @	$93 per hour =	$8,835
		Estimated Labor Subtotal	**$16,035**
Other Direct Costs (ODCs)	**Unit**	**Rate**	**Cost**
Field Truck	2 day @	$60 per day =	$120
Field Truck Mileage	90 miles @	$0.75 per mile =	$68
		Estimated ODC Subtotal	**$188**
		Task 2 Estimated Total	**$16,223**
		ESTIMATED PROJECT TOTAL	**$49,113**

Table 2
Construction Cost Estimate Summary
Lingering Oil Removal Pilot Project
Prince William Sound, Alaska
Farallon PN: 506-002

Construction Cost Summary

	Quantity	Unit	Unit Cost	Cost
Treatment System Fabrication	3	per beach	$ 23,432	$ 70,295
Equipment Mobilization	3	per beach	$ 16,883	$ 50,649
Treatment System Installation and Testing	3	per beach	$ 74,351	$ 223,052
Treatment System Removal and Site Restoration	3	per beach	$ 34,323	$ 102,969
Total				$ 446,966

Construction Cost Estimate

		Project Cost	Total with Markup
$397,615.50	Base Bid	$330,946.04	$397,615.50
			Total P&O
			$66,669.46

Item 1, Treatment Equipment System Fabrication at Glacier Shop		Men	Days	Hours	Qty		Units	Labor Rate	Mat Unit	Equip Unit	Subs Unit	Total Labor	Total Mat
LABOR													
Supervisor	ST	1	20	2	40	HR		45.20				1,808.00	
Labor	ST	2	20	8	320	HR		44.37				14,198.40	
			Total Labor		360	MH							
MATERIALS													
8'x10' Containers					3	ea			2850.00				8550.0
1/2" Sched 80 PVC Pipe					1000	LF			0.25				250.0
1/2" Sched 80 PVC Couplers					100	ea			1.70				170.0
1/2" Sched 80 PVC 90's					100	ea			0.94				94.0
1/2" Sched 80 PVC 45's					100	ea			0.94				94.0
12 each, Metering Pumps (Plus Spares)					24	ea			261.00				6264.0
Static Inline mixers					24	ea			300.00				7200.0
Submersible Salt Water Pumps (Plus Spares)					6	ea			1000.00				6000.0
Control Panels					3	ea			1000.00				3000.0
Unistrut					120	LF			3.00				360.0
Unistrut Bolt & Clamps					1	ea			50.00				50.0
Plywood & Lumber for Work Benches					1	LS			500.00				500.0
Misc Valves & Fittings					1	ea			1500.00				1500.0
Solar Power (Includes Batteries)					3	ea			3000.00				9000.0
					0	ea			0.00				0.0
EQUIPMENT													
					0	EA				0.00			
					0	EA				0.00			
SUBCONTRACTORS													
					0	EA					0.00		
					0	EA					0.00		
				Subtotals								$16,006.40	$43,032.0

Item 2, Treatment System Installation Phase Mobilization/Demobilization		Men	Days	Hours	Qty		Units	Labor Rate	Mat Unit	Equip Unit	Subs Unit	Total Labor	Total Mat
LABOR													
Project Management	ST	1	7	1	7	HR		45.20				316.40	
Travel (GES Crew)	ST	4	7	8	224	HR		44.37				9,938.88	
	ST	0	0	0	0	HR		0.00				0.00	
			Total Labor		231	MH							
MATERIALS													
Perdiem					35	ea			90.00				3150.0
Lodging					35	ea			180.00				6300.0
Round Trip Air Fares					5	ea			1000.00				5000.0
					0	ea			0.00				0.0
EQUIPMENT													
Misc. Rental Equipment (Whittier)					1	LS				3000.00			
					0	DY				0.00			
SUBCONTRACTORS													
Barge Line (Freight Charges)					1	EA					15000.00		
					0	EA					0.00		
				Subtotals								$10,255.28	$14,450.0

Item 3, Treatment System Installation at Smith, Eleanor, and Montague Islands	Labor	Mat	Equip	Subs	Total

		Men	Days	Hours	Qty	Units	Rate	Unit	Unit	Unit	Labor	Mat
LABOR												
Supervisor/Operator	ST	1	21	8	168	HR	45.20				7,593.60	
Supervisor/Operator	OT	1	21	2	42	HR	65.24				2,740.08	
Labor	ST	4	21	8	672	HR	44.37				29,816.64	
Labor	OT	4	21	2	168	HR	63.98				10,748.64	
			Total Labor		1050	MH						
MATERIALS												
Perdiem					105	ea		90.00				9450.0
Lodging					0	ea		0.00				0.0
Stainless Steel Well Points					12	ea		350.00				4200.0
1/2" ID HDPE Tubing					6000	lf		0.84				5040.0
5/8" PP Tees					100	ea		5.65				565.0
5/8" PP 45's					100	ea		3.53				353.0
5/8" PP unions					100	ea		2.96				296.0
5/8" x1/2" Connectors					100	ea		2.35				235.0
2" Sched 80 PVC Pipe					1000	LF		1.26				1260.0
2" Sched 80 PVC Couplers					50	ea		4.18				209.0
Type 1 Catch Basin With Grates					3	ea		300.00				900.0
Float & Level Switches					12	ea		150.00				1800.0
3000 Gallon Poly Tanks					3	ea		1500.00				4500.0
Expendables (PPE ect.)					3	ea		1000.00				3000.0
Bentonite Chips					40	BGS		6.90				276.0
Hydrogen Peroxide 30%					870	Gal		0.40				348.0
					0	ea		0.00				0.0
EQUIPMENT												
120 Excavator					1	MO			4500.00			
Misc. Hand Tools					1	MO			3000.00			
Diesel Fuel & Oil					600	Gal			4.00			
					0	EA			0.00			
SUBCONTRACTORS												
Crew Boat Rental (Lodging)					21	DY				1675.00		
Landing Craft / Barge Rental					10	DY				1600.00		
					0	EA				0.00		
					Subtotals						$50,898.96	$32,432.0

Item 4, Treatment System Removal and Site Restoration

		Men	Days	Hours	Qty	Units	Labor Rate	Mat Unit	Equip Unit	Subs Unit	Total Labor	Total Mat
LABOR												
Supervisor/Operator	ST	1	15	8	120	HR	45.20				5,424.00	
Supervisor/Operator	OT	1	15	2	30	HR	65.24				1,957.20	
Labor	ST	4	15	8	480	HR	44.37				21,297.60	
Labor	OT	4	15	2	120	HR	63.98				7,677.60	
			Total Labor		750	MH						
MATERIALS												
Perdiem					35	ea		90.00				3150.0
Lodging					23	ea		180.00				4140.0
Round Trip Air Fares					5	ea		1000.00				5000.0
					0	ea		0.00				0.0
EQUIPMENT												
Misc. Rental Equipment (Staging in Cordova / Valdez)					1	LS			3000.00			
120 Class Excavator (on island)					0.5	MO			4500.00			
Diesel Fuel & Oil					300	Gal			4.00			
					0	DY			0.00			
SUBCONTRACTORS												
Crew Boat Rental (Lodging)					12	DY				1675.00		
Landing Craft / Barge Rental					6	DY				1600.00		
					0	EA				0.00		
					Subtotals						$36,356.40	$12,290.0

Table 3
Construction Cost Estimate Detail
Lingering Oil Removal Pilot Project
Prince William Sound, Alaska
Farallon PN: 506-002

Pilot Treatment System Installation and Startup Engineering Support

Labor	Unit	Rate	Cost
Principal I Engineer/Geologist/Scientist	80 hour @	$180 per hour =	$14,400
Senior I Engineer/Geologist/Scientist	20 hour @	$150 per hour =	$3,000
Project I Engineer/Geologist/Scientist	10 hour @	$93 per hour =	$930
Staff I Engineer/Geologist/Scientist	290 hour @	$82 per hour =	$23,780
Clerical Level 1	20 hour @	$70 per hour =	$1,400
			$0
		Estimated Labor Subtotal	**$43,510**

Other Direct Costs (ODCs)	Unit	Rate	Cost
Transportation (round trip)	2 each @	$1,000 per each =	$2,000
Per diem	26 day @	$90 per day =	$2,340
Misc. materials	1 each @	$1,500 per each =	$1,500
		Estimated ODC Subtotal	**$5,840**
		Task 3 Estimated Total	**$49,350**
		ESTIMATED PROJECT TOTAL	**$49,350**

Irons

Trustee Council Use Only Project No: 11100853 Date Received:	**PROPOSAL SUMMARY PAGE**
Project Title:	Pigeon Guillemot Restoration Research in Prince William Sound, Alaska, FY11 Amendment
Project Period:	February 15, 2011 to December 31, 2016
Proposer(s):	David B. Irons, U.S. Fish and Wildlife Service, and Daniel D. Roby, U.S. Geological Survey – Oregon Cooperative Fish and Wildlife Research Unit
Study Location:	Prince William Sound, Alaska

Abstract: This amendment to project 070853, Pigeon Guillemot Restoration Research in Prince William Sound, Alaska, provides an opportunity to restore the population of Pigeon Guillemots (*Cepphus columba*) in Prince William Sound, Alaska, which has declined by more than 90% at the Naked Island group since 1989. A restoration plan for Pigeon Guillemots in PWS was prepared to address the species' lack of population recovery following injury by the 1989 *Exxon Valdez* oil spill. Predation on nests and adults by mink is now the primary limiting factor for guillemot reproductive success and population recovery at the most important historical nesting site for guillemots in PWS (i.e., the Naked Island group). Mink on the Naked Island group are descended in part from fur farm stock and apparently were introduced to the island group during the 1980s. Eradication of mink at these islands was selected as the preferred restoration alternative because it is feasible and most likely to result in the recovery of guillemots in PWS. Other alternatives are either currently unavailable or unlikely to be effective. An eradication effort is likely to be successful due to both well-developed methods and the low likelihood of re-colonization. Potential negative effects of the preferred alternative are either negligible or largely avoidable. The guillemot population at the Naked Island group would likely double within the first 10 years following mink eradication, and the Sound-wide population of guillemots would likely increase within 15 years of mink eradication at the Naked Island group, once guillemots nesting at the Naked Island group had become a source population for other parts of PWS.

Phase I : Completion of the NEPA process for the proposed action
Phase II: Mink eradication and restoration monitoring (if warranted by NEPA analysis)

Funding:	**EVOS Funding Requested:** (must include 9%GA) FY 2011 – $218,000.00 FY 2012 -- $580,081.00 FY 2013 –$580,081.00 FY 2014 –$360,656.70 FY 2015 –$347,669.90 FY 2016 --$347,669.90 TOTAL EVOS funding: $2,434,218.40 or $1,321,109.20* *NOTE: David Irons and Dan Roby are submitting a proposal to the National Fish and Wildlife Foundation for 50% of the $2.22 million budget (half of the budget, excluding the cost of NEPA analysis). If we get this matching money we will reduce our request to the EVOS TC to $1.32 million. We will know before Phase II begins if we have that money. **Non-EVOS Funds to be Used:** FY 2011 – $10,000.00 FY 2012 -- $173,000.00 FY 2013 –$173,000.00 FY 2014 –$113,000.00 FY 2015 –$98,000.00 FY 2016 --$98,000.00 TOTAL non-EVOS funding: $665,000.00 **TOTAL, EVOS and non-EVOS funding: $3,099,218.40 K**
Date:	January 14, 2011

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EXECUTIVE SUMMARY

The Pigeon Guillemot (*Cepphus columba*) is now the only marine bird species in Prince William Sound (PWS), Alaska that is listed as "not recovering" on the Exxon Valdez Oil Spill Trustee Council's Injured Resources List. Since 1989, the population of Pigeon Guillemots in Prince William Sound (PWS) has undergone a continuous and marked decline, with no sign of stabilization. Given this alarming trend, restoration is warranted for the recovery of Pigeon Guillemots in PWS. The logical location to focus restoration effort for guillemots is the most important historical breeding location in the Sound, the Naked Island group in central PWS. These islands provide an opportunity for recovery of a significant proportion of the PWS guillemot population, although the Naked Island group constitutes only about 2% of the total shoreline in PWS. One fourth of all guillemots nesting in PWS in 1989 (just after the spill) were located at the Naked Island group. Restoration of guillemots at the Naked Island group to the number counted at that time would result in a substantial increase in the Sound-wide population. Most of the available information on the factors limiting the Pigeon Guillemot population in PWS originates from research on guillemot population size, nesting success, and diet conducted at the Naked Island group during 15 breeding seasons between 1978 and 2008. These data, placed in a historical and socioeconomic context, permit the development of a restoration plan designed to facilitate the population recovery of Pigeon Guillemots in PWS.

A few historical events have had a considerable impact on Pigeon Guillemots nesting at the Naked Island group in PWS. First, fox farming occurred at the Naked Island group for more than 50 years beginning in 1895. The foxes (*Alopex lagopus*) almost certainly caused severe declines in the populations of native fauna, including Pigeon Guillemots, as they did across many formerly fox-free islands in Alaska. Nearly a century later, the EVOS caused acute mortality from oiling estimated at between 500 and 1,500 Pigeon Guillemots in PWS in the immediate aftermath of the spill. There was evidence that guillemots were exposed to and negatively affected by residual oil for at least a decade after the spill. However, there was no longer an indication of guillemot exposure to residual oil from EVOS by 2004. Studies have demonstrated that EVOS and/or a climatic regime shift associated with the Pacific Decadal Oscillation affected guillemots in the Sound through reduced availability of preferred forage fish species. The prevalence of high-lipid schooling forage fish in the diet of guillemot chicks at the Naked Island group was significantly lower in the decade after EVOS, and this change was associated with lower nestling survival and growth rates, and lower overall nesting success. The level of predation on guillemot nests at the Naked Island group also increased significantly during the 1990s when compared to pre-spill, potentially limiting the recovery of Pigeon Guillemots at this location.

The primary limiting factor for guillemot reproductive success and population recovery at the Naked Island group is now predation of nests and adults by American mink (*Neovison vison*). Guillemot population trends at the Naked Island group compared to the rest of PWS are consistent with this conclusion. At sites outside of PWS, guillemot population declines and even local extirpation of breeding guillemots due to predation by mink have been successfully and rapidly reversed through mink eradication as a restoration action. Although a precise estimate of the guillemot population response to proposed mink eradication at the Naked Island group is not possible, all available evidence indicates that eliminating mink predation on guillemot nests and

adults would result in a dramatic increase in the breeding population and productivity of Pigeon Guillemots at the Naked Island group. Nest predation by mink may also have caused declines in populations of other seabirds nesting at the Naked Island group, including Arctic Terns (*Sterna paradisaea*), Parakeet Auklets (*Aethia psittacula*), Tufted Puffins (*Fratercula cirrhata*), and Horned Puffins (*Fratercula corniculata*). The presence of foraging marine mammals and large flocks of piscivorous birds provide supporting evidence that predation by mink and not limitations in food supply have caused the declines in seabirds breeding at the Naked Island group. The introduction or range expansion of mink in areas outside of PWS have caused rapid population declines in a wide variety of taxa, including several species of ground-nesting birds, small mammals, amphibians (Banks et al. 2008), and crustaceans.

Mink are native to the mainland and nearshore islands of PWS, but do not naturally occur on offshore islands. Observational data indicate that mink were absent on the Naked Island group until the 1980s. Data from both mtDNA sequencing and nuclear microsatellite genotyping indicate that the mink on the Naked Island group are descended in part from fur farm mink stock and were likely introduced to the Naked Island group by humans.

The Naked Island group is part of Chugach National Forest with the exception of one small privately-owned parcel on Peak Island. The islands are used periodically for camping, hiking, deer hunting, and fishing. Although frequently exploited for their fur in other parts of PWS, trapping of mink at the Naked Island group occurs rarely. Pigeon Guillemots contribute to the success of ecotourism in PWS through their conspicuous, vocal, and charismatic displays along the shoreline.

The restoration objective for Pigeon Guillemots in PWS is population recovery, which in this case is defined as a stable or increasing population. All reasonable potential restoration alternatives have been considered and assessed for their likelihood of facilitating guillemot population recovery. The preferred alternative (Alternative A) is the eradication of mink (i.e., the removal of all individuals of the species) at the Naked Island group. The suggested method is trapping with lethal body grip traps set along the coastline during fall, winter, and especially early spring (when snow cover is present and mink are largely restricted to the shoreline), supplemented with hunting using dogs, as necessary. Successful eradication will likely require multiple years of effort, likely 3-5 years. Long-term monitoring of the islands should be conducted periodically when mink are most easily detected (i.e., when snow cover is present) and any mink discovered should be immediately trapped and the carcass saved for genetics analysis. The culling of mink (Alternative B) would result in suppression of the mink population at the Naked Island group, rather than complete elimination. This alternative was rejected for four primary reasons: (1) the level of culling effort necessary to cause a significant reduction in predation rates on guillemots is unknown, (2) culling would have to occur on an annual basis to be effective, (3) the ultimate economic cost and the total number of animals killed under a culling program would far exceed that of eradication, and (4) because even a single mink can devastate a guillemot colony, culling is unlikely to effectively enhance the recovery of the Pigeon Guillemot population. Alternative C, enhancement of the guillemot food supply during the nesting season, included the release of high-lipid hatchery-reared juvenile fish (i.e., Pacific herring, *Clupea pallasi*, and/or Pacific sand lance, *Ammodytes hexapterus*) near foraging areas of Pigeon Guillemots at the Naked Island group. Although this alternative may be an effective

restoration technique for guillemots and other species in the future, it was eliminated because there is currently no stock enhancement program for herring or sand lance in PWS, plus it fails to address the primary cause of guillemot egg and chick mortality at the Naked Island group. The construction and installation of guillemot nest boxes (Alternative D) to enhance the availability of sites inaccessible to mink was considered and rejected as well. A few nest boxes were installed at the Naked Island group during the 1990s, but there was a low incidence of use by guillemots, most likely because there was an abundance of available, unoccupied natural cavities. The population of Pigeon Guillemots at the Naked Island group is now significantly lower than it was during the 1990s, and thus nest box installation would almost certainly be an ineffective restoration technique. Alternative E consists of the lethal control of avian predators of Pigeon Guillemots and their nests, including Common Ravens (*Corvus corax*), Northwestern Crows (*Corvus caurinus*), and Black-billed Magpies (*Pica pica*). This alternative would require a constant, persistent, and intensive effort to reduce populations of avian predators, and the resulting increase in survival of guillemot eggs and chicks is likely to be insignificant in comparison to the loss of eggs, chicks, and adults due to mink predation. Alternative F consisted of a combination of provisioning of nest boxes (Alternative D) and control of corvid (Alternative E) and mink (Alternative B) populations. This combination of alternatives is unlikely to be more effective than any of the alternatives implemented on its own. The current management strategy (Alternative G), involves no restoration action. Given the high predation pressure on guillemot nests at the Naked Island group, this alternative will almost certainly lead to a continued low (< 25 nesting pairs) breeding population or local extirpation of the guillemot breeding population at this site.

Eradication of mink was selected as the preferred alternative because it is most likely to facilitate the recovery of Pigeon Guillemots throughout PWS. This alternative is less expensive, both economically and in terms of the number of mink killed, compared to any effective, perennial culling effort. Other alternatives are either currently unavailable or unlikely to be effective. An effort to eradicate mink at the Naked Island group is likely to be successful in a relatively short period of time (3-5 years) due to both well-developed methods of eradication and the low likelihood of mink re-colonization. Although, the preferred alternative would be implemented to address the Pigeon Guillemot population decline in PWS, a suite of other seabird species, including Tufted Puffins, Horned Puffins, and Arctic Terns, with depressed breeding populations at the Naked Island group would also benefit. Mink eradication may also promote local increases in other populations of ground-nesting birds (e.g., shorebirds, waterfowl), small mammals, amphibians, and crustaceans.

Potential negative effects of the preferred alternative appear to be either negligible or largely avoidable. Proposed eradication methods include steps to minimize capture of non-target species (i.e., selection of trap type and use of artificial burrows in which to set traps). The restoration of guillemots at the Naked Island group will not have a significant negative impact on herring stocks because juvenile herring have never been an important part of the diet of guillemots nesting at this location. Eradication of mink at the Naked Island group would not adversely affect trappers in PWS because mink at the Naked Island group are rarely exploited for their fur and are remote to trappers in the region. Due to the fur farm ancestry of mink at the Naked Island group, this alternative would not injure the Sound-wide population of native mink. There is no concern over a potential detrimental population eruption by small introduced herbivores or omnivores,

such as rabbits or rats, following mink eradication because no such species occur at the Naked Island group.

The population response of guillemots to mink eradication at the Naked Island group is measurable through the comparison of historical and recent guillemot population surveys completed at the Naked Island group and the Smith Island group (mink-free islands) using a Before–After–Control–Impact design. Although a precise prediction of the guillemot population response to mink eradication is not possible, the time expected to population recovery can be estimated. If the expected increase in guillemot productivity following mink eradication is realized and model assumptions are correct, the guillemot population at the Naked Island group would double within 10 years of mink eradication and the Sound-wide population of Pigeon Guillemots would begin to increase 15 years after eradication of mink at the Naked Island group.

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Introduction

The Pigeon Guillemot (*Cepphus columba*) is now the only marine bird species injured by the 1989 *Exxon Valdez* oil spill (EVOS) that is listed as "not recovering" on the Exxon Valdez Oil Spill Trustee Council's Injured Resources List (*Exxon Valdez* Oil Spill Trustee Council 2010). Since 1989, the population of Pigeon Guillemots in Prince William Sound (PWS) has declined by an alarming 47%, and there is no sign of population stabilization (McKnight et al. 2008). Given this steady, long-term, and drastic trend, restoration action is warranted and in all probability necessary for the recovery of the Pigeon Guillemot population in PWS.

The Naked Island group is a logical location to focus restoration efforts for guillemots in PWS (Figure 1). These islands provide a unique opportunity to facilitate the recovery of a disproportionately large number of guillemots through restoration along a small portion (~2%) of the total PWS shoreline. The Naked Island group was historically the most important breeding location for guillemots in the Sound (Sanger and Cody 1994). Approximately one quarter of the guillemot population in PWS nested at the Naked Island group in 1989 in the aftermath of the EVOS (U.S. Fish and Wildlife Service, unpubl. data). Recovery of Pigeon Guillemots at the Naked Island group to the number counted just after the spill (Oakley and Kuletz 1996) would increase the Sound-wide population by nearly 45% (McKnight et al. 2008).

The Naked Island group is also the site where we have the most thorough understanding of mechanisms regulating Pigeon Guillemot populations in PWS. Data on population size, nesting success, and diet of guillemots has been collected at the Naked Island group during 15 years between 1978 and 2008 (Bixler 2010). The historical, ecological, and socioeconomic contexts of Pigeon Guillemots at the Naked Island group are presented below. This information provides the foundation crucial for the development and assessment of feasible restoration alternatives designed to facilitate the population recovery of Pigeon Guillemots in PWS.

Historical Context

The Naked Island group was the site of arctic fox (*Alopex lagopus*) fur farms for more than 50 years beginning in 1895 (Bailey 1993, Lethcoe and Lethcoe 2001). The foxes roamed free on the islands (Evermann 1914) and, as in other locations, likely relied on native small mammals (i.e., voles, shrews, and mice) and seabirds as a food source (Heller 1910, Bailey 1993). The populations of native fauna, including Pigeon Guillemots, almost certainly plummeted following the introduction of foxes to the Naked Island group, as they did across many formerly fox-free islands in Alaska (Bailey 1993). In fact, there were apparently no rodents or shrews on Storey Island and no shrews on Naked Island by 1908, within 15 years of the commencement of fox farming (Heller 1910). A variety of native species including salmon, herring, harbor seals, and even whales were killed to provide supplemental food for foxes in the Sound (Bailey 1993, Lethcoe and Lethcoe 2001, Wooley 2002), thereby altering the entire ecosystem. The depression of the 1930's, the end of World War II, and changes in women's

fashions in Europe together caused fox farming to become unprofitable (Lethcoe and Lethcoe 2001). Upon closure of the fox farms, foxes in PWS either were removed by trapping or died of starvation; arctic foxes are no longer found in the PWS region (Bailey 1993).

Other historical developments in PWS that may have directly or indirectly impacted the nearshore habitat of the Naked Island group include mining, commercial fishing of salmon and herring, pink salmon hatcheries, marine mammal harvest, and logging (Lethcoe and Lethcoe 2001, Wooley 2002). The 1964 earthquake resulted in an uplift of about four feet at the Naked Island group and massively altered both the shoreline and shallow nearshore habitat (Hanna 1971) where guillemots nest and forage (Ewins 1993).

On 24 March 1989, the T/V *Exxon Valdez* ran aground at Bligh Reef in PWS resulting in the release of at least 44 million liters of Prudhoe Bay crude oil into PWS. The oil spread to the southwest through the Sound and into the northern Gulf of Alaska. An estimated 500 to 1,500 Pigeon Guillemots in PWS were immediately killed due to oil exposure (Piatt and Ford 1996). There was evidence that guillemots were exposed to residual oil for at least a decade after the spill (Golet et al. 2002). However, there was no longer indication of direct contact with oil in guillemots by 2004 (B. Ballachey, U.S. Geological Survey, pers. comm.).

Previous studies have demonstrated that EVOS and/or a climatic regime shift associated with the Pacific Decadal Oscillation may have indirectly affected Pigeon Guillemots in PWS (Agler et al. 1999, Golet et al. 2002). The decline in the number of guillemots in the Sound, which began prior to EVOS, has been associated with the 1976 shift in the Pacific Decadal Oscillation (Agler et al. 1999, Golet et al. 2002) that resulted in reduced abundance of schooling forage fish across the North Pacific Ocean (Anderson et al. 1997, Francis et al. 1998, Anderson and Piatt 1999). EVOS also apparently contributed to the decline in populations of schooling forage fish, specifically Pacific herring (*Clupea pallasi*) and Pacific sand lance (*Ammodytes hexapterus)* in Prince William Sound (Marty et al. 1999, Golet et al. 2002, Marty 2008). The prevalence of high-lipid schooling forage fish in the diet of guillemot chicks at the Naked Island group was significantly lower in the decade after EVOS than prior to EVOS (Oakley and Kuletz 1996, Golet et al. 2002). Low proportions of high-lipid schooling prey, particularly sand lance, in the diet of Pigeon Guillemot chicks have been associated with lower nestling survival, lower nestling growth rates, and lower overall nesting success (Golet et al. 2000, Litzow et al. 2002).

Top-down factors, such as predation, may also have limited the recovery of the Pigeon Guillemot population in PWS (Hayes 1995, Oakley and Kuletz 1996, Golet et al. 2002). Common potential predators of guillemot nests in PWS include Glaucous-winged Gulls (*Larus glaucescens*), Black-billed Magpies (*Pica hudsonia*), Northwestern Crows (*Corvus caurinus*), Common Ravens (*Corvus corax*), river otters (*Lontra canadensis*), and American mink (*Neovison vison*) (Oakley and Kuletz 1979, Ewins 1993, Hayes 1995, Oakley and Kuletz 1996). The level of predation on guillemot nests at the Naked Island group increased significantly during the late 1990s compared to earlier years (Golet et al. 2002).

Current Ecological Context

The Pigeon Guillemot is a pursuit-diving seabird that preys upon a variety of nearshore demersal fishes, schooling fishes, and, occasionally, crustaceans (Ewins 1993). Guillemots are semi-colonial members of the seabird family Alcidae that produce 1- or 2-egg clutches (Ewins 1993). Pigeon Guillemots usually nest in rock crevices or burrows along rocky shorelines but are also known to nest in crevices of anthropogenic structures such as piers, bridges, and wooden

nest boxes (Ewins 1993). Guillemots nest along the coastline of western North America from the Bering Strait to Santa Barbara, California, and as far south as the Kurile Islands in the Russian Far East. The current number of Pigeon Guillemots is considered stable and estimated to be about 470,000 individuals range-wide (BirdLife International 2009). The species is regarded as "of least conservation concern" (BirdLife International 2009). The Pigeon Guillemot is however, susceptible to long-term local declines in breeding populations (Ewins 1993).

