Ecological Risk Assessment: Consensus Workshop

Environmental Tradeoffs Associated with Oil Spill Response Technologies

Northwest Arctic Alaska

Session 1: 18 - 20 October 2011
Session 2: 16 - 17 November 2011

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Environmental Tradeoffs Associated with Oil Spill Response Technologies

Northwest Arctic Alaska

A Report to the US Coast Guard
Sector Anchorage

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Ecosystem Management & Associates, Inc.

Ecosystem Management & Associates, Inc.
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LIST OF ABBREVIATIONS, SYMBOLS, AND ACRONYMS

ACS	Alaska Clean Seas
ADIOS	Automated Data Inquiry for Oil Spills
ADF&G	Alaska Department of Fish & Game
AK	Alaska
ANS	Alaskan North Slope
AVEC	Alaska Village Electric Cooperative
CAPT	Captain
CD	Compact Disc
CERA	Consensus Ecological Risk Assessment
CG533	Office of Incident Management & Preparedness
CROSERF	Chemical Response to Oil Spills: Ecological Effects Research Forum
DOSS	Dioctyl Sodium Sulfosuccinate
EM&A, Inc.	Ecosystem Management & Associates, Inc.
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ERD	Emergency Response Division
G	Global
GNOME	General NOAA Oil Modeling Environment
GRS	Geographic Response Strategies
HAZMAT	Hazardous Materials
ICS	Incident Command System
IFO	Intermediate Fuel Oil
ISB	*In-situ* Burning
L	Local
M/V	Merchant Vessel
NANA	NANA Regional Corporation, Inc.
NOAA	National Oceanic & Atmospheric Administration
NGO	Non-Governmental Organization
NPFC	National Pollution Fund Center
NRC	National Resource Council
NSEDC	Norton Sound Economic Development Corporation
OSRL	Oil Spill Response Limited
PAH	Polycyclic Aromatic Hydrocarbons
PPOR	Potential Places of Refuge
R	Regional
RAR	Resources at Risk
SMART	Special Monitoring of Applied Response Technologies
SSC	Scientific Support Coordinator
TEK	Traditional Ecological Knowledge
VRT	Village Response Team
μ	Microns
US	United States
USCG	United States Coast Guard
USGS	United States Geological Survey

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Executive Summary

In October/November 2011, the United States Coast Guard (USCG) Sector Anchorage hosted a workshop to evaluate the relative risk to natural resources from various oil spill response-options. These options included no response (natural recovery), on-water mechanical recovery, *in-situ* burning, dispersant application, shoreline protection and shoreline recovery. The workshop involved participants from local, borough, tribal, state and Federal agencies and was designed to emphasize cooperative decision-making if a spill were to threaten resources in the Northwest Arctic Alaska. The workshop consisted of one 3-day session and one 2-day session separated by approximately four weeks.

The spill scenario designed by the Steering Committee involved the release of 400,000 gallons of IFO 180 fuel from a fuel carrier grounded near Little Diomede Island, AK on 7-8 August 2011. The release was treated with dispersant via aircraft sorties on the second day of the release, targeting the spill's leading edge. The modeled effectiveness of the dispersant application was forty percent.

Participants, divided into four focus groups, evaluated the relative risks and benefits of the response options during the October session. The groups completed analysis for natural recovery, on-water mechanical recovery, and *in-situ* burning options, and began the analysis for dispersant application. At the November session, initial participant attendance declined due to travel constraints. However, several new members participated. During the second session, all participants reviewed the ranking process and evaluated the remaining alternatives (dispersant application, shoreline protection, and shoreline removal).

Following evaluation of all response options, the participants concluded that the location of the spill could potentially increase the risks to shoreline and shallow water habitats, historic properties, and subsistence use. All four groups viewed shoreline protection as having the greatest benefit by reducing the impact on the lagoons and marshes. Shoreline mechanical recovery was perceived as beneficial to some habitats such as upland, tidal marsh, tidal flats and fine/medium sand beach areas, but has the potential to damage those areas during the removal process. On-water mechanical recovery and *in-situ* burning were viewed as providing limited benefit. The use of dispersants raised serious concerns among all four groups. Two groups did not evaluate and consequently did not recommend this option. However, the two remaining groups felt that dispersant use would provide some net benefit despite having a negative effect on subsistence use. The workshop concluded with the participants developing a list of lessons learned and recommendations for future area oil spill response planning.

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1.0 Objectives of the Anchorage – Kotzebue Workshop

1.1 Background and Process

In 1998, the USCG began sponsoring efforts to develop a comparative risk methodology to evaluate oil spill response-options. Interest in selecting response-options based on a risk/benefit analysis predates the 1998 initiatives, but the current effort emphasizes a consensus-building approach to evaluate risks and benefits.

Headquarters, USCG (G-MOR, now Office of Incident Management & Preparedness (CG-533)) sponsored the development of a guidebook on this process. The document, *Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning. A Guidebook* (Aurand et al., 2000), is available from CG-533. It can also be downloaded from the contractor's web site at www.ecosystem-management.net.

The Consensus Ecological Risk Assessment (CERA) process is designed to guide planners when comparing ecological consequences of specific response options, especially sensitive nearshore or estuarine habitats. The process has been particularly useful when considering dispersants and/or *in-situ* burning, which often presents difficult analytical issues. The process focuses on ecological "trade-offs" or cross-resource comparisons. Through a facilitated and structured analytical approach, participants find "common ground" for evaluating impacts and develop defensible logic to support their conclusions. The process is consistent with the U.S. Environmental Protection Agency's (EPA) *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998), but emphasizes development of group consensus among stakeholders. The process uses a series of analytical tools specifically developed for use in a group environment. It is designed as a planning and training tool and should not be used during an actual event. However, knowledge gained by participants in the consensus-building process facilitates real-time decision-making.

Training usually involves two 2- or 3-day workshops led by a facilitator. The ideal size is 25 to 30 participants, including spill response managers, natural resource managers and trustees, subject matter experts, and non-governmental organizations (NGO). The goal is to achieve consensus interpretations of potential risks and benefits associated with selected response options based on a scenario developed by local participants. Participants utilize the time between the two workshops to research issues of concern before developing conclusions. The process focuses heavily on achieving a consensus interpretation of the available technical information. Therefore, it is important to have broad and consistent stakeholder participation throughout the process; otherwise, not all stakeholders who might become involved or concerned during an actual spill event may accept the results.

The workshop process includes three primary phases: problem formulation, analysis, and risk characterization. Details of the process are described in the Guidebook. In the first phase (prior to the first meeting) of problem formulation, participants (usually a small subgroup serving as a Steering Committee) develop a scenario for analysis, identify resources of concern along with associated assessment thresholds, and prepare a conceptual model to guide subsequent analysis. In the analytical phase, all the participants evaluate exposure and ecological effects. The conceptual model, developed in the problem formulation phase, directs the analysis using standard templates and simple analytical tools that define and summarize the analysis for each resource of concern and each response option. Finally, participants complete a risk characterization interpreting their results in terms of the risks and benefits of each response option to overall environmental protection as compared with natural recovery (i.e., baseline).

1.2 Sponsor's Objectives

USCG Sector Anchorage (part of USCG District 17) sponsored the Northwest Arctic Alaska workshop in support of the revision of the Northwest Arctic Subarea Contingency Plan. The workshop objectives include evaluating and potentially improving oil spill response strategies, and enhancing existing oil spill contingency planning for the area. To achieve this objective, the workshop used a scenario based on the worst-case discharge identified in the plan. The scenario, designed to threaten both offshore and shoreline resources of value, enabled participants to address the benefits and inherent tradeoffs associated with different response tools.

Through the experience with the Consensus Ecological Risk Assessment (CERA) process and its methodology, the sponsors expect that resource and response agency stakeholders will be able to engage in effective risk assessment and tradeoff identification in future pre-spill and spill specific consultations. This would result in a better understanding of local/tribal, resource trustee and response agency concerns, more timely and effective response decisions, and hopefully greater resource protection and recovery.

1.3 Participants

Fifty-three individuals from 17 organizations attended all or some of the workshop sessions. There were two sessions, an initial 3-day meeting in Anchorage, followed by a 2-day meeting in Kotzebue. The workshop sessions were held in two different locations to encourage participation by individuals and government representatives from the Northwest Arctic Borough. During the first session in October, the participants were divided into four focus groups, however the participation differed causing changes to the focus groups composition over the course of the full workshop (see Section 2). Each participant's attendance and respective focus group is listed in Appendix A.

1.4 Organization of the Report and the Associated Compact Disk

This report is one of a series of files on a Compact Disk (CD) prepared as a project deliverable product. The report summarizes the results of the workshop and presents the conclusions of the participants. It is formatted to be printed as an independent, double-sided report. In addition, the CD contains copies of all of the presentations made at the workshop, as well as copies of documents provided as reference material. These files are cited at appropriate locations in the text of the report.

2.0 Overview of Workshop Events

The workshop consisted of a 3-day session in Anchorage from 18 to 20 October 2011, followed by a 2-day session in Kotzebue on 16 and 17 November 2011. The first meeting began with introductions of the participants, and welcoming comments from CAPT Jason Fosdick, Sector Anchorage. A presentation on the basic elements of the CERA, and an introduction to the scenario followed. The scenario presentation included the results of the National Oceanographic and Atmospheric Administration (NOAA) trajectory and fate modeling produced by the General NOAA Modeling Environment (GNOME) model and the Automated Data Inquiry for Oil Spills (ADIOS). The day concluded with a series of presentations on potentially impacted Federal, state, and local resources along with why and how those resources would be vulnerable to the spill and/or response activities. Topics included:

- U.S. Fish & Wildlife Service Trust Resources at Risk
- National Park Service Purposes, Natural & Cultural Resources, and Facilities
- Native Allotments
- Essential Fish Habitat
- Marine Mammals
- Toxicity and Tradeoffs
- Alaska Department of Fish & Game (ADF&G)'s Role in Risk Assessment
- Historic Properties (Cultural Resources)

Day 2 began with presentations on resource issues. The first presentation discussed subsistence resources and uses, and traditional ecological knowledge. The second presented an overview of the wreck of the ship *M/V Selendang Ayu*, and was included because of the potential parallels between the *M/V Selendang Ayu* response effort and likely scenario operations.

An open discussion followed regarding habitats and how they relate to the proposed resources at risk (RAR) table. The draft table included the resource category “Cultural and Subsistence” for all habitats, a category not included in previous RAR tables. After discussion, this category was further subdivided to allow for independent consideration. Additional modifications emphasized the difference between habitats on the outer coast, and habitats in the lagoons behind the barrier islands. In a further departure from previous workshops, no attempt was made to develop a list of representative species for each category in the table. Instead, the participants were instructed to use the RAR data sheet to record notes on species or groups of species that were of “specific concern.” The final RAR table with species notes is presented in Appendix D.

The participants reviewed and discussed the draft levels of concern risk-ranking matrix. The matrix was finalized by the groups and presented in Figure 4.1. Participants then examined the issue of defining a reference population, assuming a base population in order to estimate the percent of a population affected. The participants agreed on the following definitions for the population levels:

- Local (L) – defined as spill footprint;
- Regional (R) – defined as the Northwest Arctic region; and
- Global (G).

In preparation for the evaluation of the natural recovery scenario, participants received an overview on oil spills followed by an explanation of the procedures for evaluating the baseline response option (natural recovery/no intervention). The participants separated into four focus groups (Appendix A) and began evaluating the natural recovery option.

Day 3 began with an on-water mechanical recovery presentation (including a brief introduction to on-water *in-situ* burning (ISB), followed by comments concerning local on-water response capabilities and logistics. Participants agreed on an on-water offshore mechanical recovery efficiency of 5% or less for this scenario and then divided into their four focus groups to rank the "On-Water Mechanical Recovery" and "ISB" response options. They completed the analysis by mid-afternoon and the facilitators proceeded to the evaluation of dispersants.

The dispersant discussion began with a presentation on dispersant issues, including a discussion of "encounter rate." NOAA modeling results were evaluated (including a QuickTime movie of the trajectories of remaining surface oil and dispersed oil in comparison to the baseline case) and discussed. Participants reviewed the procedure for utilizing the toxicity information provided in the workshop notebooks, including the results of a cooperative dispersant effects research program (Section 8 from Chemical Response to Oil Spills: Ecological Effects Research Forum (CROSERF)). They viewed an introductory movie on dispersant use and discussed these presentations with their focus groups, developing a list of issues needing clarification at the next workshop. The issues, organized by category, include:

- Modeling
    - Are there noticeable differences between ANS crude oil and IFO-380 modeling runs? - Group 1
    - Verify effectiveness rates (40% and 30%) and toxicity rates between ANS crude and IFO-380. - Group 1
    - Run model on dispersant application near vessel - Group 1
    - What are the characteristics of currents in the area where dispersants would be used? - Group 3
    - How long would it take to move the oil and dispersants out of the area? - Group 3
    - How quickly will IFO 180 emulsify? - Group 4
- Fate
    - Can we use residual DOSS (Dioctyl Sodium Sulfosuccinate) in the water column as a marker of biodegradation? - Group 4
    - How persistent are the primary elements of dispersants in the water column? - Group 4
    - Do dispersed oil droplets sink? What is the mechanism for this effect? - Group 4
- Dispersant Effectiveness
    - What would happen if a second or third application of dispersant occurred? - Group 2
    - How do you determine dispersant effectiveness if weather is too rough and a fluorometer cannot be deployed? - Group 2
    - Can dispersants be applied if a fluorometer cannot be deployed? - Group 2
    - What would happen if a second or third application of dispersants occurred that treated 50% or 70% of the total oil? - Group 2
    - Why does dispersant work on some and not all product (40% vs. 70%)? - Group 4

  - Will the dispersant window of opportunities will be shorter than for skimming - Group 4
  - Is it worth utilizing dispersants if effectiveness is 10%? - Group 4
  - Need to address the questions regarding dispersant effectiveness identified in the National Research Council's 2005 report and the U.S. Geological Survey's 2011 report - Group 1
- Dispersant Operations
  - What is the dispersant capability in Alaska? - Group 1
  - How long does the dispersant permit process take? - Group 2
- Shoreline Impacts
  - Analysis of shoreline impacts with dispersants used versus not used. More detailed information - Group 1
  - How much dispersant would it take to keep the majority of oil off the beaches? - Group 2
  - How much oil reaches the shoreline if dispersant use is effective? - Group 2
  - How much dispersed oil reaches the beach? - Group 3
  - Does less oil enter the lagoons if dispersants are used? - Group 3
- Toxicity
  - What quantities of "lighter ends" are contained in dispersed oil in water column? - Group 1
  - What are the Polycyclic Aromatic Hydrocarbon (PAH) concentrations in the IFOs? - Group 3
  - What is the concentration of PAHs that disperse into the water column and how long do they persist? - Group 2
  - What organisms might have eggs or larvae in the water column that may be affected by PAHs? - Group 2
  - How toxic are PAHs to potential organisms in the water column? - Group 2
  - What are dispersant and oil toxicity levels, concentrations, and persistence through the water column over time? - Group 2
  - Would a bacterial "bloom" result and could it affect the food chain? - Group 2
  - How many toxic components would reach the benthic environment? - Group 2
  - How long would the toxic components persist? - Group 2
  - Would the components be taken-up by organisms in the sediment and have the potential to bioaccumulate up the food chain? - Group 2
  - Bacteria in Arctic - Group 2
  - What is the toxicity of both dispersant and dispersed oil? - Group 2
  - Do we really know what organisms are in the water column? - Group 2
  - What exactly is in the water column this time of year? - Group 2
  - What is the toxicity of dispersed IFO and its effect on pelagic eggs/embryos? - Group 4
  - What are the downstream food web impacts, especially for filter feeders consuming plankton? - Group 4
  - What is the effect of non-dispersed product on the nearshore assemblage of subsistence species (crustaceans)? - Group 4

    - Need to address the questions regarding dispersant toxicity identified in the National Research Council's 2005 report and the U.S. Geological Survey's 2011 - Group 1

- Subsistence
    - Learn about subsistence/way of life concerns related to the use of dispersants - Group 1
    - Dispersants will have psychological impacts on cultural/subsistence - Group 4

At the second session held (16-17 November 2011) 19 of the original 37 participants attended, with 11 new individuals joining for at least part (but not necessarily all) of the two day meeting. A nucleus of previous attendees in each of the focus groups was present and so the new participants were divided amongst the four focus groups (see Appendix A for the attendance and group participation by day for the entire 5-day period). The morning of the first day was devoted to a rapid overview of the CERA process and accomplishments to date so the new participants could understand the process. The revised focus groups reviewed the work completed in Anchorage, and summarized the information used during their decision making processes. The day ended by discussing dispersant questions identified during the Anchorage meeting. The questions with answers are located in Appendix B.

