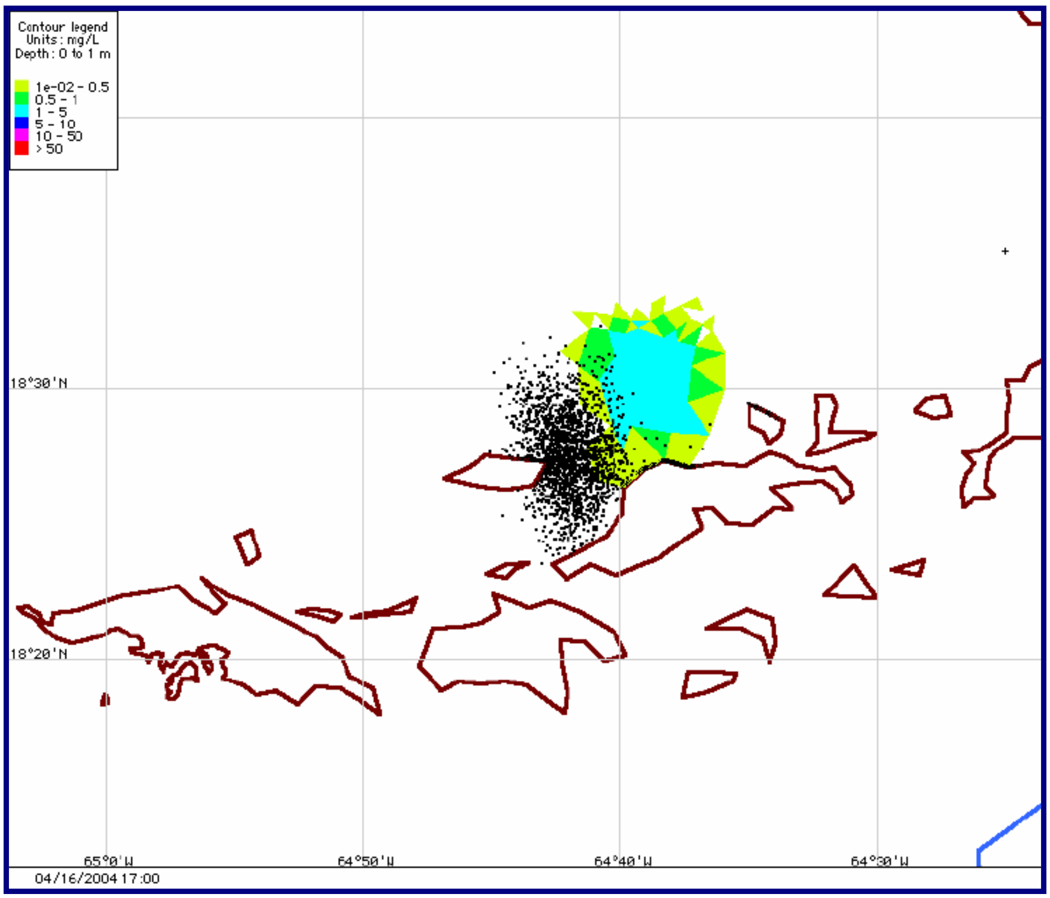
Ecological Risk Assessment: Consensus Workshop

Environmental Tradeoffs Associated With Oil Spill Response Technologies

U.S. and British Virgin Islands



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A Report to US Coast Guard District 7

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Ecosystem Management & Assoc., Inc.

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

Term	Abbreviation, Symbol, or Acronym
Automated Data Inquiry for Oil Spills	ADIOS
Barrel	bbl
British Virgin Islands	BVI
Clean Caribbean Cooperative	CCC
Ecological Risk Assessment	ERA
Environmental Protection Agency	EPA
Environmental Sensitivity Index	ESI
Fish and Wildlife Service	FWS
General NOAA Oil Modeling Environment	GNOME
International Maritime Organization	IMO
International Tanker Owners Pollution Fund	ITOPF
National Oceanic and Atmospheric Administration	NOAA
Office of Response (USCG HQ)	G-MOR
Parts per million	ppm
Regional Response Team	RRT
Scientific Support Coordinator	SSC
Square Kilometer	km^2
Square Mile	mi^2
Total Petroleum Hydrocarbons	TPH
United Nations Environment Program	UNEP
United States Coast Guard	USCG
United States Virgin Islands	USVI

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Ecological Risk Assessment: Consensus Workshop