The availability of schooling forage fish may continue to limit the rate and extent of Pigeon Guillemot population recovery, both at the Naked Island group and in the Sound as a whole (Bixler 2010). The prevalence of schooling forage fish in the diet of Pigeon Guillemots at the Naked Island group has not recovered to pre-EVOS levels. In addition, the average group size of Pigeon Guillemots detected in surveys declined near the Naked Island group, but also across a number of other important guillemot nesting areas in central and western PWS, a pattern consistent with a region-wide reduction in food availability.

However, the primary limiting factor for guillemot reproductive success and population recovery at the Naked Island group is now predation by a recent colonizer of the islands, the American mink (Bixler 2010). The overall abundance of schooling forage fish at the Naked Island group has increased since the 1990s, suggesting that forage fish populations are recovering from EVOS. Despite improving prey resources, the guillemot breeding population at the Naked Island group has declined by more than 90% during the last 15 years. Guillemots, like many other seabirds, produce few offspring and their populations are sensitive to even small decreases in adult survival. The rate of egg and chick predation increased during the 1990s and caused the majority of nest failures during this period. By 1998, at least 60% of monitored guillemot nests and 4.5% of breeding adults at those nests were killed by mink. In 2008, we determined that the rate of nest predation at the Naked Island group was similar to the late 1990s, and mink were still able to locate guillemot nests and kill guillemot nestlings, despite few remaining nests (only 17 active guillemot nests found). The prevalence of guillemot nest sites in crevices on cliffs increased at the Naked Island group, while the prevalence of nests in crevices or burrows near the ground, presumably more accessible to mink, decreased compared to pre-spill. The guillemot population trend at the Naked Island group compared to elsewhere in PWS is also consistent with the hypothesis that mink predation is the primary limiting factor. Guillemot numbers were stable between 1990 and 2008 at nearby mink-free islands (Smith Island group), and guillemot population declines at the Naked Island group since EVOS have been much more severe than across the rest of PWS. The number of guillemots at the Naked Island group comprised about 25% of the total population in PWS just after the spill in 1989. But in 2008, the number of guillemots at the Naked Island group comprised just 1% of the total Sound-wide population.

Prior to the invasion of mink during the 1980s, the Naked Island group had the largest nesting colony of Parakeet Auklets (*Aethia psittacula*) in PWS and high densities of Tufted Puffins (*Fratercula cirrhata*), Horned Puffins (*Fratercula corniculata*), and Arctic Terns (*Sterna paradisaea*), in addition to supporting the highest numbers of nesting Pigeon Guillemots (Oakley and Kuletz 1979). Nest predation by mink likely caused declines in these other seabirds nesting at the Naked Island group. Arctic Terns and Parakeet Auklets have been extirpated as breeding species at the Naked Island group. Other seabirds currently nest in greatly reduced numbers (i.e., Tufted Puffins and Horned Puffins; KSB, pers. obs). The few remaining pairs of puffins nesting on the Naked Island group are restricted to the highest available shoreline cliffs (80 - 100 m) on the archipelago. Foraging humpback whales (*Megaptera novaeangliae*), minke whales

(*Balaenoptera acutorostrata*), harbor seals (*Phoca vitulina*), and Steller sea lions (*Eumetopias jubatus*) along with large foraging flocks of piscivorous birds, including Marbled Murrelets (*Brachyramphus marmoratus*), Black-legged Kittiwakes (*Rissa tridactyla*), and Glaucous-winged Gulls (*Larus glaucescens*) still occurred in the nearshore waters of the Naked Island group in 2008 (KSB, pers. obs.). These aggregations of piscivorous marine birds and mammals near the Naked Island group provide supporting evidence that predation by mink, and not limited forage fish, have caused the decline in seabirds breeding at the site.

Mink are semi-aquatic, largely nocturnal, generalist carnivores that are native to the mainland and nearshore islands of PWS. The natural distribution of mink on the more isolated, offshore islands in PWS is less well known, however, due to two centuries of trapping of furbearers by non-Native Alaskans and 50 years of fur farms for foxes and mink (Lethcoe and Lethcoe 2001, Fleming and Cook 2010). Mink most likely arrived at the Naked Island group during the 1980s (U.S. Fish & Wildlife Service, unpubl. Data; Appendix B. Evidence from both mtDNA sequencing and nuclear microsatellite genotyping suggest that the mink on the Naked Island group are descended in part from fur farm mink (Fleming and Cook 2010). In addition, mink were almost certainly introduced to the Naked Island group by humans (Appendix B). There is no evidence of a gradual natural immigration of individuals and the founding population size was about 5 pairs, larger than expected from a natural colonization event. Mink from the Naked Island group are most closely related to those that occur on Knight Island, the nearest island to the Naked Island group (6 km away). This distance exceeds by 2 km the longest recorded natural dispersal distance over open water by mink. Mink were intentionally introduced by federal and state agencies to at least one remote island in PWS (i.e., Montague Island) in order to provide a harvestable population (Paul 2009). There is also suggestive evidence of introductions of mink to islands in PWS by fox farmers (Fleming and Cook 2010) and fur trappers (R. Ellis, USDA-Wildlife Services, pers. comm.) to establish new harvestable populations.

American mink have escaped from fur farms or from been intentionally introduced across much of Europe (Bonesi and Palazon 2007) where they have caused rapid population declines in a variety of ground-nesting birds (Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, amphibians (Banks et al. 2008), and crustaceans (Bonesi and Palazon 2007). These effects are especially apparent on islands (Banks et al. 2008). A long-term, large-scale American mink removal program on islands in the Baltic Sea demonstrated that 1) nearly all species of birds, mammals, and amphibians present on the islands were negatively affected by mink predation and 2) populations of most species increased following mink removal (Nordström et al. 2003, Banks et al. 2008). Mink eradication resulted in successful reversal of the population decline and local extirpation of Black Guillemots (*Cepphus grylle*), a close relative of Pigeon Guillemots, in this study (Nordström et al. 2003).

Although we are unaware of any examples of mink eradication programs within the breeding range of Pigeon Guillemots, introduced arctic foxes have been removed from multiple islands in the Alaska Maritime National Wildlife Refuge Complex (Byrd et al. 1997). At two of these islands, Simeonof and Chernabura islands in the Shumagin Islands, the population of Pigeon Guillemots increased by 275% and 150%, respectively, within just six years of fox removal (Byrd 2001).

Not all guillemot nesting failure on the Naked Island group is caused by mink predation and the diet of the few guillemots that continue to nest on the Naked Island group does not

include as high a proportion of schooling forage fishes as pre-EVOS (Bixler 2010). Consequently, a precise estimate of the guillemot population response should mink be eradicated at the Naked Island group is not possible. However, all available evidence indicates that eliminating mink predation on guillemot nests and adults would result in a measureable increase in the Pigeon Guillemot breeding population and its productivity at the Naked Island group, as well as increases in the breeding populations of other seabirds at the Naked Island group.

Socioeconomic Context

Outside of one privately owned parcel of land on Peak Island, the Naked Island group is part of the publically owned Chugach National Forest (Oakley and Kuletz 1979). The islands are used periodically for camping, hiking, deer hunting, and fishing (Oakley and Kuletz 1979). The protected bays on the west and north sides of Naked Island provide safe anchorages for sailboats, fishing boats, and an oil spill response barge. Although frequently exploited for their fur in other parts of PWS, trapping of mink at the Naked Island group rarely occurs due to the low price of furs and the time and expense involved in traveling to the islands (R. Ellis, U.S. Department of Agriculture – Wildlife Services, pers. comm.). Although Pigeon Guillemots have little subsistence value, they contribute to the success of ecotourism in PWS. Guillemots are conspicuous, vocal, and charismatic and thus play a role in the auditory and visual experience of all who frequent the shoreline of PWS.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The proposed restoration would facilitate the recovery of a species injured by EVOS, the Pigeon Guillemot, through eradication of mink at the Naked Island group. Given the high level of guillemot egg and chick mortality at the Naked Island group, there is no evidence to suggest that the population could recover without restoration action. Because the Naked Island group is the most important historical nesting area for guillemots in PWS, this proposal provides an opportunity for recovery of a significant proportion of the PWS guillemot population.

The removal of all mink from the Naked Island group would promote naturally occurring productivity and diversity in Prince William Sound. This population of mink was almost certainly introduced to the Naked Island group. A suite of seabird species with depressed breeding populations at the Naked Island group (e.g., Arctic Terns, Parakeet Auklets, Tufted Puffins, and Horned Puffins) (KSB, pers. obs.; Oakley and Kuletz 1979) would benefit from this restoration action in addition to Pigeon Guillemots. Mink eradication may promote local increases in other populations of ground-nesting birds (Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, amphibians (Banks et al. 2008), and crustaceans (Bonesi and Palazon 2007).

II. PROJECT DESIGN

A. Alternatives

Introduction

The restoration objective for Pigeon Guillemots in PWS is population recovery, in this case defined as a stable or increasing population (*Exxon Valdez* Oil Spill Trustee Council 1994). All reasonable potential restoration alternatives have been considered. The ability of each alternative to meet the restoration objective was assessed and the most effective approach was selected as the preferred alternative. The compliance of the preferred alternative with the policies and standards of restoration of the *Exxon Valdez* Oil Spill Trustee Council (*Exxon Valdez* Oil Spill Trustee Council 1994) are addressed in more detail in Appendices A and B.

Detailed description of alternatives

Alternative A - Eradication of Mink – PREFERRED ALTERNATIVE

Actions under this alternative aim to eradicate mink at the Naked Island group. We consider eradication "the complete removal of all the individuals of the population, down to the last potentially reproducing individual" (Courchamp et al. 2003). The suggested method is lethal trapping with body grip traps along the coastline, supplemented with hunting using dogs as necessary.

Trapping is the most practical and effective method available to control mink (Boggess 1994, Macdonald and Harrington 2003, Moore et al. 2003). Although lethal trapping is more successful (Boggess 1994, Moore et al. 2003), live trapping followed by euthanasia with an air pistol or shotgun has been utilized in a few mink eradication projects due to concern for non-target captures and public acceptance (Moore et al. 2003). Other methods of euthanasia were considered but rejected. Although toxicants (e.g., sodium fluoroacetate - compound 1080 and sodium cyanide - M44) and fumigants (e.g. carbon monoxide) are in use in the United States for carnivore control, there are currently no chemical agents registered by the U.S. Environmental Protection Agency for the control of mink (Boggess 1994, National Wildlife Research Center 2008). Further, poisoning or secondary poisoning of non-target species (Courchamp et al. 2003, Moore et al. 2003) such as river otters (*Lontra canadensis*) and Bald Eagles (*Haliaeetus leucocephalus*) would likely be unacceptable. Shooting as a method of killing mink is considered inefficient (Boggess 1994, Courchamp et al. 2003). Although a potentially important management tool in European countries (Macdonald and Harrington 2003, Bonesi and Palazon 2007), control of mink through enhancement of possible competitors (i.e., river otters) seems unlikely to be effective in PWS given the lack of evidence for niche overlap (BenDavid et al. 1996). Other means of biological control, such as virus vectored immune-contraception, have yet to be fully developed (Courchamp and Cornell 2000, Macdonald and Harrington 2003) and might pose an irreversible danger to the viability of mink and other closely-related native furbearers (e.g., American marten) outside of the Naked Island group.

Trapping success would be maximized through continuous effort for at least three months of the year during the mating (January to March), juvenile dispersal (August to October), and/or winter (November to December) seasons (Bonesi et al. 2007). The precise timing of trapping will be determined using an adaptive management approach (see below). Traps would be set along the coastline of the islands (See Bixler et al. 2010 for details). Although mink on the Naked Island group may occur along a few inland streams and small lakes, there is evidence that mink re-locate to the coast as territories become available during the eradication program (Bodey et al.

2010). We suggest the use of experienced trappers (Macdonald and Harrington 2003) for the duration of the project and hunting dogs to locate the last few mink (Moore et al. 2003).

Although we do not know the total number of mink at the Naked Island group, there likely is between 70 and 200 mink in this population (Fleming and Cook 2010). We anticipate that successful eradication would likely require multiple years of effort (Macdonald and Harrington 2003), potentially up to five years. Carcasses would be donated to permanent archives in public museums to be made available to research organizations for further genetic study. Long-term monitoring of the islands would be conducted periodically when mink are most easily detected (i.e., during deep snow cover; Bonesi and Palazon 2007) and any mink discovered will immediately be trapped.

The geography of the Naked Island group improves the likelihood of successful mink eradication, should eradication be attempted. The islands are relatively small with gentle topography and access to safe anchorages (Courchamp et al. 2003, Bonesi and Palazon 2007). Because the Naked Island group is geographically isolated, it is unlikely to be re-colonized by mink (Nordström and Korpimäki 2004, Bonesi and Palazon 2007).

Mink eradication at the Naked Island group would likely be followed by a clear and dramatic increase in the guillemot breeding population, but the precise response of the guillemot population following mink eradication is unknown. Based on the best available information, however, we estimate that the productivity of guillemots at the Naked Island group will increase by 16% to 36%. If this change in productivity is realized and model assumptions are accurate, the Sound-wide population should begin to increase within 15 years following eradication (See Chapter 4).

Alternative B - Culling of Mink

Alternative B is similar to Alternative A, with the exception that in this alternative the aim of lethal trapping is the suppression of the mink population at the Naked Island group, rather than eradication. Methods used would be identical to Alternative A with two main differences; 1) hunting with dogs would not be necessary and, 2) lethal trapping would have to occur indefinitely and on an annual basis in order to maintain a low density of mink on the archipelago (Bonesi et al. 2007).

There are several drawbacks to this alternative. It is possible for the population of mink to remain stable even under a culling program, and the level of culling necessary to cause and sustain a reduction in population density is unknown (Bonesi and Palazon 2007). If the population of mink declines and is released from density-dependent limiting factors, the reproductive rate would likely increase, raising the trapping effort required to maintain a low density (Courchamp et al. 2003). In order to maintain a low density population of mink, culling must occur annually (Bonesi et al. 2007), thus the ultimate economic cost and the total number of animals killed under a culling program would far exceed that of eradication (Courchamp et al. 2003). And finally, because even a single mink can devastate a guillemot colony (U.S. Fish and Wildlife, unpubl. data), culling is unlikely to significantly reduce the level of guillemot nest predation or facilitate population recovery.

Alternative C – Enhance the Pigeon Guillemot Food Supply during the Nesting Season

Actions under Alternative C would include the release of hatchery-reared juvenile forage fish within PWS, preferably in close proximity to the foraging areas of Pigeon Guillemots nesting at the Naked Island group. Due to the importance of prey lipid content to the reproductive success of guillemots (Golet et al. 2000, Litzow et al. 2002), only high-lipid schooling forage fish would be released (i.e. herring and/or sand lance). An increase in the abundance of high-lipid prey might lead to increased productivity and survival in guillemots (Golet et al. 2000, Litzow et al. 2002). The enhancement of native stocks of forage fish in PWS might also have a positive impact on populations of a variety of other species of seabirds, fish, and mammals that prey upon them, including the ESA-listed humpback whale (*Megaptera novaeangliae*) and Steller sea lion (*Eumetopias jubatus*). There is currently no stock enhancement program for either herring or sand lance in PWS. The initiation of such a program requires further research in order to ensure no unexpected negative consequences to the ecosystem (*Exxon Valdez* Oil Spill Trustee Council 2009). Although this alternative might be an effective restoration technique in the future, it is not a viable solution to stem the current alarming population decline of guillemots. More importantly however, this alternative fails to address the primary cause of guillemot nesting failure at the Naked Island group, namely predation on eggs and chicks.

Other methods of supplementing the guillemot food supply have been considered and rejected. For instance, releases of dead herring or sand lance into waters adjacent to active nests are unlikely to be utilized by guillemots because there is no indication that this species currently exploits such potential food resources (i.e., offal discarded from fishing vessels; Ewins 1993). Supplementing the diet of chicks in the nest was rejected as well. Although studies suggest that the supplementation of prey to nests can significantly increase productivity of seabirds (Robb et al. 2008), Pigeon Guillemots are prone to nest abandonment when subjected to high rates of human disturbance at the nest (Ainley et al. 1990, Vermeer et al. 1993).

Alternative D - Provide Nest Boxes to Enhance Nest Site Availability

Under this alternative, nest boxes would be installed on cliff faces that appear to be inaccessible to mink. The boxes would be placed in the immediate vicinity of either current or historical nesting locations.

Other options to prevent mink from depredating guillemot adults, chicks, and eggs inside nests were considered but eliminated. For instance, fencing is highly unlikely to be effective at reducing predation of guillemot nests at the Naked Island group. The prevention of gaps larger than 1 inch (Boggess 1994) on talus slopes and cliffs is not feasible. There are no registered chemical repellents or known effective frightening devices to modify the behavior of mink near guillemot nests (Boggess 1994, National Wildlife Research Center 2008).

There is no evidence that Pigeon Guillemots at the Naked Island group are limited by the availability of nesting habitat (Bixler 2010). A few nest boxes were installed at the Naked Island group during the late 1990s, but there was low incidence of use (DBI; pers. obs), most likely because there was an abundance of natural cavities available. The population of Pigeon Guillemots at the Naked Island group is now significantly lower than it was during the late 1990s. Consequently, nest box installation would almost certainly be an ineffective restoration technique.

Alternative E - Control Avian Predators of Pigeon Guillemot Nests

Actions under Alternative E intend to prevent the predation of Pigeon Guillemot nests through reduction in population of native avian predators at the Naked Island group. Avian species targeted would include the Common Raven (*Corvus corax*), Northwestern Crow (*Corvus caurinus*), and Black-billed Magpie (*Pica pica*). Lethal population control would be attained by shooting avian nest predators throughout the guillemot nesting season, April through August.

There are no other feasible methods of lethal or non-lethal control available. Although there is a conditioned taste aversion chemical registered by the U.S. Environmental Protection Agency (methiocarb) for corvid control, it is limited in use for the protection of federally threatened or endangered species (National Wildlife Research Center 2008). Similarly, lethal control of corvids through a toxicant (i.e. DRC-1339 [3-chloro-4-methylbenzenamine HCL]) is not permitted for this application (National Wildlife Research Center 2008). Harassment techniques, such as auditory deterrents, were rejected because they would likely negatively affect guillemot nest attendance.

There are several flaws inherent to this alternative. Culling by shooting has a decreasing efficacy for corvid species through time (Liebezeit and George 2002) suggesting that each year of control would require more effort with less success. The program would need to be conducted annually and continue indefinitely due to the high dispersal capability of these species. Finally, because an increase in survival of chicks after culling avian predators is likely to be insignificant in comparison to the loss of eggs, chicks, and adults due to mink predation, it seems very unlikely that this alternative would change the current population trajectory of Pigeon Guillemots at the Naked Island group.

Alternative F - Combination of Nest Boxes and Control of Predator Populations

Under this alternative, nest predators of Pigeon Guillemots (i.e., mink, ravens, crows, and magpies) would be culled and nest boxes would be installed at the Naked Island group. Actions taken include all of those listed in Alternatives B, D, and E. Due to flaws in each action (see above) that will not be lessened by the combination of alternatives, the population trajectory of Pigeon Guillemots at the Naked Island group is unlikely to change significantly.

Alternative G - No Action – Current Management

No management action would be taken under this alternative. The current breeding population of Pigeon Guillemots at the Naked Island group is likely to remain either exceedingly low (< 25 nesting pairs) or decline to local extirpation in the absence of restoration action given the high rate of predation on guillemot nests and adults by mink.

Rationale for selection of eradication of mink on the Naked Island Group as the preferred alternative

Alternative A, eradication of mink, is the preferred alternative because it is the most effective method to elevate the productivity of Pigeon Guillemots at the Naked Island group and facilitate the recovery of the species in PWS. This alternative is less expensive, both financially and in number of mink killed, than any culling method (Courchamp et al. 2003). Other alternatives are either currently unavailable or unlikely to facilitate guillemot population

recovery. Given the high level of guillemot egg and chick mortality at the Naked Island group, there is no evidence to suggest that the population could recover without such restoration action. Mink eradication at the Naked Island group is likely to be successful due to both well developed methods of eradication (Bonesi and Palazon 2007) and geographic isolation of the islands (Nordström and Korpimäki 2004). The removal of all mink at the Naked Island group can be achieved within a relatively short period of time (3-5 years). Although the population response of guillemots is difficult to predict precisely, mink eradication would result in an increase in adult survival, reproductive success, and population size at the Naked Island group. A suite of seabird species with depressed breeding populations at the Naked Island group (e.g., Arctic Terns, Parakeet Auklets, Tufted Puffins, and Horned Puffins) (KSB, pers. obs.; Oakley and Kuletz 1979) would also benefit from this restoration action. Mink eradication may promote local increases in other populations of ground-nesting birds (Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, amphibians (Banks et al. 2008), and crustaceans (Bonesi and Palazon 2007).

Potential negative effects of the preferred alternative appear to be negligible or largely avoidable. The preferred alternative includes steps to minimize capture of non-target species (i.e., trap type and use of artificial burrows as trap sites; see Bixler et al. 2010). There is no evidence to suggest that restoration of guillemots at the Naked Island group would have a significant negative impact on herring because they have never been an important part of the diet of guillemots at this site (Golet et al. 2000). Mink at the Naked Island group are rarely exploited for their fur (R. Ellis, U.S. Department of Agriculture – Wildlife Services, pers. comm.), and thus the eradication of mink at these islands would not adversely affect trappers in PWS. Due to fur farm ancestry, the preferred alternative would not have a negative impact on the Sound-wide population of mink. There is no concern of sudden destructive eruptions of small exotic herbivore or omnivore (e.g. rabbits, rats) populations (Bergstrom et al. 2009) following mink eradication because no such introduced species occur at the Naked Island group.

B. Objectives

Phase I

Complete the NEPA analysis process to decide how to proceed.

Phase II, if warranted by the outcome of the NEPA analysis.

1. Remove all mink from the Naked Island group.
2. Monitor the guillemot population response to mink eradication at the Naked Island group.

C. Procedural and Scientific Methods

Experimental Design

1. Mink eradication at the Naked Island group would require up to five years to accomplish via lethal trapping (Bixler et al. 2010) and hunting with dogs.

2. A long-term monitoring program is integral to the success of this proposed restoration. The Naked Island group would be surveyed every year for mink sign (tracks, scat) in snow, when mink are most easily detected (Bonesi and Palazon 2007). The population of

guillemots would be censused at both the Naked Island group and the Smith Island group during late May/early June each year using the protocol described in Oakley and Kuletz (1996). This monitoring will be continued by USFWS after the current project is over.

3. The preferred alternative requires an adaptive management strategy. This technique requires that data collected during trapping (e.g., trapping success, sex of trapped animals) as well as Pigeon Guillemot censuses be reviewed regularly to assess the success of the actions and methods. If there is evidence that the specified objective is not being met, the restoration methods or actions should be altered.

Time Frame for Pigeon Guillemot Population Recovery

We estimated the response of Pigeon Guillemot populations using a Leslie population-projection matrix after Golet et al. (2002). The following equation was used to calculate the population multiplication rate (λ):

$$\lambda = ((P_F * F_X * P_A^2) + (N_X * P_A)) / N_X$$

We assumed that fledgling survival (P_F) is 0.75 and age-constant adult survival (P_A) is 0.9. The initial population size (N_X) is the current population at the Naked Island group, 101 individuals. The initial number of offspring produced (F_X) was calculated using the average clutch size at the Naked Island group (1.7 eggs), average productivity after EVOS (0.35 chicks fledged/egg laid) plus 16% to 36%, and an initial breeding population size of about 90 (~ 45 pairs). The estimated increase in productivity, 16% to 36%, following the removal of all mink at the Naked Island group was derived from 1) the 16% increase in mortality of all chicks and eggs from pre-EVOS to post-EVOS coinciding with the apparent arrival of mink and 2) the 36% increase in the rate of predation of guillemot eggs and chicks in the years after EVOS compared to prior years. If this change in productivity is realized and model assumptions are accurate, the guillemot population at the Naked Island group would double within 10 years following eradication (Figure 2). Assuming that the model assumptions are met, the Sound-wide population of Pigeon Guillemots will increase within 15 years after eradication of mink at the Naked Island group (Figure 3). This will occur despite inclusion in the model of a 1.2% per year guillemot population decline that was documented between 1989 and 2008 across the remainder of the Sound.

Constraints

A precise estimate of the guillemot population response to mink eradication at the Naked Island group is not possible because there is some uncertainty about the exact proportion of all nest predation events that are caused by mink (Bixler 2010). Also there is some evidence that availability of preferred forage fish may affect the rate of guillemot population recovery in some parts of PWS. Consequently, the expected time until guillemot population recovery is an estimate based upon the best available information.

C. Data Analysis and Statistical Methods

The Pigeon Guillemot population trajectory between 1989 and 2008 at the Naked Island group and at the nearby Smith Island group (mink-free islands) can be compared to population trends following eradication using a Before–After–Control–Impact design (Smith 2002).

D. Description of Study Area

Restoration would occur at the Naked Island group. The Pigeon Guillemot population at both the Naked Island group and the Smith Island group would be monitored.

E. Coordination and Collaboration with Other Efforts

Implementation of this plan would require coordination with agencies with authority and responsibility of the Naked Island group, American mink, and Pigeon Guillemots (see below). Monitoring of Pigeon Guillemots would be conducted by the U.S. Fish and Wildlife Service. Permits for eradication of mink at the Naked Island group would be obtained from both the Alaska Department of Fish and Game and the U.S. Department of Agriculture – Forest Service. Mink eradication would be conducted by the U.S. Department of Agriculture – Wildlife Services or other contractor.

Authority and Responsibility

U. S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service mission is "to work with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people." Along with other Federal, State, Tribal, local, and private entities, the Service protects migratory birds, endangered species, certain fish species, and wildlife habitat. The Service is the primary agency responsible for the conservation of the Pigeon Guillemot and its habitat as authorized by the Migratory Bird Treaty Act.

Alaska Department of Fish and Game

The mission of the Alaska Department of Fish and Game is to "protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the best interest of the economy and the well-being of the people of the state, consistent with the sustained yield principle." The Department is responsible for maintaining a harvestable surplus of fish and wildlife species, including furbearers and marine forage fish.

U.S. Department of Agriculture Forest Service

The mission of the Forest Service is "to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations." The Forest Service is responsible for the management of the 5.4 million acre Chugach National Forest that includes nearly all of the Naked Island group, along with most of the rest of the land area of Prince William Sound.