The second day began with all focus groups completing their discussion of dispersant application. Only two of the four groups felt comfortable completing the risk matrix as the new members did not fully understand the process. Each group however, drafted a summary statement about their discussions. Following an overview presentation and a discussion of local capabilities, the groups evaluated and scored shoreline mechanical recovery, clean-up, and shoreline protection options. Lessons learned and general conclusion discussions followed. Due to time constraints, each group was asked to list their five most significant conclusions, and then present them, one at a time, in rotation. There was insufficient time to review all conclusions for consensus, but the recommendations of each group are presented in Section 5.2, along with the consensus conclusions.

3.0 Exercise Scenario and Basic Analytical Information

3.1 Exercise Scenario

The scenario used during the workshop was developed by NOAA and reviewed by the Steering Committee to ensure workshop objectives were met. The scenario was designed to represent a worst-case discharge scenario, threatening valuable nearshore and shoreline resources in order to compare possible on-water and shoreline response options.

Table 3.1 Key Parameters for the Northwest Arctic Alaska Scenario

Time/Date	**0800/7 August 2011**
Initial Release Location	**65º 44.85´ N, 168º 55.38´ W**
Volume	**400,000 Gallons (9624 barrels)**
Oil Type	**IFO-180**
API Gravity	**14.7**
Pour Point	**10º C**
Wind Direction/Speed	**Variable N and NW, 30 – 40 Knots**
Air/Water Temperature	**10º C**
Wave Height	**13 – 19 feet**

The NOAA Emergency Response Division (ERD) Modeling Group used the basic information in the scenario to develop a surface and dispersed oil trajectory for the workshop. Oil fate and transformation information was calculated using the ADIOS II program for IFO-180. Oil trajectories were calculated using the GNOME model. QuickTime movies and time-series snapshots were produced for both the surface slicks and the dispersed oil plumes.

The modeled response options included the following: no response, where the released oil was allowed to weather (evaporation, natural dispersion) and strand on shore with no intervention; and the use of dispersants (at an overall effectiveness of 40%). In the model, chemical dispersant application only occurred during daylight hours. Sufficient dispersant resources were available, with the application of the required volume of dispersant completed in less than one day. The remaining options (mechanical recovery, *in-situ* burning, shoreline protection, shoreline recovery) were not modeled.

3.2 Geographic Area of Concern

The geographic areas of concern included the Northwest Arctic Alaskan coast, and the waters and lagoons of the Seward Peninsula of Alaska from Wales to Shishmaref, extending out towards Little Diomede Island.

3.3 Resources at Risk

The following areas, habitat and resource categories comprised the Resources At Risk table (RAR):

- Areas
  - Upland
  - Inside Barrier Islands
  - Outside Barrier Islands
  - Subtidal Bottom
  - Lagoon Water Column
  - Offshore Water Column
- Habitats
  - Upland
  - Marsh
  - Tidal Flats
  - Sheltered Rocky Shore
  - Exposed Rocky Shore
  - Mixed Sand/Gravel Beaches
  - Fine/Medium Sand Beaches
  - Shallow Inlets and Bays
  - Offshore Less Than 10 Meters
  - Offshore Greater Than 10 Meters
  - Surface Layer
  - Water Column
  - Upper 10 Meters
  - Below 10 Meters
- Resource Category
  - Mammals
  - Birds
  - Fish
  - Invertebrates
  - Plankton
  - Vegetation
  - Historic Properties
  - Cultural and Subsistence

The RAR table was distributed during the first day of the Anchorage session, discussed and edited by the participants. Unlike tables distributed during previous workshops, the RAR tables did not include example organisms or specific concerns. During their analysis of the response options, each focus group populated the table by adding organisms they felt were of highest concern for a habitat. These individual tables were consolidated into one final RAR Table presented in Appendix D.

3.4 Conceptual Model

In lieu of a conceptual model, the workshop participants accepted the list of seven hazards developed in a detailed conceptual model prepared for the San Francisco Bay workshop (Pond *et al.*, 2000). They agreed that these hazards (air pollution, aqueous exposure, physical trauma, oiling/smothering, thermal, waste and indirect) should be considered for each of the proposed response options. The participants also agreed to evaluate the response options (natural recovery (no response), on-water mechanical recovery, *in-situ* burning, dispersant application, shoreline protection and shoreline mechanical recovery) recommended by the Steering Committee.

3.5 Modeling Results

A surface and dispersed oil trajectory was developed using the scenario information. Basic weathering information was calculated and is presented below. Mass balance estimates for untreated oil, and for oil treated with dispersant at 40% effectiveness are presented in Table 3.2; Figure 3.1 shows a graphical representation of the fate of the untreated oil over time.

Table 3.2 Oil Budget (in Gallons) for Undispersed as Predicted in the Northwest Arctic Alaska, Scenario, Spill Volume 400,000 Gallons

400,000 Gallons No Chemical Dispersion (Natural)					
Hours	**Released**	**Floating**	**Evaporated**	**Dispersed**	**Beached**
0	0	0	0	0	0
6	85,200	76,700	5,600	2,900	0
12	174,100	159,100	11,400	3,600	0
24	351,800	316,900	27,200	7,700	0
48	400,000	310,400	58,300	9,200	22,100
60	400,000	287,000	67,000	9,200	36,800
72	400,000	301,300	70,900	9,200	18,600
96	400,000	308,200	80,000	9,200	2,600
120	400,000	302,400	84,200	9,200	4,200
144	400,000	290,600	84,200	9,200	16,000
168	400,000	238,600	84,200	9,200	68,000
192	400,000	158,000	84,200	9,200	148,600
216	400,000	94,300	84,200	9,200	212,300
240	400,000	48,600	84,200	9,200	258,000
264	400,000	7,700	84,200	9,200	298,900
400,000 Gallons 40% Chemical Dispersion					
Hours	**Released**	**Floating**	**Evaporated**	**Dispersed**	**Beached**
0	0	0	0	0	0
6	85,200	76,700	5,600	2,900	0
12	174,100	159,100	11,400	3,600	0
24	351,800	316,900	27,200	7,700	0
48	400,000	288,300	58,300	40,100	13,300
60	400,000	270,200	67,000	40,100	22,700
72	400,000	275,500	70,900	40,100	13,500
96	400,000	279,200	78,200	40,100	2,500
120	400,000	274,900	81,700	40,100	3,300
144	400,000	269,300	81,700	40,100	8,900
168	400,000	235,600	81,700	40,100	42,600
192	400,000	161,200	81,700	40,100	117,000
216	400,000	97,300	81,700	40,100	180,900
240	400,000	52,900	81,700	40,100	225,300
264	400,000	10,400	81,700	40,100	267,800

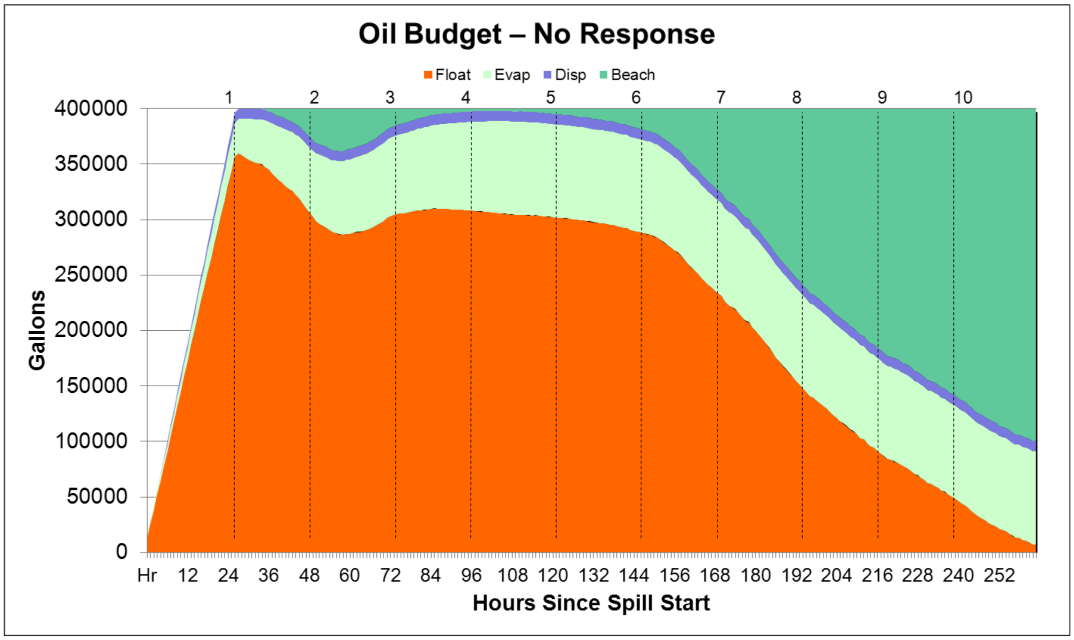


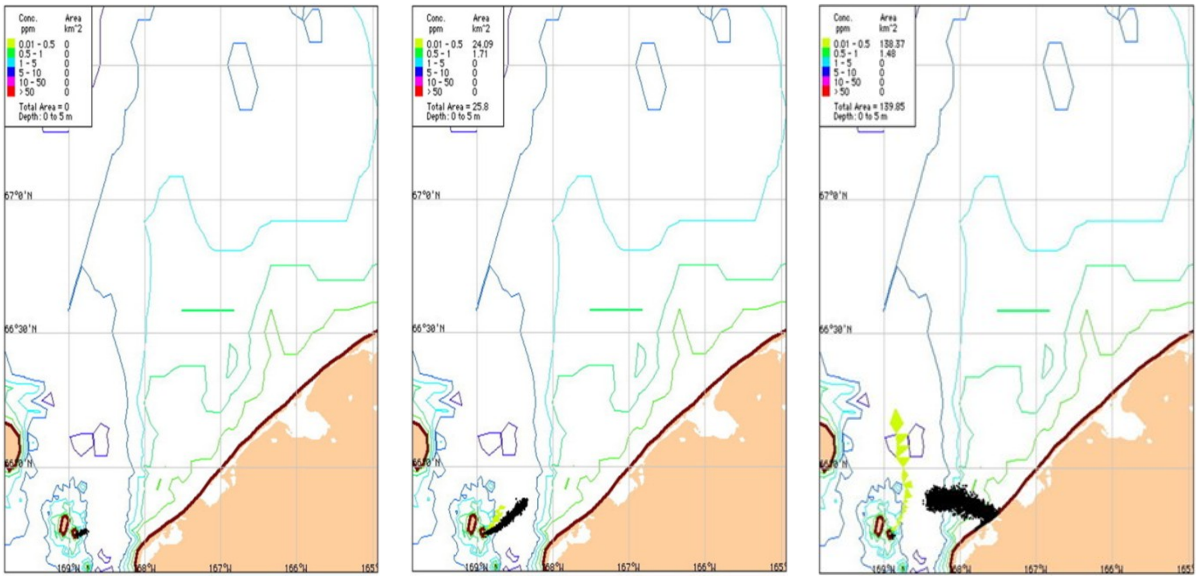
Figure 3.1 *The ADIOS predictions for the fate of the floating oil in Northwest Arctic Alaska scenario without the use of dispersants.*

Selected snapshots from the surface oil trajectory modeling results are presented in Figure 3.2. The average and maximum concentrations from 0 to 5 meters in the dispersed oil plume produced without the use of dispersants are shown in Figure 3.3 and are compared to toxicity threshold values for sensitive life history stages in Figure 3.4.

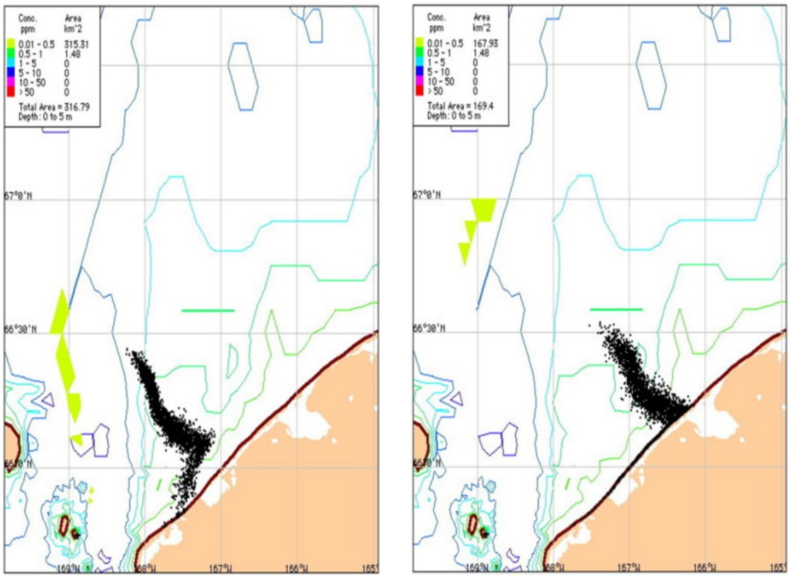
Under the modeled wind conditions, the floating oil from the spill moves to the northeast and impacts the coastal areas near Wales, AK approximately 36 to 48 hours after release. The spill continues to move northeast, further affecting the coastal areas and lagoons of Shishmaref, AK approximately 9 to 10 days after release.

A very small amount of oil naturally disperses, and moves northward with the modeled current. No toxicity thresholds of concern for sensitive life species (Figure 3.4) are predicted to be exceeded.

Figure 3.5 is a graphical representation of the fate of the oil following dispersant application over time. According to the NOAA model inputs, applying dispersant approximately 48 hours after the spill dissipates only a small amount (7.5%) of oil into the water column, and does not dramatically reduce the amount of oil reaching the shoreline. Snapshots from the dispersed oil modeling results (at 40% effectiveness) are presented in Figure 3.6. When comparing Figure 3.1 to Figure 3.5, the differences in the extent and concentration of the dispersed oil plume are not easily seen. The predicted maximum concentrations are higher, but do not exceed 1 ppm when dispersants are utilized. The average and maximum concentrations from 0 to 5 meters in the dispersed oil plume produced with the use of dispersants at 40% effectiveness are shown in Figure 3.7 and are compared to toxicity threshold values for sensitive life history stages in Figure 3.8. No toxicity thresholds of concern for sensitive life species (Figure 3.8) are predicted to be exceeded.