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Executive Summary

In mid-June 2003, the United States Coast Guard (USCG) District 7 sponsored a four-day workshop to provide oil spill response training based on the relative risk to natural resources from various oil spill response options (on-water mechanical recovery, dispersant application and shoreline cleanup) in comparison to natural recovery. Representatives from various government agencies in the United States, the US Virgin Islands, the British Virgin Islands and seven other countries participated in the meeting. The discussions were based on a spill scenario involving the release of 5,000 barrels (210,000 gallons) of Venezuelan crude oil (Furrial) approximately five miles north of Virgin Gorda Island, under conditions which threatened the coastline of several islands in the U.S. and British Virgin Islands, as well as a variety of valuable subtidal habitats. After the participants received briefings on the expected results of the spill with and without response options they were asked to discuss the risks and benefits of these response options to the habitats and natural resources of the area. For these discussions, the participants were divided into four focus groups and were asked to develop relative risk scores for the various alternatives, using standard analytical protocols outlined in the USCG guidebook entitled "Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning. A Guidebook." The scores from the four groups were then compared and a composite risk matrix developed which represented the overall consensus of the entire group. At the conclusion of the meeting, the group developed a list of lessons learned and recommendations for the RRT and the international oil spill response community in the Caribbean region. In general, participants concluded that on-water mechanical recovery was unlikely to provide much protection for shoreline habitats in the scenario under consideration. Dispersant use, if effective, did provide such protection, but with some increased risk to coral habitat. This risk was limited because much of the area where dispersants were applied was relatively deep. The participants recommended reexamining the current dispersant preauthorization limits to see if they could be made less restrictive.

1.0 Objectives of the U.S. and British Virgin Islands Workshop

1.1 Background and Process

Since 1998, the U.S. Coast Guard (USCG) has been sponsoring efforts to use a comparative risk methodology to provide training about oil spill response options. Interest in selecting response options based on a risk/benefit analysis goes back even further, but the current effort is different in that it emphasizes a consensus-building approach to evaluate risks and benefits.

Headquarters, USCG (G-MOR) has sponsored the development of a guidebook on this process (Aurand et al., 2000). The document, entitled "Developing Consensus Ecological Risk Assessments: Environmental Protection in Oil Spill Response Planning. A Guidebook" is available from G-MOR, or can be downloaded from the contractor's web site at www.ecosystem-management.net.

The process is designed to help planners compare the ecological consequences of response options, especially in nearshore or estuarine situations. This is particularly important for consideration of dispersants and in-situ burning, which present difficult analytical issues. It is focused on ecological "trade offs" or cross-resource comparisons. Through a structured analytical approach the participants find "common ground" for evaluation of impacts and develop a defensible logic to support their conclusions. This process is consistent with the U.S. Environmental Protection Agency (EPA) Ecological Risk Assessment (ERA) guidelines (US 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 to be a training and planning tool, and it should not be used during an actual event. The knowledge gained by participants in the process, however, will facilitate real-time decision-making.

The 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. The goal is to achieve consensus interpretations of the potential risks and benefits associated with selected response options based on a scenario developed by the local sponsor of the training. The time between the two workshops is used for the participants to research issues of concern before they develop their final conclusions. The process is heavily focused on achieving a consensus interpretation of the available technical information. It is very important to have a broad representation of the potential stakeholders in the decision process; otherwise the results may not be accepted by all of the groups who will be concerned if a spill occurs. 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, **problem formulation**, participants in the Virgin Islands workshop were:

- presented by the sponsor with a predesigned scenario for analysis,

- approved a table that summarized the resources of concern,
- discussed appropriate assessment thresholds, and
- modified a conceptual model (a matrix defining relative ecological risk) developed in previous workshops to guide the subsequent analysis.

In the **analytical phase**, participants characterized exposure and ecological effects. The conceptual model developed in the problem formulation phase directed 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, the participants completed a **risk characterization**. During this phase, participants interpreted their results in terms of the costs and benefits of each response option to overall environmental protection as compared to natural recovery (i.e., baseline).

1.2 Sponsor's Objectives

This series of workshops was sponsored by USCG District 7 (D7) (Miami, FL) in support of oil spill response planning. The overall purpose of the project was to evaluate the ecological resource impacts of spilled oil and oil spill response operations in the U.S. Virgin Islands (USVI), with a special emphasis on the consequences of dispersant use. Since any oil spill (especially large spills) in the Caribbean can pose a risk to multiple countries, a secondary objective was to foster cooperation and provide training for oil spill response professionals from countries throughout the Caribbean Basin.

The results of this ERA process are intended to improve oil spill response strategies and to enhance existing oil spill contingency planning. There are tradeoffs to every response decision. Exercises such as this are intended to help identify those natural resources at risk during a spill and to address the benefits and inherent tradeoffs associated with the different spill response tools.