III. SCHEDULE

A. Project Milestones

- Eradication completed at Naked Island group
  To be met by March 31, 2016

- Revise final report for EVOS project 10070853 to include details of eradication efforts and Pigeon Guillemot population trends.
  To be met by Sept 30, 2016

B. Measurable Project Tasks

FY 11, 2nd quarter (January 1 – March 31)
Project funding approved by Trustee Council
Begin Phase I: NEPA process begins

FY 11, 3rd quarter (April 1 – June 30)
Continue NEPA process

FY 11, 4th quarter (July 1 – September 30)
Continue NEPA process

FY 12, 1st quarter (October 1 – December 31)
Complete Phase I: NEPA process
Begin Phase II: Mink eradication and restoration monitoring (if warranted by NEPA analysis)

FY 12, 2nd quarter (January 1 – March 31)
Trap mink at the Naked Island group

FY 12, 3rd quarter (April 1 – June 30)
Census breeding guillemots at Naked Island and nearby islands, 28-30 May

FY 12, 4th quarter (July 1 – September 30)
Submit annual report to Trustee Council

FY 13, 1st quarter (October 1 – December 31)

Trap mink at the Naked Island group

FY 13, 2nd quarter (January 1 – March 31)
Trap mink at the Naked Island group

FY 13, 3rd quarter (April 1 – June 30)
Census breeding guillemots at Naked Island and nearby islands, 28-30 May

FY 13, 4th quarter (July 1 – September 30)
Submit annual report to Trustee Council

FY 14, 1st quarter (October 1 – December 31)
Trap mink at the Naked Island group

FY 14, 2nd quarter (January 1 – March 31)
Complete mink trapping and use dogs to check for any remaining mink at the Naked Island group

FY 14, 3rd quarter (April 1 – June 30)
Census breeding guillemots at Naked Island and nearby islands, 28-30 May

FY 14, 4th quarter (July 1 – September 30)
Submit annual report to Trustee Council

FY 15, 1st quarter (October 1 – December 31)

FY 15, 2nd quarter (January 1 – March 31)
Check for any remaining mink using dogs at the Naked Island group

FY 15, 3rd quarter (April 1 – June 30)
Census breeding guillemots at Naked Island and nearby islands, 28-30 May

FY 15, 4th quarter (July 1 – September 30)
Submit annual report to Trustee Council

FY 16, 1st quarter (October 1 – December 31)
Monitor to confirm absence of mink at the Naked Island group

FY 16, 2nd quarter (January 1 – March 31)
Set up field camp on Naked Island (Cabin Bay)
Monitor to confirm absence of mink at the Naked Island group
Eradication complete
Remove field camp on Naked Island

FY 16, 3rd quarter (April 1 – June 30)
Census breeding guillemots at Naked Island and nearby islands, 28-30 May
Amend Final Report with information on eradication and guillemot population trends

FY 16, 4th quarter (July 1 – September 30)
Submit Final report to Trustee Council

IV. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

All community input is always welcome to our project; the proposal process is open and the PAG members and other members of local communities may comment on proposals. The findings of the study will be communicated to local communities through various means including the annual EVOS meeting, on the web, distribution of reports, and the reports will be available in local libraries.

B. Resource Management Applications

The restoration described in this proposal is the only option likely to be effective or currently available to "initiate, sustain, or accelerate recovery", a recovery objective for Pigeon Guillemots identified in the 1994 Restoration Plan. This amendment represents the culmination of several years of research previously supported by the EVOS Trustee Council that assessed factors limiting recovery of Pigeon Guillemot populations damaged by EVOS. It directly reflects the findings of research conducted under Project 070853 in 2007 and 2008 on current factors limiting recovery of Pigeon Guillemots at the Naked Island group.

V. PUBLICATIONS AND REPORTS

An annual report for each year of this project will be submitted by 15 April of the following year. The final report for this project will be submitted by 30 September 2016. One manuscript will be generated from this research and will be published in the peer-reviewed scientific literature.

Budget Justification

FY 2011 – $218,000.00 Phase I
FY 2012 -- $580,081.00 Phase II
FY 2013 –$580,081.00 Phase II
FY 2014 –$360,656.70 Phase II
FY 2015 –$347,699.90 Phase II
FY 2016 --$347,870.00 Phase II
TOTAL: $2,434,218.40 Phase II

NOTE: David Irons and Dan Roby are submitting a proposal to the National Fish and Wildlife Foundation for 50% of the proposed budget of $2.2 million (half of the budget, excluding the cost of NEPA analysis). We will know before Phase II begins if we have been awarded funding by the National Fish and Wildlife Foundation.

Project Title: Pigeon Guillemot Restoration Research in Prince William Sound, Alaska, FY11 Amendment

Personnel: A project leader (GS 11) is needed to assist the Principal Investigators and must possess supervisory skills to oversee the activities of 9 subordinate workers. For the recovery monitoring we will need two bio techs for one month the first two years and three bio techs for three months the last three years. We will need one bio tech for 12 months each year to take care of all field gear preparation/maintenance and survey logistics. The project leader will allocate 7 months to the project -- 4 months for field work in each year of the project to conduct QA/QC on the data, enter data into the North Pacific Pelagic Seabird Database, conduct the analysis, and write the report. The analysis and writing will occur in FY16, when the report is due.

Request: (FY 2011: $0.0K; FY 2012: $98.1K; FY2013: $98.1K; FY 2014: $124.5K; FY 2015: $124.5K; FY 2016: $124.5K; TOTAL: $569.7K)

Travel: Three people in Years 1 and 2, and four people in Years 3, 4, and 5. Personnel will be traveling throughout Prince William Sound and will need approximately 8 nights of lodging in towns around the Sound. Per diem rates will be given to each person during the survey. A tunnel fee is assessed to every vehicle traveling through the tunnel between Portage and Whittier, and the truck/boat will make 10 round trips during the survey.

Request: (FY 2011: $0.0K; FY 2012: $9.1K; FY2013: $9.1K; FY 2014: $11.8K; FY 2015: $11.8K; FY 2016: $11.8K; TOTAL: $53.6K)

Contractual: A contract will be let to complete the NEPA analysis process in Phase I in FY 2011.

APHIS Wildlife Services will be contracted to eradicate mink at the Naked Island group. A minimum of three persons per boat (3 boats) for a total of nine persons are needed to trap mink for the first two years and one boat the last three years. We will need nine trappers for three months –in winter the first two years, six trappers for one month in year 3, and three trappers for one month for years 4 and 5. The trappers will need 6 nights of lodging in Whittier. Per diem rates will be given to the trappers while traveling and camping.
Prince William Sound is large and requires extensive travel by boat. To make the survey cost effective, a support vessel will be contracted to provide lodging and food for the winter trapping period, which is three months the first two years and one month the last three years. The small boats used to put the trappers on shore and for restoration monitoring will operate for hundreds of hours and will need repairs and replacement parts. There are also fees associated with launching and parking the boat in the harbors. Fuel storage at Naked Island will require a barge for transportation.

Requested: (FY 2011: $200.0K; FY 2012: $335.2K; FY2013: $335.2K; FY 2014: $119.0K; FY 2015: $113.1; FY 2016: $113.1K; TOTAL: $1,215.7K)

Commodities: Includes gas and oil to support boat transport and operation during the trapping in the winter, which will include three boats for three months the first two years, two boats for one month in the third year, and one boat for one month in the last two years. Restoration monitoring will require one boat for one month in the summer the first two years. During the last

three years, monitoring will require two boats for one month and one boat for two months. This also includes food for 6 people while conducting the restoration monitoring in the summer, when there would be no support vessel; and personal safety devices.

Request: (FY 2011: $0.0K; FY 2012: $86.8K; FY2013: $86.8K; FY 2014: $72.6K; FY 2015: $66.6K; FY 2016: $66.6K; TOTAL: $379.3K)

Equipment: We are using USFWS equipment for this survey as an in-kind contribution, but the survey work takes a toll on boats; on average, each boat will run a total of 40 full days. As a result, we are including funds for emergency replacement of motor parts that fail during the survey, should the need arise.

Request: (FY 2011: $0.0K; FY 2012: $3.0K; FY2013: $3.0K; FY 2014: $3.0K; FY 2015: $3.0K; FY 2016: $3.0K; TOTAL: $15.0K)

Indirect: We are using the standard G&A rate of 9%.

Request: (FY 2011: $18.0K; FY 2012: $47.9K; FY2013: $47.9K; FY 2014: $29.8K; FY 2015: $28.7K; FY 2016: $28.7K; TOTAL: $201.0K)

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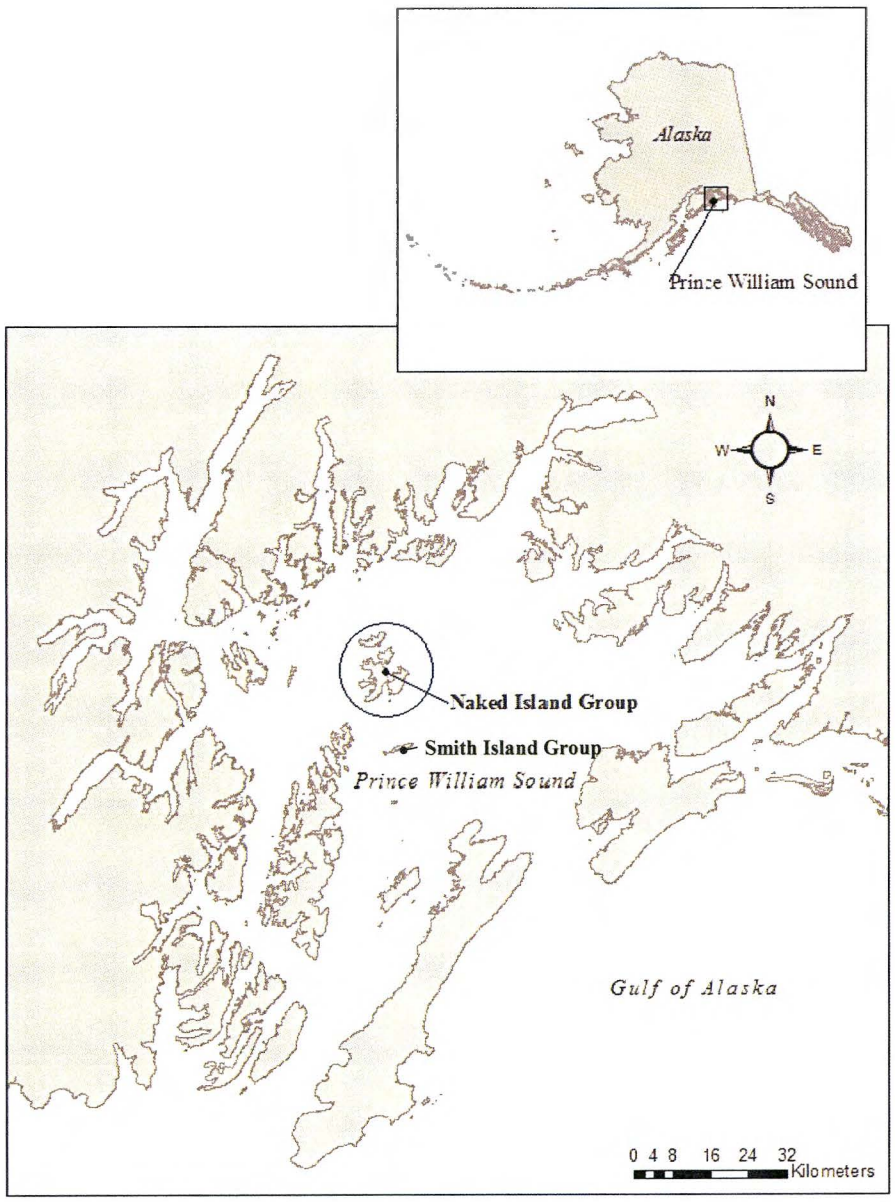

Figure 1. The location of Prince William Sound (inset map), the Naked Island group, and the nearby mink-free Smith Island group in Alaska.

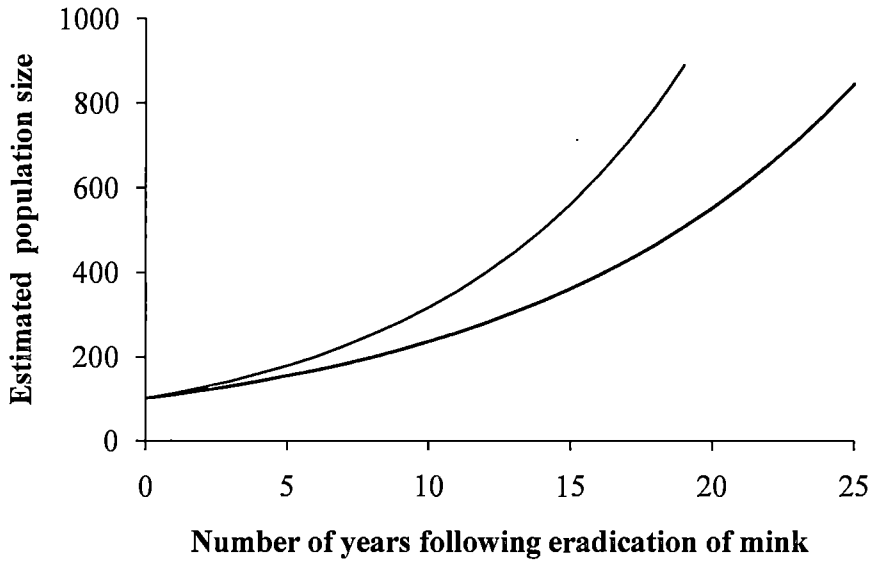

Figure 2. The maximum and minimum estimated Pigeon Guillemot population response at the Naked Island group in Prince William Sound, Alaska for 25 years after the eradication of American mink. The responses are calculated using a Leslie population-projection matrix after Golet et al. (2002). The two estimates are based upon an increase in productivity of 16% or 36% from the average productivity during the late 1990s, when the mink predation rate on guillemot nests was high at the Naked Island group.

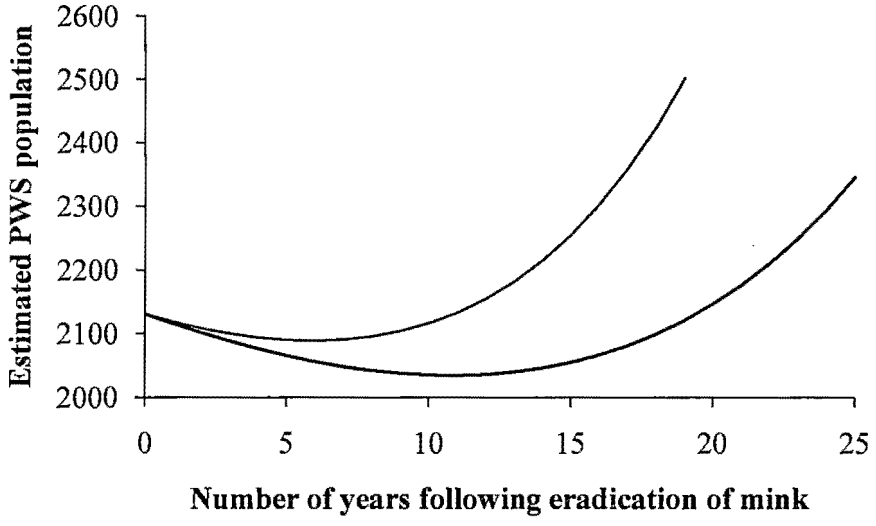

Figure 3. The maximum and minimum estimated Pigeon Guillemot population response in Prince William Sound, Alaska for 25 years after the eradication of American mink at the Naked Island group. The responses are calculated using a Leslie population-projection matrix after Golet et al. (2002). The two estimates are based upon a 16% or 36% increase from the average productivity at the Naked Island group during the late 1990s, when the mink predation rate on guillemot nests was high. Recovery of Pigeon Guillemots in Prince William Sound would occur despite the 1.2% mean decrease per annum in the population elsewhere in the Sound, as documented between 1989 and 2008.

Appendix A

American Mink Introduction to the Naked Island Group in Prince William Sound, Alaska: A Review of the Evidence

Kirsten S. Bixler, Dr. David B. Irons, and Dr. Daniel D. Roby

January 3, 2011

A recent drastic decline in numbers of Pigeon Guillemots (*Cepphus columba*) nesting at the Naked Island group in central Prince William Sound (PWS) is concurrent with the onset of sightings of American mink on the Naked Island group and frequent guillemot nest failures due to mink predation.

- Four islands in central PWS without mink had an average density of 49.4 Pigeon Guillemots/kilometer of shoreline. Four islands in central PWS with mink had an average density of 0.55 Pigeon Guillemots/kilometer of shoreline. Prior to the arrival of mink on the Naked Island group, the average density was 47.8 Pigeon Guillemots/kilometer of shoreline. After mink colonization, the Naked Island group had an average density of 0.96 Pigeon Guillemots/kilometer of shoreline.
- In 1978, no predation of guillemot nests was observed on the Naked Island group.
- By 1998, at least 60% of guillemot nests and 4.5% of breeding adult guillemots on the Naked Island group were depredated by mink.
- The Pigeon Guillemot breeding population at the Naked Island group has declined by more than 90% during the last 15 years, following the arrival of mink; in contrast, the guillemot population at nearby mink-free islands has been stable since 1990.
- Researchers have documented abundant food for guillemots (forage fish) near the Naked Island group.
- In addition to Pigeon Guillemots, several other seabird species show similar recent drastic declines in breeding populations on the Naked Island group. Tufted Puffins (*Fratercula cirrhata*) and Horned Puffins (*F. corniculata*) nest in greatly reduced numbers and are confined to the tallest cliffs. Parakeet Auklets (*Aethia psittacula*) and Arctic Terns (*Sterna paradisaea*) no longer nest at the Naked Island group.

Historical and current distribution of mink in Prince William Sound (PWS) demonstrate that mink are not native to the Naked Island group

- Mink do not naturally occur on isolated islands (> 5 km from the nearest mainland) in PWS (i.e., Montague, Green, Seal, Smith, and Little Smith islands).
- The Naked Island group is similarly isolated (6 km from the nearest island).
- The record for longest natural dispersal distance over open water by mink is 4 km.
- There were no mink found on the Naked Island group during a collecting expedition in 1908.

- No mink or evidence of mink were recorded on the Naked Island group between 1946 and the mid-1990's (see Ed Bilderback's Letter below) and mink were first documented on the Naked Island Group about 17 years ago.
- American mink have been intentionally introduced to isolated islands in PWS (i.e., Montague Island) and undocumented introductions of mink to other isolated islands have occurred in PWS.

Genetic study indicates mink at the Naked Island group were introduced

- Mink at the Naked Island group are descended in part from fur farm stock.
- Observed genetic diversity of mink at the Naked Island group is not consistent with natural colonization during infrequent dispersal events.
- The estimate of initial (founder) population size (about 5 pairs) is much larger than would be expected from a natural colonization event.

Published accounts of the effects of introduced American mink on their prey elsewhere document rapid and drastic declines in numbers of birds after mink introduction and large increases in bird populations following mink eradication

- On islands where mink were introduced, nearly all native species of birds, mammals, and amphibians present on the islands declined due to mink predation.
- Populations of most of these native species increased dramatically following mink removal.
- Eradication of introduced American mink on islands in the Baltic Sea resulted in a population increase of Black Guillemots (*Cepphus grylle*), a close relative of Pigeon Guillemots.

June 17, 2008

To Whom It May Concern:

I trapped mink, river otter, martin and wolverine throughout Prince William Sound from 1946 to 2002. I had a boat and traveled around trapping on the mainland and on most large islands. In the 1940's I noted that there were no mink on Montague, Green, Naked, Storey and Peak islands. There were river otter but no mink or martin. Mink occurred on the mainland and most large islands except for the ones mentioned above. Martin occurred on the mainland, but not on islands. In the 1950's the Alaska Department of Fish and Game introduced farmed mink on Montague Island, after that, I caught mink on Montague. I trapped the Sound every year and I never saw or caught a mink on the Naked Island group until the mid 1990's, when I saw a mink on Peak Island. It is my belief that mink did not naturally occur on Montague, Green, Naked, Storey, or Peak Islands.

Sincerely, Ed E. Bilderback

Ed Bilderback
P.O. Box 536
Cordova Alaska
99574

APPENDIX B

Compliance of Preferred Alternative with Standards Used to Judge Importance of Restoration Under the 1994 *Exxon Valdez* Oil Spill Restoration Plan

This document lists the seven standards used to assess the importance of restoration by the *Exxon Valdez* Oil Spill (EVOS) Trustee Council (*Exxon Valdez* Oil Spill Trustee Council 1994). Following each quoted policy, we provide details on compliance of the preferred alternative for restoration of Pigeon Guillemots (*Cepphus columba*) in Prince William Sound (i.e., eradication of mink at the Naked Island group; Restoration Project 10070853) with that standard.

1. "NATURAL RECOVERY"

There is no evidence that the population of Pigeon Guillemots in Prince William Sound (PWS) is recovering from the EVOS (McKnight et al. 2008, Appendix B). Given the persistent long-term population declines, even in the absence of exposure to residual oil (B. Ballachey, U.S. Geological Survey, pers. comm.), the population is unlikely to recover in the foreseeable future without restoration. Following action under the preferred alternative, we estimate that guillemot population at the Naked Island group would show significant signs of recovery within a decade and the Sound-wide guillemot population would show signs of increase within 15 years (Figure 3). This project provides a unique opportunity for recovery of an injured resource. There are no other restoration options currently available that are likely to be effective in addressing factors limiting recovery of the guillemot population in PWS.

2. "THE VALUE OF AN INJURED RESOURCE TO THE ECOSYSTEM AND TO THE PUBLIC"

The Pigeon Guillemot is neither federally endangered nor threatened, but it now the only marine bird species injured by EVOS that is listed as "not recovering" on the Exxon Valdez Oil Spill Trustee Council's Injured Resources List and has shown no sign of population recovery (*Exxon Valdez* Oil Spill Trustee Council 2009).

The Pigeon Guillemot is an apex predator in PWS, consuming a variety of nearshore demersal and schooling forage fishes. As such, the guillemot has been a sensitive indicator of both residual oil and changes in availability of marine forage fish in PWS (Golet et al. 2002). With its charisma and striking appearance the species contributes to the success of ecotourism, vital to the economy of the Sound.

3. "DURATION OF BENEFITS"

The benefits of the preferred alternative will be recognized indefinitely. The eradication of mink and subsequent monitoring will benefit the survival of both Pigeon Guillemot chicks and adults at the Naked Island group, increasing the viability of the species in the Sound in the face of large-scale environmental change.

4. "TECHNICAL FEASIBILITY"

Success in eradication of mink at the Naked Island group is expected. Due to geographic isolation, immigration by mink to the islands and natural recolonization is unlikely (Nordström and Korpimäki 2004). Methods of mink removal have been developed through several successful eradication campaigns in Europe, where feral American mink have had disastrous effects on native fauna (Bonesi and Palazon 2007). Methods for the lethal capture of mink have been successfully tested at the Naked Island group.

5. "LIKELIHOOD OF SUCCESS"

The best available science indicates that mink predation on guillemot nests and adults is the primary limiting factor for Pigeon Guillemots nesting at the Naked Island group (Appendix B). Further, there are striking declines in the guillemot population at the Naked Island group, where mink are present, and stable guillemot populations at nearby mink-free islands (Smith Island group). This suggests that mink eradication will result in a significant increase in guillemot adult survival, reproductive success, and population size. The effect of the proposed restoration action on the population size of guillemots at the Naked Island group would be readily measurable through periodic shoreline censuses using established protocols.

6. "HARMFUL SIDE EFFECTS"

The methods proposed in the preferred alternative include actions to minimize capture of non-target species. There is no evidence to suggest that restoration of guillemots at the Naked Island group would have a significant negative effect on herring (*Clupea pallasi*) because this fish has never been a large part of the diet of guillemots at this location (Golet et al. 2000). The unintended negative consequence of abrupt and destructive increases in the population of small exotic herbivores or omnivores following invasive carnivore removal (Bergstrom et al. 2009) is not a concern at the Naked Island group because no such exotic species (e.g., rabbits, rats) are present. Because mink at the Naked Island group are descendants in part from fur farm stock, their eradication would not have a negative impact on the Sound-wide population of native mink. Removal of mink from the Naked Island group would not pose a hardship to trappers in PWS because these islands are rarely used for mink harvest (R. Ellis, U. S. Department of Agriculture – Wildlife Services, pers. comm.).

7. "OPERATION AND MAINTENANCE SUPPORT REQUIRED"

Independent operational and maintenance funding will be identified during the competitive bid process.

8. "BENEFIT TO A SINGLE RESOURCE OR MULTIPLE RESOURCES"

The preferred alternative would be implemented specifically to address impacts on Pigeon Guillemots, but may also benefit a suite of seabird species whose breeding populations have declined or been locally extirpated at the Naked Island group including Arctic Terns (*Sterna paradisaea*), Parakeet Auklets (*Aethia psittacula*), Tufted Puffins (*Fratercula cirrhata*), and Horned Puffins (*Fratercula corniculata*) (Oakley and Kuletz 1979, KSB, pers. obs). Mink eradication may also benefit other populations of ground-nesting birds (Ferreras and MacDonald

1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, Banks et al. 2008), small mammals, amphibians (Banks et al. 2008), and crustacea (Bonesi and Palazon 2007).

9. "EFFECTS ON HEALTH AND HUMAN SAFETY"

The lethal mink removal methods proposed as part of the preferred alternative are specific to mink and would pose no risk to human health and safety.

10. "CONSISTENCY WITH APPLICABLE LAWS AND POLICIES"

The preferred alternative complies with the mission and policies of the EVOS Restoration Plan as well as the state and federal agencies responsible for the involved resources. Prior to implementation, this plan requires permit approval from responsible agencies (U.S. Forest Service, Alaska Department of Fish and Game).

11. "DUPLICATION"

The proposed action is a unique opportunity for the restoration of Pigeon Guillemots in PWS and does not duplicate other projects.

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APPENDIX C

Compliance of Preferred Alternative with Policies of the 1994 *Exxon Valdez* Oil Spill Restoration Plan

This document lists all 21 restoration policies of the *Exxon Valdez* Oil Spill (EVOS) Trustee Council (*Exxon Valdez* Oil Spill Trustee Council 1994). Following each quoted policy, we provide details on compliance of the preferred alternative for restoration of Pigeon Guillemots (*Cepphus columba*) in Prince William Sound (i.e., eradication of mink at the Naked Island group; Restoration Project 10070853) with that policy.

1. "RESTORATION SHOULD CONTRIBUTE TO A HEALTHY, PRODUCTIVE, AND BIOLOGICALLY DIVERSE ECOSYSTEM WITHIN THE SPILL AREA THAT SUPPORTS THE SERVICES NECESSARY FOR THE PEOPLE WHO LIVE IN THE AREA"

The proposed restoration would occur within the EVOS area at the Naked Island group in PWS. This location is the most important historical breeding site for Pigeon Guillemots in Prince William Sound. Guillemots are a conspicuous and particularly stunning resident of nearshore waters, and thus contribute to ecotourism in Prince William Sound. Eradication of mink at this location is likely to benefit not just the population of Pigeon Guillemots but a variety of locally depressed breeding populations of seabirds including Arctic Terns (*Sterna paradisaea*), Parakeet Auklets (*Aethia psittacula*), Tufted Puffins (*Fratercula cirrhata*), and Horned Puffins (*Fratercula corniculata*) (Oakley and Kuletz 1979, KSB, pers. obs). Mink eradication at the Naked Island group may also benefit additional taxa for which population declines due to predation by invasive mink have been documented in other areas. These taxa include ground-nesting birds (e.g., waterfowl; Ferreras and MacDonald 1999, Clode and MacDonald 2002, Nordström et al. 2002, Nordström et al. 2003, e.g., waterfowl; Banks et al. 2008), small mammals, amphibians (Banks et al. 2008), and crustacea (Bonesi and Palazon 2007).

2. "RESTORATION WILL TAKE AN ECOSYSTEM APPROACH TO BETTER UNDERSTAND WHAT FACTORS CONTROL THE POPULATIONS OF INJURED RESOURCES"

There has been intensive research on the nesting ecology and mechanisms regulating the population of Pigeon Guillemots nesting at the Naked Island group during 15 breeding seasons in the last 30 years. This research has identified three main factors constraining guillemot population recovery following EVOS; 1) exposure to residual oil, 2) availability of preferred prey, and 3) nest predation. The most recent study of Pigeon Guillemot nesting ecology at the Naked Island group concluded that mink predation on guillemot nests and adults is now the primary factor limiting their recovery (Appendix B). A study of mink genetic structure at the Naked Island group and other locales in PWS determined that mink at the Naked Island group are in part descendants of fur farm stock and were most likely introduced to the Naked Island group by humans (Appendix C). The restoration alternatives evaluated as part of this plan were based upon the extensive research previously conducted on Pigeon Guillemots at the Naked

Island group and elsewhere in PWS, and the preferred alternative was selected because it most effectively addressed our understanding of the current primary factor limiting recovery of the Pigeon Guillemot population at the Naked Island group.