A: 0 Hours **B: 12 Hours** **C: 48 Hours**



D: 96 Hours **E: 168 Hours**

Key to Dissolved Oil Concentration:

Light Green	< 0.5 ppm
Med. Green	0.5 – 1 ppm
Light blue	1 – 5 ppm
Dark blue	5 – 10 ppm
Pink	10 – 50 ppm
Red	> 50 ppm

Figure 3.2 *Results from the NOAA GNOME modeling for the spill in the Northwest Arctic Alaska Region Scenario without the use of dispersants showing surface oil and average dispersed oil concentrations from 0 to 5 meters.*

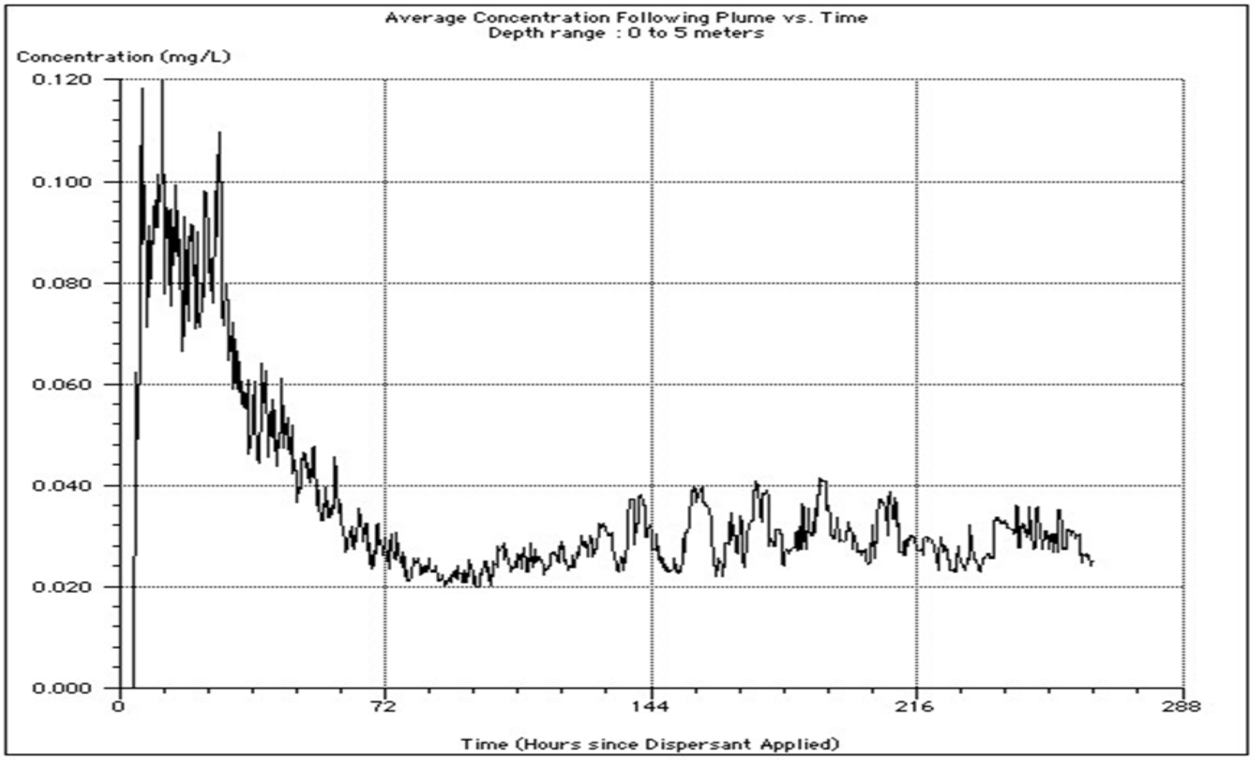


Figure 3.3 *Maximum and average oil concentration from 0 to 5 meters in the plume versus time without the use of dispersant.*

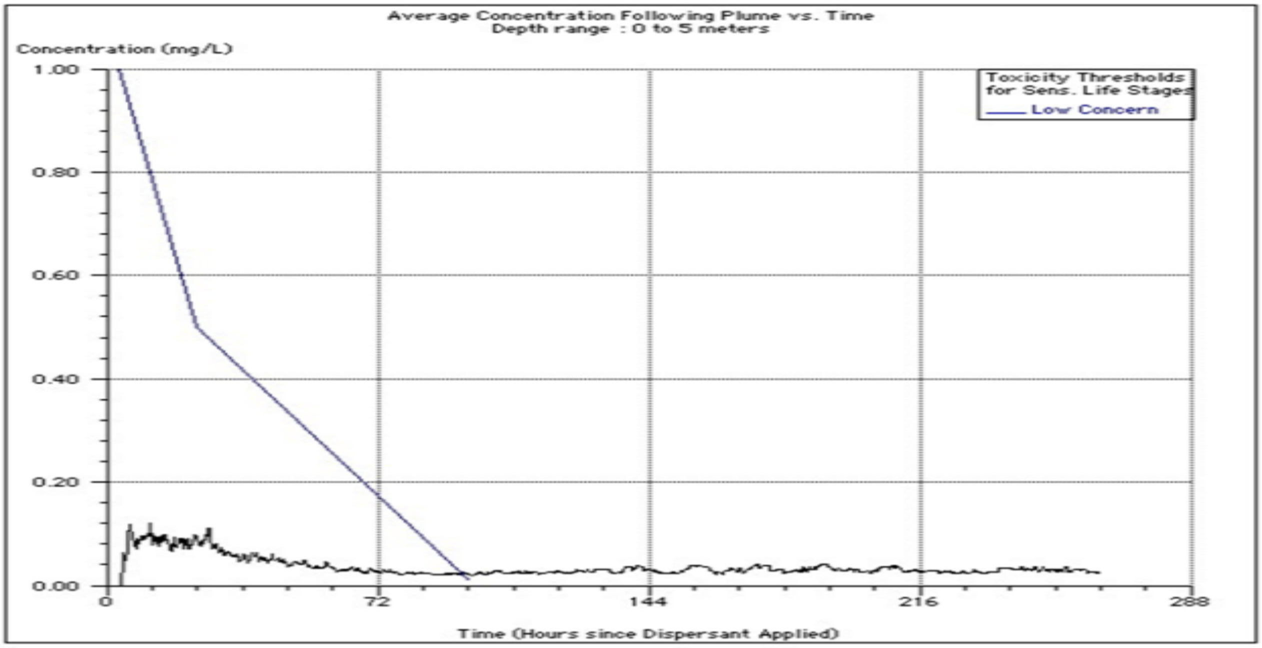


Figure 3.4 *Conservative toxicity thresholds of dispersed oil for sensitive life history stages compared to maximum and average dispersed oil concentrations at 0 to 5 meters without the use of dispersants.*

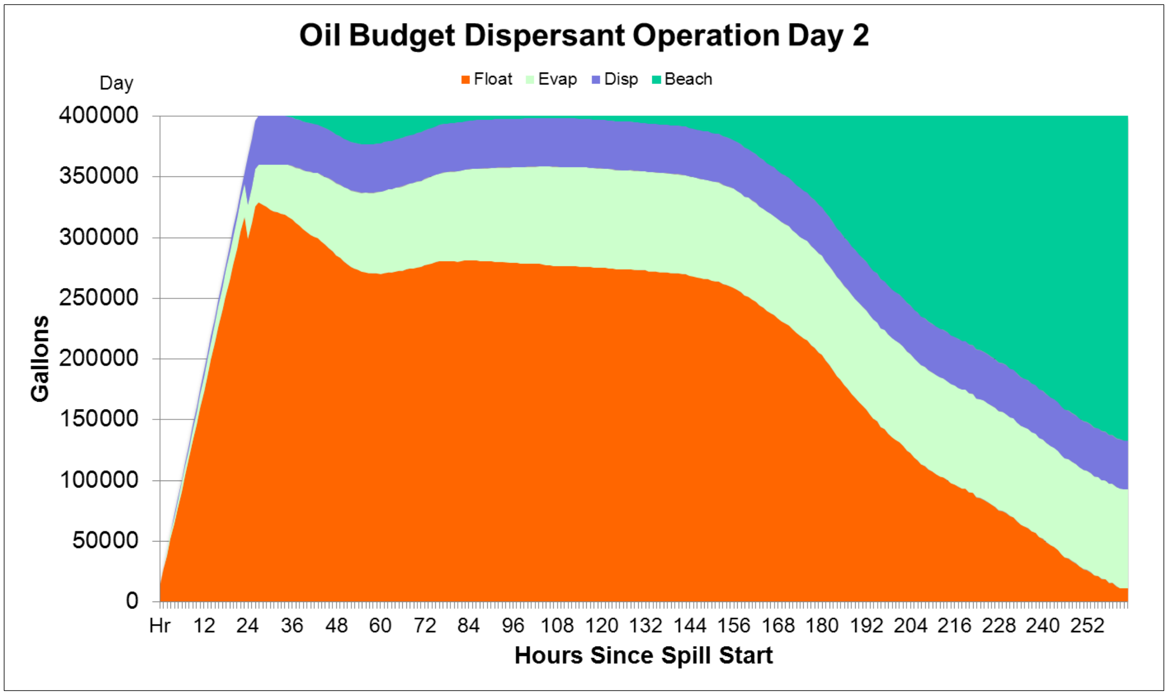
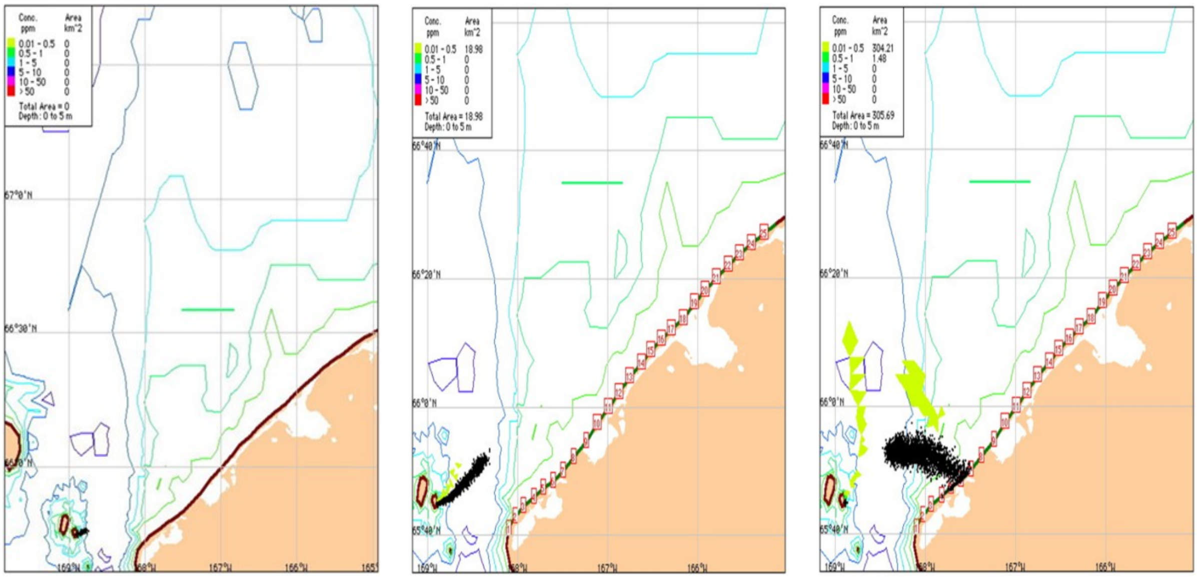
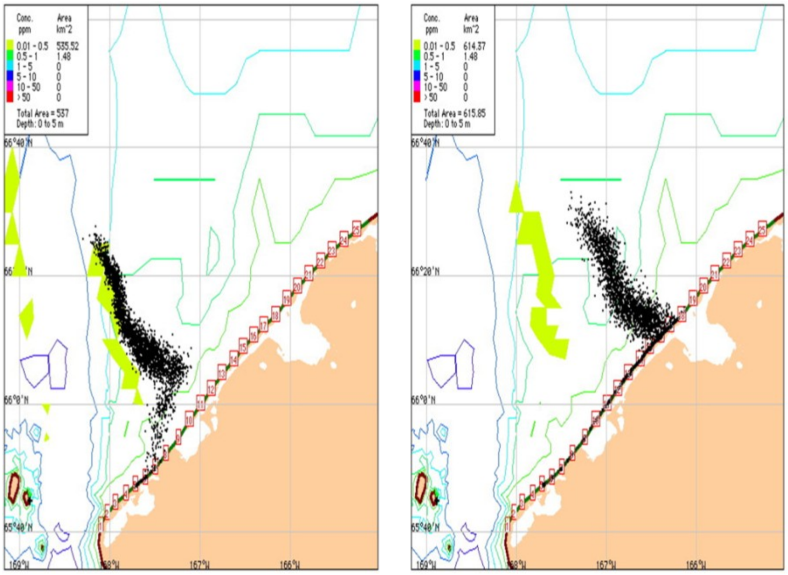


Figure 3.5 *The ADIOS predictions for the fate of the floating oil in Northwest Arctic Alaska scenario with the use of dispersants at 40% effectiveness.*



A: 0 Hours **B: 12 Hours** **C: 48 Hours**

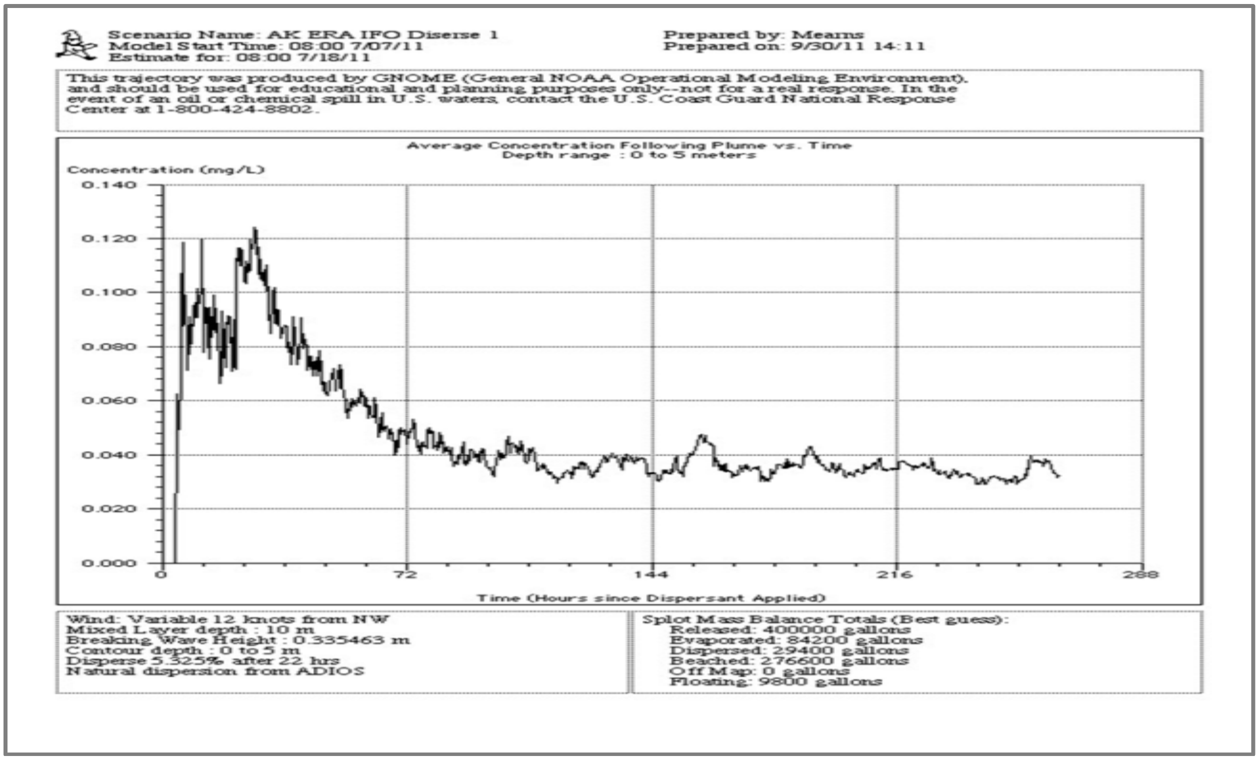


D: 96 hours **E: 168 Hours**

Key to Dissolved Oil Concentration:

Light Green	< 0.5 ppm
Med. Green	0.5 – 1 ppm
Light blue	1 – 5 ppm
Dark blue	5 – 10 ppm
Pink	10 – 50 ppm
Red	> 50 ppm

Figure 3.6 *Results from the NOAA GNOME modeling for the Northwest Arctic Alaska Region Scenario with the use of dispersants at 40% effectiveness showing average dispersed oil concentrations (in ppm) from 0 to 5 meters and remaining surface oil.*



Scenario Name: AK ERA IFO Diserse 1
Model Start Time: 08:00 7/07/11
Estimate for: 08:00 7/18/11

Prepared by: Mearns
Prepared on: 9/30/11 14:11

This trajectory was produced by GNOME (General NOAA Operational Modeling Environment), and should be used for educational and planning purposes only--not for a real response. In the event of an oil or chemical spill in U.S. waters, contact the U.S. Coast Guard National Response Center at 1-800-424-8802.