3. "RESTORATION ACTIVITIES MAY BE CONSIDERED FOR ANY INJURED RESOURCE OR SERVICE"

The Pigeon Guillemot is the only marine bird species known to have been injured by EVOS that is listed as "not recovering" on the Exxon Valdez Oil Spill Trustee Council's Injured Resources List and has shown no sign of population recovery (*Exxon Valdez* Oil Spill Trustee Council 2009).

4. "RESTORATION WILL FOCUS UPON INJURED RESOURCES AND SERVICES AND WILL EMPHASIZE RESOURCES AND SERVICES THAT HAVE NOT RECOVERED"

The population of Pigeon Guillemots in PWS was injured by EVOS and has declined by more than 90% on the Naked Island group since 1990. Although there is no longer evidence that residual oil from EVOS is having a direct negative effect on Pigeon Guillemots in the Sound (B. Ballachey, U.S. Geological Survey, pers. comm.), the population continues to decline.

5. "RESOURCES AND SERVICES NOT PREVIOUSLY IDENTIFIED AS INJURED MAY BE CONSIDERED FOR RESTORATION IF REASONABLE SCIENTIFIC OR LOCAL KNOWLEDGE OBTAINED SINCE THE SPILL INDICATES A SPILL-RELATED INJURY"

The Pigeon Guillemot in PWS is considered a resource injured by EVOS (*Exxon Valdez* Oil Spill Trustee Council 2009).

6. "PRIORITY WILL BE GIVEN TO RESTORING INJURED RESOURCES AND SERVICES WHICH HAVE ECONOMIC, CULTURAL AND SUBSISTENCE VALUE TO PEOPLE LIVING IN THE OIL SPILL AREA, AS LONG AS THIS IS CONSISTENT WITH OTHER POLICIES"

Although Pigeon Guillemots have little subsistence value, they contribute to the local culture as well as the success of ecotourism in PWS. Guillemots are conspicuous, vocal, and charismatic and thus play a role in the auditory and visual experience of all who frequent the shoreline of PWS.

7. "POSSIBLE NEGATIVE EFFECTS ON RESOURCES OR SERVICES MUST BE ASSESSED IN CONSIDERING RESTORATION PROJECTS"

The preferred alternative includes actions to minimize capture of non-target species (i.e., trap type and use of artificial burrows for trap deployment). There is no evidence to suggest that restoration of guillemots at the Naked Island group would have a significant negative effect on Pacific herring (*Clupea pallasi*). Herring have never been an important part of the diet of guillemots nesting at the Naked Island group (Golet et al. 2000). Mink at the Naked Island group are rarely exploited for their fur (R. Ellis, U.S. Department of Agriculture – Wildlife Services, pers. comm.), and thus a mink eradication project at this location would not pose a hardship to trappers in PWS. Due to fur farm ancestry, the eradication of mink at the Naked Island group would not have a negative impact on the Sound-wide population of native mink. Finally, because there are no small exotic herbivores or

omnivores (e.g., rabbits, rats) at the Naked Island group, there is no concern for abrupt and destructive increases in the population of exotic species following invasive carnivore removal (Bergstrom et al. 2009).

8. "RESTORATION ACTIVITIES WILL OCCUR PRIMARILY WITHIN THE SPILL AREA"

The preferred alternative consists of restoration actions at the Naked Island group located in the EVOS area. In fact, the first shoreline to be oiled following EVOS was the Naked Island group in the center of PWS (Oakley and Kuletz 1996).

9. "PROJECTS DESIGNED TO RESTORE OR ENHANCE AN INJURED SERVICE"

The preferred alternative is the most effective alternative available for increasing the reproductive success and population size of Pigeon Guillemots at the Naked Island group and would facilitate the recovery of this injured resource within PWS. However, the Pigeon Guillemot is not considered an injured service.

10. "COMPETITIVE PROPOSALS FOR RESTORATION PROJECTS WILL BE ENCOURAGED"

The restoration would be conducted by a team chosen through a competitive bid process.

11. "RESTORATION WILL TAKE ADVANTAGE OF COST SHARING OPPORTUNITIES WHERE EFFECTIVE"

Opportunities for cost sharing, especially with the U.S. Fish and Wildlife Service, will be identified during the competitive bid process.

12. "RESTORATION SHOULD BE GUIDED AND REEVALUATED AS INFORMATION IS OBTAINED FROM DAMAGE ASSESSMENT STUDIES AND RESTORATION ACTIONS"

The preferred alternative would use an adaptive management approach. Data collected through trapping (e.g., trapping success, sex of trapped animals), as well as shoreline censuses for Pigeon Guillemots would be reviewed regularly. If there is evidence that the project's objective is not being met, restoration project methods would be modified.

13. "PROPOSED RESTORATION STRATEGIES SHOULD STATE A CLEAR, MEASURABLE AND ACHIEVABLE ENDPOINT"

The restoration action includes eradication of mink at the Naked Island group, which should be achievable within 5 years or less. Continued monitoring, to document the response by the guillemot breeding population and verify the continued absence of mink at the Naked Island group, is recommended.

14. "RESTORATION MUST BE CONDUCTED AS EFFICIENTLY AS POSSIBLE, REFLECTING A REASONABLE BALANCE BETWEEN COSTS AND BENEFITS"

The preferred alternative is the most effective method to elevate the productivity and population size of Pigeon Guillemots nesting at the Naked Island group and facilitate the recovery of the species in PWS. This alternative is less expensive, both economically and in numbers of mink and other guillemot predators sacrificed, compared to culling methods (Courchamp et al. 2003). Other alternatives are either currently unavailable or unlikely to be effective in restoring Pigeon Guillemots.

15. "PRIORITY SHALL BE GIVEN TO STRATEGIES THAT INVOLVE MULTI-DISCIPLINARY, INTERAGENCY, OR COLLABORATIVE PARTNERSHIPS"

The Pigeon Guillemot restoration plan was developed by employees of the U.S. Fish and Wildlife Service, Oregon State University, and U.S. Geological Survey - Oregon Cooperative Fish & Wildlife Research Unit at Oregon State University. In addition, employees of the Museum of Southwestern Biology at the University of New Mexico contributed to the most current research used in the development of this restoration plan.

16. "RESTORATION PROJECTS WILL BE SUBJECT TO OPEN, INDEPENDENT SCIENTIFIC REVIEW BEFORE TRUSTEE COUNCIL APPROVAL"

In addition to the EVOS Trustee Council review, Appendix A, B, and C of this report have or will be subjected to the peer-review process required for M.Sc. thesis defense and/or publication in peer-reviewed scientific journal(s).

17. "PAST PERFORMANCE OF THE PROJECT TEAM SHOULD BE TAKEN INTO CONSIDERATION WHEN MAKING FUNDING DECISIONS ON FUTURE RESTORATION PROJECTS"

The past performance of potential project teams would be reviewed by the Council during the competitive bid process for restoration implementation.

18. "RESTORATION WILL INCLUDE A SYNTHESIS OF FINDINGS AND RESULTS, AND WILL ALSO PROVIDE AN INDICATION OF IMPORTANT REMAINING ISSUES OR GAPS IN KNOWLEDGE"

The preferred alternative would provide new quantitative information on the population response of Pigeon Guillemots within PWS to release from intense predation pressure by mink at the Naked Island group. These results would clarify the importance of predator management for seabirds in PWS and provide important information to seabird managers world-wide. The project team responsible for implementation of the restoration project would adhere to all EVOS Trustee Council reporting requirements.

19. RESTORATION MUST INCLUDE MEANINGFUL PUBLIC PARTICIPATION AT ALL LEVELS - PLANNING, PROJECT DESIGN, IMPLEMENTATION AND REVIEW"

Prior to implementation, the restoration plan would be subject to a public comment period.

20. "RESTORATION MUST REFLECT PUBLIC OWNERSHIP OF THE PROCESS BY TIMELY RELEASE AND REASONABLE ACCESS TO INFORMATION AND DATA"

The project team responsible for implementation would adhere to all EVOS Trustee Council reporting requirements.

21. "GOVERNMENT AGENCIES WILL BE FUNDED ONLY FOR RESTORATION PROJECTS THAT THEY WOULD NOT HAVE CONDUCTED HAD THE SPILL NOT OCCURRED"

There are currently no plans by government agencies to restore the breeding population of Pigeon Guillemots, either on the Naked Island group or within Prince William Sound.

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PROPOSAL FORM

THIS FORM MUST BE SUBMITTED BY THE PROPOSED PRINCIPAL INVESTIGATOR (S) AND SUBMITTED ALONG WITH THE PROPOSAL.

By submission of this proposal, I agree to abide by the Trustee Council's data policy (*Trustee Council Data Policy**, adopted March 17, 2008) and reporting requirements *(Procedures for the Preparation and Distribution of Reports***, adopted June 27, 2007).

PROJECT TITLE: Lingering Oil on Boulder-Armored Beaches in the Gulf of Alaska 22 Years after the *Exxon Valdez* Oil Spill

Name of PI: Gail V. Irvine

Email: girvine@usgs.gov Phone: 907-786-7069

Mailing Address U.S. Geological Survey, 4210 University Drive

City, State, Zip Anchorage, AK 99508

Name of PI: Daniel H. Mann

Email: dhmann@alaska.edu Phone: 907-474-7127

Mailing Address Scenarios Network for Alaska Planning, Geography Program

University of Alaska

City, State, Zip Fairbanks, AK 99775

Name of PI: Mark G. Carls

Email: mark.carls@noaa.gov Phone: 907-789-6019

Mailing Address National Marine Fisheries Service, Auke Bay Laboratories

17109 Pt. Lena Loop Road

City, State, Zip Juneau, AK 99801

* www.evostc.state.ak.us/Policies/data.cfm

** www.evostc.state.ak.us/Policies/reporting.cfm

FY11 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Lingering Oil on Boulder-Armored Beaches in the Gulf of Alaska 22 Years after the *Exxon Valdez* Oil Spill

Project Period: FFY2011-2012

Primary Investigator(s): Dr. Gail Irvine (USGS), Dr. Daniel Mann (Mann's Environment), Mark Carls (NOAA, NMFS)

Study Location: Gulf of Alaska, (Katmai National Park & Preserve, Kenai Fjords NP&P)

Abstract: We want to continue long-term monitoring of lingering oil at six Gulf of Alaska sites where we have tracked the fate and persistence of stranded *Exxon Valdez* oil over the last 22 years. It has been six years since our last survey revealed that relatively unweathered oil still persisted at some sites. Interestingly these sites have less weathered oil (e.g., contains more *n*-alkanes) than similarly aged oil from Prince William Sound. All five of our monitoring sites on the Katmai National Park coast are boulder beaches with high wave energies. Accepted knowledge predicted that rapid natural weathering of stranded oil would occur in such settings. This was not the case, and we are still figuring out why. We think it is because the boulder armors that cover these shorelines protect the underlying oil. In addition to resampling our monitoring plots, we will be testing to see if oil is leaking out from these beaches. By extending our long term study of oil stranded on this little understood shoreline type, we will contribute important new data useful for predicting the geographic distribution of lingering oil, assessing its potential for continued pollution, and designing methods for its remediation.

Estimated Budget: $203.8k
EVOS Funding Requested:
FFY2011: $178.2k, FFY2012: $25.6k
Non-EVOS Funds to be used:
FFY2011: $31.6, FFY2012: $4.0k

Date: Jan. 7, 2011

(NOT TO EXCEED ONE PAGE)

Lingering Oil on Boulder Armored Beaches in the Gulf of Alaska 22 Years after the *Exxon Valdez* Oil Spill

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

Contrary to the predictions made by oil-spill experts in 1989, significant amounts of *Exxon Valdez* oil remain in the spill region 20 years later. Short et al. (2004) estimate there are 7.8 hectares of oiled shorelines left in Prince William Sound (PWS) containing some 56,000 kilograms (kg) of lingering oil in the subsurface. Furthermore, Short et al. (2007) assert that the areal extent of oiled beaches in PWS did not change significantly between 2001 and 2005, which implies that the rate of decline in lingering oil has slowed. There have been no detailed studies of the amount of lingering oil in the Gulf of Alaska; however, long-term monitoring of oiled sites shows persistence of relatively unweathered oil in Kenai Fjords National Park and Katmai National Park (Irvine et al., 1999; 2006; 2007). Is that oil still there on high wave energy beaches in the Gulf of Alaska? Has its chemical weathering changed significantly? Is it leaking from the beach, thereby potentially posing biological threat? If it is still there, what factors are causing it to persist?

1)Background

a) Lingering Exxon Valdez Oil

Our knowledge about lingering oil in the spill region has become much more complete over the last 20 years, but large gaps still exist. Some of these gaps involve geographical differences in oiling and geomorphology/exposure within the spill region. For example, in PWS oil reached shorelines in a more fluid or less viscous form than the emulsified water/oil form (mousse) that landed on GOA shores. Also, PWS is in general a more protected environment than the GOA, and this basic fact has widespread implications for the coastal geomorphologies of the two areas. We know now that in PWS much of the remaining oil is found at a lower level in the intertidal zone than was thought immediately after the spill (Short et al., 2006). On the other hand, this is not a universal pattern, since lingering oil in the GOA tends to be located high in the intertidal zone (Irvine et al., 2006). A modeling study designed to predict the location of lingering subsurface oil within the spill area, including both Prince William Sound (PWS) and the Gulf of Alaska (GOA), was begun in 2007 (Michel et al., 2010). This ground-breaking work has developed geospatial models that identify areas where subsurface oil is still present on the shorelines of PWS and the GOA and estimate the relative quantities of subsurface oil remaining at different sites. One of the most significant results of this work is its prediction that a significant number of as-yet-unsurveyed sites in PWS and the GOA still contain subsurface oil. On the down side, this geospatial model has been developed primarily based on data from PWS and so has limited applicability to GOA sites. Furthermore, it is implicit in multi-variable models that while overall predictive success may be high (as in PWS), the linkages between the data used and the physical phenomena that drive oil persistence remain unclear (Michel et al., 2010). In other words, the model may work, but we still do not understand the geomorphic and geochemical processes that allow the persistence of stranded oil.

Other recent EVOS-funded studies focus on smaller-scale processes related to subsurface oil persistence. M. Boufadel and collaborators are studying factors that limit the degradation rate of oil in PWS beaches including nutrient and oxygen concentrations and water flow (Boufadel et al., 2010; Li and Boufadel, 2010). A. Venosa et al. (2010) have researched the factors limiting biodegradability of oiled sediment. Both these small-scale, process studies emphasize the importance of oxygenation, nutrient availability, and hydraulic conductivity in the subsurface of oiled beaches. Certainly, these small-scale variables are influenced at larger spatial scales by the nature and stability of the overlying armor layers.

b) Boulder Armored Beaches

Boulder armors develop naturally when the finer particles (silt, sand, pebbles, and cobbles) are winnowed away by waves, deflating the pre-existing sediments until a layer of boulders remains that prevents further winnowing. Natural boulder armors are little studied despite their wide distribution on shorelines around the world and despite the widespread use of artificial boulder armors to stabilize eroding beaches (Dean and Dalrymple, 2004). Natural and artificial armors are distinctly different phenomena, and the stability formulae used to design artificial armors have little relevance to natural armors (Oak, 1986). A recent review of armored, gravel beaches on paraglacial coastlines is given by Hayes et al. (2010).

Boulder beaches are often intricately packed or fitted together with the projections of one boulder accommodated in the concavities of its neighbors (Shelley, 1968). Smaller boulders are often imprisoned amongst larger ones (Hills, 1970). The fitting together of boulder armors occurs by boulders shifting in place, rubbing against their neighbors until achieving a packing of maximum stability. Tracking of the positions of individually marked boulders on the Katmai coastline shows that while individual boulders regularly roll and shift in place, few ever move out of their niches within the surrounding armor (Irvine et al., 2006; 2007). Armors form tightly fitted fabrics that are highly resistant to wave attack and may be stable for thousands of years (Bishop and Hughes, 1989). Hence boulder armors represent equilibrium geomorphic features; that is, they develop into progressively more stable entities to the point where most wave events cannot disturb them or the sediments (and oil) they cover. Boulder armors are ubiquitous on Gulf of Alaska shorelines (Hayes et al., 2010). Exceptions are shorelines where sea-level changed radically during the Great Alaskan Earthquake in 1964 and shorelines experiencing rapid progradation by glacial outwash.

In summary, naturally occurring boulder armors are widespread on rocky shorelines. Because they are created through waves, armors are most common and best developed on high energy shorelines like many in the GOA and on exposed shorelines in PWS. The dynamics of boulder armors have been little studied relative to sandy and gravel beaches, which tend to be more widespread at lower latitudes. As a result, the processes important in the development and maintenance of boulder armors remain poorly known, though it is clear that boulder beaches are quite different from sand and gravel beaches with a unique set of formative processes (Oak, 1984; Hayes et al., 2010). Another thing that is clear is that boulder-armored shorelines can harbor slightly weathered oil for long periods of time (Irvine et al., 2006; 2007; Short et al., 2007). It seems likely that if there is still *Exxon Valdez* oil in the environment of southern Alaska 50 years hence, it will be associated with boulder armors.

c) Our Long Term Monitoring Study of GOA Shorelines

Since 1994, we have monitored the status of *Exxon Valdez* oil at six sites in the Gulf of Alaska (Irvine et al., 1999; 2006; 2007; Short et al., 2007). These sites are now the most consistently studied, long-term monitoring sites of stranded oil in the spill region. Sixteen years post-spill, surface oiling had declined markedly at all sites, but subsurface oil remained abundant. The oil collected from beneath the boulder armor at three of the four sites surveyed was still compositionally similar to eleven-day old *Exxon Valdez* oil (Short et al., 2007). Remarkably, this oil still contained *n*-alkanes, which normally would be degraded by microbes within weeks of a spill. When the composition of *Exxon Valdez* oil from the GOA was compared to that from PWS, the GOA oil was less-weathered (Short et al., 2007). These findings indicate that our GOA study of the long-term persistence of stranded oil may provide insights not possible from PWS studies and that may apply to some of the extensive coastline that was oiled outside of PWS.

The persistence of oil at high wave-energy sites in the GOA seems to be related to the presence of stable boulder armors. Though not initially chosen for this reason, all five of our monitoring sites on the Katmai National Park and Preserve coast in the GOA possess such boulder armors. The prediction that oil persistence correlates with armor stability has been borne out over the last 16 years. Analysis of movements in the boulder armors reveals that only minor shifts have occurred since 1994. These findings suggest that boulder armors, combined with the stranding of oil mousse high in the intertidal zone, results in the unexpectedly lengthy persistence of only slightly to moderately weathered oil within otherwise high-energy wave environments on GOA coastlines. The three-dimensional matrix provided by boulder-armored beaches allows oil to penetrate into finer sediments lying beneath stable, boulder lags. Previously it was thought that oil would be rapidly removed from such geomorphic settings by the vigorous wave action (Vandermuelen, 1977). Instead, these surface armors attenuate wave energy and reduce wave reworking of the underlying substrates and the included oil. Additionally, oil on boulder-armored beaches is sheltered by the boulders from sun exposure (Irvine et al., 1999). Similar inferences about the importance of boulder armors in allowing oil to persist for long periods on exposed shorelines comes from observations made inside PWS (Michel and Hayes, 1993a, b; 1995; 1999; Hayes and Michel, 1999; Hayes et al., 2010). Understanding the dynamics of armored shorelines is basic to understanding what determines the distribution of persistent, subsurface oil.

The persistence of this oil in the GOA raises questions about it potential or realized biological effects. In PWS a number of studies have examined biological effects of the spill over the years (e.g., Bodkin et al., 2002; Esler and Iverson, 2010), but these types of studies are lacking in the GOA except for more limited temporal sampling of oiled mussel beds (Babcock, et al., 1996; Carls, et al., 2001, Irvine et al., 2007). Thus the ability to tie lingering oil to biotic effects is limited. We propose to examine whether oil is being released from these sites as a first step in addressing this particular gap in our understanding of biological effects of lingering oil.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

Our proposed work will address the physical and chemical processes responsible for the persistence of lingering oil in the spill region within the GOA and seeks to understand the reasons why this long lingering oil has failed to degrade. Additionally, we are investigating whether the oil is being released and may be affecting biota. Of particular significance is the fact

that five of our long-term monitoring sites are located within a designated wilderness area in Katmai National Park and Preserve. Our findings will provide direct evidence of the recovery status of these special-value lands and will assist in the evaluation of remediation options that could lead to restoration of these injured natural resources. Our proposed study of lingering subsurface oil on boulder armored beaches in the GOA will fill a geographical gap in our understanding of the distribution of lingering oil and directly complement recent or ongoing studies of oil biodegradation at finer spatial scales.

II. PROJECT DESIGN

Objective #1. What is the status of oiling at our long-term monitoring sites, 22 years after the *Exxon Valdez* spill? Specifically, how chemically weathered is the oil today, and how have the extents of surface and subsurface oiling changed?

Objective #2: How much of the subsurface oil preserved under boulder armors at our GOA monitoring sites is presently leaking into the surrounding environment?

Objective #3: How stable have the boulder armors on our study beaches been over the last 22 years and how does this relate to the findings from Objectives #1 and 2?

B. Procedural and Scientific Methods

1) What is the status of oiling at our long-term monitoring sites, 22 years after the *Exxon Valdez* spill? Specifically, how weathered is the oil and how have the extents of surface and subsurface oiling changed?
We will reassess the extent of both surface and subsurface oil using the same methods we have used since 1994 at these sites. Additionally, we will collect two oiled sediment samples from each site for hydrocarbon analyses. These samples will be analyzed via gas-chromatography/mass-spectrometry (GCMS) by NOAA's Auke Bay Laboratory.

2) Is the subsurface oil preserved under boulder armors presently leaking into surrounding environment?
Although oil has persisted at our GOA monitoring sites for at least 16 years, we do not know if oil is presently leaking from the subsurface into the environment. If it is occurring, such leakage could be having biological impacts. To ascertain if oil is leaking out, we will deploy low density polyethylene strips (LDPEs), which we refer to here simply as "plastic strips." These plastic strips function like the better known semi-permeable membrane devices (SPMDs) (Chapman, 2006), but are superior when the hydrocarbon signal is low (e.g., in relatively unpolluted environments), since they record less background 'noise' than do SPMDs (Jeep Rice, pers. comm.). Polynuclear aromatic hydrocarbons (PAHs) are adsorbed onto the plastic strips, but not alkanes or particulate oil. We will deploy the plastic strips, in their protective containers, in radiating patterns near boulder armors that still shelter remnant oil, and also at control sites. Our plan is to place the plastic strips at two of our long-term monitoring sites on the Katmai coast and at two un-oiled control sites relatively near these oiled sites. At each oiled site, we will deploy 10 plastic strips, while at each control site we plan to deploy 4 plastic strips. Trip and field blanks will be collected and analyzed for control purposes. At all sites, the plastic strips will be

left in place for up to 30 days, then collected for analysis of hydrocarbons. We also plan to collect mussels (*Mytilus trossulus*) near these same sites - where they are present - and analyze them for hydrocarbons as well, since they are better indicators of particulate hydrocarbons (Jeff Short, pers. comm.).

3) How stable are the boulder armors?
We will resurvey the locations of the marked boulders at each site, using the same methods as previously. The deviations from the previous locations will be calculated and used to determine if individual boulders have moved significantly over time. The degree of boulder movement on each beach will be used to interpret the data gathered in Objectives #1 and #2 on the extent, chemical composition of oiling and whether oil is being released into the environment. If boulder armors are responsible for the long term persistence of EVOS oil, we expect to see the most oil and the least weathered oil at sites whose armors have moved the least.

C. Data Analysis and Statistical Methods

Surface oiling at our GOA monitoring sites is reassessed in marked quadrats by estimating oil percent cover. Percent cover data for individual quadrats will be compared through time (1994, 1999, 2005, and 2011) via pair-wise tests. As for all tests discussed here, the data will be tested for normality and the appropriate parametric or non-parametric test chosen. Data from previous years (1994, 1999 and 2005) were compared in our latest report and manuscript via Wilcoxon signed-rank tests.

Subsurface oiling is assessed through the sampling of "dip stones" at each site. These are naturally occurring cobbles that extend from the sub-armor surface of the substrate downwards through the zone of subsurface oiling. Means and ranges of the depth of oiling for each site will be compared through time.

Hydrocarbon analyses:
Oil composition and weathering: As in our previous studies, chemical analysis of sediment, mussel and LDPE samples will be conducted via gas-chromatography/mass-spectrometry (Short et al., 1996a). We will compare the presence and relative abundance of polynuclear aromatic hydrocarbons (PAH) within samples, and compute a weathering index based on a first-order kinetic loss rate model of Short and Heinz (1997), which will be used to compare the degree of weathering of different samples at the same and different sites. Additionally, the proportion of *n*-alkanes and PAHs remaining through time will be compared among samples and sites. These analyses permit identification of the source of the oil.
LDPE data: The concentration and distribution of PAHs in these samples will be compared between oiled and non-oiled (control) armored beaches.

Boulder movement: We will use the same combination of survey methods employed in our earlier surveys. Measurement of boulder movement will be compared between years, by site. Various measures of movement, e.g., horizontal and vertical displacements, changes in angular orientation of the marker bolts, will be considered separately. Measurement error is determined through repeated measurements of selected marked bolts. The significance of displacements for the boulder armoring will be evaluated in relation to the size classes of the boulders on the beach.

Variations between beaches will be contrasted, especially in relation to the extent of chemical weathering of oil samples.

D. Description of Study Area

As detailed above, we are proposing to continue monitoring of six sites located on the GOA coastline, in Katmai National Park & Preserve and Kenai Fjords National Park and Preserve (Irvine et al., 1999; 2006; 2007; Short et al., 2007). We have monitored oiling conditions and boulder movements at these sites since 1994. Maps with the location of the study sites and details of site morphology and sampling have been included in previous reports submitted to the EVOS Trustee Council.

E. Coordination and Collaboration with Other Efforts

NOAA is a cooperating agency, and Mark Carls, the head of the analytical lab at NOAA's Auke Bay Fisheries Laboratory, is a principal investigator on the project. We have been in communication with the NPS regarding this project, and most closely there with Bud Rice. We plan to have NPS staff with us in the field, and will be training staff in our sampling procedures. The NPS continues to be interested in and concerned with the persistence of oil on the Katmai and Kenai Fjords National Park coastlines.

III. SCHEDULE

A. Project Milestones

Objective 1. Determine status and extent of persistent oiling at the long-term GOA study sites.
To be met by March 2012

Objective 2. Determine if oil is leaking from GOA armored beaches.
To be met by March 2012

Objective 3. Determine the stability of the boulder armors.
To be met by February 2012

B. Measurable Project Tasks

FFY 11, 2nd quarter (January 1, 2011-March 31, 2011)
February: *Project funding approved by Trustee Council*

FFY 11, 3rd quarter (April 1, 2011-June 30, 2011)
Contracting, hiring, preparation for field work

FFY 11, 4th quarter (July 1, 2011-September 30, 2011)
Field work
Shipment of hydrocarbon samples to Auke Bay Labs

FFY 12, 1st quarter (October 1, 2011-December 31, 2011)

December 15: *Begin data and hydrocarbon analyses*

FFY 12, 2nd quarter (January 1, 2012-March 31, 2012)

January 18: *Annual Marine Science Symposium*

March 1: *Complete hydrocarbon analyses*

Write report/manuscript

FFY 12, 3rd quarter (April 1, 2012-June 30, 2012)

April 15: *Submit final report. This will consist of a draft manuscript for publication to the Trustee Council Office.*

FFY 12, 4th quarter (July 1, 2012-September 30, 2012)

Present findings at national conference (during FFY12 or FFY13)

C. Publications & Reports

The study results will be submitted to EVOS TC as a manuscript that will later be submitted for publication in a peer-reviewed journal. We are requesting funding for the writing of this manuscript and its publication in a peer-reviewed journal. The tentative title of one manuscript is: "Oil persistence 22-years after the *Exxon Valdez* spill on boulder-armored beaches distant from the spill origin." We plan to target the journal, Marine Environmental Research, with a submission date planned for Dec. 2012.