Wind: Variable 12 knots from NW
Mixed Layer depth : 10 m
Breaking Wave Height : 0.335463 m
Contour depth : 0 to 5 m
Disperse 5.325% after 22 hrs
Natural dispersion from ADIOS

Splot Mass Balance Totals (Best guess):
Released: 400000 gallons
Evaporated: 84200 gallons
Dispersed: 29400 gallons
Beached: 276600 gallons
Off Map: 0 gallons
Floating: 9800 gallons

Figure 3.7 *Maximum and average oil concentration from 0 to 5 meters in the plume versus time with the use of dispersants at 40% effectiveness.*

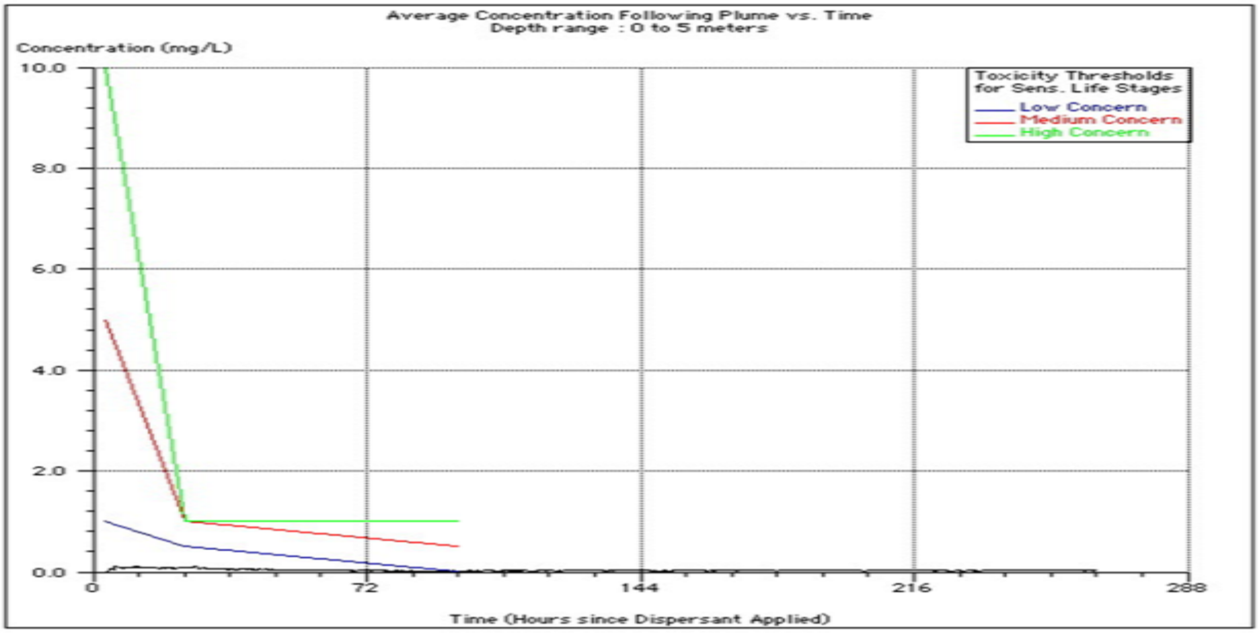
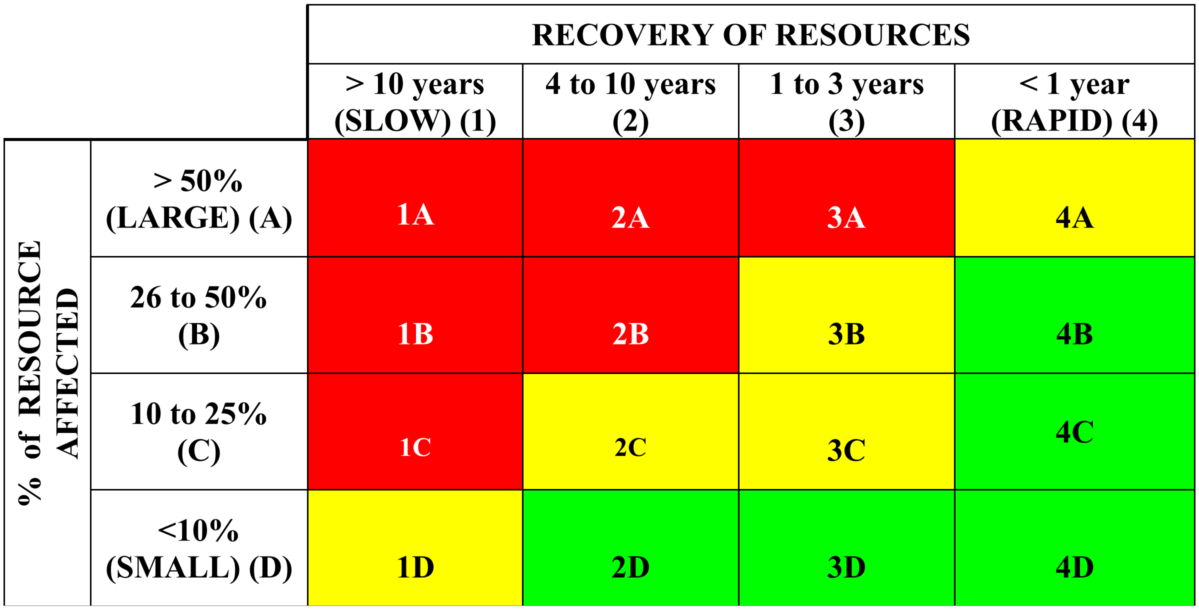


Figure 3.8 *Toxicity thresholds of dispersed oil for plankton compared to maximum and average dispersed oil concentrations at 0 to 5 meters with the use of dispersants at 40% effectiveness.*

4.0 The Results of the Risk Analysis Process

As previously discussed, the focus groups reviewed, approved and utilized the risk matrix shown in Figure 4.1. Each group then reviewed the scenario, modeling results, information on exposure and sensitivity to oil and dispersed oil, and basic life histories and distributions. This information was utilized to estimate the percentage of each resource affected, and associated recovery time. During the initial evaluation, alphanumeric codes were used to rank the level of concern. After developing the scaling, color-coding was added to indicate summary levels of concern.



		RECOVERY OF RESOURCES			
		> 10 years (SLOW) (1)	4 to 10 years (2)	1 to 3 years (3)	< 1 year (RAPID) (4)
% of RESOURCE AFFECTED	> 50% (LARGE) (A)	🟥 1A	🟥 2A	🟥 3A	🟨 4A
	26 to 50% (B)	🟥 1B	🟥 2B	🟨 3B	🟩 4B
	10 to 25% (C)	🟥 1C	🟨 2C	🟨 3C	🟩 4C
	<10% (SMALL) (D)	🟨 1D	🟩 2D	🟩 3D	🟩 4D

Legend: Red cells represent a “high” level of concern, yellow cells represent a “moderate” level of concern, and green cells represent a “limited” level of concern.

Figure 4.1 *Levels of concern risk matrix for the Northwest Arctic Alaska assessment.*

4.1 Summary Results

The participants used all available information to develop the risk levels of concern. The risk scores do not represent a prediction of actual impacts. Instead, they represent a consensus on the part of the participants that such consequences were likely to occur with the scenario under consideration. Additionally, the finished matrices were only briefly discussed by the entire group due to the locations, scheduling, and the changes in participants. The trade-off decisions made and discussed were based upon notes produced by each group. The summaries of the groups’ conclusions are presented below.

4.1.1 Natural Recovery

The detailed results for natural recovery (i.e. no response) are shown in Figure 4.2. Group 1 discussion ranked the offshore surface layer and offshore upper 10m conservatively, based upon the potential pathways to water column and on-shore impacts. They felt that the interface between water and air would affect all water-based subsistence uses. There was also concern for the intertidal marshes and tidal flats due to mammal foraging and scavenging, the presence of waterfowl, the location of historic properties and the dependence of the areas for cultural and subsistence activities.

Group 2 chose the exposed rocky shore as their area of greatest concern. The upland areas followed due to potential for scavengers/raptors bringing oiled animals into the area, and the slow recovery of historic properties. Additional concerns include subsistence and recreation; the presence of oil in the surf zone, beaches, lagoons and marshes; and the exposure of salmon to oil in the water.

The resources located in the lagoon and marsh environments were the greatest concerns for Group 3. They felt that oil would persist in these areas and affect the birds and fish utilized as a subsistence resource. The group did not anticipate any chronic effects from surface oil.

Group 4 felt that the surface and intertidal areas would experience significant short-term impacts if oil was not recovered since oil and oily residue could potentially travel and deposit in these areas. Additional mid-term and long-term impacts would occur to beaches, birds, mammals and their associated subsistence activities. Because of these potential impacts, they did not recommend natural recovery as the sole response method. Lastly, Group 4 felt that aquatic environments deeper than 10m would see very little short- or long-term impacts.

4.1.2 Mechanical Recovery

The detailed mechanical recovery results for all focus groups are shown in Figure 4.3. Group 1 felt that offshore skimming would reduce surface water impacts, and the equipment needed for mechanical recovery could potentially be stored at the Little Diomede High School and the Little Diomede tank farm. In all, they estimated that the effectiveness of mechanical recovery in the lagoon areas would range from 10-15%. Short-term disturbance impacts would be evident due to wildlife protection and hazing techniques implemented in conjunction with response activities, and workers churning the water column, forcing oil into sediments during the recovery process.

Following their analysis of the mechanical recovery option, Group 2 concluded that there is a potential to recover 10-15% of oil at the mouths of lagoons by utilizing skimmers (which may be currently stored at Red Dog Mine or Crowley). They also thought that the anchoring equipment, human traffic, and fuel storage would affect historical properties.

Group 3 did not anticipate any change in risk ranking scores from natural recovery due to the mechanical removal of oil from the water.

Group 4 anticipated very little change from natural recovery with the use of mechanical removal, but noted skimming at the mouths of the lagoons in the intertidal areas might effectively remove oil. The group did not anticipate any appreciable changes from natural recovery if oil was mechanically removed from the marsh areas.

4.1.3 *In-situ* Burning

The detailed results for all focus groups for *in-situ* burning are shown in Figure 4.4. The rankings for the four groups did not change from those of natural recovery.

4.1.4 Dispersant Use

The results for the use of dispersants are shown in Figure 4.5. Group 1 did not rank dispersant use on this incident due to concerns about effectiveness and toxicity, and therefore would not recommend its use. They felt the use of dispersants would only be feasible at or near the spill source. They were doubtful (from a logistics perspective) that “large-scale” application could be accomplished, but could support a test if it followed Tier 1, 2, and 3 of the Special Monitoring of Applied Response Technologies (SMART) protocols would not cause subsistence concerns for the residents of Little Diomede Island.

Group 2 did not anticipate an appreciable change in scoring from natural recovery. However, they believed there would be a negative impact to the perception of cultural/subsistence use because of the dispersant application. Although only a small percentage of villagers participate in subsistence activity, the use of dispersants may impact their comfort level. They did alter the ranking of the subsistence/cultural category by one level anticipating that hunting will continue despite dispersant use.

Although Group 3 did not agree on a scoring for dispersants, they did feel that dispersants are a viable option, provided the following are considered:

- Appropriate water depth and energy are present;
- Concentrations of species of concern are identified and protected;
- Marine mammals have the highest priority for protection, followed by lagoons;
- Outreach efforts occur before, during and after the spill; and
- The public perception will be negative despite any biological benefit.

The level of concern, for Group 4 changed (compared to natural recovery and on-water mechanical recovery) due to potential perceived impacts on cultural and subsistence activities. The area/habitat types are:

- Subtidal bottom/offshore > 10m from 4D to 3C;
- Offshore Water column/Upper 10m from 3D to 3B; and
- Offshore Water column/Below 10m from 4D to 3C.

These scores validate their concerns regarding unanticipated downstream impacts from dispersants. Although they assumed that dispersants increased the level of concern on cultural and subsistence activities, they felt that their use would result in a net environmental benefit.

4.1.5 Shoreline Protection

The detailed results for all focus groups for shoreline protection are shown in Figure 4.6. Group 1 felt that shoreline protection would result in less resources affected and a faster recovery time. However, they believed that using shoreline protection in conjunction with shoreline recovery would be a better option.

Group 2 thought that shoreline protection might prevent 50% of the oil from reaching all habitats, but did not anticipate a noticeable difference from natural recovery.

Group 3 assumed that the identification and monitoring of historical properties would occur during the anchoring and deploying of booms. As a result, they ranked the upland, intertidal – inside barrier islands, and the lagoon water column, as they thought the utilization of shoreline protection would affect the biological concerns for these areas. They also felt that public perception might improve by the utilization of shoreline protection as it indicates increasing concern for historical properties.

Group 4 assumed that the utilization of shoreline protection would drastically reduce the impacts on the lagoons and marshes, especially when Geographic Response Strategy (GRS) locations receive priority before oil reaches the shoreline.

4.1.6 Shoreline Recovery

The detailed results for all focus groups for shoreline recovery are shown in Figure 4.7. Group 1 concluded that shoreline cleanup affects fewer resources and allows for a faster recovery than the natural recovery option.

Group 2 believed that manual recovery would not be a feasible option until the spring and did not alter their rankings appreciably from natural recovery.

Group 3 felt that shoreline recovery would be a viable option only for the upland, tidal marsh, tidal flats, and fine/medium sand beaches, as it could potentially increase the damage to other environmental habitats.

Group 4 concluded that shoreline recovery (with access from seaward versus crossing the uplands) would reduce the secondary oiling of animals and their habitats, allowing most impacted resources to recover quickly.

Habitats	Upland						Intertidal - Inside Barrier Islands													
Subhabitat							Marsh							Tidal Flats						
Natural Recovery	Mammals	Birds	Fish	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	3C	4D	2B	2C	4D	3C	4B	1A	3D	2C	2B	3C	3D	4B	1A
	3D						2B							2B						
Group 2	R	G	NA	L	L	L	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	3D	3D	4D	4D	1D	4D	3C	2B	2B	2B	4B	4D	2B	4D	2C	2C	3C	3C	4D	3D
	3D						2B							2C						
Group 3	L	L	L	L	L	L	L	G	L	L	L	L	L	L	G	L	L			L
	3D	2D	4D	4D	2C	2C	1D	1C	1C	1C	1C	4C	1B	2D	2B	2D	2B	NA	NA	4C
	3D						1C							2C						
Group 4	L	R/G		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	2C	2D	NA	3D	NA	3C	2D	2B	1B	1C	1C	NA	1C	3C	3C	2C	3C	3C	4D	3D
	3D						1C							3C						

Habitats	Intertidal - Inside Barrier Islands							Intertidal - Outside Barrier Islands													
Subhabitat	Sheltered Rocky Shore							Exposed Rocky Shore							Mixed Sand/Gravel Beaches						
Natural Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	2D	4D	3C	4D	4B	2C	4D	1B	4C	3B	4D	3C	1A	2C	2C	3B	3B	4D	3C	1A
	3C							2C							2C						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	NA	L	L	G	L	L	L	L	L
	4D	3D	4D	3D	3D	4D	4D	3D	1D	3D	2A	3A	4D	4D	4D	4D	4D	4D	4D	4D	4D
	4D							3C							4D						
Group 3	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	G		L		L	L
	3D	3D	3D	3D	3D	3D	3D	4D	4D	4D	4D	4D	4D	4D	3D	3C	NA	3C	NA	3C	3C
	3D							4D							3C						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	3D	3D	3D	3D	4D	3D	3A
	4D							4D							3A						

Habitats	Intertidal - Outside Barrier Islands							Subtidal Bottom						
Subhabitat	Fine/Medium Sand Beaches							Shallow Inlets and Bays						
Natural Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	2C	2C	3B	3B	4D	3C	1A	4D	4D	3C	4C	3D	4D	3C
	2C							3C						
Group 2	L	G	L	L	L	L	L	NA	G	L	L	L	L	L
	4D	3D	3D	3B	4A	1D	3A	4D	3C	3C	3D	1B	4D	3A
	3B							3B						
Group 3	L	G		L		L	L	L	G	L	L	L		L
	3D	3C	NA	3C	NA	3C	3C	3D	3C	3C	3C	1C	NA	1A
	3C							2C						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3D	3D	3D	4D	3D	3A	2C	2C	2C	2C	2C	4D	2B
	3A							2C						

	Subtidal Bottom													
	Offshore Less Than 10 Meters							Offshore Greater Than 10 Meter						
Natural Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	3C	3C	4D	4D	2C	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	2C	2C	4C	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D	4A
	3C							4D						
Group 3	L	G	L	L	L	L	L	R	R	R	R	R	R	R
	3C	3C	3C	3C	3C	3C	3C	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 4	R	L	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3D	3D	3D	3D	4D	3D	4D	4D	4D	4D	4D	4D	4D
	3D							4D						

	Lagoon Water Column												Offshore Water Column					
	Surface Layer						Water Column						Surface Layer					
Natural Recovery	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	R	L	R	R	R	L
	2C	2B	2C	4D	4D	1C	3C	2B	2C	4D	4D	1C	2C	1B	4D	4D	4D	3A
	2C						2C						2B					
Group 2	L	G	L	L	L	L	NA	G	L	L	L	L	R	G	R	R	L	L
	3C	2B	4D	4C	4C	3A	4D	3C	3C	3D	4C	3A	3D	1B	4D	4D	4B	3A
	3B						3B						3B					
Group 3	L	R/G	L	L	L	L	L	R/G	L	L	L	L	R	G	R	L	L	L
	3D	3A	3A	3A	4C	2A	3D	3A	3A	3A	4C	2A	4C	4C	4C	4C	4C	3C
	2B						2B						4C					
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	R	R/G	L/R	L	L	L
	2D	2B	1B	1C	4D	1C	4D	4D	2B	4D	4D	4D	3C	2C	4D	4D	4D	3A
	1B+						4D						3C					

	Offshore Water Column											
	Upper 10 Meters						Below 10 Meters					
Natural Recovery	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	L	L	L	L	L	L	R	R	R	R	R	R
	3C	1B	3A	4D	4D	2A	4D	4D	4D	4D	4D	4D
	2C						4D					
Group 2	R	G	R	R	L	L	R	NA	R	R	L	L
	4D	4D	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D
	4A						4D					
Group 3	L	R/G	L	L	L	L	R	G	R	L	L	L
	4D	4C	4D	4C	4D	3D	4D	4D	4D	4D	4D	4D
	4C						4D					
Group 4	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L
	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
	4D						4D					

Reference Area codes: L = Local, R = Regional, and G = Global (see Section 2 for definitions).
Scoring codes: NA = Not Applicable, NR = Not Recommended, NS = Not Scored

Figure 4.2 *Detailed focus group risk analysis results for natural recovery.*

Habitats	Upland						Intertidal - Inside Barrier Islands						
Subhabitat							Marsh						
Mechanical Recovery	Mammals	Birds	Fish	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	3C	4D	3B	3A	4D	3D	4D	2C
	3D						3C						
Group 2	R	G	NA	L	L	L	L	G	L	L	L	L	L
	3D	4D	4D	4D	1D	4D	3D	2C	2C	2C	4C	4D	2C
	3D						2C						
Group 3	L	L	L	L	L	L	L	G	L	L	L	L	L
	3D	2D	4D	4D	2C	2C	1D	1C	1C	1C	1C	4C	1B
	3D						1C						
Group 4	L	R/G		L	L	L	L	L	L	L	L	L	L
	2C	2D	NA	3D	NA	3C	2D	2B	1B	1C	*	NA	1C
	3D						1C						

Habitats	Intertidal - Inside Barrier Islands													
Subhabitat	Tidal Flats							Sheltered Rocky Shore						
Mechanical Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3C	3B	3D	3D	4D	2C	4D	3D	4D	3D	4D	4D	3C
	3C							3D						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	4D	2D	2D	3D	3D	4D	3D	4D	3D	4D	3D	3D	4D	4D
	2D							4D						
Group 3	L	G	L	L			L	L	L	L	L	L	L	L
	2D	2B	2D	2B	NA	NA	4C	3D	3D	3D	3D	3D	3D	3D
	2C							3D						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	3C	3C	2C	3C	3C	4D	3D	4D	4D	4D	4D	4D	4D	4D
	3C							4D						

Habitats	Intertidal - Outside Barrier Islands													
Subhabitat	Exposed Rocky Shore							Mixed Sand/Gravel Beaches						
Mechanical Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	1B	4C	3B	4D	3C	1A	2C	2C	3B	3B	4D	3C	1A
	2C							2C						
Group 2	L	G	L	L	L	NA	L	L	G	L	L	L	L	L
	3D	1D	3D	2A	3A	4D	4D	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 3	L	L	L	L	L	L	L	L	G		L		L	L
	4D	4D	4D	4D	4D	4D	4D	3D	3C	NA	3C	NA	3C	3C
	4D							3C						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	4D	4D	3D	3D	3D	3D	4D	3D	3A
	4D							3A						

Habitats	Intertidal - Outside Barrier Islands							Subtidal Bottom						
Subhabitat	Fine/Medium Sand Beaches							Shallow Inlets and Bays						
Mechanical Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	2C	2C	3B	3B	4D	3C	1A	4D	4D	3D	4C	3D	4D	4D
	2C							3D						
Group 2	L	G	L	L	L	L	L	NA	G	L	L	L	L	L
	4D	3D	3D	3B	4A	1B	3A	4D	3D	3D	3D	1C	4D	3B
	3A							3C						
Group 3								L	G	L	L	L		L
	3D	3C	NA	3C	NA	3C	3C	3D	3C	3C	3C	1C	NA	1A
	3C							2C						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3D	3D	3D	4D	3D	3A	2C	2C	2C	2C	2C	4D	2B
	3A							2C						

	Subtidal Bottom													
	Offshore Less Than 10 Meters							Offshore Greater Than 10 Meters						
Mechanical Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	3C	3C	4D	4D	2C	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	2C	2C	4C	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D	4A
	3C							4D						
Group 3	L	G	L	L	L	L	L	R	R	R	R	R	R	R
	3C	3C	3C	3C	3C	3C	3C	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 4	R	L	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3D	3D	3D	3D	4D	3D	4D	4D	4D	4D	4D	4D	4D
	3D							4D						

	Lagoon Water Column											
	Surface Layer						Water Column					
Mechanical Recovery	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3B	3D	4D	4D	2C	3D	3B	3D	4D	4D	2C
	3C						3C					
Group 2	L	G	L	L	L	L	NA	G	L	L	L	L
	3D	2C	4D	4D	4D	3B	4D	3D	3D	3D	4D	3B
	3C						3C					
Group 3	L	R/G	L	L	L	L	L	R/G	L	L	L	L
	3D	3A	3A	3A	4C	2A	3D	3A	3A	3A	4C	2A
	2B						2B					
Group 4	L	L	L	L	L	L	L	L	L	L	L	L
	2D	2C	1C	1D	4D	1C	4D	4D	2B	4D	4D	4D
	2C						4D					

	Offshore Water Column																	
	Surface Layer						Upper 10 Meters						Below 10 Meters					
Mechanical Recovery	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	R	L	R	R	R	L	L	L	L	L	L	L	R	R	R	R	R	R
	2C	1B	4D	4D	4D	3A	3C	1B	3A	4D	4D	2A	4D	4D	4D	4D	4D	4D
	2B						2C						4D					
Group 2	R	G	R	R	L	L	R	G	R	R	L	L	R	NA	R	R	L	L
	3D	1B	4D	4D	4B	3A	4D	4D	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D
	3B						4A						4D					
Group 3	R	G	R	L	L	L	L	R/G	L	L	L	L	R	G	R	L	L	L
	4C	4C	4C	4C	4C	3C	4D	4C	4D	4C	4D	3D	4D	4D	4D	4D	4D	4D
	4C						4C						4D					
Group 4	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L
	3C	2C	4D	4D	4D	3A	4D	4D	4D	4D	4D	3D	4D	4D	4D	4D	4D	4D
	3C						4D						4D					

Reference Area codes: L = Local, R = Regional, and G = Global (see Section 2 for definitions).
Scoring codes: NA = Not Applicable, NR = Not Recommended, NS = Not Scored

Figure 4.3 *Detailed focus group risk analysis results for mechanical recovery.*

Habitats	Upland						Intertidal - Inside Barrier Islands													
Subhabitat							Marsh							Tidal Flats						
In-situ Burning	Mammals	Birds	Fish	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	3C	4D	2B	2C	4D	3C	4B	1A	3D	2C	2B	3C	3D	4B	1A
	3D						2B							2B						
Group 2	R	G	NA	L	L	L	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	3D	4D	4D	4D	1D	4D	3C	2B	2B	2B	4B	4D	2B	4D	2C	2C	3C	3C	4D	3D
	3D						2B							2C						
Group 3	L	L	L	L	L	L	L	G	L	L	L	L	L	L	G	L	L			L
	3D	2D	4D	4D	2C	2C	1D	1C	1C	1C	1C	4C	1B	2D	2B	2D	2B	NA	NA	4C
	3D						1C							2C						
Group 4	L	R/G		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	2C	2D	NA	3D	NA	3C	2D	2B	1B	1C	1C	NA	1C	3C	3C	2C	3C	3C	4D	3D
	3D						1C							3C						

Habitats	Intertidal - Inside Barrier Islands							Intertidal - Outside Barrier Islands													
Subhabitat	Sheltered Rocky Shore							Exposed Rocky Shore							Mixed Sand/Gravel Beaches						
In-situ Burning	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	2D	4D	3C	4D	4B	2C	4D	1B	4C	3B	4D	3C	1A	2C	2C	3B	3B	4D	3C	1A
	3C							2C							2C						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	NA	L	L	G	L	L	L	L	L
	4D	3D	4D	3D	3D	4D	4D	3D	1D	3D	2A	3A	4D	4D	4D	4D	4D	4D	4D	4D	4D
	4D							3C							4D						
Group 3	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	G		L		L	L
	3D	3D	3D	3D	3D	3D	3D	4D	4D	4D	4D	4D	4D	4D	3D	3C	NA	3C	NA	3C	3C
	3D							4D							3C						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	3D	3D	3D	3D	4D	3D	3A
	4D							4D							3A						

Habitats	Intertidal - Outside Barrier Islands							Subtidal Bottom						
Subhabitat	Fine/Medium Sand Beaches							Shallow Inlets and Bays						
In-situ Burning	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	2C	2C	3B	3B	4D	3C	1A	4D	4D	3C	4C	3D	4D	3C
	2C							3C						
Group 2	L	G	L	L	L	L	L	NA	G	L	L	L	L	L
	4D	3D	3D	3B	4A	1D	3A	4D	3C	3C	3D	1B	4D	3A
	3B							3B						
Group 3								L	G	L	L	L		L
	3D	3C	NA	3C	NA	3C	3C	3D	3C	3C	3C	1C	NA	1A
	3C							2C						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3D	3D	3D	4D	3D	3A	2C	2C	2C	2C	2C	4D	2B
	3A							2C						

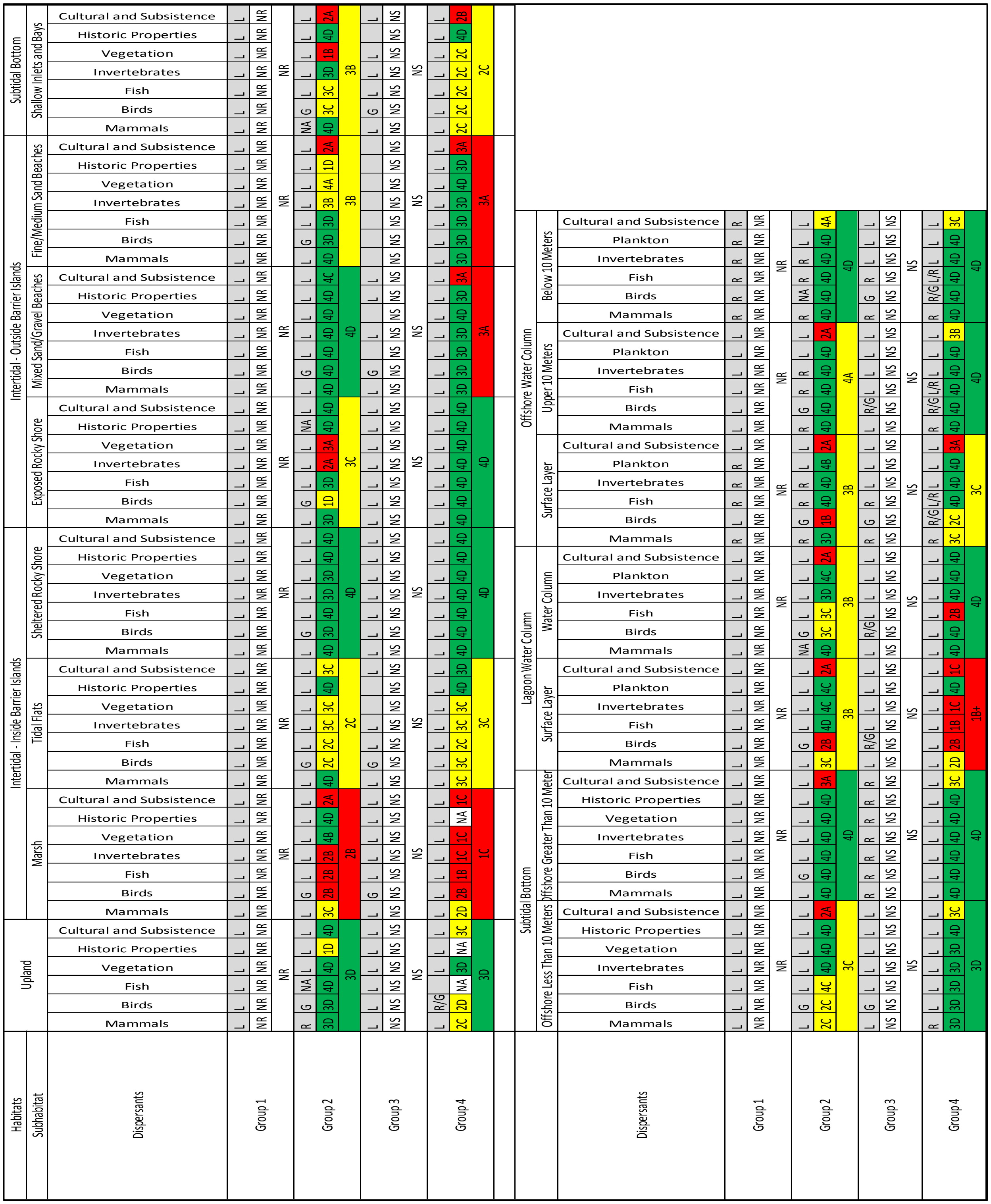
	Subtidal Bottom													
	Offshore Less Than 10 Meters							Offshore Greater Than 10 Meter						
In-situ Burning	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	3C	3C	4D	4D	2C	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	2C	2C	4C	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D	4A
	3C							4D						
Group 3	L	G	L	L	L	L	L	R	R	R	R	R	R	R
	3C	3C	3C	3C	3C	3C	3C	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 4	R	L	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3D	3D	3D	3D	4D	3D	4D	4D	4D	4D	4D	4D	4D
	3D							4D						

	Lagoon Water Column											
	Surface Layer						Water Column					
In-situ Burning	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L
	2C	2B	2C	4D	4D	1C	3C	2B	2C	4D	4D	1C
	2C						2C					
Group 2	L	G	L	L	L	L	NA	G	L	L	L	L
	3C	2B	4D	4C	4C	3A	4D	3C	3C	3D	4C	3A
	3B						3B					
Group 3	L	R/G	L	L	L	L	L	R/G	L	L	L	L
	3D	3A	3A	3A	4C	2A	3D	3A	3A	3A	4C	2A
	2B						2B					
Group 4	L	L	L	L	L	L	L	L	L	L	L	L
	2D	2B	1B	1C	4D	1C	4D	4D	2B	4D	4D	4D
	1B+						4D					

	Offshore Water Column																	
	Surface Layer						Upper 10 Meters						Below 10 Meters					
In-situ Burning	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	R	L	R	R	R	L	L	L	L	L	L	L	R	R	R	R	R	R
	2C	1B	4D	4D	4D	3A	3C	1B	3A	4D	4D	2A	4D	4D	4D	4D	4D	4D
	2B						2C						4D					
Group 2	R	G	R	R	L	L	R	G	R	R	L	L	R	NA	R	R	L	L
	3D	1B	4D	4D	4B	3A	4D	4D	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D
	3B						4A						4D					
Group 3	R	G	R	L	L	L	L	R/G	L	L	L	L	R	G	R	L	L	L
	4C	4C	4C	4C	4C	3C	4D	4C	4D	4C	4D	3D	4D	4D	4D	4D	4D	4D
	4C						4C						4D					
Group 4	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L
	3C	2C	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
	3C						4D						4D					