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V. RESUMES

Gail V. Irvine

Research Ecologist
U.S. Geological Survey, Alaska Science Center
4210 University Drive
Anchorage, AK 99508

Phone: 907-786-7069
FAX: 907-786-7150
E-mail:girvine@usgs.gov

A. Education

Ph.D. 1983 University of California, Santa Barbara, Biological Sciences
Emphasis – Aquatic and Population Biology
M.S. 1973 University of Washington, Seattle; Zoology
B.A. 1969 University of California, Santa Barbara; Zoology (Honors)
Attended 1965-66 Alaska Methodist University

B. Professional Positions

Research Ecologist, U.S. Geological Survey, Alaska Science Center, 1995 – present
Coastal Resources Specialist, National Biological Survey/U.S.Geological Survey, 1993-1995
Coastal Resources Specialist, National Park Service, 1991-1993
Marine Biologist/Fisheries Scientist, Minerals Management Service, 1984-1991

Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara, 1983

C. Scientific Involvement

Editorial Board of Marine Systems Domain, online journal, TheScientificWorld, *2001-present*

Member, Non-indigenous Species Working Group, PWS RCAC

D. Five Recent Publications Related to the Lingering Oil Project

Irvine, G.V., Mann, D.H., Short, J.W. Sixteen-year persistence of slightly weathered *ExxonValdez* oil under boulder armors on beaches distant from the 1989 spill. (***in revision***)

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E. Other Publications

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F. Persons with whom Dr. Irvine has collaborated on a project or publication with over the last four years

Scott Carpenter, Dept. of Geosciences, University of Iowa, Iowa City, Iowa
Sandra Lindstrom, Dept. of Botany, University of British Columbia, Vancouver, B.C., Canada
Dan Mann, Institute of Arctic Biology, University of Alaska, Fairbanks
Anne Pasch, Dept. Biology, University of Alaska, Anchorage

Jeanne Schaaf, Director, Lake Clark-Katmai Studies Center, National Park Service, Anchorage, AK

Nora Foster, NF Taxonomic Services, Fairbanks, Alaska

Jeff Short, Auke Bay Lab, NOAA, Juneau, Alaska
John Southon, Earth System Science Dept., University of California, Irvine, CA
Bernd Schoene, University of Mainz, Germany
Nadine Hallman, University of Mainz, Germany
Jacqui Michel, Research Planning, Inc., South Carolina
Zach Nixon, Research Planning, Inc., South Carolina
Miles Hayes, Research Planning, Inc., South Carolina

DANIEL H. MANN

CONTACT INFORMATION
email: dhmann@alaska.edu
mailing address: Scenarios Network for Alaska Planning, Geography Program, University of Alaska, Fairbanks, AK 99775
telephone: work (907) 474-7127

PROFESSIONAL CREDENTIALS

1983-1985 Post-Doctoral Fellow, Quaternary Research Center, University of Washington: Sea-level history and soil development in Svalbard.

1978-1983 PhD. Quaternary Science, College of Forest Resources, University of Washington: Quaternary History of the Lituya Glacial Refugium, Alaska.

1976-1978 MSc. Entomology, University of Washington: Ecology of Snowfield-Foraging Arthropods on Mount Rainier

1971-1975 B.A. Social Anthropology, University of Washington

EMPLOYMENT HISTORY

2008-present Associate Professor, Geography Program, School of Natural Resources University of Alaska, Fairbanks, Alaska

1994-2008 Research Associate, Institute of Arctic Biology, University of Alaska

1991-2006 Research Associate, Alaska Quaternary Center and Institute of Arctic Biology, University of Alaska

1988-1991 Research Associate, Quaternary Research Center, University of Washington

1985-1988 Director, School for Field Naturalists, University of Vermont

FIVE RELATED PUBLICATIONS

Mann, D.H. and Streveler, G.P. (2008). Relative sea level history, isostasy, and glacial history in Icy Strait, Southeast Alaska. *Quaternary Research* 69, 201–216.

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Irvine, G.V., D.H. Mann, J.W. Short. 1999. Multi-year persistence of oil mousse on high energy beaches distant from the *Exxon Valdez* spill origin. Marine Pollution Bulletin, 38(7): 572-584.

FIVE OTHER SIGNIFICANT PUBLICATIONS

Mann, D.H., Groves, P., Reanier, R.E. and Kunz, M.L. (2010). Floodplains, cottonwood trees, hillslopes and peat: What happened the last time climate warmed suddenly in arctic Alaska? *Quaternary Science Reviews* 29, 3812-3830.

Mann, D.H., Reanier, R.E., Beck, W., and Edwards, J. (2008). Drought, vegetation change, and human history on Rapa Nui (Isla de Pascua, Easter Island). *Quaternary Research* 69, 16–28

Mann, D.H., Crowell, A.L., Hamilton, T.D., and Finney, B.P. (1999). Holocene Geologic and climatic history around the Gulf of Alaska. *Arctic Anthropology* 35, 112-131.

Crowell, A.L. and Mann, D.H. (1996). Human populations, sea level change, and the archaeological record of the Northern Gulf of Alaska coastline. *Arctic Anthropology* 33, 16-37.

Mann, D.H. and Hamilton, T.D. (1995). Late Pleistocene and Holocene Paleoenvironments of the North Pacific Coast. *Quaternary Science Reviews* 14, 449-471.

COLLABORATORS AND CO-AUTHORS (Last 4 years)

Suzanne Anderson (Department of Geography, University of Colorado)
James Edwards (Department of Surgery, Oregon Health Sciences University)
John Edwards (Department of Zoology, University of Washington)
Bruce Finney (Institute of Marine Science, University of Alaska)
Pamela Groves (Institute of Arctic Biology, University of Alaska)
Thomas Hamilton (US Geological Survey, Alaska Branch)
David Meltzer (Department of Anthropology, Southern Methodist University)
Scott Rupp (School of Natural Resources, University of Alaska)
Ronald Sletten (Department of Geology, University of Washington)
John Stone (Department of Geology, University of Washington)
Gail Irvine (US Geological Survey, Alaska Science Center)
Jeffrey Short (NOAA, Auke Bay Laboratory)
Jacqui Michel (Research Planning, Inc., South Carolina)
Zach Nixon (Research Planning, Inc., South Carolina)

Curriculum Vitae for Mark G. Carls

National Marine Fisheries Service, Auke Bay Laboratories
17109 Pt. Lena Loop Road
Juneau, AK 99801

email: mark.carls@noaa.gov
Phone: (907) 789-6019
FAX: (907) 789-6094

Education

M.Sc., 1978, biological oceanography, Dalhousie University, Halifax, Nova Scotia.
B.A., 1975, biology; Magna cum laude, Gustavus Adolphus College, St. Peter, Minnesota.
Additional coursework (30 semester hours), University of Alaska Southeast (statistics, genetics, fish, and misc)

Professional Experience

Fisheries Biologist, 1979-present, Auke Bay Laboratory.
Principal Investigator for *Exxon Valdez* Oil Spill Trustee Council

- Embryo toxicity: pink salmon, Pacific herring, zebrafish
- Herring Synthesis
- Hydrocarbon chemistry: sampling, interpretation, modeling
- Pink salmon habitat
- Mussel and sediment contamination

Biological Review Teams

- Pacific herring, Lynn Canal, Alaska (chairman)
- Status of Pacific herring in Puget Sound, Washington

Habitat and Ecological Processes Team

Recent related publications (lead author only)

Carls MG, Meador JP. 2010. A perspective on the toxicity of petrogenic PAHs to developing fish embryos related to environmental chemistry. Human and Ecological Risk Assessment 15:1084-1098.

Carls, M.G. 2006. Nonparametric identification of petrogenic and pyrogenic hydrocarbons in aquatic ecosystems. Environ Sci Technol. 40:4233-4239.

Carls, M.G., S.D. Rice, G.D. Marty, and D.K. Naydan. 2004. Pink salmon spawning habitat is recovering a decade after the *Exxon Valdez* oil spill. Trans Am Fish Soc 133:834-844.

Carls MG, LG Holland, JW Short, RA Heintz, SD Rice. 2004. Monitoring polynuclear aromatic hydrocarbons in aqueous environments with passive low-density polyethylene membrane devices. Environ Toxicol Chem 23:1416-1424.

Carls MG, Thomas RE, Rice SD. 2003. Mechanism for transport of oil-contaminated water into pink salmon redds. Mar. Ecol. Prog. Ser. 248:245-255.

Other significant publications

Carls MG, Thedinga J.F. 2010. Exposure of pink salmon embryos to dissolved polynuclear aromatic hydrocarbons delays development, prolonging vulnerability to mechanical damage. Marine Ecology Research 69:318-325

Carls MG, Holland L, Larsen M, Collier TK, Scholz NL, Incardona JP. 2008. Fish embryos are damaged by dissolved PAHs, not oil particles. Aquatic Toxicology 88:121-127.

Carls MG., PM Harris, SD Rice. 2004. Restoration of Oiled Mussel Beds in Prince William Sound, Alaska. Mar. Environ. Res. 57:359-376.

Carls MG, GD Marty, JE Hose. 2002. Synthesis of the toxicological impacts of the *Exxon Valdez* oil spill on Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska, U.S.A. Can. J. Fish. Aquat. Sci. 59:1-20.

Carls MG, MM Babcock, PM Harris, GV Irvine, JA Cusick, SD Rice. 2001. Mar Env Res 51:167-190.

Recent Collaborators (excluding ABL staff):

Dr. Mace Barron (P.E.A.K. Research)
Frederick C. Funk (consultant, Juneau, AK)
Dr. Jo Ellen Hose (Occidental University, CA)
Dr. John Incardona (NOAA, Northwest Fisheries Science Center)
Dr. John Kern (NOAA Damage Assessment and Restoration Center Northwest, Seattle, WA)
Dr. Gary Marty (Animal Health Centre, Abbotsford, BC)
Dr. Brenda Norcross (University of Alaska Fairbanks)
Dr. James Payne (Payne Environmental Consultants)
Dr. Terrance J. Quinn II (University of Alaska Fairbanks)
Dr. Robert Spies (Applied Marine Sciences, Livermore, CA)
Dr. Katherine Springman (University of California, Davis)
Dr. Bob Thomas (University of California, Chico).

VI. BUDGET JUSTIFICATION

Personnel: amount requested FY11-FY12 - $ 56.8k

The amount of time requested for personnel is concentrated in year 1, due primarily to the demands of getting the project going (hiring, contracts, purchasing), plus field work. The level greatly decreases in FY12 to reflect the emphasis on data analysis and report/manuscript production. In FY11, $23.4k will be to support G. Irvine's involvement in planning, contracting, hiring, supervising, field work, data quality assurance, etc. Her assistant (FY11 cost = $13.8k) will do the bulk of permitting, contracting, purchasing for the field, testing equipment, mobilization and demobilization of field studies, sample management, data management and processing, GIS integration. The assistant and another assistant will be involved in the FY11 field work .

Travel: amount requested FY11-FY12 – $ 8.7k

Travel expenses are largest in FY11 due to multiple field work trips. Travel in FY12 is associated with presentation of the findings at a scientific conference; the conference is not known at the present, and this could mean that the travel could shift to FY13.

Contractual: amount requested FY11-FY12 - $ 118.5k

On this budget form, the apparent contractual costs are elevated, as the costs for NOAA's analysis of our samples for hydrocarbons is included (FY11, $24.8k). The major sources of contracts are for logistics (boat charters, some fixed wing and helicopter time; Total = $59k) and for the support of Dr. Dan Mann's involvement (through contracts with Mann's Environment). Our contract with D. Mann includes his time, travel costs, and some miscellaneous expenses. Minor contract costs are included for shipment of samples and gear.

Commodities: amount requested FY11-FY12 - $ 3.0k

In FY11 the commodities cost, $3.0k, is for various field gear and supportive supplies.

Equipment: amount requested FY11-FY12 - $0k

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11-FY12

Budget Category:	Proposed FY 11	Proposed FY 12	TOTAL PROPOSED
Personnel	$44.6	$12.2	$56.8
Travel	$5.1	$3.6	$8.7
Contractual	$110.8	$7.7	$118.5
Commodities	$3.0	$0.0	$3.0
Equipment	$0.0	$0.0	$0.0
SUBTOTAL	$163.5	$23.5	$187.0
General Administration (9% of subtotal)	$14.7	$2.1	$16.8
PROJECT TOTAL	$178.2	$25.6	$203.8
Other Resources (Cost Share Funds)	$31.6	$4.0	$41.6

COMMENTS: **In kind contributions:** NOAA - hydrocarbon analytical support (Mark Carls, 2 months @$8k/mo= $16k; Jeep Rice, 1 month @$9k/mo = $9k; Mandy Lindeberg, 1 month @ $7k/mo; Total = $32k); USGS (Gail Irvine, 0.5 mo @$11.7/mo = $6k); NPS - field experience/support ($3.6k) - **NOTE:** because no Multi-Trustee_Multi-year forms were available, costs for NOAA to do the hydrocarbon analyses are included on this form, under Contracts. The total budget amount that should go to NOAA is the cost of the hydrocarbon analyses ($24.8k), plus 9% GA ($2.2k), which totals $27.0k. The USGS portion of the budget should be reduced accordingly. This does not affect total project cost, which is reflected on this form.

FY11-12

Project Title: Lingering Oil - GOA
Lead PI: Irvine
Agency: USGS

FORM 3A
TRUSTEE AGENCY
SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 11-FY12

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Project Title					
						0.0
Gail Irvine	Research Ecologist	GS 13/7	2.0	11.7		23.4
no name at present	Biologist	GS 7/1	3.0	4.6		13.8
no name at present	Biologist/geologist	GS 5/1	2.0	3.7		7.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.0	20.0	0.0	
					Personnel Total	$44.6

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
Anchorage - Homer, RT	0.3	6	9	0.2	3.6
Invitational travel for Auke Bay person (to aid deployment of LDPEs)					0.0
Juneau- Homer RT	0.7	1	4	0.2	1.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.1

FY11

Project Title: Lingering Oil - GOA
Lead PI: Irvine

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11-FY12

Contractual Costs: Description	Contract Sum
Contract with Mann's Environment (Dr. Dan Mann) - time, travel, phone, misc.	
2.0 mo. of Mann's time @$12k/mo = $24k; Travel: 2 trips Fairbanks -Homer RT (2x 0.5 = 1.0); misc = 0.5	25.5
Boat charter, 12 days, Katmai and Kenai Fjords coast @ $4k/day	48.0
Helicopter charters (Homer to Katmai coast) 2 days @ $5k/d	10.0
Air charter from Homer to boat and return; to support limited time of NOAA staff in field	1.0
Shipment of samples, gear	1.5
Hydrocarbon Analyses (NOAA Auke Bay Laboratory): GCMS (and prep and shipping) of LDPEs, 28 @$350 = $9.8k	
GCMS (mussel and sediments), 20 @$750 = $15k	24.8
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$110.8

Commodities Costs: Description	Commodities Sum
Field and sampling supplies (e.g., I-chem jars; rock drill and accessories; misc.)	2.0
Camera/computer accessories, software	1.0
Commodities Total	$3.0

FY11

Project Title: Lingering Oil - GOA
Lead PI: Irvine

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11-FY12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY11

Project Title: Lingering Oil - GOA
Lead PI: Irvine

FORM 3B
EQUIPMENT
DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11-FY12

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Project Title	Step	Budgeted	Costs	Overtime	Sum
						0.0
Gail Irvine	Research Ecologist	GS-13/7	1.0	12.2		12.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	12.2	0.0	
					Personnel Total	$12.2

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
					0.0
Travel to present results at conference; estimate	1.8	1	6	0.3	3.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.6

FY12

Project Title: Lingering Oil - GOA
Lead PI: Irvine

FORM 3B
PERSONNEL & TRAVEL DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11-FY12

Contractual Costs: Description		Contract Sum
Contract with Mann's Environment (Dr. Dan Mann); includes 0.5 mo Dan's time@ $12k/mo = $6k		6.0
Page charges		1.0
Registration for scientific conference		0.5
Finalizing report/manuscript for EVOS/ARLIS		0.2
If a component of the project will be performed under contract, the 4A and 4B forms are required.	**Contractual Total**	$7.7

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY12

Project Title: Lingering Oil - GOA
Lead PI: Irvine

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11-FY12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Descriptior	Number of Units	Inventory Agency

FY12

Project Title: Lingering Oil - GOA
Lead PI: Irvine

FORM 3B
EQUIPMENT
DETAIL

Robertson

PROPOSAL FORM

THIS FORM MUST BE SUBMITTED BY THE PROPOSED PRINCIPAL INVESTIGATOR (S) AND SUBMITTED ALONG WITH THE PROPOSAL.

By submission of this proposal, I agree to abide by the Trustee Council's data policy (*Trustee Council Data Policy**, adopted March 17, 2008) and reporting requirements *(Procedures for the Preparation and Distribution of Reports***, adopted June 27, 2007).

PROJECT TITLE: Evaluation of Polypropylene Geotextile-Based Mechanical Removal Methods for Lingering Oil on Gravel Beaches in Prince William Sound, Alaska

Name of PI: Tim Robertson

Email: timrobertson@nukaresearch.com Phone: 907-234-7821

Mailing Address P.O. Box 175

City, State, Zip Seldovia, AK 99663

Name of PI: Bretwood Higman

Email: hig314@gmail.com Phone: 907-399-5530

Mailing Address P.O. Box 164

City, State, Zip Seldovia, AK 99663

Name of PI: David P. Janka

Email: info@auklet.com Phone: 907-424-3428

Mailing Address P.O. Box 1231

City, State, Zip Cordova, AK 99574

* www.evostc.state.ak.us/Policies/data.cfm
** www.evostc.state.ak.us/Policies/reporting.cfm

FY11 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Evaluation of Polypropylene Geotextile-Based Sediment Treatment Methods for Lingering Oil on Gravel Beaches in Prince William Sound, Alaska (Submitted under the BAA)

Project Period: Fiscal Year 2011 (final report completed by April 15, 2012)

Primary Investigator(s): Tim Robertson, Nuka Research and Planning Group, LLC
Bretwood Higman, Ground Truth Trekking
Dave Janka, Auklet Charters

Study Location: Prince William Sound, Alaska

Abstract:

This proposal describes the scope of work, methodology, and estimated costs associated with a pilot project that will evaluate lingering oil removal methods using oleophilic geotextiles in combination with sediment washing and reworking. The study builds on both the early work of EVOS volunteer cleanup workers at Mars Cove involving geotextiles and the more recently published literature suggesting that sediment washing shows promise as a lingering oil treatment method for certain types of beaches. Investigators will a conduct series of small-scale field trials that evaluate and compare the potential for several geotextile-based mechanical removal methods to enhance total recovery and limit adverse environmental impacts to shoreline areas where lingering oil persists. The removal techniques to be evaluated in this pilot project represent basic low-technology manual methods that, if successful, provide simple, practical, scalable and relatively inexpensive field treatment techniques that may be the best available treatment options for at least some of the lingering oil sites along the spectrum of beaches in need of further treatment.

The geotextile-based sediment treatment methods will be evaluated for the removal efficiency, cost, logistical feasibility, secondary pollution of water column and sediments, and impacts to sediment grain size of treated sediments. The results will be compiled in oral and written reports to the Trustee Council, public outreach materials, and a manuscript for submission to a peer-reviewed journal.

Estimated Budget: $226.4
EVOS Funding Requested: FFY11: $226.4
(breakdown by fiscal year and must include 9% GA)

Non-EVOS Funds to be used:
(breakdown by fiscal year)

Date: January 6, 2011

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

A. Statement of Problem

The *Exxon Valdez* oil spill (EVOS) resulted in the oiling of approximately 1,500 km of south-central Alaska's coastline. Oiled beach sediment posed a cleanup challenge during the initial *Exxon Valdez* cleanup process, over twenty years ago. In 1989, there were a number of novel and inventive approaches to oil spill cleanup that were applied to oiled beaches. Many of these techniques were developed *ad hoc* by local community members during the massive volunteer cleanup effort that occurred during the spill. Unfortunately, few of these methods were documented in the published literature. One such effort – at Mars Cove in Port Dick on the Kenai coast – involved the use of geotextile bags to encapsulate oiled sediments and then transport them into the intertidal zone where increased wave energy would rework the sediments and remove some of the entrapped oil. Some of that oil would then adhere to the oleophilic geotextile bags so that it could be removed from the environment (Hunt, 2010). More recently, geotextiles were used during rock and sediment cleaning following the 1999 *Erika* spill cleanup in France (Ansel *et al.*, 2001).

Research over the past two decades has shown that an estimated 23,000 gallons of *Exxon Valdez* oil has persisted in subsurface beach sediments in a relatively un-weathered state. This lingering oil is present in discontinuous patches that are not visible on the beach surface, and its presence has been documented through field assessments. (Integral Consulting, 2006; Short *et al.*, 2004; Taylor and Reimer, 2005). In unsurveyed areas, computer models have been developed to predict locations where there is a high probability that lingering oil also exists based on shoreline characteristics and other factors (Michel *et al.,* 2010). Oil residues in surface and subsurface beach sediments may be causing ongoing exposure and potential harm to wildlife, habitats, wilderness areas, recreational activities, and subsistence users in Prince William Sound and the Gulf of Alaska (Michel *et al.*, 2010; Payne *et al.,* 2010, Integral Consulting, 2006). The accumulation of data on the actual and probable location of residual shoreline oil points to an obvious next step: removal of surface and subsurface oil and residues to speed recovery of local resources and reduce ongoing exposure.

A number of shoreline cleanup techniques exist for treating oiled sediments, as documented in the Alaska Shoreline Countermeasures Manual (NOAA, 1994) and other widely available shoreline cleanup manuals. The EVOSTC recently funded a project that evaluated published data regarding treatment options for removal and remediation of lingering oil within Prince William Sound beaches (Michel *et al.,* 2006). Of the options evaluated, several treatment technologies were considered promising, including some techniques that involved reworking and washing the sediment. Michel *et al.* (2006) noted that the lingering oil treatment technologies evaluated could be combined or tailored to best serve the specific site, based on a range of considerations such as beach geomorphology, sediment characteristics, wave energy, wildlife and habitat characteristics, cultural and historical resource considerations, beach access, and logistical constraints.

The Evaluation of Polypropylene Geotextile-Based Sediment Treatment Methods for Lingering Oil on Gravel Beaches in Prince William Sound, Alaska (hereafter, pilot study) will build on both the early work of volunteer cleanup workers at Mars Cove involving geotextiles and the more recently published literature suggesting that sediment washing shows promise as a lingering oil treatment method for certain types of beaches. Tim Robertson, a Principal Investigator for this study – was a firsthand participant in the Mars Cove project. The removal techniques to be evaluated in this pilot project all involve encapsulating oiled sediments in various geotextile configurations and then subjecting those sediments to different wave energy regimes to agitate the oil from the sediment. They represent basic low-technology manual methods that, if successful, provide simple, practical, scalable and relatively inexpensive field treatment techniques that may be the best available treatment options for at least some of the lingering oil sites along the spectrum of beaches in need of further treatment.

Oleophilic polypropylene geotextiles reduce the amount of secondary pollution generated during sediment reworking and washing, thereby reducing the adverse effects of treating lingering oil on beaches that are already in various stages of recovery. Since oleophilic geotextiles are a readily available and relatively inexpensive material, their utility as a beach cleanup method for both lingering oil and future oil spills may represent a practical, scalable, low technology method with widespread applicability for Alaska beaches.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The pilot study aligns with the goals, policies, and scientific priorities outlined in the 1994 Restoration Plan (EVOSTC, 1994). The work directly addresses the main study question posed in the FY11 Invitation: to design and implement projects to determine the feasibility of removing lingering oil from Prince William Sound beaches.

The pilot study involves a general restoration activity (as described in EVOSTC, 1994) aimed at improving the rate of recovery of oiled sediments. This pilot study is consistent with the sediment restoration strategy in the 1994 Restoration Plan, which includes a directive to "Remove or reduce residual oil if treatment is cost effective and less harmful than leaving the oil in place. Removal of residual oil may accelerate recovery of sediment where natural recovery is insufficient. However, this benefit would have to be balanced against cost and the potential for further disruption to intertidal communities." This pilot study will capture information about both the effectiveness and the costs involved with geotextile-based mechanical recovery techniques. Because the treatment methods involve manipulating the environment, the study design will incorporate an evaluation of any adverse impacts resulting from the treatment methods.

The beaches where this technique is likely to be most successful – mixed gravel beaches with minimal shoreline armoring where lingering oil is still bioavailable to otters and birds – are also the types of beaches that represent a high priority for treatment according to EVOSTC annual work plans.

II. PROJECT DESIGN

A. Objectives

The goal of this project is to evaluate lingering oil removal methods that use oleophilic geotextiles in combination with sediment washing and reworking to enhance total recovery of oiled sediments and limit adverse environmental impacts. This research will build on previous work in this area (Michel *et al.*, 2006) and will also draw on the past experience of the Principal Investigator using oleophilic geotextiles in conjunction with sediment washing and reworking to reduce the amount of oil released back to the environment.

The study is designed to answer several questions about the practical use of oleophilic geotextiles in conjunction with sediment reworking and washing techniques:

- How much of the oil and residue removed from beach sediments during washing is captured by oleophilic geotextile materials?
- Is there a difference in the treatment efficiency between three different geotextile containment configurations – a bag, a loose wrap, and a sheet?
- Is there a difference in the treatment efficiency between high- and moderate-energy wave regimes (for geotextile bags only)?
- Are there adverse impacts of geotextile sediment washing tactics to sediment grain distribution? If so, are there differences among the three containment configurations (bag, loose wrap, sheet)?
- Are there observable differences in hydrocarbon concentrations in the water column and soft sediments at the beach toe adjacent to various geotextile sediment washing configurations?

The study will accomplish the following objectives:

1. Select testing site(s) based on potential for lingering oil to impact biological resources, beach geomorphology, sediment characteristics, wave exposure, and lingering oil concentrations and distribution.

2. Finalize testing plan, to include the following four methods of sediment reworking using geotextiles:

    a. Excavate, bag in geotextile, transport to a higher energy beach, agitate (7 days), and return.

    b. Excavate, bag in geotextile, agitate (7 days), and return.

    c. Excavate, wrap in geotextile, agitate (7 days), and unwrap.

    d. Excavate, spread over geotextile sheet, rework (7 days), and return.

3. Conduct testing of four variations on the geotextile-based mechanical treatment method for removing lingering oil from beach sediments in the EVOS-impacted area.

4. Collect data for all methods:

    a. Cost data.

    b. Practical data, such as relative time and level of effort required, logistical support needs and constraints.

    c. Effectiveness data consistent with the parameters established in Michel *et al.*, 2006.

    d. Adverse impact data such as contamination of water column or sediments in other areas or disruption to the sediment grain size distribution.

5. Compile all data into a database and analyze.

6. Produce a report that synthesizes the data for each method tested based on practicality, effectiveness, and adverse impacts.

    a. Draft Reporting (oral)

    b. Final Reporting (written)

7. Prepare and publish a manuscript for submission to appropriate peer-reviewed journal, such as "Marine Pollution Bulletin."

8. Outreach materials. Video record and photodocument all activities to produce educational outreach videos and other materials showing the tactics tested and the results, and incorporating historical footage from Mars Cove cleanup.

B. Procedural and Scientific Methods

Objective 1: Select testing site(s).
Principal Investigators will confer with resource agencies and land owners to select beach or beaches to be used as testing sites, based on potential for lingering oil to impact biological resources, beach geomorphology, sediment characteristics, wave exposure, and lingering oil concentrations. An ideal site will be a relatively flat gravel beach with widespread oiled sediment, to allow for the opportunity to compare all four methods across a single, similar location. Once the candidate site(s) are identified, members of the project team will conduct a forward field visit to survey the beach and begin to plan testing logistics.