Reference Area codes: L = Local, R = Regional, and G = Global (see Section 2 for definitions).
Scoring codes: NA = Not Applicable, NR = Not Recommended, NS = Not Scored

***Figure 4.4** Detailed focus group risk analysis results for in-situ burning.*

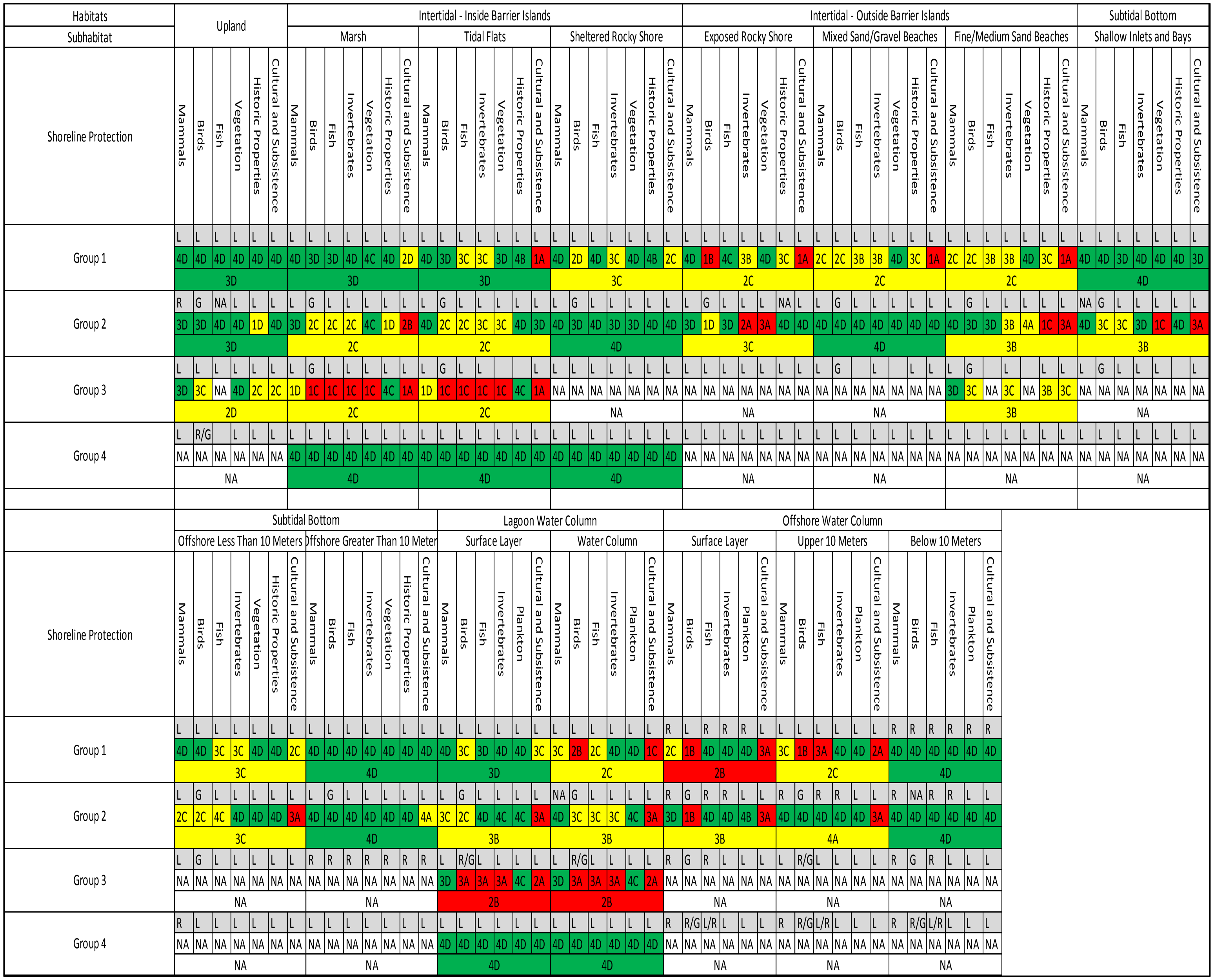


Habitats	Subhabitat	Dispersants	Group 1			Group 2			Group 3			Group 4		
Subtidal Bottom	Shallow Inlets and Bays	Cultural and Subsistence	L	NR	NR	L	2A	3B	L	NS	NS	L	2B	2C
		Historic Properties	L	NR		L	4D			NS		L	4D	
		Vegetation	L	NR		L	1B		L	NS		L	2C	
		Invertebrates	L	NR		L	3D		L	NS		L	2C	
		Fish	L	NR		L	3C		L	NS		L	2C	
		Birds	L	NR		G	3C		G	NS		L	2C	
		Mammals	L	NR		NA	4D		L	NS		L	2C	
Intertidal - Outside Barrier Islands	Fine/Medium Sand Beaches	Cultural and Subsistence	L	NR	NR	L	2A	3B		NS	NS	L	3A	3A
		Historic Properties	L	NR		L	1D			NS		L	3D	
		Vegetation	L	NR		L	4A			NS		L	4D	
		Invertebrates	L	NR		L	3B			NS		L	3D	
		Fish	L	NR		L	3D			NS		L	3D	
		Birds	L	NR		G	3D			NS		L	3D	
		Mammals	L	NR		L	4D			NS		L	3D	
	Mixed Sand/Gravel Beaches	Cultural and Subsistence	L	NR	NR	L	4C	4D	L	NS	NS	L	3A	3A
		Historic Properties	L	NR		L	4D		L	NS		L	3D	
		Vegetation	L	NR		L	4D			NS		L	4D	
		Invertebrates	L	NR		L	4D		L	NS		L	3D	
		Fish	L	NR		L	4D			NS		L	3D	
		Birds	L	NR		G	4D		G	NS		L	3D	
		Mammals	L	NR		L	4D		L	NS		L	3D	
	Exposed Rocky Shore	Cultural and Subsistence	L	NR	NR	L	4D	3C	L	NS	NS	L	4D	4D
		Historic Properties	L	NR		NA	4D		L	NS		L	4D	
		Vegetation	L	NR		L	3A		L	NS		L	4D	
		Invertebrates	L	NR		L	2A		L	NS		L	4D	
		Fish	L	NR		L	3D		L	NS		L	4D	
		Birds	L	NR		G	1D		L	NS		L	4D	
		Mammals	L	NR		L	3D		L	NS		L	4D	
Intertidal - Inside Barrier Islands	Sheltered Rocky Shore	Cultural and Subsistence	L	NR	NR	L	4D	4D	L	NS	NS	L	4D	4D
		Historic Properties	L	NR		L	4D		L	NS		L	4D	
		Vegetation	L	NR		L	3D		L	NS		L	4D	
		Invertebrates	L	NR		L	3D		L	NS		L	4D	
		Fish	L	NR		L	4D		L	NS		L	4D	
		Birds	L	NR		G	3D		L	NS		L	4D	
		Mammals	L	NR		L	4D		L	NS		L	4D	
	Tidal Flats	Cultural and Subsistence	L	NR	NR	L	3C	2C	L	NS	NS	L	3D	3C
		Historic Properties	L	NR		L	4D			NS		L	4D	
		Vegetation	L	NR		L	3C		L	NS		L	3C	
		Invertebrates	L	NR		L	3C		L	NS		L	3C	
		Fish	L	NR		L	2C		L	NS		L	2C	
		Birds	L	NR		G	2C		G	NS		L	3C	
		Mammals	L	NR		L	4D		L	NS		L	3C	
	Marsh	Cultural and Subsistence	L	NR	NR	L	2A	2B	L	NS	NS	L	1C	1C
		Historic Properties	L	NR		L	4D		L	NS		L	NA	
		Vegetation	L	NR		L	4B		L	NS		L	1C	
		Invertebrates	L	NR		L	2B		L	NS		L	1C	
		Fish	L	NR		L	2B		L	NS		L	1B	
		Birds	L	NR		G	2B		G	NS		L	2B	
		Mammals	L	NR		L	3C		L	NS		L	2D	
Upland		Cultural and Subsistence	L	NR	NR	L	4D	3D	L	NS	NS	L	3C	3D
		Historic Properties	L	NR		L	1D		L	NS		L	NA	
		Vegetation	L	NR		L	4D		L	NS		L	3D	
		Fish	L	NR		NA	4D		L	NS			NA	
		Birds	L	NR		G	3D		L	NS		R/G	2D	
		Mammals	L	NR		R	3D		L	NS		L	2C	

Habitats	Subhabitat	Dispersants	Group 1			Group 2			Group 3			Group 4		
Offshore Water Column	Below 10 Meters	Cultural and Subsistence	R	NR	NR	L	4A	4D	L	NS	NS	L	3C	4D
		Plankton	R	NR		L	4D		L	NS		L	4D	
		Invertebrates	R	NR		R	4D		L	NS		L	4D	
		Fish	R	NR		R	4D		R	NS		L/R	4D	
		Birds	R	NR		NA	4D		G	NS		R/G	4D	
		Mammals	R	NR		R	4D		R	NS		R	4D	
	Upper 10 Meters	Cultural and Subsistence	L	NR	NR	L	2A	4A	L	NS	NS	L	3B	4D
		Plankton	L	NR		L	4D		L	NS		L	4D	
		Invertebrates	L	NR		R	4D		L	NS		L	4D	
		Fish	L	NR		R	4D		L	NS		L/R	4D	
		Birds	L	NR		G	4D		R/G	NS		R/G	4D	
		Mammals	L	NR		R	4D		L	NS		R	4D	
	Surface Layer	Cultural and Subsistence	L	NR	NR	L	2A	3B	L	NS	NS	L	3A	3C
		Plankton	R	NR		L	4B		L	NS		L	4D	
		Invertebrates	R	NR		R	4D		L	NS		L	4D	
		Fish	R	NR		R	4D		R	NS		L/R	4D	
		Birds	L	NR		G	1B		G	NS		R/G	2C	
		Mammals	R	NR		R	3D		R	NS		R	3C	
Lagoon Water Column	Water Column	Cultural and Subsistence	L	NR	NR	L	2A	3B	L	NS	NS	L	4D	4D
		Plankton	L	NR		L	4C		L	NS		L	4D	
		Invertebrates	L	NR		L	3D		L	NS		L	4D	
		Fish	L	NR		L	3C		L	NS		L	2B	
		Birds	L	NR		G	3C		R/G	NS		L	4D	
		Mammals	L	NR		NA	4D		L	NS		L	4D	
	Surface Layer	Cultural and Subsistence	L	NR	NR	L	2A	3B	L	NS	NS	L	1C	1B+
		Plankton	L	NR		L	4C		L	NS		L	4D	
		Invertebrates	L	NR		L	4C		L	NS		L	1C	
		Fish	L	NR		L	4D		L	NS		L	1B	
		Birds	L	NR		G	2B		R/G	NS		L	2B	
		Mammals	L	NR		L	3C		L	NS		L	2D	
Subtidal Bottom	Offshore Greater Than 10 Meter	Cultural and Subsistence	L	NR	NR	L	3A	4D	R	NS	NS	L	3C	4D
		Historic Properties	L	NR		L	4D		R	NS		L	4D	
		Vegetation	L	NR		L	4D		R	NS		L	4D	
		Invertebrates	L	NR		L	4D		R	NS		L	4D	
		Fish	L	NR		L	4D		R	NS		L	4D	
		Birds	L	NR		G	4D		R	NS		L	4D	
		Mammals	L	NR		L	4D		R	NS		L	4D	
	Offshore Less Than 10 Meters	Cultural and Subsistence	L	NR	NR	L	2A	3C	L	NS	NS	L	3C	3D
		Historic Properties	L	NR		L	4D		L	NS		L	4D	
		Vegetation	L	NR		L	4D		L	NS		L	3D	
		Invertebrates	L	NR		L	4D		L	NS		L	3D	
		Fish	L	NR		L	4C		L	NS		L	3D	
		Birds	L	NR		G	2C		G	NS		L	3D	
		Mammals	L	NR		L	2C		L	NS		R	3D	

Reference Area codes: L = Local, R = Regional, and G = Global (see Section 2 for definitions).
Scoring codes: NA = Not Applicable, NR = Not Recommended, NS = Not Scored

Figure 4.5 *Detailed focus group risk analysis results for dispersants.*



Habitats	Upland						Intertidal - Inside Barrier Islands						
Subhabitat							Marsh						
Shoreline Protection	Mammals	Birds	Fish	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	4D	4D	3D	3D	4D	4C	4D	2D
	3D						3D						
Group 2	R	G	NA	L	L	L	L	G	L	L	L	L	L
	3D	3D	4D	4D	1D	4D	3D	2C	2C	2C	4C	1D	2B
	3D						2C						
Group 3	L	L	L	L	L	L	L	G	L	L	L	L	L
	3D	3C	NA	4D	2C	2C	1D	1C	1C	1C	1C	4C	1A
	2D						2C						
Group 4	L	R/G		L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	4D	4D	4D	4D	4D	4D	4D
	NA						4D						

Habitats	Intertidal - Inside Barrier Islands													
Subhabitat	Tidal Flats							Sheltered Rocky Shore						
Shoreline Protection	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	3D	3C	3C	3D	4B	1A	4D	2D	4D	3C	4D	4B	2C
	3D							3C						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	4D	2C	2C	3C	3C	4D	3D	4D	3D	4D	3D	3D	4D	4D
	2C							4D						
Group 3	L	G	L	L			L	L	L	L	L	L	L	L
	1D	1C	1C	1C	1C	4C	1A	NA	NA	NA	NA	NA	NA	NA
	2C							NA						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
	4D							4D						

Habitats	Intertidal - Outside Barrier Islands													
Subhabitat	Exposed Rocky Shore							Mixed Sand/Gravel Beaches						
Shoreline Protection	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	1B	4C	3B	4D	3C	1A	2C	2C	3B	3B	4D	3C	1A
	2C							2C						
Group 2	L	G	L	L	L	NA	L	L	G	L	L	L	L	L
	3D	1D	3D	2A	3A	4D	4D	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 3	L	L	L	L	L	L	L	L	G		L		L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						

Habitats	Intertidal - Outside Barrier Islands							Subtidal Bottom						
Subhabitat	Fine/Medium Sand Beaches							Shallow Inlets and Bays						
Shoreline Protection	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	2C	2C	3B	3B	4D	3C	1A	4D	4D	3D	4D	4D	4D	3D
	2C							4D						
Group 2	L	G	L	L	L	L	L	NA	G	L	L	L	L	L
	4D	3D	3D	3B	4A	1C	3A	4D	3C	3C	3D	1C	4D	3A
	3B							3B						
Group 3	L	G		L		L	L	L	G	L	L	L		L
	3D	3C	NA	3C	NA	3B	3C	NA	NA	NA	NA	NA	NA	NA
	3B							NA						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						