Objective 2: Finalize testing plan.
A final testing plan will include the methods, equipment, personnel, and timeline for carrying out the testing using the four methods to be evaluated: (1) excavate, bag, transport, agitate, return; (2) excavate, bag, agitate, return; (3) excavate, wrap, agitate, unwrap; (4) excavate, spread,

rework, return. The Principal Investigators will work with state and federal agencies to procure any NEPA assessment, permits or site access permissions required to conduct the field work.

Objective 3: Conduct testing.
Principal Investigators and field support personnel will conduct testing of four variations on the geotextile-based mechanical treatment method at a pre-selected site or sites in Prince William Sound. Method 1 will be conducted at a different beach than Methods 2 through 4. Hard boom will be used to segregate the treatment areas for Methods 2 through 4, and the area will be continually monitored for sheen. Any visible sheening within the boomed areas will be removed with sorbents.

It is important that all four techniques are tested on materials that are as homogenous as possible in terms of composition, size, and oil contamination. Therefore, the testing plan will establish a process for harvesting, characterizing, and then selecting sediments into subsets that are as similar in size and composition as possible. We anticipate excavating enough materials to provide 20 testing samples of oiled sediment – this will allow for five replicates to be treated by each of the four methods. For each testing subset, a series of samples will be randomly extracted and characterized based on mass balance (relative amounts of oil and sediment) and sediment grain size distribution. These initial mass balance and sediment grain distribution data will be used to measure changes after the treatment period and to compare effectiveness and adverse effects among each of the four methods. A seven-day treatment period will be used for all methods.

In addition to the sampling and characterization of the sediments, additional pre- and post-treatment sampling and data collection will be conducted, as described under Objective 4.

Method 1: Excavate, bag, transport, agitate, and return.
Oiled sediment is characterized, sampled, and shoveled into individual geotextile bags. These bags are transported to a beach exposed to strong wave action, and left in the mid-tide zone for a period of seven days, during which the sites will be actively monitored by field personnel. The bags are then transported back to the original beach, where the contents are again characterized (sediment grain size distribution), sampled (mass balance), and emptied. The geotextile will be sent to a laboratory and analyzed to determine the amount of oil captured prior to disposal. The sediments will be returned to the excavated area.

Method 2: Excavate, bag, agitate, and return.
Oiled sediment is characterized, sampled, and shoveled into individual geotextile bags. These bags are left on the source beach in the mid-tide zone for a period of seven days, during which the site will be actively monitored by field personnel. To enhance agitation, depending upon the characteristics of the selected beach, the bags may be suspended from floating barrels to re-arrange them with each tide. The bags are then emptied, and the contents are again characterized (sediment grain size distribution), sampled (mass balance). The geotextile will be sent to a laboratory and analyzed to determine the amount of oil captured prior to disposal. The sediments will be returned to the excavated area.

Method 3: Excavate, wrap, agitate, unwrap.
Oiled sediment is characterized, sampled, and shoveled onto strips of geotextile. The sediment is then loosely wrapped in geotextile (geotextile folded over the sediment sample but not sealed in any way, like a taco. This wrap is then left on the source beach in the mid-tide zone for a period of seven days, during which the site will be actively monitored by field personnel. To enhance agitation, depending upon the characteristics of the selected beach, the wrapped sediment may be floated on barrels to re-arrange them with each tide. The sediment is then unwrapped and the contents are again characterized (sediment grain size distribution), sampled (mass balance). The geotextile will be sent to a laboratory and analyzed to determine the amount of oil captured prior to disposal. The sediments will be returned to the excavated area.

Method 4: Excavate, spread over geotextile, rework, return.
Oiled sediment is characterized, sampled and shoveled onto sheets of geotextile in a thin layer where it is exposed to wave action. Oil booms may be deployed to capture and floating oil that escapes from the sediment into the water column. Oil that is pushed further down into the sediment will encounter the geotextile and be trapped while the sediments are reworked[1] and cleaned. After seven days in the mid-tide zone, sediment is removed from the geotextile, and the contents are again characterized (sediment grain size distribution), sampled (mass balance). The geotextile will be sent to a laboratory and analyzed to determine the amount of oil captured prior to disposal. The sediments will be returned to the excavated area.

Objective 4: Collect data.
For each of the four methods, data will be collected and analyzed for four general parameters: cost, practicality, effectiveness, and adverse impacts.

Cost Data
Costs associated with materials, personnel, logistical support, sampling handling and analysis, disposal of materials, and any other real or material costs required to implement the technique will be compiled in a spreadsheet to facilitate cost comparison among the four methods.

Practical Data
Information about the logistical and practical considerations involved in implementing the method will be collected. Data parameters in this category may include time required to deploy methodology, logistical support requirements, site requirements, and other considerations or constraints that may impact the feasibility of implementing the methodology at a larger scale. This category will also include data collection regarding environmental, physical, and climatic testing parameters. Data observations to be collected at six hour intervals throughout the testing period and will include wind speed

[1] The geotextile under the sediment should actually help sediment reworking if the sediment layer is kept thin enough. Sediment moves more readily over smooth surfaces, so if there are open areas of geotextile between clumps of sediment, we should expect very thorough reworking.

and direction, wave action (height and period), precipitation, air and water temperatures. Photographs and video will be used liberally throughout the testing period to document on-scene conditions.

Effectiveness Data

Measurements comparing the amount of oil present in the sediment sample before and after treatment and the amount of oil adhered to the geotextile will be used to estimate the mass balance for each subset. A sediment sampling protocol will be developed in an attempt to collect heterogeneous samples across the beach area and the minimize handling of the sediment. To get a representative sample of the pre-treatment sediment, we will collect a vertical column of sediment (since vertical samples are more likely to be heterogenous than horizontal ones) from near the center of a treatment test site (likely less than 1 m^2 total.) This column, with uniform x-section through its height, should be representative of the surrounding sediment to the extent that sediment and oil stratification is laterally continuous. Each sediment sample will be approximately 1 kg.

To avoid collecting a post-treatment sample that is biased in terms of oil or sediment size from the treated sediment, the whole treated volume will be spread over a clean surface, and 10 point samples will be collected and combined. The treated sediment will be spread to a uniform thickness of about 3 cm (about 70 cm x 70 cm for 20kg of sediment). A grid will be overlaid on the spread sediment, and the ten samples collected from random locations on that grid through the entire thickness of the spread sediment. Each sediment sample will total about 1 kg, so each subsample will be about 100 g, or about 5 cm x 5cm x 3 cm thick. Generally we will avoid working in sediment grain sizes over a few cm maximum dimension. If cobbles are encountered in sampling, they will be omitted from the sample.

To calculate the amount of oil present in each testing subset, samples will be taken pre- and post- treatment and send to a laboratory for analysis of Total Petroleum Hydrocarbon (TPH)[2]. Similarly, to calculate the amount of oil retained by the geotextile, the sub-samples of the geotextile materials will be sent to a laboratory for analysis of TPH.

Qualitative observations of gross oiling using the subsurface oiling descriptions from the NOAA Shoreline Assessment Manual, e.g. oil residue (OR), oil film (OF), partially filled pores (PP) will be recorded for each sample pre- and post- treatment (NOAA, 2000). Qualitative observations of geotextile oiling will also be recorded for each sample.

Adverse Impacts Data

Since the study involves moving sediments and treating them prior to their return, there are possibilities for some adverse impacts. Oil or residue that is released may not all adhere to the geotextile materials, allowing for the potential to contaminate the water column or other areas of sediment. Treatment of sediments may impact the sediment grain size distribution, and have the unintended adverse impact of removing fine grain particles, which are biologically and ecologically important.

[2] TPH will be measured using a modification of EPA standard SW-846. TPH values will be normalized by sediment grain size in sediment samples.

To measure adverse impacts to the water column and beach sediments, semipermeable membrane devices (SPMDs) will be used to provide a time-weighted average concentration of dissolved hydrocarbons in the water column near the testing sites (USGS, 2004; Nuka Research, 2006; Greenwood *et al.*, 2007). Samples will be taken pre- and post- sampling at the same locations to monitor for any changes to dissolved hydrocarbon levels during the testing period.

Sediment sampling will also be conducted pre- and post-testing at the toe of the beach to assess whether benthic sediment contamination is detected, using a Van Veen grab sample and laboratory analysis of total hydrocarbons (Nuka Research, 2006; EPA, 2001). Sediment sampling will also be conducted at both the primary beach site and the high-energy beach site pre- and post- testing to assess whether and observable changes occur to the total hydrocarbons present in the beach sediment at the toe.

Because of the importance of fine-grained sediments to biological communities, disruptions to fine grain sediments that occur during beach cleaning have been observed to disrupt the recovery of infaunal assemblages on some EVOS-impacted beaches (Lees and Driskell, 2007). Sediment grain size and sedimentary structure for cleaned sediment will be compared with analyses done prior to treatment to assess and measure the impact to sediment grain size distribution across the treatment methods. Sediment characteristics pre- and post- treatment will also be evaluated qualitatively using commonly accepted sediment classification terminology.

Objective 5: Compile and analyze data.

The data gathering involved in this study will yield both qualitative and quantitative data sets and will require several different types and levels of analyses.

Cost Data

Cost data will be analyzed qualitatively to determine whether certain cost parameters may be reduced or increased by scaling each treatment method, and to consider whether changes to the methodology (i.e. reducing the treatment time, changes to sampling design) may represent potential cost savings for each treatment method.

Practical Data

Practical data will be analyzed qualitatively to consider how certain logistical or practical factors may impact the scalability of each treatment method.

Effectiveness Data

Raw data on effectiveness will include both quantitative and qualitative measures – both sets of data will be considered to estimate the comparative effectiveness of each of the four methods at (1) removing oil from the sediments; (2) entrapping the oil in the geotextile and therefore reducing the amount of oil released back into the environment during treatment; and (3) maximizing removal while minimizing environmental impacts.

Quantitative data from laboratory analysis of pre- and post- testing samples of both the sediments and the geotextiles will yield a numeric measurement of the total amount of oil removed by weight. The difference between these two amount will represent the gross effectiveness of the treatment method in removing oil from the sediments. This value can be calculated for each of the five replicates tested for each of the four treatment methods. Values within each method can be averaged or aggregated for comparison among methods.

To calculate the efficiency of each method at entrapping the removed oil in the geotextiles, the total amount of oil entrapped on the geotextile may be expressed as a proportion of the total amount of oil present in the pre-testing sample or the post-testing sample, in order to gain insight into the mass balance of where the original quantity of oil went.

Qualitative observations of gross oiling of the sediments and the geotextile may be compared to make a broad assessment of whether the treatment was effective in reducing the level of sediment contamination, and also to compare the relative oiling of the geotextiles based on the various configurations (bags, "tacos," or sheet).

Adverse Impacts Data

Water column and beach toe sediment data will be compiled to estimate adverse impacts from hydrocarbon contamination, and sediment grain analysis will be used to determine whether excavating, washing and reworking the sediments reduces the amount of fine grain sediments within the testing subset.

Hydrocarbon contamination data for water column and benthic sediments will be expressed numerically based on the dissolved hydrocarbon and total hydrocarbon values respectively for the samples taken. Adverse impacts data will not necessarily be cleanup-technique specific since three of the methods will be tested along the same beach segment with free water and sediment exchange. However, any changes between pre- and post-testing values will indicate whether the geotextile treatment methods in general appear to create measurable changes to hydrocarbon levels in the water column or benthic sediments.

Adverse impacts to fine grain sediments will be evaluated based on measurable changes to the sediment grain composition within samples from each testing subset. A reduction in fine grain sediments between pre- and post- testing samples will indicate an adverse impact. Since the sediment grain data will be sample-specific, this data should yield insight into the continuum of adverse impacts to fine grain sediments for each of the four geotextile treatment methods.

Objective 6: Report

As specified in the invitation, a final report to the Trustee Council will be completed by April 15, 2012. The final report will describe the study objectives, field and laboratory methods, results, and analysis. The final report will include a discussion of the costs, logistical constraints, effectiveness and adverse impacts of the four methods tested and will offer recommendations for

future work, which may include larger scale field trials or full-scale implementation of one or more methods.

There will likely be a significant time lag for processing laboratory samples, particularly given the current backlog of samples from the Deepwater Horizon blowout. The project team will do everything possible to expedite sample processing to meet the April 15, 2012 final report deadline.

We will also prepare and deliver an interim report to the Council upon completion of the testing cycle, describing initial observations and analyzing qualitative data. We anticipate delivering this interim report verbally or as a PowerPoint presentation to the Council during the Fall of 2011, with flexibility to accommodate the Council's meeting schedule.

Objective 7: Develop Manuscript for Publication

An important facet of this study is that it will rigorously test variations on a cleanup method that was utilized during EVOS but poorly documented in the published literature. The Principal Investigators will develop a manuscript for publication in an appropriate peer-reviewed journal, such as the Marine Pollution Bulleting, documenting the objective, methods, and results of this pilot study. We anticipate working on the manuscript concurrent with the final report development, and submitting the manuscript for publication in April 2012.

Objective 8: Develop Outreach Materials

This study is well suited to communicate basic concepts related to EVOS lingering oil to the public. The methods proposed are readily accessible and easily portrayed in video and photos, and they inherit from volunteer cleanup efforts shortly after the spill. The people involved have long personal experience with EVOS. Nuka Research is a consulting firm with a strong history of working with Alaska stakeholder groups and the public to interpret complex technical issues related to oil spill prevention, response, cleanup, and restoration. Ground Truth Trekking (GTT) specializes in generating content for the public that communicates technical scientific issues using narratives involving wilderness expeditions and fieldwork. Auklet Charters has been a firsthand participant in dozens of field research and survey cruises related to lingering oil and resource recovery in Prince William Sound.

Video provides perhaps the broadest, most accessible outreach tool, especially when made available online and supported by good photos and clear writing. Through all phases of the project (Objectives 1 through 7), video and photographic (including time-lapse) documentation will be compiled in order to communicate to the public the following key points:

- The challenges and effort required for lingering oil cleanup, including the cost/benefits of cleanup vs. natural recovery.
- Extent and impact of lingering oil in EVOS region.
- Range and history of techniques and tactics available to treat oiled sediments.
- The contribution this study seeks to make to lingering oil cleanup techniques.

Outreach efforts may also include media outreach to local print, television, and radio outlets. All outreach materials will be coordinated with the Trustee Council.

C. Data Analysis and Statistical Methods

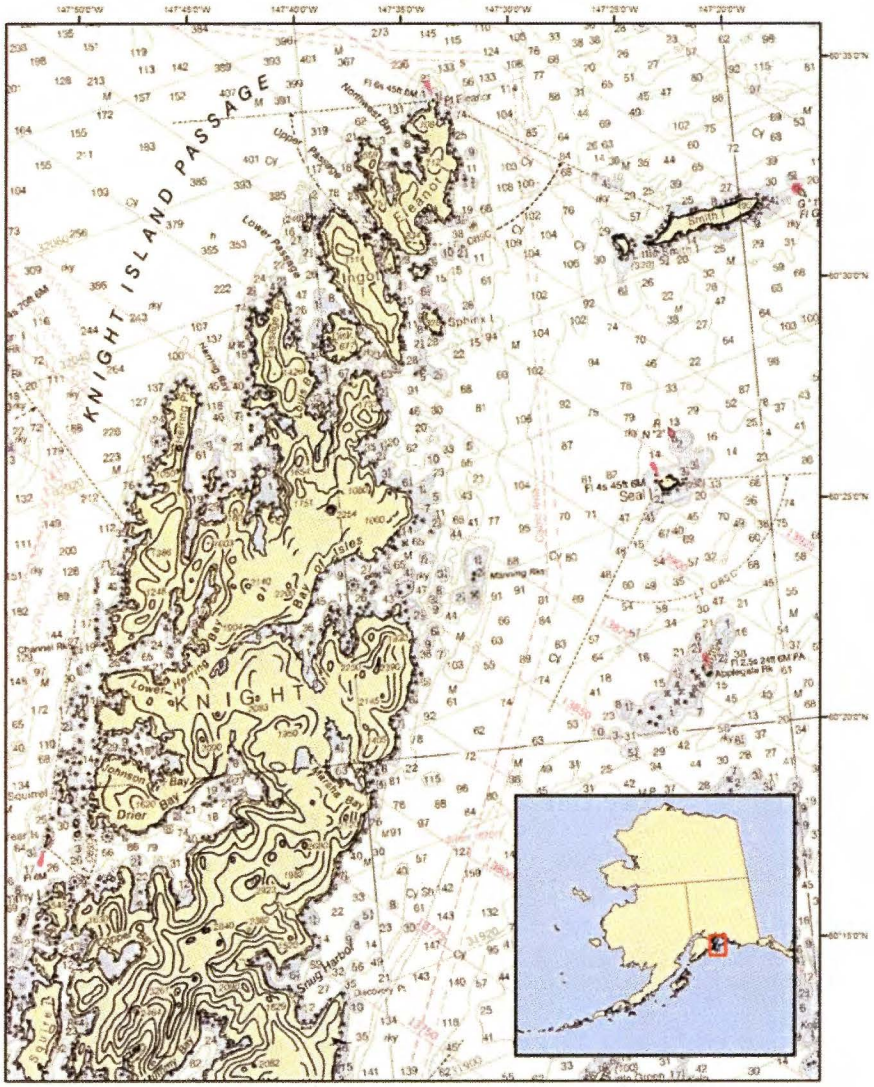
Both the qualitative and quantitative measurements of oil removal from sediments will be directly comparable to previous work on lingering oil and the proposed mass-balance analysis will provide a simple measure of effectiveness. The data on sediment grain size distribution will be collected in a standard manner and will be comparable to any similar analysis, particularly those focused on the importance of fine sediments for biological activity.

Each experimental condition will have five replicate samples, each of which will be measured for oil content before and after treatment. The difference will be calculated as % of oil lost, and averaged across the five replicates. This data will be checked for normality and homogeneity of variance, and transformed if necessary. Pairwise means tests will be undertaken between each possible pairing of experimental conditions using Student's t-tests and considered significantly different when the obtained p-value is < 0.05. If the conditions are statistically different from each other, they will be ranked from most effective to least effective. If the conditions are statistically similar, the data will be considered on an absolute basis (i.e. the conditions were all similar, but each removed around 90% of the oil from the sediment). Assuming a p-value of .05, and five replicates, the statistical power of these Student's t-tests will be above the generally accepted threshold of 0.8, if the difference between the means of two experimental conditions is at least 2.1-fold. The same analysis will be undertaken for sediment grain size distribution.

D. Description of Study Area

The map below shows the general study area. A beach site or sites will be selected based on a range of considerations as described in the methodology for Objective 1.

Proposed Study Area



E. Coordination and Collaboration with Other Efforts

This project will build directly upon previous work by Michel *et al.* (2006), which evaluated the information available in published literature regarding treatment options for lingering oil but did not include a corresponding field testing component. This study will focus specifically on field testing a combination of low technology mechanical options with the use of oleophilic geotextiles. Whenever possible, we will utilize similar evaluation parameters as the 2006 study.

III. SCHEDULE

A. Project Milestones

The projected milestones for critical project tasks listed below presume that the project will be initiated by March 2011.

Objective 1. Select testing site(s) based on beach geomorphology, sediment characteristics, wave exposure, and lingering oil concentrations.
To be met by April 2011

Objective 2. Finalize testing plan.
To be met by May 2011

Objective 3. Conduct testing of four variations on the geotextile-based mechanical treatment method for removing lingering oil from beach sediments in the EVOS-impacted area.
To be met by August 2011

Objective 4. Collect data on cost, practical considerations, effectiveness and adverse impacts for all methods tested.
To be met by August 2011

Objective 5. Compile and analyze all data.
To be met by September 2011[3]

Objective 6. Complete a preliminary and final report synthesizing all data and reporting results.
To be met by October 2011 (preliminary oral report to council) and April 2012 (final report draft)

Objective 7. Prepare and publish a manuscript for submission to peer-reviewed journal.
To be met by April 2012

Objective 8. Develop outreach materials
To be conducted throughout life of project and completed by April 2012

B. Measurable Project Tasks

The following schedule for measurable project tasks will form the basis for the quarterly project progress reports that are submitted to the Trustee Council Office.

FFY 11, 2nd quarter (January 1, 2011-March 31, 2011)
February/March: *Project funding approved by Trustee Council*

[3] Note that this timeline may be impacted, possibly quite significantly, by the ongoing backlog of sample processing in most U.S. analytical laboratories due to the large volume of samples generated by the Deepwater Horizon oil spill. If this backlog continues, it may slow the sample processing time and therefore the data analysis timeline for this project.

FFY 11, 3rd quarter (April 1, 2011-June 30, 2011)

April 30: *Testing site(s) selected*
May 15: *Testing plan and methods finalized*
June: *Testing initiated (somewhat weather/site dependent)*

FFY 11, 4th quarter (July 1, 2011-September 30, 2011)

July 30: *Testing completed*
July 30: *Data collection completed*
September 30: *Data compilation and analysis completed*

FFY 12, 1st quarter (October 1, 2011-December 31, 2011)

October 30: *Preliminary oral report to Council on testing results and data analysis*

FFY 12, 2nd quarter (January 1, 2012-March 31, 2012)

March 1: *Written report draft submitted for preliminary review by Trustee Council Draft outreach materials also provided for Council review.*

FFY 12, 3rd quarter (April 1, 2012-June 30, 2012)

April 15 *Submit final report. This will consist of a draft manuscript for publication to the Trustee Council Office. Final outreach materials completed.*

IV. REFERENCES

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CVs/RESUMES

Curricula vitae are provided on the following pages for the following key project personnel:

Principal Investigators:

- Tim Robertson, Nuka Research
- Bretwood Higman, Ground Truth Trekking
- David Janka, Auklet Charters

Associate Investigators:

- Elise DeCola, Nuka Research
- David Coil, Ground Truth Trekking
- Erin McKittrick, Ground Truth Trekking

CURRICULUM VITAE

Tim L. Robertson

PO Box 175, Seldovia, AK 99663
(907) 234-7821 timrobertson@nukaresearch.com

EDUCATION

1985	M.S., Fisheries Science, University of Alaska
1977	B.S., Fisheries Biology, Colorado State University
1999, 2002, 2003	Oil Spill Scientific Methods (NOAA)

PROFESSIONAL

2004-Present	Nuka Research and Planning Group, LLC General Manager and principal consultant with environmental consulting firm specializing in oil spill prevention, planning, and response and academic and practical research into marine pollution, oil spill risk assessment, and spill cleanup technologies.
1996-2003	Owner and manager of a private consulting business providing clients with project management and professional advice in natural resource and marine transportation issues.
1993-1995	Founding owner of the North Coast Research Group, Inc. a small business involved in environmental compliance and policy analysis.
1992	Negotiator for the Regional Citizens Advisory Council at the Negotiated Rulemaking on Vessel Response Plan regulations under OPA 90.
1989-1992	Chairman, Oil Spill Response Committee, Prince William Sound Regional Citizens' Advisory Council.
1990-1991	Director, Oil Spill Response Office, City of Cordova, Alaska.
1989-1990	Oil Spill Coordinator, City of Seldovia, Alaksa (*Exxon Valdez* oil spill)
1981-1989	Sales Engineer, M-I Drilling Fluids (North Slope)

RESEARCH

1977-1981	Research Biologist, Alaska Department of Fish and Game. Directed research projects and supervised employees for Division of Commercial Fisheries. Most

projects were related to salmon populations in Bristol Bay and Cook Inlet, Alaska. Six field seasons managing research projects in remote Alaska.

SELECTED PUBLICATIONS

Robertson, T.L. and A. Kumar. 2008. "Estimating the Response Gap for Two Operating Areas in Prince William Sound, Alaska. Proceedings of the 2008 International Oil Spill Conference, Savannah, Georgia.

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CERTIFICATIONS, ASSOCIATIONS, AND PROFESSIONAL DEVELOPMENT

FEMA Emergency Management Institute, Disaster Planning and ICS Training
President, S.O.S. Team, 1989-1992
Member, Seldovia City Council, Appointed (1989)
Acting Mayor of Seldovia (1989)
Mars Cove Oil Spill Cleanup (1989)
Prince William Sound and Cook Inlet Regional Citizen Advisory Councils (1989-1994)
U.S.C.G. Masters License (expired)
Conservation Award, Wildlife Federation of Alaksa (1992)
Public Service Award, U.S. Coast Guard (1992)
National Wildlife Federation, endangered species (1992-1993)
Volunteer kayak instructor – Kenai Peninsula Schools, Boy Scouts of America
Seldovia Boys and Girls Club outdoor programs
Systematic Development of Informed Consent

CURRICULUM VITAE

Bretwood Higman

PO Box 164
Seldovia, AK 99663
(907)399-5530
hig314@gmail.com

EDUCATION

2007 Ph.D., Earth and Space Sciences, University of Washington, Seattle, WA

1999 B.A., Geology, Carleton College, Northfield, MN.

PROFESSIONAL

Present Executive Director for a non-profit environmental group (Ground Truth Trekking). Responsibilities include project management, technical/scientific review, and planning field expeditions.

Present Consultant with Nuka Research, an environmental consulting firm. Responsibilities include technical/scientific review, data visualization, and software design.

RESEARCH

2001-2007 Graduate Student Ph.D. research – Earth and Space Sciences dept. at the University of Washington, Seattle. Primary dissertation work was on geologic hazards, particularly on sedimentary records of tsunamis. Lead field research in Nicaragua, Hurricane-Katrina damaged coastal Mississippi, Thailand, and Alaska. Research advisor: Dr. Joanne Bourgeois

SELECTED PUBLICATIONS

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CURRICULUM VITAE

David P. Janka

P.O. Box 1231
Cordova, AK 99574
(907) 424-3428
info@auklet.com

EDUCATION AND ACCREDIDATION

1990-2002 Prince William Sound Community College, continuing education courses in Hazardous Materials Operations, Grantwriting, CPR/First Aid, Astronomy, Prince William Sound Ecology, Sailing and Seamanship, and others.

1987 U.S. Coast Guard licensed operator of uninspected vessels on inland waters (current).

PROFESSIONAL

1980- Present Owner and operator of Auklet Charter Services, a Cordova based charter boat business specializing in Prince William Sound scientific research, film crew support and adventure cruises, emphasizing natural history, wildlife viewing, birding, photography, kayak support. Experience with all aspects of operations and maintenance of 58' motor vessel including diesel engine and generator; AC and DC systems; marine electronics usage, maintenance and installation including VHF radio, marine radar, GPS/computer (Mac) navigation; hydraulics, outboards and skiffs. Over 30 years Alaskan boating experience.

1980- Present Involved with a variety of research projects requiring exact record keeping, meticulous observations and odd hours in sometimes difficult conditions. Other duties included vessel operations, computer usage, learning and adapting lab and field techniques, species identification and sampling procedures. Fields of study included glaciology, marine, lake and stream ecology, fisheries, water quality and pollution monitoring, marine intertidal, remote weather stations, ice detection radar.

1991-1992 Served as Executive Director of Prince William Sound Conservation Alliance, a private non-profit public advocacy and environmental education organization.

1990-1991 Coordinated the fall 1990 and participated in the summer 1990 and spring 1991 Valdez Local Response Program (a State funded program for local response to the 1989 Exxon Valdez oil spill). Hired, trained and outfitted a crew for manual clean-up of oiled salmon stream sites in Prince William Sound. Worked with state, federal and industry personnel. Supervised and/or participated in field, vessel and office operations, shoreline surveys, and documentation.

RESEARCH

1980-1985 Fisheries Technician/Biologist for Valdez Fisheries Developme Association, Solomon Gulch Hatchery, Valdez, Alaska

1979-1980 Research Assistant (in Alaska) for Rockwell International, Canoga Park CA

1978-1979 Research Assistant (in Alaska) for U.S. Geological Survey, Tacoma, WA

SELECTED PUBLICATIONS

Payne, J.R., W.B. Driskell, and D. Janka. 2010. A Possible Source for Dissolved-Phase PAH Signals Observed in *Mytilus* Samples Throughout Prince William Sound, Alaska. *Proceedings of the Thirty-Third AMOP Technical Seminar on Environmental Contamination and Response.* Environment Canada. pp. 101-126.

Payne, J.R., W.B. Driskell, M.R. Lindeberg, W. Fournier, M.L. Larsen, J. W. Short, S.D. Rice, and D. Janka. 2005. Dissolved and Particulate-Phase Hydrocarbons in Interstitial Waters from Prince William Sound Beaches Containing Buried Oil Thirteen Years After the *Exxon Valdez* Oil Spill. *Proceedings of the 2005 International Oil Spill Conference.* pp. 1-6.

PROFESSIONAL AFFILIATIONS AND RECENT COLLABORATIONS WITH ACADEMIC INSTITUTIONS

Prince William Sound Science Center, Cordova, Alaska
Alaska SeaLife Center, Seward, Alaska
US Fish and Wildlife Service, Anchorage, Alaska
US Geological Survey/Biological Resources, Anchorage, Alaska
National Marine Fisheries Service/Auke Bay Lab, Juneau, Alaska
US Coast Guard, Valdez, Alaska
Alaska Dept. of Natural Resources/State Parks, Anchorage & Soldotna, Alaska
US Forest Service, Cordova, Alaska
USDA/Natural Resources Conservation Service, Anchorage, Alaska
National Oceanic and Atmospheric Administration/Hazmat, Seattle, Washington
Alaska Department of Fish and Game, Cordova, Alaska
Bureau of Indian Affairs, Anchorage, Alaska
US Geological Survey, California & Virginia
Sitka Science Center, Alaska
Smithsonian Environmental Research, Maryland
University of Alaska/Institute of Marine Science, Fairbanks Alaska
Temple University, Pennsylvania
University of Alaska Anchorage
Virginia Institute of Marine Science
Universites of California, Texas & Washington
Alaska Department of Fish and Game, Cordova, Alaska

CURRICULUM VITAE

Elise G. DeCola

PO Box 1672, Plymouth, MA 02362
(508) 454-4009 elise@nukaresearch.com

EDUCATION

1996	M.A., Marine Affairs, University of Rhode Island
1992	B.S., Environmental Science, College of William and Mary in Virginia
1991	Field Studies in Marine Ecology, School For Field Studies, Northeastern University

PROFESSIONAL

2004-Present	Nuka Research and Planning Group, LLC (Plymouth, MA) Managing partner and principal consultant with environmental consulting firm specializing in oil spill prevention, planning, and response and academic and practical research into marine pollution, oil spill, and emergency preparedness.
1998-2002	Research Editor, Cutter Environment/Aspen Publishers/Oil Spill Intelligence Report (Cambridge, MA). Freelance writer and editor for publisher of environmental literature; developed technical reports for oil spill professionals on topics including oil spill contingency planning, dispersant use, in-situ burning, non-tank vessel spillss, environmental risk management, and statistical analyses of annual oil spill data.
1998-2000	Project Manager, Technical Response Planning Corporation (Houston, TX). Managed special projects for major oil companies. Developed, trained, and exercised a Y2K Crisis Management Team for Texaco's International Safety, Health and Environment Division, and developed an on-line training program and response manual for Conoco's North America Incident Support Team.
1996-2003	Owner and manager of a private consulting business providing clients with project management and general consulting in natural resource issues. The firm specialized in environmental compliance and emergency response planning.

RESEARCH

1996	Marine Environmental Policy Fellow – Rhode Island Senate Fiscal and Policy Office. In the wake of North Cape oil spill, researched and developed legislation to strengthen the state's requirements for oil-carrying vessels, and participated in U.S. Senate hearings on the Chaffee Amendments to OPA 90.

1996 Marine Policy Intern – Save the Bay (Narragansett Bay). Participated in an agency-industry cooperative Regional Risk Assessment Team to develop oil pollution prevention regulations for a special Regulated Navigation Area for New England waterways.

1995-1996 Graduate Teaching and Research Assistant, University of Rhode Island. Assisted professor of Admiralty Law with legal research, preparation of class reading materials, development of course content, and evaluation of student submissions in Coastal and Marine Law classes. (Supervisor: Dennis Nixon, JD).

SELECTED PUBLICATIONS

Folley, G., L. Pearson, C. Crosby, E. DeCola, and T. Robertson. 2006. "The Alaska Commercial Fisheries Water Quality Sampling Methods and Procedures Manual." Proceedings of the 29th Arctic and Marine Oilspill Technical Seminar. Vancouver, British Columbia, Canada.

DeCola, E.G., Robertson, T.L., Robertson, R.R., and J. Banta. 2004. "Approach to Downstream Planning for Nearshore Response and Sensitive Areas Protection Outside Prince William Sound, Alaska." Proceedings of the 27th Arctic and Marine Oil Pollution Technical Seminar. Edmonton, Alberta, Canada.

DeCola, E.G. 2003. Dispersant Use in Oil Spill Response: A Worldwide Legislative and Practical Update. Aspen Law and Business, New York, NY. 314 pp.
Coil DA, Miller AD. Enhancement of enveloped virus entry by phosphatidylserine. J Virol. 2005 Sep;79(17):11496-500.

Nuka Research and Planning Group, LLC. 2006. Alaska Commercial Fisheries Water Quality Sampling Methods and Procedures Manual. Anchorage, Alaska: Alaska Department of Environmental Conservation. http://www.dec.state.ak.us/spar/perp/wq/wq_manual.htm

Nuka Research and Planning Group, LLC. 2006. "Oil Spill Response Mechanical Recovery Systems for Ice-Infested Waters: Technology Assessment for the Alaska Beaufort Sea." Report to Alaska Department of Environmental Conservation.

CERTIFICATIONS, ASSOCIATIONS, AND PROFESSIONAL DEVELOPMENT

Member, Environmental Business Council of New England
Member, Society for Women Environmental Professionals
PADI Certified Divemaster
Incident Command System (ICS) 100-400
Hazwoper (24-hour)
Coastal Oil Spill Response (NOAA)
Shoreline Cleanup and Assessment Techniques (SCAT) Training
Oil Spill Response in Fast Water
Cold Water Oil Spill Response
Systematic Development of Informed Consent

CURRICULUM VITAE

David A. Coil

3331 Morro Bay Ave
Davis, CA 95616
(970)261-0850
coil.david@gmail.com

EDUCATION

2005 Ph.D., Molecular and Cellular Biology, University of Washington and Fred Hutchinson Cancer Research Center (FHCRC), Seattle, WA

1999 B.A., Biology, Cum Laude, Carleton College, Northfield, MN.

PROFESSIONAL

Present Independent contractor for a non-profit environmental group (Ground Truth Trekking) as a researcher, writer, and director developing a website to increase public awareness of natural resource management and energy production issues in Alaska.

Present Consulting inventor for Ardent Research Corporation

Present Independent contractor for Dr. Luca Comai, UC Davis Genome Center. Creating educational and training videos related to bioinformatics and next-generation sequencing technologies.

Present 50% Postdoctoral Fellow at the UC Davis Genome Center working for Dr. Jonathan Eisen. Focused on outreach in Microbiology, with an emphasis on "Science 2.0" tools.

TEACHING

2006-2009 Guest Lecturer and Co-Instructor, various Microbiology courses at K.U. Leuven, Leuven, Belgium

2005-2006 Faculty Lecturer in the Biology department, various Molecular and Cellular Biology courses and Introductory courses. University of Washington, Seattle, WA.

RESEARCH

2006-2009 Postdoctoral Fellow – Rega Institute, K.U. Leuven, Belgium. Investigated the role of tandem repeats in the generation of microbial variability within *Legionella pneumophila.* Described and characterized twitching motility in this organism. Research advisor: Prof. Jozef Annè.

2001-2005 Graduate Student Ph.D. thesis – Molecular and Cellular Biology Program, Fred Hutchinson Cancer Research Center and University of Washington, Seattle, WA. Investigated the roles of phosphatidylserine (PS) in enveloped virus entry. Research advisor: Dr. A. Dusty Miller.

2000-2001 Graduate Student Lab Rotations, Investigated gene expression variability between inbred mouse strains (Dr. Peter Nelson). Worked on nitrogen fixation in the methanogen Archea, *Methanococcus maripaludis* (Dr. John Leigh). Also participated in a Biotechnology Externship, Corixa Corporation, Seattle, WA working on the use of specific cancer antibodies for targeted cancer therapy (Dr. Marc Retter).

SELECTED PUBLICATIONS

Coil, D.A., Cunningham, M., Wenderoth, M.P., Dirks, C. Teaching the Process of Science: Faculty Perceptions and an Effective Methodology. CBE-Life Sciences Education. 2010 Winter;9:524-35

Coil, D.A., Anné, J. The role of *fimV* and the importance of its tandem repeat copy number in twitching motility, pigment production, and morphology in *Legionella pneumophila.* Archives of Microbiology. 2010 June;192(8):625-31

Coil, D.A., Anné, J. An examination of twitching motility in *Legionella pneumophila.* FEMS Microbiology Letters. 2009 Apr;293(2):271-7.

Coil, D.A., Anné, J., and Lammertyn, E. A faster and more accurate assay for intracellular replication of *Legionella pneumophila* in amoebae hosts. Journal of Microbiological Methods. 2008 Feb;72(2):214-6.

Coil DA, Miller AD. Enhancement of enveloped virus entry by phosphatidylserine. J Virol. 2005 Sep;79(17):11496-500.

CURRICULUM VITAE

Erin McKittrick

PO Box 164
Seldovia, AK 99663
(907)399-5530
mckittre@gmail.com

EDUCATION

2004 M.S., Molecular and Cellular Biology, University of Washington and Fred Hutchinson Cancer Research Center (FHCRC), Seattle, WA

2001 B.A., Biology, Summa Cum Laude, Carleton College, Northfield, MN.

PROFESSIONAL

Present Independent contractor for a non-profit environmental group (Ground Truth Trekking) as a researcher, writer, and director developing a website to increase public awareness of natural resource management and energy production issues in Alaska.

Present Consultant with Nuka Research, an environmental consulting firm. Report writing, editing, and analysis of a variety of issues, including oil spill impact assessment, environmental impact statements, and scientiic reports.

RESEARCH

2001-2004 Graduate Student Master's research – Molecular and Cellular Biology Program, Fred Hutchinson Cancer Research Center and University of Washington, Seattle, WA. Investigated the role of histone modifications and variants on gene expression. Research advisor: Dr. Steven Henikoff.

SELECTED PUBLICATIONS

Ballast Water Discharges into Cook Inlet, Alaska: 2002-2008. Nuka Research for Cook Inlet Regional Citizens' Advisory Council. In Press.

Henikoff S, McKittrick E, Ahmad K. Epigenetics, histone H3 variants, and the inheritance of

chromatin states. Cold Spring Harb Symp Quant Biol. 2004;69:235-43. Review.
McKittrick E, Gafken PR, Ahmad K, Henikoff S. Histone H3.3 is enriched in covalent modifications associated with active chromatin. Proc Natl Acad Sci U S A. 2004 Feb 10;101(6):1525-30. Epub 2004 Jan 19.

Bergstrom CT, McKittrick E, Antia R. Mathematical models of RNA silencing: unidirectional amplification limits accidental self-directed reactions. Proc Natl Acad Sci U S A. 2003 Sep 30;100(20):11511-6. Epub 2003 Sep 12.

BUDGET JUSTIFICATION

I. PERSONNEL

Total Amount Requested for Personnel - $123,400

A total of $59,800 is requested for Principal Investigator time. Tim Robertson and Bretwood Higman are budgeted for a total of 2.5 months each at a cost of $27,500 each. David Janka is budgeted for .5 months for a total of $4,800. Mr. Robertson and Dr. Higman will work together to design and conduct the fieldwork, compile and analyze data, and contribute to reporting. Mr. Robertson, the lead Principal Investigator, will be the primary liaison with the Trustee Council and will lead all presentations to the Council. Mr. Higman will lead the data analysis and visualization effort. Mr. Janka is the Captain of the vessel Auklet and will participate in all the fieldwork as well in logistical planning for fieldwork and reporting.

A total of $34,400 is requested for Associate Investigator time. Elise DeCola is budgeted at 1.7 months, David Coil at 1.5 months, and Erin McKittrick at .8 months. Ms. DeCola will be the lead writer and editor for all plans and reports developed throughout the life of the project, including the manuscript for journal publication. Dr. Coil will be responsible for quality assurance and review of all sampling techniques, data management, and statistical analysis. Ms. McKittrick will assist with technical writing and editing, and will lead the outreach process. She will also help to coordinate field logistics.

A total of $29,300 is requested for Other Personnel. Kathleen George has been budgeted for 1.5 months at a cost of $7,200 to provide graphic design, layout, and mapping for all reports and illustrations, and will provide webmaster support. Four Field Assistants with appropriate qualifications will work a combined total of 5.3 months for a total cost of $22,100 ($5,525 apiece).

II. TRAVEL

Total Amount Requested for Travel - $6,100

Travel costs cover the required travel for field team members from Seldovia to Whittier (round trip) at an estimated $5,100. An additional $1,00 in travel costs are estimated for Principal Investigator travel between Seldovia and Anchorage to coordinate with agencies on site selection and Environmental Assessment.

III. CONTRACTUAL COSTS

Total Amount Requested for Contractual Costs - $57,700

Contractual costs are required to cover vessel charters of the research vessel *Auklet,* which will serve as the primary research vessel to stage all field activities, and will house the field personnel. Charter costs for the *Auklet* are $29,900. A second vessel – the *Johanna Rose* – will be chartered to provide field support, move field equipment, serve as a decontamination station, and to lift sediment samples. Charter costs for the *Johanna Rose* are $9,800.

Laboratory analytics (TDI Brooks and others) are estimated at $13,000 to cover sediment and geotextile analysis for TPH and SPMD analysis of PAH, and to conduct sediment grain size analysis.

Video post production costs for outreach materials are estimated at $2,000, with another $2,000 allocated for outreach material printing and distribution. $1,000 is required to rent containment boom.

IV. COMMODITIES

Total Amount Requested for Commodities - $9,000

Commodities costs will cover field sampling supplies, at $7,500, for geotextile materials, sampling containers, sorbents, shovels, and supplies. Other costs include communications ($200), mailing and shipping ($800), and miscellaneous supplies ($500).

V. EQUIPMENT

No equipment will be purchased for this project.

VI. INDIRECT COSTS

Indirect costs include an overhead rate of 9% of personnel costs, or $11,500.

BUDGET FORMS

Budget figures are contained on the following pages using the EVOSTC forms.

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 11

Budget Category:	Proposed FY 11	TOTAL PROPOSED
Personnel	$123.4	$123.4
Travel	$6.1	$6.1
Contractual	$57.7	$57.7
Commodities	$9.0	$9.0
Equipment	$0.0	$0.0
Indirect *(will vary by proposer)*	$ 11.5	$11.5
SUBTOTAL	$207.7	$207.7
General Administration (9% of subtotal)	$18.7	$18.7
PROJECT TOTAL	$226.4	$226.4
Other Resources (Cost Share Funds)	$0.0	$0.0

COMMENTS: In this box, identify non-EVOS funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY11

Project Title:Evaluation of Polypropylene Geotextile-Based Sediment Treatment Methods for Lingering Oil on Gravel Beaches in Prince William Sound, Alaska
Lead PI:Tim Robertson

FORM 4A
NON-TRUSTEE AGENCY SUMMARY

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Project Title					
Tim Robertson	Principal Investigator		2.5	11.0		27.5
Bretwood Higman	co-Principal Investigator		2.5	11.0		27.5
David Janka	co-Princial Investigator		0.5	9.5		4.8
Elise Decola	Associate Investigator		1.7	8.6		14.6
David Coil	Associate Investigator		1.5	8.6		12.9
Erin McKittrick	Associate Investigator		0.8	8.6		6.9
To be determined	Field Assistants		5.3	4.2		22.1
Kathleen George	Graphic Artist/Web Design		1.5	4.8		7.2
						0.0
						0.0
						0.0
						0.0
	Subtotal		16.3	66.3	0.0	
					Personnel Total	$123.4

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Travel from Seldovia to Whittier	0.4	12	6	0.2	5.1
Travel from Seldovia to Anchorage	0.4	2	2	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.1

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11

FY11	Project Title:Evaluation of Polypropylene Geotextile-Based Sediment Treatment Methods for Lingering Oil on Gravel Beaches in Prince William Sound, Alaska Lead PI:Tim Robertson	FORM 4B PERSONNEL & TRAVEL DETAIL

Contractual Costs: Description	Contract Sum
Vessel Charter - Auklet	29.9
Vessel Charter - Nuka Work Boat	9.8
Laboratory analytics	13.0
Post production video	2.0
Outreach materials printing	2.0
Containment Boom Rental	1.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$57.7

Commodities Costs: Description	Commodities Sum
Field Supplies	7.5
Communication	0.2
Mailing/Shipping	0.8
Micellanous	0.5
Commodities Total	$9.0

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 11

FY11	Project Title:Evaluation of Polypropylene Geotextile-Based Sediment Treatment Methods for Lingering Oil on Gravel Beaches in Prince William Sound, Alaska Lead PI:Tim Robertson	FORM 4B CONTRACTUAL & COMMODITIES DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

Habitat

Kenai Small Parcels

Poore Parcel

Virginia Poore has nominated her parcel containing 52 acres with river frontage located at Eagle Rocks on mile 11 of the Kenai River for Trustee Council consideration. The parcel provides valuable riparian habitat as well as recreational opportunities for anglers. With 1,250 linear feet of water front and an existing protected boat ramp, this is an exceptional opportunity.

The majority of the parcel is undisturbed with 30 acres of low-lying wetlands typical of the lower Kenai River. In addition, the parcel contains a small creek which meanders east to west and provides important salmon habitat. Furthermore, acquisition of the parcel would add to the contiguous habitat protection efforts along prime development areas of the Kenai River.

The launch facilities on site are better known as Eagle Rocks, which enjoys recreational use primarily during the summer fishery. This parcel is adjacent to state lands and is a prime parcel for acquisition given its size, location, benefits, and because it fits into the existing land management regime. Acquisition of the parcel would provide much needed recreational opportunities and public access on the lower Kenai River. In addition, if acquired and managed by the State this parcel would fill a critical gap in the recreational opportunities on the Kenai River. This parcel potentially has the safest boat launch facility on the river given its slough waterfront, which is ideal for novice and family boaters, so it would provide public access to a safe boat launch on the lower river.

DNR has been working with the landowner and her attorney to consider this parcel in a methodical, measured manner. Preliminary due diligence indicated no title issues and the landowner has provided a Uniform Appraisal Standards for Federal Land Acquisitions - compliant appraisal for agency review.

This parcel would ultimately be included in Kenai River Special Management Area (KRSMA) and jointly managed by the Division of Parks and Outdoor Recreation and the Department of Fish and Game.

Silver Parcel

Richard Silver and Gregory Gennette have nominated their 4 acre parcel that is adjacent to and borders the northern border of the Big Eddy State Recreation Area (between Kenai and Soldotna) and to the west by federal (BLM) lands. The parcel is accessible by road. A man-made canal borders the parcel and drains into the Kenai River. The parcel is forested with black spruce with an understory of shrubs and grasses.

The parcel is comprised of lowland wetland habitat characteristic of the lower Kenai River that supports injured and recovered species. Acquisition of the parcel would provide for a continuous wetland connection by connecting adjacent parcels of the same management intent and wetland characteristics, while providing upland habitat important for Coho salmon. This parcel also provides a high level of recreational opportunities for bird watching.

This is another parcel that would ultimately be included in Kenai River Special Management Area (KRSMA) and jointly managed by the Division of Parks and Outdoor Recreation and the Department of Fish and Game.

Saltz parcel

Clyde Saltz has nominated a 1.85 acre island parcel at mile 15 of the Kenai River. The parcel is a partially treed island with an understory of shrubs and grasses. This parcel is located within a mile of two EVOS small parcels – Tall Timber and Kobylarz. The island remains undeveloped except for an old homesteaders' cabin.

The parcel provides approximately 1,293 feet of undeveloped riparian habitat that is important for rearing and migration of Pink, Sockeye, Coho and Chinook salmon, and rearing and overwintering habitat for resident fishes of the Kenai River, including Dolly Varden. Chinook salmon spawn both immediately upstream and downstream of the island. Although these species are considered to be recovered, protecting important habitat is essential to maintaining recovery objectives.

This parcel would also ultimately be included in Kenai River Special Management Area (KRSMA) and jointly managed by the Division of Parks and Outdoor Recreation and the Department of Fish and Game.

KEN 3009: Saltz' Island – Kenai River

Owner:	Clyde Saltz
Physical Location:	This parcel is located at mile 15 of the Kenai River
Acreage:	1.85 acres
Brief Description:	T 5 N, R 10 W, SM, Sec. 19, Lot 7
Agency Sponsor:	Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation, and the Department of Fish and Game
Appraised Value:	Unknown

Parcel Description. The Saltz parcel is a partially treed island with an understory of shrubs and grasses located at mile 15 of the Kenai River. It is a low profile island, vulnerable to damage during high water or ice events. The parcel is located within one-half mile of two previously acquired EVOS small parcels, the Tall Timbers and the Kobylarz parcels. The island remains undeveloped except for an old homesteader's cabin that is succumbing to time and weather.

Linkage to Restoration:

Restoration Benefits.
Injured species that will benefit from this parcel acquisition include, pink and sockeye salmon, Dolly Varden and bald eagles. Although these species are considered to be recovered, protecting important habitats is essential to maintaining recovery objectives. The parcel also supports Chinook and coho salmon.

This parcel provides approximately 1,293 feet of undeveloped riparian habitat that is important for rearing and migration of pink, sockeye, coho and Chinook salmon, and rearing and overwintering habitat for resident fishes of the Kenai River, including Dolly Varden. Chinook salmon spawn both immediately upstream and downstream of the island.

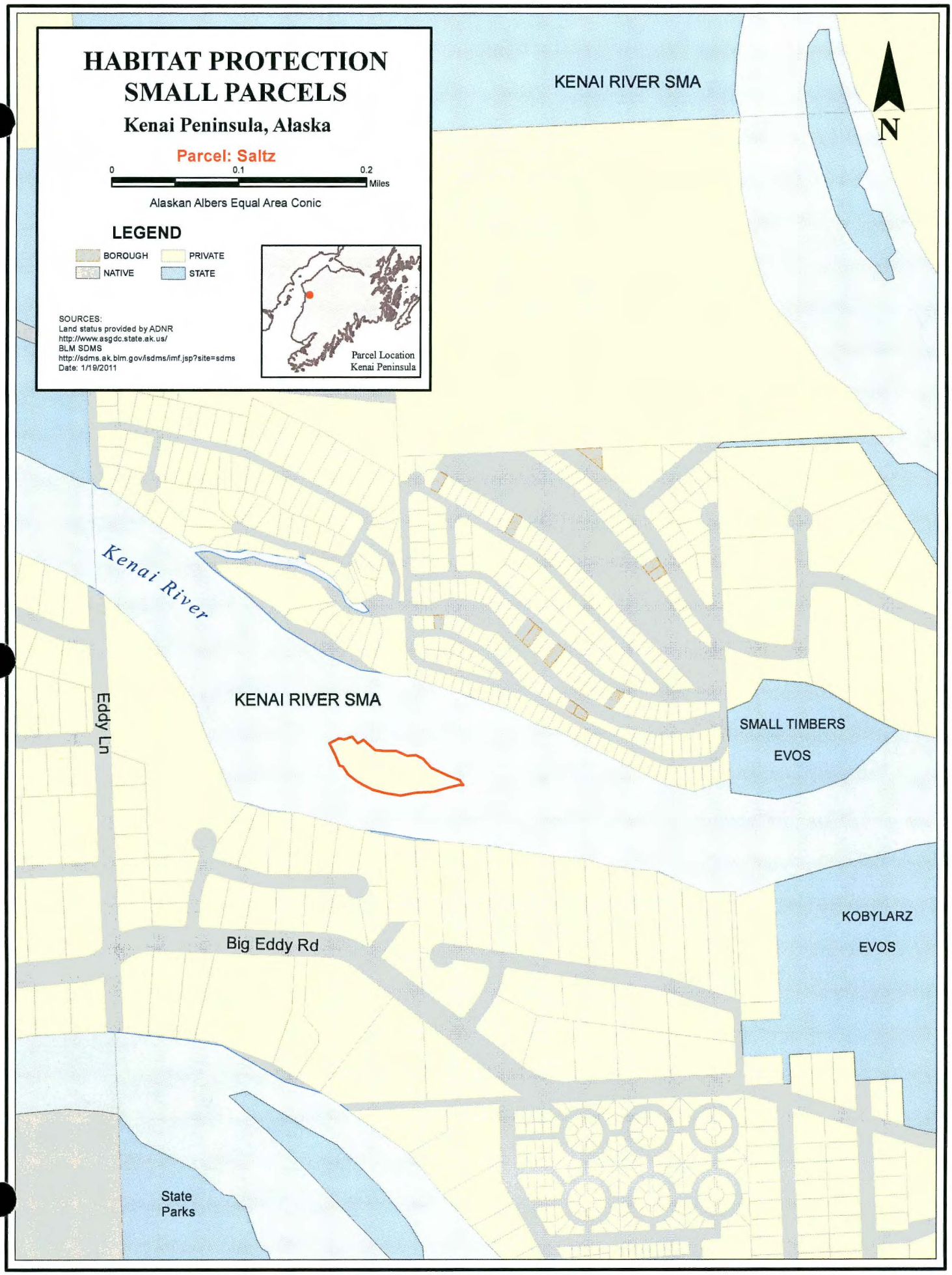
This area supports popular recreational fisheries for Chinook, sockeye and coho salmon. Since 1981 approximately 45% of the total sport fishing effort expended on the Kenai River occurs in the lower 20 miles of river. In particular this area supports a popular shore fishery for sockeye salmon during approximately the last 2-weeks of July and early August. All of the salmon species contribute to the commercial fisheries of Cook Inlet.

Potential Threats.
This parcel is currently listed for sale with a local realtor. Although the DPOR has several park units in the area, a large proportion of land along this section of river is privately owned. In recent years much private land adjacent to the river has been developed into small parcel subdivisions. Other islands in the area are in private ownership and have been subdivided. Current aerial photographs of the islands compared with aerial photographs approximately twenty years ago show these islands have largely been developed by private landowners. State ownership of undeveloped lands in this area will allow additional habitat protections to aid in maintaining habitat for anadromous and resident fish species of the Kenai River. Unaltered

riparian habitat typical of the lower Kenai River is important and development of this island would reduce the amount of unaltered riparian habitat in the lower Kenai River.

Proposed Management.

This parcel has been identified as a priority for the Department of Fish and Game and the Department of Natural Resources, Division of Parks and Outdoor Recreation. This parcel will be jointly managed by the Alaska Department of Fish and Game and the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation for the purposes of protecting resources and services injured by the *Exxon Valdez* Oil Spill and will be recommended for addition to KRSMA.


HABITAT PROTECTION
SMALL PARCELS
Kenai Peninsula, Alaska
Parcel: Saltz
0
0.1
0.2
Miles
Alaskan Albers Equal Area Conic
LEGEND
BOROUGH
PRIVATE
NATIVE
STATE
SOURCES:
Land status provided by ADNR
http://www.asgdc.state.ak.us/
BLM SDMS
http://sdms.ak.blm.gov/sdms/imf.jsp?site=sdms
Date: 1/19/2011
Parcel Location
Kenai Peninsula
KENAI RIVER SMA
N
Kenai River
Eddy Ln
KENAI RIVER SMA
SMALL TIMBERS
EVOS
KOBYLARZ
EVOS
Big Eddy Rd
State
Parks

Silver

KEN 3008: Silver Parcel – Kenai River

Owner:	Gregory Gennette and Richard Silver
Physical Location:	This parcel is located adjacent to the Big Eddy State Recreation Area
Acreage:	4.01 acres
Brief Description:	T 5 N, R 11 W, SM, Sec. 24, Tract A
Agency Sponsor:	Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation
Appraised Value:	Unknown

Parcel Description. This parcel is located adjacent to the Big Eddy State Recreation Area between Kenai and Soldotna and is accessible by road. Most of the parcel is lowland wetlands characteristic of the lower Kenai River. A man-made canal borders this parcel and drains into the river. It is forested with black spruce and has an understory of shrubs and grasses.