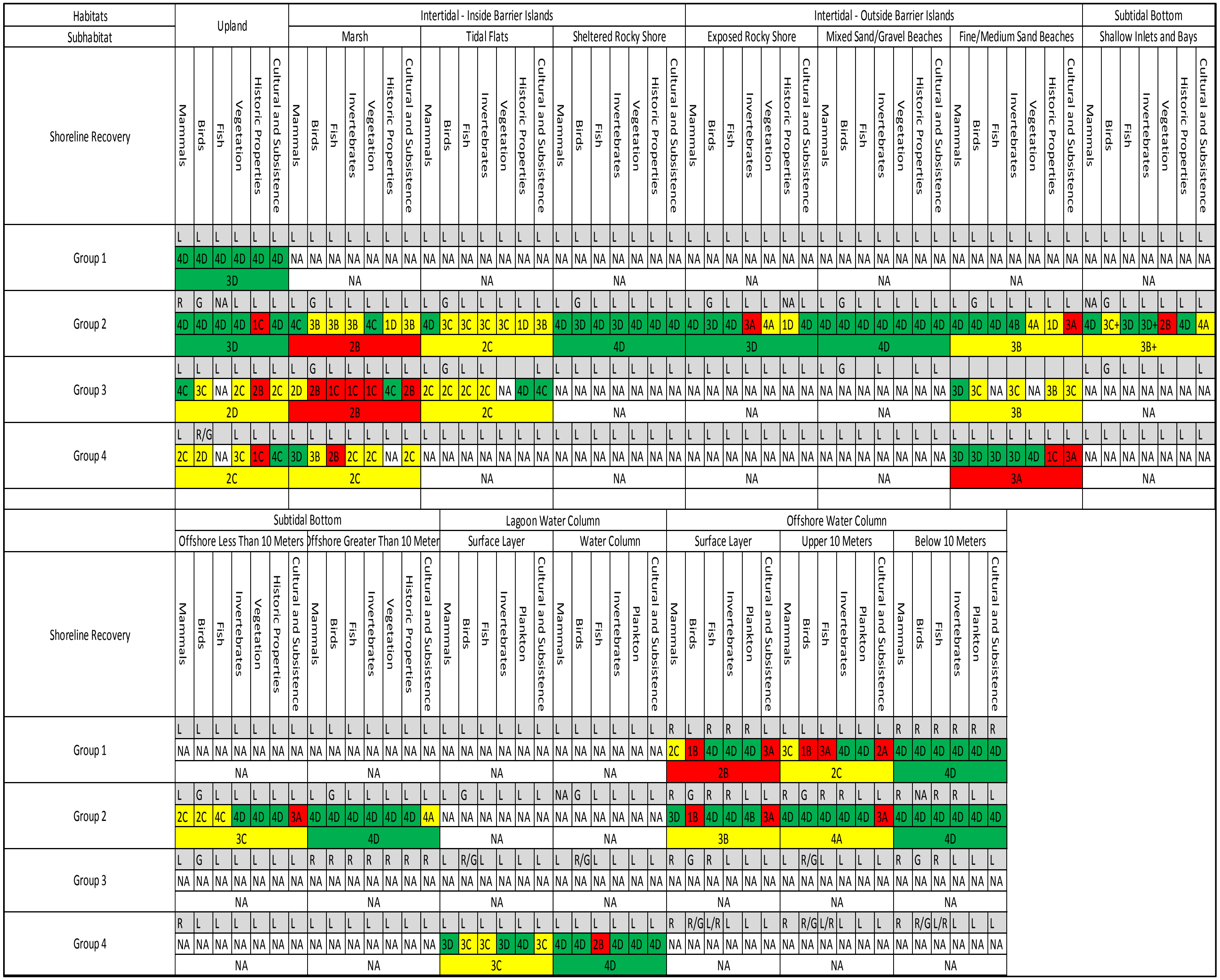
	Subtidal Bottom													
	Offshore Less Than 10 Meters							Offshore Greater Than 10 Meter						
Shoreline Protection	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	3C	3C	4D	4D	2C	4D	4D	4D	4D	4D	4D	4D
	3C							4D						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	2C	2C	4C	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D	4A
	3C							4D						
Group 3	L	G	L	L	L	L	L	R	R	R	R	R	R	R
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						
Group 4	R	L	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						

	Lagoon Water Column											
	Surface Layer						Water Column					
Shoreline Protection	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L
	4D	3C	3D	4D	4D	3C	3C	2B	2C	4D	4D	1C
	3D						2C					
Group 2	L	G	L	L	L	L	NA	G	L	L	L	L
	3C	2C	4D	4C	4C	3A	4D	3C	3C	3C	4C	3A
	3B						3B					
Group 3	L	R/G	L	L	L	L	L	R/G	L	L	L	L
	3D	3A	3A	3A	4C	2A	3D	3A	3A	3A	4C	2A
	2B						2B					
Group 4	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D	4D
	4D						4D					

	Offshore Water Column																	
	Surface Layer						Upper 10 Meters						Below 10 Meters					
Shoreline Protection	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	R	L	R	R	R	L	L	L	L	L	L	L	R	R	R	R	R	R
	2C	1B	4D	4D	4D	3A	3C	1B	3A	4D	4D	2A	4D	4D	4D	4D	4D	4D
	2B						2C						4D					
Group 2	R	G	R	R	L	L	R	G	R	R	L	L	R	NA	R	R	L	L
	3D	1B	4D	4D	4B	3A	4D	4D	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D
	3B						4A						4D					
Group 3	R	G	R	L	L	L	L	R/G	L	L	L	L	R	G	R	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA						NA						NA					
Group 4	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA						NA						NA					

Reference Area codes: L = Local, R = Regional, and G = Global (see Section 2 for definitions).
Scoring codes: NA = Not Applicable, NR = Not Recommended, NS = Not Scored

Figure 4.6 *Detailed focus group risk analysis results for shoreline protection.*



Habitats	Upland						Intertidal - Inside Barrier Islands													
Subhabitat							Marsh							Tidal Flats						
Shoreline Recovery	Mammals	Birds	Fish	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	4D	4D	4D	4D	4D	4D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	3D						NA							NA						
Group 2	R	G	NA	L	L	L	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	4D	4D	4D	4D	1C	4D	4C	3B	3B	3B	4C	1D	3B	4D	3C	3C	3C	3C	1D	3B
	3D						2B							2C						
Group 3	L	L	L	L	L	L	L	G	L	L	L	L	L	L	G	L	L			L
	4C	3C	NA	2C	2B	2C	2D	2B	1C	1C	1C	4C	2B	2C	2C	2C	2C	NA	4D	4C
	2D						2B							2C						
Group 4	L	R/G		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	2C	2D	NA	3C	1C	4C	3D	3B	2B	2C	2C	NA	2C	NA	NA	NA	NA	NA	NA	NA
	2C						2C							NA						

Habitats	Intertidal - Inside Barrier Islands							Intertidal - Outside Barrier Islands													
Subhabitat	Sheltered Rocky Shore							Exposed Rocky Shore							Mixed Sand/Gravel Beaches						
Shoreline Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA							NA						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	NA	L	L	G	L	L	L	L	L
	4D	3D	4D	3D	4D	4D	4D	4D	3D	4D	3A	4A	1D	4D	4D	4D	4D	4D	4D	4D	4D
	4D							3D							4D						
Group 3	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	G		L		L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA							NA						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA							NA						

Habitats	Intertidal - Outside Barrier Islands							Subtidal Bottom						
Subhabitat	Fine/Medium Sand Beaches							Shallow Inlets and Bays						
Shoreline Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						
Group 2	L	G	L	L	L	L	L	NA	G	L	L	L	L	L
	4D	4D	4D	4B	4A	1D	3A	4D	3C+	3D	3D+	2B	4D	4A
	3B							3B+						
Group 3								L	G	L	L	L		L
	3D	3C	NA	3C	NA	3B	3C	NA	NA	NA	NA	NA	NA	NA
	3B							NA						
Group 4	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3D	3D	3D	4D	1C	3A	NA	NA	NA	NA	NA	NA	NA
	3A							NA						

	Subtidal Bottom													
	Offshore Less Than 10 Meters							Offshore Greater Than 10 Meter						
Shoreline Recovery	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Vegetation	Historic Properties	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						
Group 2	L	G	L	L	L	L	L	L	G	L	L	L	L	L
	2C	2C	4C	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D	4A
	3C							4D						
Group 3	L	G	L	L	L	L	L	R	R	R	R	R	R	R
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						
Group 4	R	L	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA							NA						

	Lagoon Water Column											
	Surface Layer						Water Column					
Shoreline Recovery	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	L	L	L	L	L	L	L	L	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA						NA					
Group 2	L	G	L	L	L	L	NA	G	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA						NA					
Group 3	L	R/G	L	L	L	L	L	R/G	L	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA						NA					
Group 4	L	L	L	L	L	L	L	L	L	L	L	L
	3D	3C	3C	3D	4D	3C	4D	4D	2B	4D	4D	4D
	3C						4D					

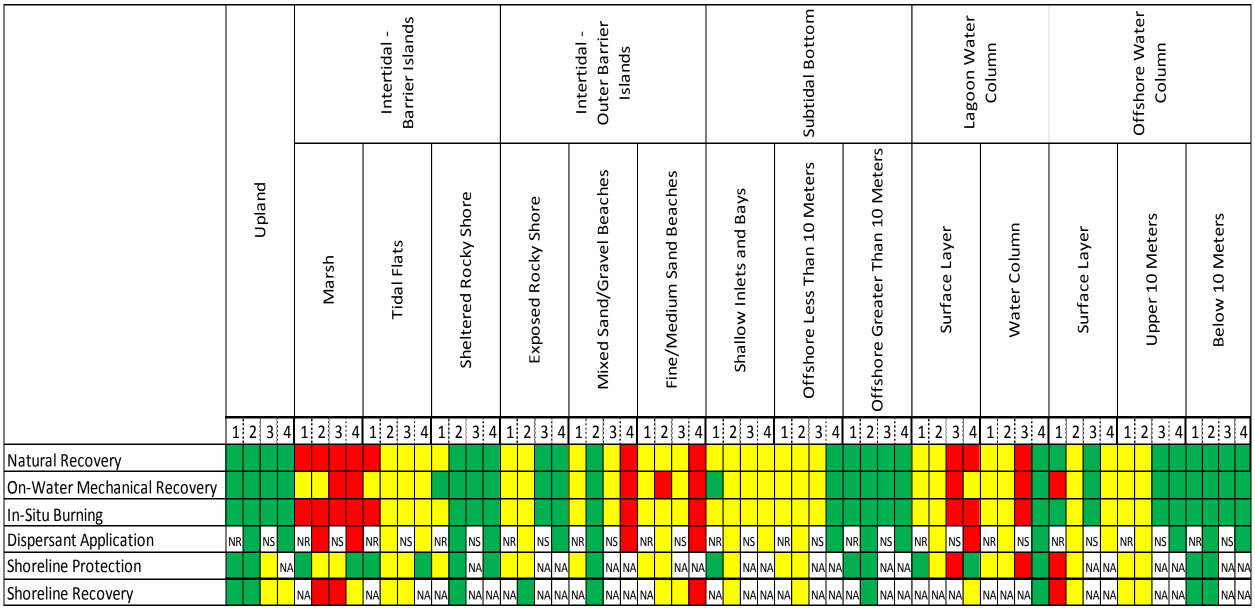
	Offshore Water Column																	
	Surface Layer						Upper 10 Meters						Below 10 Meters					
Shoreline Recovery	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence	Mammals	Birds	Fish	Invertebrates	Plankton	Cultural and Subsistence
Group 1	R	L	R	R	R	L	L	L	L	L	L	L	R	R	R	R	R	R
	2C	1B	4D	4D	4D	3A	3C	1B	3A	4D	4D	2A	4D	4D	4D	4D	4D	4D
	2B						2C						4D					
Group 2	R	G	R	R	L	L	R	G	R	R	L	L	R	NA	R	R	L	L
	3D	1B	4D	4D	4B	3A	4D	4D	4D	4D	4D	3A	4D	4D	4D	4D	4D	4D
	3B						4A						4D					
Group 3	R	G	R	L	L	L	L	R/G	L	L	L	L	R	G	R	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA						NA						NA					
Group 4	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L	R	R/G	L/R	L	L	L
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA						NA						NA					

Reference Area codes: L = Local, R = Regional, and G = Global (see Section 2 for definitions).
Scoring codes: NA = Not Applicable, NR = Not Recommended, NS = Not Scored

Figure 4.7 *Detailed focus group risk analysis results for shoreline recovery*

5.0 Summary Risk Analysis Results and Lessons Learned

Figure 5.1 presents the summary results for this workshop. The six response options analyzed are natural recovery, on-water mechanical recovery, *in-situ* burning, dispersant application at 40% effectiveness, shoreline protection, and shoreline recovery. This figure utilizes the detailed data in Section 4.0 and allows for easy comparison across response options.



	Upland				Intertidal - Barrier Islands											
					Marsh				Tidal Flats				Sheltered Rocky Shore			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Natural Recovery	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟨	🟨	🟨	🟨	🟩	🟩	🟩
On-Water Mechanical Recovery	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩
In-Situ Burning	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟨	🟨	🟨	🟨	🟩	🟩	🟩
Dispersant Application	NR	🟩	NS	🟩	NR	🟥	NS	🟥	NR	🟨	NS	🟨	NR	🟩	NS	🟩
Shoreline Protection	🟩	🟩	🟨	NA	🟩	🟨	🟨	🟩	🟩	🟨	🟨	🟩	🟨	🟩	NA	🟩
Shoreline Recovery	🟩	🟩	🟨	🟨	NA	🟥	🟥	🟨	NA	🟨	🟨	NA	NA	🟩	NA	NA

	Intertidal - Outer Barrier Islands												Subtidal Bottom											
	Exposed Rocky Shore				Mixed Sand/Gravel Beaches				Fine/Medium Sand Beaches				Shallow Inlets and Bays				Offshore Less Than 10 Meters				Offshore Greater Than 10 Meters			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Natural Recovery	🟨	🟨	🟩	🟩	🟨	🟩	🟨	🟥	🟨	🟨	🟨	🟥	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩
On-Water Mechanical Recovery	🟨	🟨	🟩	🟩	🟨	🟩	🟨	🟥	🟨	🟥	🟨	🟥	🟩	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩
In-Situ Burning	🟨	🟨	🟩	🟩	🟨	🟩	🟨	🟥	🟨	🟨	🟨	🟥	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩
Dispersant Application	NR	🟨	NS	🟩	NR	🟩	NS	🟥	NR	🟨	NS	🟥	NR	🟨	NS	🟨	NR	🟨	NS	🟩	NR	🟩	NS	🟩
Shoreline Protection	🟨	🟨	NA	NA	🟨	🟩	NA	NA	🟨	🟨	NA	NA	🟩	🟨	NA	NA	🟨	🟨	NA	NA	🟩	🟩	NA	NA
Shoreline Recovery	NA	🟩	NA	NA	NA	🟩	NA	NA	NA	🟨	🟨	🟥	NA	🟨	NA	NA	NA	🟨	NA	NA	NA	🟩	NA	NA

	Lagoon Water Column								Offshore Water Column											
	Surface Layer				Water Column				Surface Layer				Upper 10 Meters				Below 10 Meters			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Natural Recovery	🟨	🟨	🟥	🟥	🟨	🟨	🟥	🟩	🟩	🟨	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩
On-Water Mechanical Recovery	🟨	🟨	🟥	🟨	🟨	🟨	🟥	🟩	🟥	🟨	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩
In-Situ Burning	🟨	🟨	🟥	🟥	🟨	🟨	🟥	🟩	🟩	🟨	🟩	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩
Dispersant Application	NR	🟨	NS	🟥	NR	🟨	NS	🟩	NR	🟨	NS	🟨	NR	🟨	NS	🟩	NR	🟩	NS	🟩
Shoreline Protection	🟩	🟨	🟥	🟩	🟨	🟨	🟥	🟩	🟥	🟨	NA	NA	🟨	🟨	NA	NA	🟩	🟩	NA	NA
Shoreline Recovery	NA	NA	NA	🟨	NA	NA	NA	🟩	🟥	🟨	NA	NA	🟨	🟨	NA	NA	🟩	🟩	NA	NA

Legend: Red cells represent a “high” level of concern, yellow cells represent a “moderate” level of concern, and green cells represent a “limited” level of concern. There are four group scores per sub-habitat type (columns).
NR = response option was not recommended; **NA** = response option was not applicable; **NS** = response option was not scored

Figure 5.1 *Final relative risk matrix for the Northwest Arctic Alaska ERA.*

5.1 Group Drafted Recommendations

The participants reviewed the results of their discussions from both workshop sessions and drafted a list of recommendations for future consideration by the response community. Listed below are the recommendations as drafted by each group.

Group 1

Group 1 did not provide a group-drafted list of recommendations.

Group 2

1. Village level (Diomede, Wales and Shishmaref) consultation is needed to validate concerns for mammals, birds, fish and subsistence.
2. Ground truthing with Iñupiaq TEK is needed for identifying historical sites in the area.

3. Need to define lagoon depths in the affected areas and environment information (flows, seasonal changes, bottom organisms, etc.).
4. Need village response team development for oil spill preparedness (Kivalina, Kotzebue, Deering, Shishmaref, Wales, Diomede, Nome) work with village fire departments.
5. Recognize/understand response capabilities are limited due to remote-rural locations and lack of equipment. Need to identify local resources at the village level and at Red Dog Mine, Tin City, and recommend supplies and equipment to store at villages.
6. Document TEK of tidal sea currents in all villages within the Northwest Arctic subarea (interviews, photographs, onsite fieldwork with the village boaters/hunters).
7. Test effectiveness of dispersants in the Chukchi Sea. Seawater test in swirling flask, temperature, effects to plankton-sea organisms, sea trial.
8. Conduct a workshop in Shishmaref for one week to identify their concerns onto a matrix (additional group to add for review with the rest) prior to finalizing the ERA.
9. Support shore-zone mapping in the area. Collaboration and funding for baseline and habitat information with aerial photography and biology-habitat typing.
10. Additional sea/winds/tides monitoring buoys in the Northern Bering Sea and Chukchi Sea.
11. Field test GRS plans in the Northwest Arctic area (equipment, logistics, people, village training).
12. Oil toxicity to Arctic species – IFO, crude. Important species, food chain basis, subsistence sensitivity/human consumption.
13. Oil spill drills in the Northwest Arctic subarea. Meeting of all three areas (readiness, identify needs and recommendations and involve).
    a. St. Lawrence Island
    b. South area
    c. North area
14. Industry meeting of companies in the Arctic – Crowley, FOSS Maritime, Teck, NANA, Delta Western, Chadux, NSEDC, Drake Construction, AVEC.
15. Fee collection (done already – resources there) of shipping vessels through the Bering Strait – NPFC (National Pollution Fund Center). Need funds directed to Arctic response and research needs.
16. Cooperative agreement and sharing of Arctic oil spill response capacity, resources, equipment, supplies, research, GRS and PPOR sites, dispersant storage/stockpile with Russia.
17. ERA process – less lag-time between sessions and better orientation of new people, consistency of participants.

Group 3

1. Provide training and outreach in the villages to prepare local citizens for work and decision making. Use the Geographic Response Strategies to generate local knowledge regarding specifics on access and resources.
2. Establish regional working groups to coordinate individuals and strategies (groups of villages).
3. The use of dispersants is a decision that must be made cooperatively and include the involvement of local people (village, city, borough, corporation, organization,

agency) to be used, pre-acceptance as a method/tool must be in place. Pre-acceptance would include parameters and conditions when dispersants would be used.

4. Land and resource agencies must establish baseline information on cultural, historical, biological, ecological resources that can be collected and referred to during an emergency response effort.
5. During response, activate local and resource specific advisor group.
6. Prior to a response effort, regulations regarding wilderness, motorized vehicles, etc. must be identified, as some may limit the capabilities of personnel and equipment.

Group 4

1. Need to gather information on and test the use of dispersants in cold waters on multiple types of product in the Arctic and ensure dispersants (for that ‘product risk’) are available for rapid application during window of opportunity.
2. Need to exercise existing GRS’s and create more. We need more science on water in/outflows and meteorological data (wind, etc.) to determine if these GRSs will work in reality.
3. Develop local response capabilities (training, equipping, exercising) to include local communities’ consideration to purchase equipment (e.g. loaders, backhoes, dump truck, bulldozer) of their own in advance of a spill.
4. Ensure availability of material and equipment for the various types of oil potentially spilled in a particular geographic area.
5. Engage a broader audience and more frequent contact in area planning and exercise.
6. Need a list of at-risk subsistence resources by habitat.
7. Establish a Basic Order Agreement between Chadux, ACS and USCG.
8. Tidal lagoons, marshes and intertidal flats need priorities for protection.

5.2 Consensus Recommendations/Lessons Learned

Group-drafted recommendations were further reviewed, discussed and modified by all participants for inclusion in the list of recommendations for future consideration by the response community. These recommendations are listed in the order that they were developed.

1. Use of dispersants is often unrealistic (e.g. weather, type of oil spilled, logistics) in Alaska but they remain a potential response option. However, if they are to be used, better communication with the local stakeholders about the risks and benefits is necessary.
2. Need to conduct additional research on the efficacy and toxicity of dispersants and dispersed oil in cold-water environments (appropriate species) on multiple products (crude oils and IFOs) in the Alaskan Arctic, and ensure dispersants are available for rapid application during window of opportunity.
3. Build on existing capacity in the villages; provide additional training, equipment and exercises to enhance capacity to prepare local residents for spill response and Incident Command System (ICS).
4. Engage local stakeholders and provide more frequent contact in area planning and exercises in the local community.

5. Through outreach efforts, expand understanding of threats and response options to oil spills as well as receive input on resource values and distribution based on an exchange of indigenous and western science, and traditional and western knowledge.
6. Document traditional knowledge and indigenous science of tidal sea currents in all villages within the Northwest Arctic subarea – interviews, photographs and on-site fieldwork with experienced boaters/hunters.
7. Conduct a Bering Strait risk assessment including all sources.
8. Ensure the availability in the region of response materials and equipment for the various types of oils potentially spilled based on that geographic area.
9. Mirror North Slope Borough Village Response Team (VRT) in the Northwest Arctic subarea.
10. Support shore-zone mapping in the area; provide collaboration and funding for comprehensive base-line habitat information (biological, cultural, historical, chemical and physical) with aerial photographs and biology habitat typing.
11. The recommendations from the Northwest Arctic Alaska CERA should be addressed and processed.
12. Revise the CERA process to:
    a. Maintain group consistency,
    b. Decrease detail in the matrices, and
    c. Ensure appropriate representation in each of the groups of topical expertise.
13. The addition of the subsistence and cultural and historic properties was essential.

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Appendix A

Participants

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Appendix B

Dispersant Concern Discussion

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Review of Interim Questions

Fate

Q: Can we use residual DOSS in the water column as a marker of biodegradation?
A: DOSS concentration in the water column is a measure of dilution rather than biodegradation. At the expected application and dilution rates, it would be below detection limits very quickly. It has been measured only during the Deepwater Horizon incident.

Q: How persistent are the primary elements of dispersants in the water column?
A: Constituents do biodegrade but emphasis has usually been on dispersed oil droplets, not dispersant alone. Some evidence that, in dispersed oil droplets, they may degrade quicker than the oil components. According to the NRC (2005) "…the dispersants themselves, which are usually readily biodegradable and support microbial growth (Mulkins-Phillips and Stewart, 1974; Bhosle and Row, 1983; Bhosle and Mavinkurve, 1984; Lindstrom and Braddock, 2002)." In most instances, dilution is a much more significant short-term process.

Q: Do dispersed oil droplets sink? What is the mechanism for this effect?
A: The purpose of using dispersants is to reduce the size of oil droplets that are formed in response to wave energy. Just like the parent "oil", they are less dense than water, but because of their small size, ideally 50 microns (µ) or less, the mixing energy in the environment causes them to remain neutrally suspended. In mesocosm experiments, when all wave mixing is stopped, droplets will resurface. Very small droplets can remain suspended even at very low energy. Bacterial colonization and aggregation may eventually lead to sinking, but by then the droplets are widely dispersed.

Dispersant Effectiveness

Q: What would happen if a second or third application of dispersants was made that treated 50% or 70% of the total oil?
A: Based on all these considerations, a prediction for results in the field is always an estimate – which is why we do multiple ranges. Most laboratory tests are less energetic than the real world, so if an oil is dispersible in the laboratory it generally will disperse in the field until it is too weathered. Field applications account for this uncertainty by planning for multiple applications if the oil appears to be dispersing.

Q: Why does dispersant work on some product and not all product (40% vs. 70%)
A: Every oil has a different dispersability, based on its chemical composition, which changes as the oil weathers. Every dispersant has different properties as well. Laboratory testing measures dispersant "effectiveness" under standard conditions, which do not directly relate to conditions in nature

- Best use – comparisons between products or as a screening tool.
- Does not tell you what will actually happen in the field

"Efficiency" refers to the overall results when dispersants are applied at a real incident. Influenced by:

- Type of oil
- Type of dispersant
- Weathering of the oil
- Hydrographic conditions and weather
- Application targeting and accuracy

- Application rate and oil thickness

Q: Will it even be worth it at only 10% dispersed
A: Any efficiency estimate is not well supported by field data.

Shoreline Impacts

Q: Analysis of shoreline impacts with dispersants used versus not used. Please provide more detailed information.
A: Treated but undispersed oil tends to be less sticky, if it strands soon after application, otherwise there is little difference. For oil dispersed away from the beach, the droplets would be carried away from the beach with the currents.
Q: How much dispersant would it take to keep the majority of oil off the beaches?
A: The amount of dispersant needed to protect the shoreline cannot be predicted with any certainty. A "ball park" upper limit would be the volume of oil to be treated divided by 20.
Q: How much oil is spared from the shoreline if the higher amounts of in-water oil are effectively treated with dispersants?
A: If dispersed oil droplets do contact the shore they tend to wash off – observed in mesocosm experiments. Amount of dispersant needed to protect the shoreline cannot be predicted with any certainty.
Q: If dispersants are used, is the amount of oil entering the lagoons reduced?
A: You can use dispersants as a wide area treatment to try to affect the fate of the entire mass of spilled oil, or you can target specific portions of the slick to try to protect specific resources. Both approaches are constrained by the limits of the "window of opportunity. Both have the potential, in this scenario, to prevent oil entering the lagoons, the efficiency would be uncertain.

Toxicity

Q: Do we really know what organisms are in the water column? What exactly is in the water column this time of year? What types of bacteria are present?
A: The presence of specific species, or sensitive life history stages can only be inferred from field distribution studies.
Q: Toxicity of dispersed IFO?
A: Unable to find any relevant toxicity information specifically on dispersed IFO 180 or IFO 380. NRC (2005) summarized available literature since 1989 (date of previous dispersant report) and a few values for medium fuel oil or diesel were included – similar to crude oils. Toxicity data is difficult to interpret because the result, in the field or laboratory, "is a complex, multi-phase mixture composed of dissolved dispersant, dissolved petroleum hydrocarbons, oil/dispersant droplets, and bulk, undispersed oil." (NRC, 2005).
Q: How much toxicity would transfer to the benthic environment?
A: In general, field and mesocosm studies seem to indicate that dispersants will reduce the persistence of oil in subtidal and intertidal sediments compared to untreated oil.
Q: What are dispersant and oil toxicity levels, concentrations, and persistence through depth of the water column through time?
A: CROSERF was "quite successful" in standardizing methods to allow for greater comparability. The program successfully addressed the relative toxicity of different dispersants and oil, as well as the relative sensitivity of test organisms.

Subsistence

Q: Learn about subsistence/way of life concerns related to the use of dispersants and determine if they will have psychological impacts on cultural/subsistence.
A: Concerns about dispersants need to be integrated into planning. Groups should focus on how those concerns relate to concerns about the fate of oil in general. If appropriate, suggests ways educate subsistence users on the results of the workshop.

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Appendix C

Northwest Arctic Alaska CERA Incident

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Northwest Arctic Alaska CERA Incident

While the true possibility of the scenario occurring as outlined is similar to the chances of winning a lottery, ERA exercises are designed to test response options regardless of the origin of the oil spill. What is important for the ERA exercise is that oil has entered the nearshore waters and response actions will affect the impact of the spill to highly sensitive coastal resources. That said, the possibility of a fuel carrier incident due to a multitude of causes is a true risk in the Chukchi Sea.

Chronology of Events

7 August 2011

0800 A fuel carrier notifies the US Coast Guard that it is experiencing problems at Little Diomede Island, AK. 400,000 gallons of IFO 180 fuel is discharging.

8 August 2011

0800 Dispersant aircraft sorties treat the leading edge of the slicks with an effectiveness of 40%.

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Appendix D

Resources at Risk

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Area	Habitat	Resource Category	Specific Concerns
Upland		Mammals (Terrestrial)	Bears, foxes, wolverines, inbound caribou for insect relief
		Birds	Nesting shorebirds, oiling eggs; Some waterfowl, raptors
		Fish	
		Vegetation	Plants not getting through hardened oil
		Historic Properties	Permeable soils will allow transport
		Cultural and Subsistence	Impact on caribou herds based on shift in diet from ocean-based food source; May influence perceptions for subsistence users, affect activities such as berry picking
Intertidal	Marsh	Mammals (Terrestrial)	Mostly furbearers, mink, otters, beavers, muskrats, moose, marten, fox
		Birds	Eiders, red-throated loons
		Fish	Concern for juveniles; Nursery areas for fish. Herring spawning
		Invertebrates	Copepods, clams, snails, insects
		Vegetation	Smothering of eelgrass
		Historic Properties	Camps and shelters
		Cultural and Subsistence	Plants, berries, sourdock bird eggs; People will choose to avoid
	Tidal Flats	Mammals	Few animals traversing
		Birds	Whimbrels, dowitches
		Fish	Herring fry, salmon
		Invertebrates	Camps and shelters
		Vegetation	Periphyton, eelgrass
		Historic Properties	Camps and shelters
		Cultural and Subsistence	People will avoid the area
	Sheltered Rocky Shore	Mammals	
		Birds	Eiders
		Fish	
		Invertebrates	
		Vegetation	
		Historic Properties	Camps and shelters
Intertidal	Sheltered Rocky Shore	Cultural and Subsistence	

Area	Habitat	Resource Category	Specific Concerns
	Mixed Sand/Gravel Beaches	Mammals	Marine animal carcasses; Polar bears, brown bears, fox, seals, walrus
		Birds	Spectacled eiders, yellow-billed loons; Shorebirds feeding
		Fish	
		Invertebrates	
		Vegetation	
		Historic Properties	Most resources in these areas
		Cultural and Subsistence	Impacts on camping and fishing
	Fine/Medium Sand Beaches	Mammals	
		Birds	Need to verify with bird experts
		Fish	
		Invertebrates	Clams
		Vegetation	Beach greens
		Historic Properties	Most resources in these areas
		Cultural and Subsistence	Impacts on camping, fishing, villages and cultural resources
Subtidal Bottom	Shallow Inlets and Lagoon Bottom	Mammals	Seals (spotted and bearded), possibly belugas would be affected, walrus
		Birds	Wading birds, birds food source, diving ducks
		Fish	Herring, capelin
		Invertebrates	
		Vegetation	Eelgrass
		Historic Properties	
		Cultural and Subsistence	
	Offshore Less than 10 Meters	Mammals	Spotted seals/young bearded seals feeding
		Birds	Diving birds
		Fish	Herring, capelin, sand lance, salmon
		Invertebrates	Clams
		Vegetation	
		Historic Properties	
		Cultural and Subsistence	
	Offshore Greater than 10 Meters	Mammals	
		Birds	
		Fish	

Area	Habitat	Resource Category	Specific Concerns
Subtidal Bottom	Offshore Greater than 10 Meters	Invertebrates	
		Vegetation	
		Historic Properties	
		Cultural and Subsistence	
Lagoon Water Column	Surface Layer	Mammals	Seals; Best potential for oiling
		Birds	
		Fish	Whitefish
		Invertebrates	
		Vegetation	
		Historic Properties	
		Cultural and Subsistence	
	Water Column	Mammals	
		Birds	
		Fish	Greater effects than at the surface layer
		Invertebrates	
		Vegetation	
		Historic Properties	
		Cultural and Subsistence	
Offshore Water Column	Surface Layer Air/Water Interface	Mammals Marine	Whales, seals (spotted seals), belugas, gray whales, bowhead whales, walrus
		Birds	Murres, spectacled eiders, seabirds, diving birds
		Fish	Salmon
		Invertebrates	Crabs below surface area
		Plankton	Phytoplankton, zooplankton. Limitation of light
		Cultural and Subsistence	Diomede Islands dependent on traditional sources; Wales, Shishmaref, etc. have alternate sources (caribou, etc.); Compromised perceptions, restricted access to resources; social, psychological perceptions; nearshore fishing, seine nets
	Upper 10 Meters	Mammals Marine	
		Birds	
		Fish	
		Invertebrates	
		Plankton	

Area	Habitat	Resource Category	Specific Concerns
Offshore Water Column	Upper 10 Meters	Cultural and Subsistence	Perception issue will impact subsistence harvest for a longer time; Population recovery
	Below 10 Meters	Mammals Marine	Spotted seals, seals
		Birds	Primary impacts on surface; Diving birds present, but encountering low concentrations at depth
		Fish	
		Invertebrates	Shrimp, squid, jellyfish present; Crabs and clams on the bottom
		Plankton	Plankton near surface; Limited impacts below 10 meters
		Cultural and Subsistence	Most subsistence activities above 10 meters; Impacts on marine mammals limited