Linkage to Restoration:

Restoration Benefits.
Injured species that will benefit from this parcel acquisition include bald eagles and Barrow's goldeneyes. Although bald eagles are considered to be recovered, protecting important habitats is essential to maintaining recovery objectives. The parcel also supports coho salmon spawning habitat and bird roosting and nesting habitat.

Barrow's goldeneyes are known to use the Kenai River corridor during the spring, summer and fall. This parcel contains wetlands that typically support nesting. The connection between the birds that molt and winter in Prince William Sound and the location where these birds nest is unknown.

The wetlands on this parcel are connected to wetlands of adjacent parcels and provide a continuous wetland connection across this peninsula with the Kenai River. This parcel floods during high water events. The canal, although man-made over 40 years ago, now provides rearing habitat for coho salmon.

The parcel also possesses high recreational opportunities for bird watching.

Potential Threats.
The habitat values of this parcel are at risk because of the potential for subdivision development of the parcel. The parcel is bordered on two sides by existing developed subdivisions and the current owner has indicated that subdivision and future development is a possibility.

Proposed Management.
This parcel has been identified as a priority for the Department of Fish and Game and the Department of Natural Resources, Division of Parks and Outdoor Recreation. This parcel will be jointly managed by the Alaska Department of Fish and Game and the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation for the purposes of protecting resources and services injured by the *Exxon Valdez* Oil Spill and will be recommended for addition to KRSMA.


HABITAT PROTECTION
SMALL PARCELS
Kenai Peninsula, Alaska
Parcel: Silver
0
0.2
0.4
Miles
Alaskan Albers Equal Area Conic
LEGEND
BOROUGH
PRIVATE
FEDERAL
STATE
NATIVE
SOURCES:
Land status provided by ADNR
http://www.asgdc.state.ak.us/
BLM SDMS
http://sdms.ak.blm.gov/isdms/imf.jsp?site=sdms
Date: 1/13/2011
Parcel Location
Kenai Peninsula
N
State Parks
Ciechanski Rd
State Parks
Kenai River
State Parks
Big Eddy Rd
State Parks

KEN 3010: Poore – Kenai River

Owner:	Virginia Poore
Physical Location:	This parcel is located at mile 11 of the Kenai River
Acreage:	52 acres
Brief Description:	T 5 N, R 10 W, SM, Sec. 6, Lots 6 and 7
Agency Sponsor:	Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation
Appraised Value:	$1,100,000

Parcel Description
The Poore parcel is located along the Kenai River near Eagle Rock and has approximately 1,250 linear feet of river frontage. It is located across the river from the Eagle Rock unit of the state parks on an outside bend of the Kenai River where the shoreline is actively eroding. The parcel has a boat launch facility, including a parking area and restrooms but most of the parcel is undisturbed with numerous areas of lowland wetlands. *Wetland Mapping and Classification of the Kenai Lowland, Alaska* (Gracz et al.) characterizes most of this parcel as lakebed ecosystem wetland with riparian wetlands along waterbodies. A small stream, cataloged in the Alaska Department of Fish and Game Anadromous Waters Catalog, meanders through the parcel east to west before entering the Kenai River in the adjacent parcel. The parcel provides valuable lowland wetland and riparian habitat as well as recreational opportunities for shore based anglers. The boat launch and parking area is especially busy during the end of July when nearby facilities are at capacity.

Linkage to Restoration:

Restoration Benefits
Injured species that will benefit from this parcel acquisition include pink and sockeye salmon, bald eagles, and Barrow's goldeneyes. Although bald eagles, and pink and sockeye salmon are considered to be recovered, protecting important habitats is essential to maintaining recovery objectives. The parcel also supports coho and sockeye salmon rearing habitat. All of these salmon species contribute to the commercial fisheries of Cook Inlet.

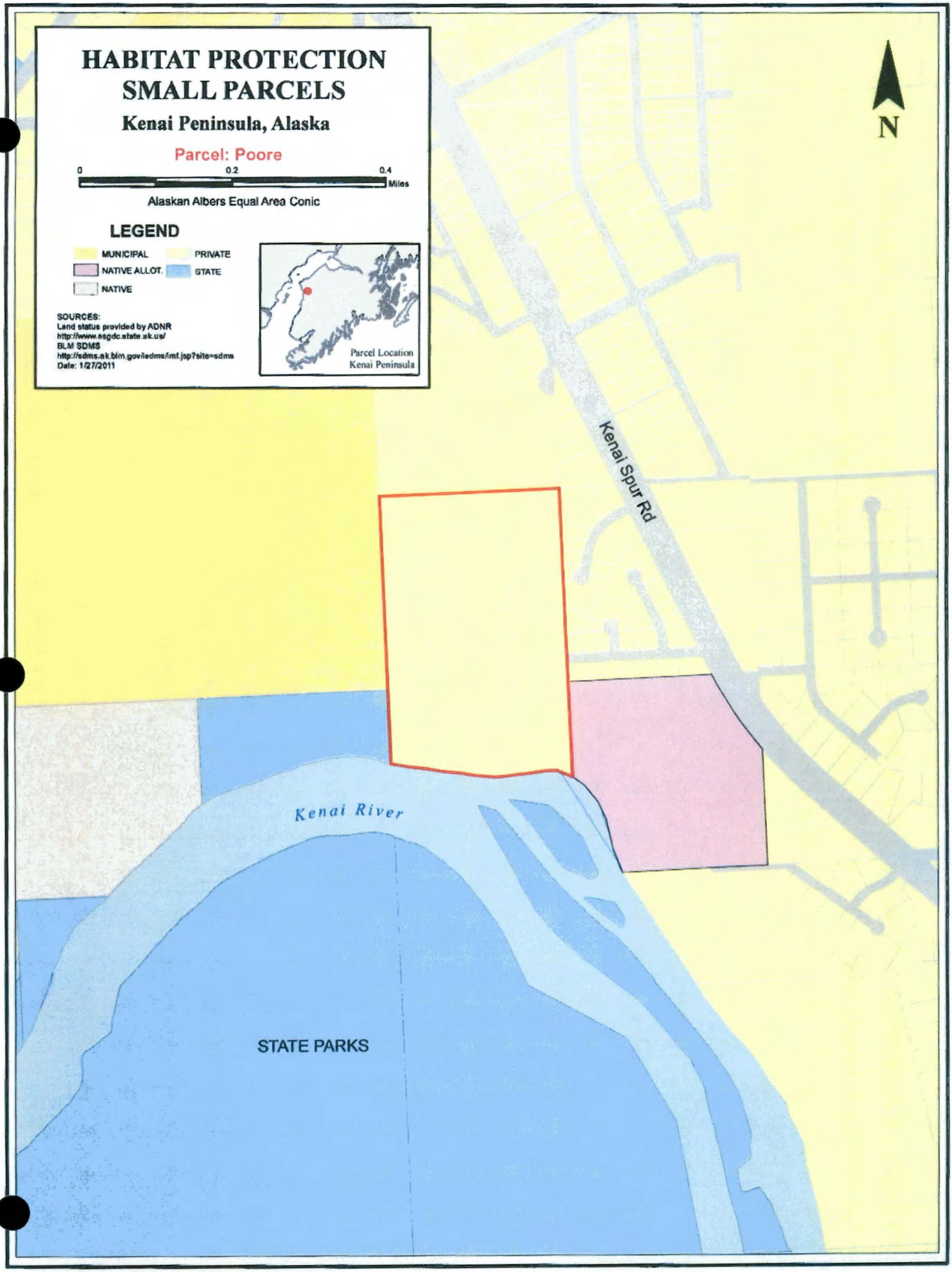
This area also supports popular recreational fisheries for Chinook, sockeye, pink and coho salmon. Since 1981 approximately 45% of the total sport fishing effort expended on the Kenai River has occurred in the lower 20 miles of river. In particular, this area supports a popular shore fishery for pink and coho salmon during August and September.

Potential Threats
The current owner has indicated that she would like to sell the property. The development potential of the parcel is unknown but would appear to be high, as it is a large parcel with

significant riverfront footage. This is an opportunity to acquire lowland and riparian habitat that may be unavailable in the future.

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, in consultation with the State Historic Preservation Officer for the purposes of protecting resources and services injured by the *Exxon Valdez* Oil Spill and will be recommended for addition to KRSMA.


HABITAT PROTECTION
SMALL PARCELS
Kenai Peninsula, Alaska
Parcel: Poore
0
0.2
0.4
Miles
Alaskan Albers Equal Area Conic
LEGEND
MUNICIPAL
PRIVATE
NATIVE ALLOT.
STATE
NATIVE
SOURCES:
Land status provided by ADNR
http://www.asgdc.state.ak.us/
BLM SDMS
http://sdms.ak.blm.gov/isdms/imf.jsp?site=sdms
Date: 1/27/2011
Parcel Location
Kenai Peninsula
N
Kenai Spur Rd
Kenai River
STATE PARKS

RESOLUTION 11-04 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL REGARDING SILVER-KEN 3008, SALTZ-KEN 3009, AND POORE-KEN 3010

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 2011, as described in Attachment A.

This resolution authorizes the distribution of $43,600 of FFY 2011 funding for due diligence expenses, consistent with State and Trustee Council requirements, in support of Kenai River habitat protection efforts for three small parcels (Silver-KEN 3008, Saltz-KEN 3009 and Poore-KEN 3010), as described in Attachment A, to be distributed according to the following schedule:

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

Authorization of the approved funding shall run from February 11, 2011, to September 30, 2012.

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 February 11, 2011, held in Anchorage, Alaska, as affirmed by our signatures affixed below.

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

JOHN J. BURNS
Attorney General
Alaska Department of Law

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

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

CORA CAMPBELL
Commissioner
Alaska Department of Fish and Game

LARRY HARTIG
Commissioner
Alaska Department of Environmental
Conservation

Attachment A - Restoration Benefits Reports and Maps for Silver-KEN 3008, Saltz-KEN 3009, and Poore-KEN 3010

RESOLUTION 11-05 OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL AMENDING THE FFY 2011 WORK PLAN

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, in U.S. District Court for the District of Alaska. This funding is for necessary Natural Resource Damage Assessment and Restoration activities for the Federal Fiscal Year 2011 Work Plan. Specifically, this Resolution authorizes funding for the following: $1,586,785 for Project 11100836 by Boufadel for Bioremediation Pilot Studies; $218,000 for Phase I of Project 11100853 by Irons for Pigeon Guillemot Restoration in PWS; and $178,200 for Project 11100112 by Irvine for Lingering Oil on Boulder-Armored Beaches. The total amount of approved funding is $1,982,985 which includes 9% General Administration (GA). The monies are to be distributed according to the following schedule:

U.S. Department of the Interior – USGS	$151,200
U.S. Department of the Interior – USFWS	$218,000
National Oceanic & Atmospheric Administration	$1,613,785
TOTAL APPROVED TO UNITED STATES OF AMERICA	**$1,982,985**

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 for the Federal Fiscal Year 2011 Work Plan, the amount of $1,982,985 from the appropriate accounts designated by the Executive Director. Funds must be spent as noted above, with the following conditions: (1) If a Principal Investigator (PI) has an overdue report or manuscript from a previous year, no funds may be expended on a project involving the PI unless the report is submitted or a schedule for submission is approved by the Executive Director; (2) a project's lead agency must demonstrate to the Executive Director that requirements of the National Environmental Policy Act (NEPA) are met before any project funds may be expended (with the exception of funds spent to prepare NEPA documentation); and (3) a PI for each project must submit a signed form to the Executive Director indicating their agreement to abide by the Trustee Council's data and report requirements before any project funds may be expended.

In addition, with regard to Project 11100853, Irons–Pigeon Guillemot Restoration in Prince William Sound, prior to the expenditure of the above-authorized funds for a NEPA review of the Project, the managing agency will provide, for approval by the Executive Director, a letter of agreement among the parties involved in the Project. At a minimum, the parties participating in the letter of agreement must include the U.S. Fish and Wildlife Service (USFWS), the U.S. Forest Service (USFS), the U.S. Animal and Plant Health Inspection Service (APHIS), and the State of Alaska Department of Fish and Game (ADF&G). This letter of agreement will define the purpose and need of the Project, the scope and scale of the Project, and the individual contributions of each of the parties involved in development of the NEPA analysis and the Project. In addition, the letter of agreement will include a spending plan to address these needs. After the completion of Phase I of Project 11100853, the Council will then make a determination of whether to fund Phase II of the project.

Approved by the Council at its meeting of February 11, 2011, held in Anchorage, Alaska, as affirmed by our signatures affixed below:

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

JOHN J. BURNS
Attorney General
Alaska Department of Law

KIM ELTON
Special Assistant to the Secretary
for Alaska
Office of the Secretary
U.S. Department of Interior

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

CORA CAMPBELL
Commissioner
Alaska Department of Fish and Game

LARRY HARTIG
Commissioner
Alaska Department of Environmental
Conservation

feb 11 TC mtg

Womac, Cherri G (EVOSTC)

From: Hsieh, Elise M (EVOSTC)
Sent: Wednesday, January 19, 2011 3:51 PM
To: Womac, Cherri G (EVOSTC)
Subject: FW: Benefits Reports
Attachments: Saltz benefits report.pdf; ATT390285.htm; Silver Benefits report.pdf; ATT390286.htm

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From: Carol Fries [mailto:carol.fries@alaska.gov]
Sent: Wed 1/19/2011 3:01 PM
To: Schorr, Jennifer L (LAW); Hsieh, Elise (EVOSTC)
Cc: Carroll, Samantha J (DNR); Simpson, Ellen M (DFG)
Subject: Benefits Reports

Hi,
Attached are benefits reports for two Kenai River parcels jointly sponsored by ADF&G and ADNR. Sam and Ellen can move forward on these. We have done some preliminary title work on Satz and there are several issues that will need to be resolved at closing or prior to, the financial kind.
More on this later. We may need to request some additional funds but I haven't sorted that out yet.
This will give you some information for your briefings early next week.
Thanks.
Carol

KEN 3009: Saltz' Island – Kenai River

Owner:	Clyde Saltz
Physical Location:	This parcel is located at mile 15 of the Kenai River
Acreage:	1.85 acres
Brief Description:	T 5 N, R 10 W, SM, Sec. 19, Lot 7
Agency Sponsor:	Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation, and the Department of Fish and Game
Appraised Value:	Unknown

Parcel Description. The Saltz parcel is a partially treed island with an understory of shrubs and grasses located at mile 15 of the Kenai River. It is a low profile island, vulnerable to damage during high water or ice events. The parcel is located within one-half mile of two previously acquired EVOS small parcels, the Tall Timbers and the Kobylarz parcels. The island remains undeveloped except for an old homesteader's cabin that is succumbing to time and weather.

Linkage to Restoration:

Restoration Benefits.
Injured species that will benefit from this parcel acquisition include, pink and sockeye salmon, Dolly Varden and bald eagles. Although these species are considered to be recovered, protecting important habitats is essential to maintaining recovery objectives. The parcel also supports Chinook and coho salmon.

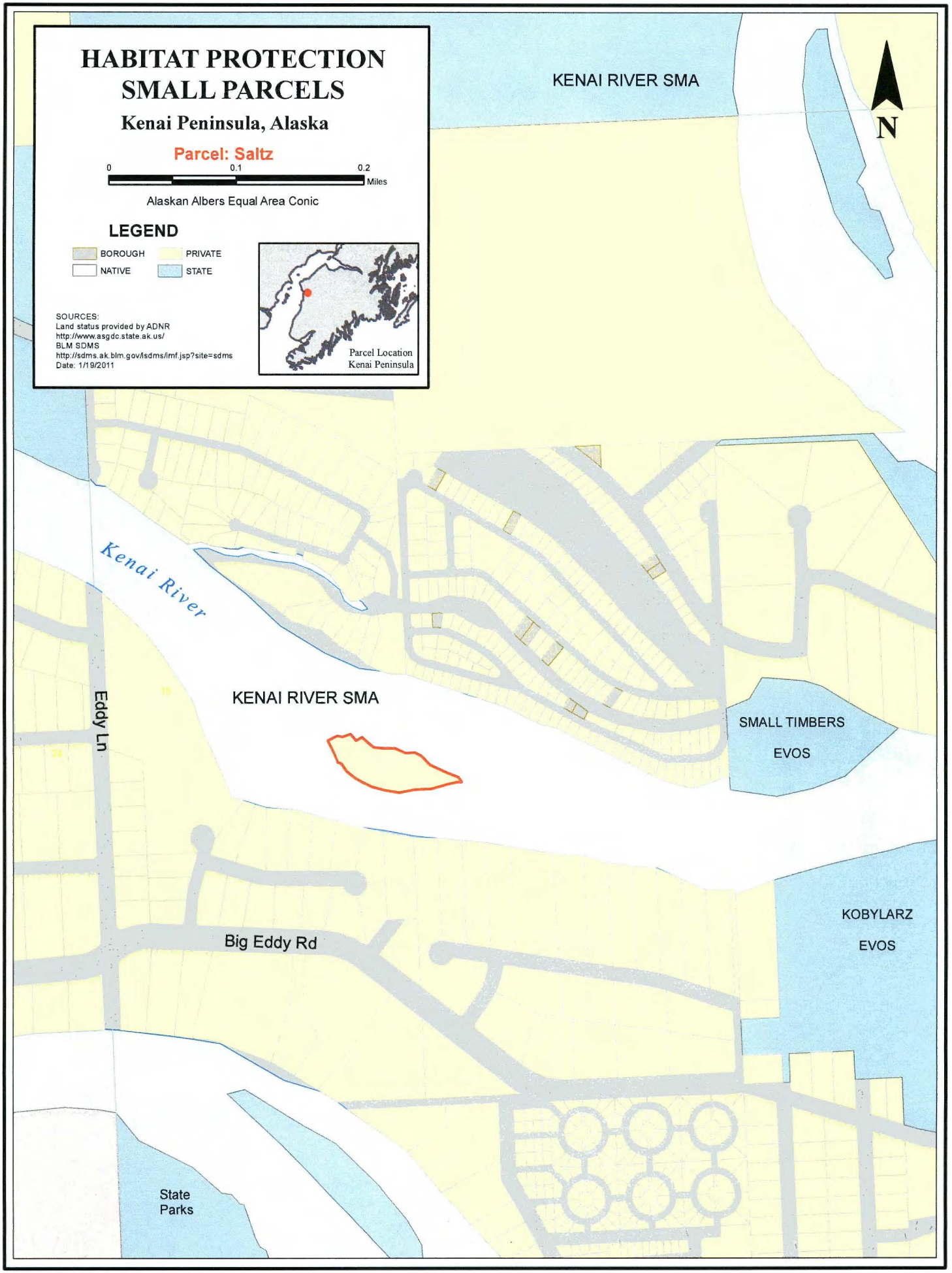
This parcel provides approximately 1,293 feet of undeveloped riparian habitat that is important for rearing and migration of pink, sockeye, coho and Chinook salmon, and rearing and overwintering habitat for resident fishes of the Kenai River, including Dolly Varden. Chinook salmon spawn both immediately upstream and downstream of the island.

This area supports popular recreational fisheries for Chinook, sockeye and coho salmon. Since 1981 approximately 45% of the total sport fishing effort expended on the Kenai River occurs in the lower 20 miles of river. In particular this area supports a popular shore fishery for sockeye salmon during approximately the last 2-weeks of July and early August. All of the salmon species contribute to the commercial fisheries of Cook Inlet.

Potential Threats.
This parcel is currently listed for sale with a local realtor. Although the DPOR has several park units in the area, a large proportion of land along this section of river is privately owned. In recent years much private land adjacent to the river has been developed into small parcel subdivisions. Other islands in the area are in private ownership and have been subdivided. Current aerial photographs of the islands compared with aerial photographs approximately twenty years ago show these islands have largely been developed by private landowners. State ownership of undeveloped lands in this area will allow additional habitat protections to aid in maintaining habitat for anadromous and resident fish species of the Kenai River. Unaltered

riparian habitat typical of the lower Kenai River is important and development of this island would reduce the amount of unaltered riparian habitat in the lower Kenai River.

Proposed Management.
This parcel has been identified as a priority for the Department of Fish and Game and the Department of Natural Resources, Division of Parks and Outdoor Recreation. This parcel will be jointly managed by the Alaska Department of Fish and Game and the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation for the purposes of protecting resources and services injured by the *Exxon Valdez* Oil Spill and will be recommended for addition to KRSMA.


HABITAT PROTECTION
SMALL PARCELS
Kenai Peninsula, Alaska
Parcel: Saltz
0
0.1
0.2
Miles
Alaskan Albers Equal Area Conic
LEGEND
BOROUGH
PRIVATE
NATIVE
STATE
SOURCES:
Land status provided by ADNR
http://www.asgdc.state.ak.us/
BLM SDMS
http://sdms.ak.blm.gov/isdms/imf.jsp?site=sdms
Date: 1/19/2011
Parcel Location
Kenai Peninsula
KENAI RIVER SMA
N
Kenai River
Eddy Ln
KENAI RIVER SMA
SMALL TIMBERS
EVOS
KOBYLARZ
EVOS
Big Eddy Rd
State
Parks

KEN 3008: Silver Parcel – Kenai River

Owner:	Gregory Gennette and Richard Silver
Physical Location:	This parcel is located adjacent to the Big Eddy State Recreation Area
Acreage:	4.01 acres
Brief Description:	T 5 N, R 11 W, SM, Sec. 24, Tract A
Agency Sponsor:	Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation
Appraised Value:	Unknown

Parcel Description. This parcel is located adjacent to the Big Eddy State Recreation Area between Kenai and Soldotna and is accessible by road. Most of the parcel is lowland wetlands characteristic of the lower Kenai River. A man-made canal borders this parcel and drains into the river. It is forested with black spruce and has an understory of shrubs and grasses.

Linkage to Restoration:

Restoration Benefits.
Injured species that will benefit from this parcel acquisition include bald eagles and Barrow's goldeneyes. Although bald eagles are considered to be recovered, protecting important habitats is essential to maintaining recovery objectives. The parcel also supports coho salmon spawning habitat and bird roosting and nesting habitat.

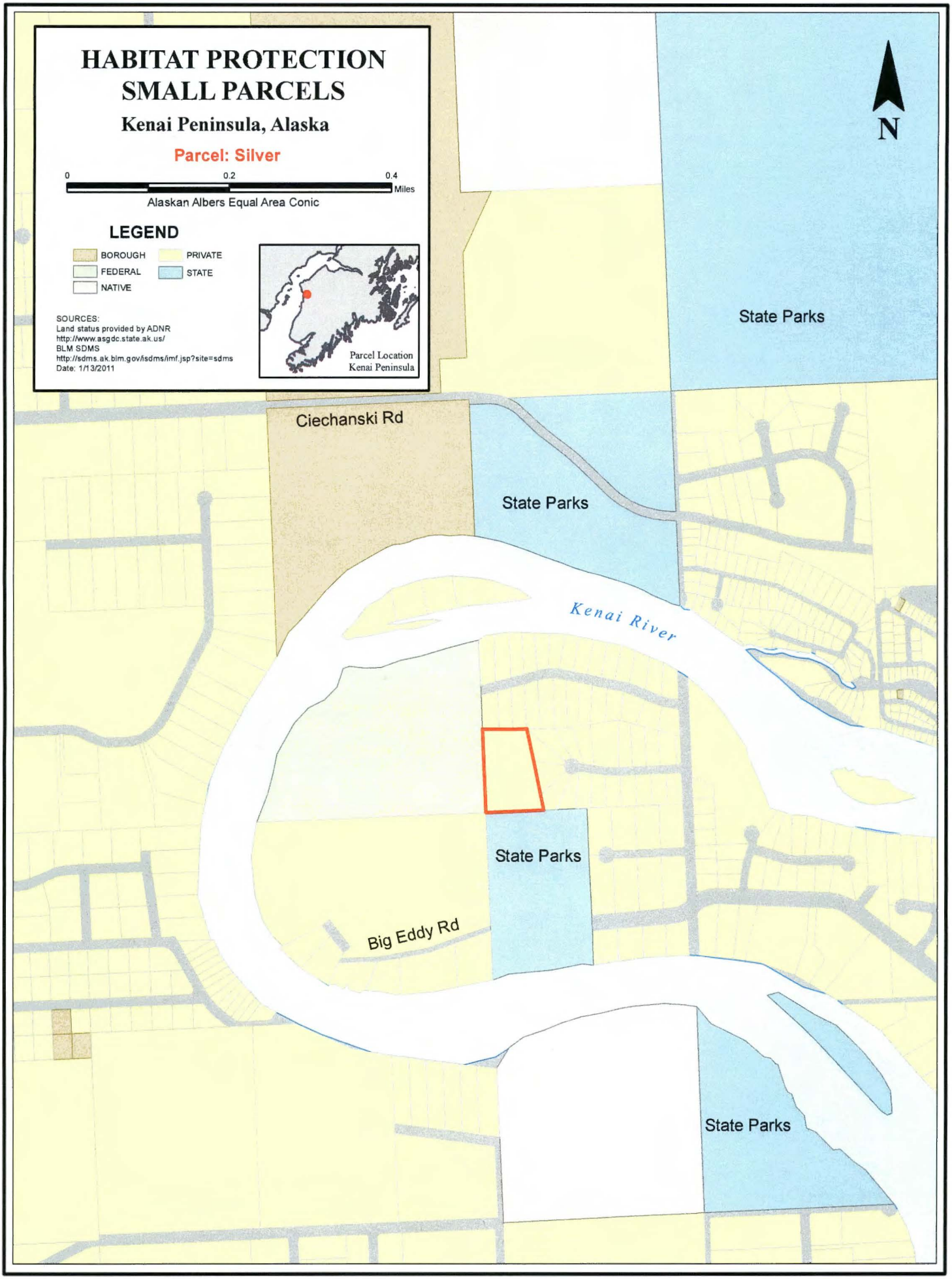
Barrow's goldeneyes are known to use the Kenai River corridor during the spring, summer and fall. This parcel contains wetlands that typically support nesting. The connection between the birds that molt and winter in Prince William Sound and the location where these birds nest is unknown.

The wetlands on this parcel are connected to wetlands of adjacent parcels and provide a continuous wetland connection across this peninsula with the Kenai River. This parcel floods during high water events. The canal, although man-made over 40 years ago, now provides rearing habitat for coho salmon.

The parcel also possesses high recreational opportunities for bird watching.

Potential Threats.
The habitat values of this parcel are at risk because of the potential for subdivision development of the parcel. The parcel is bordered on two sides by existing developed subdivisions and the current owner has indicated that subdivision and future development is a possibility.

Proposed Management.
This parcel has been identified as a priority for the Department of Fish and Game and the Department of Natural Resources, Division of Parks and Outdoor Recreation. This parcel will be jointly managed by the Alaska Department of Fish and Game and the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation for the purposes of protecting resources and services injured by the *Exxon Valdez* Oil Spill and will be recommended for addition to KRSMA.


HABITAT PROTECTION
SMALL PARCELS
Kenai Peninsula, Alaska
Parcel: Silver
0
0.2
0.4
Miles
Alaskan Albers Equal Area Conic
LEGEND
BOROUGH
PRIVATE
FEDERAL
STATE
NATIVE
SOURCES:
Land status provided by ADNR
http://www.asgdc.state.ak.us/
BLM SDMS
http://sdms.ak.blm.gov/isdms/imf.jsp?site=sdms
Date: 1/13/2011
Parcel Location
Kenai Peninsula
N
State Parks
Ciechanski Rd
State Parks
Kenai River
State Parks
Big Eddy Rd
State Parks