Resource trustee consultation is essential to identifying those tradeoff priorities that drive spill response strategy. In the spirit of promoting as much pre-spill consultation and tradeoff dialogue as possible, an ERA training session was provided prior to the evaluation of the scenario. It has been the experience of the workshop organizers in earlier exercises that once participants are familiar with the ERA process and its methodology, resource and response agency stakeholders are better able to engage in effective risk assessment and tradeoff identification for pre-spill and spill-specific consultations. The result is a better understanding of resource trustee and response agency concerns, more timely and effective response decisions, and greater resource protection and recovery.

1.3 Participants and Responsibilities

A total of 41 individuals attended the workshop. Their names and affiliations are provided in Appendix A. These 41 people represented a wide range of organizations (both national and international) and were divided into four focus groups for the purpose of the workshops, as indicated in the tables in Appendix A. The scenario used in the exercise was developed by USCG D7 staff, with the assistance of the NOAA HAZMAT staff, who also supported the oil spill fate modeling effort.

Besides the US, the USVI, and the British Virgin Islands (BVI), seven other Caribbean nations and two international organizations sent representatives (as listed in Appendix A). Because of the international nature of the meeting, many of the participants would not be involved in oil spill response decisions in the area of the exercise scenario, and therefore conclusions developed at the workshop are not necessarily an accurate reflection of local stakeholder opinions. However, because of the interdependence and vulnerability of Caribbean nations to oil spills it is critical to develop a common knowledge base to support good decisions.

2.0 Overview of Workshop Events

The following is a summary of the activities that took place in the workshop for the Virgin Islands. Additional detail on the process itself is provided in the guidebook referenced in Section 1.1.

Only one workshop was held, from 17 to 20 June, 2003. It was sponsored by USCG D7. The first day and a half consisted of a series of training lectures about dispersant application and use, monitoring protocols and environmental consequences. In support of these presentations, the USCG and NOAA HAZMAT staff compiled a compact disk (CD) which contained copies of the training presentations and selected oil spill publications. Copies of the CD were provided to the attendees at the beginning of the workshop. The material included on the CD is listed in the references (Section 6) and identified with an asterisk. Application issues were covered by Christine Lane of the Clean Caribbean Cooperative (CCC), while Alan Mearns, Charlie Henry and Ruth Yender of NOAA and Jacqui Michel of Research Planning, Inc. reviewed environmental issues and monitoring protocols, along with examples of dispersant use in other locations. Karen Purnell of the International Tanker Owners Pollution Fund (ITOPF) provided a brief overview concerning recent international response operations where ITOPF staff were involved.

When the presentations were completed, Dr. Aurand of EM&A presented an overview of the ERA process which was going to be used by the participants. The participants then reviewed the scenario, discussed and approved the previously assigned risk factors associated with the response options, and defined the geographic area of concern and defined the habitats or ecological communities that were present. The latter information had been compiled into a table of habitats, subhabitats, and representative species by the meeting staff (with the assistance of Mr. Felix Lopez of the US Fish and Wildlife Service (FWS)) prior to the workshop in order to expedite the meeting. With minor modification, participants adopted the list for use during their evaluation of the response options under consideration. When this was complete, they approved a risk ranking matrix, with scales based on recovery time and the proportion of the resource affected, to use to evaluate potential impacts.

When these initial tasks were completed, the participants were divided into smaller "focus groups" (in this case, four) and used the risk ranking matrix to evaluate their "level of concern" for potential impacts in each of the habitats for the "natural recovery" (i.e. no response) option. This option is always evaluated first because it establishes the baseline against which all other response options are compared. The focus groups independently used the alphanumeric designations to determine their level of concern, which was then summarized in a habitat/response option matrix.

When analysis for natural recovery was completed by the four focus groups, their results were compared and discussed to determine if the groups were being consistent in their approach. This process was hindered somewhat by the diversity of participants and their levels of experience. It was particularly difficult for the participants to define the use of "local" or "regional" for populations of concern given the large number of islands and international boundaries. In general, however, the participants viewed "local" as the islands immediately in the vicinity of the spill trajectory and "regional" as the greater Caribbean. While the groups attempted to resolve as many differences as possible in their scores for natural recovery (and later, the response options) they did not attempt to achieve total consensus, and so group scores are not identical. When the groups had significantly different initial conclusions, this review of natural recovery was used to make sure that areas of confusion or limited data were identified and addressed.

Once this was completed, the participants reviewed the response options to be included and identified issues related to each option that they wanted to discuss before completing the risk ranking. When the relevant questions had been discussed, the participants reviewed the three response options selected for analysis (on water mechanical recovery, on shore mechanical recovery and use of dispersants), and then the four focus groups completed the risk ranking process for each response option.

After the evaluation of the Virgin Islands spill scenario was completed, the participants were asked to briefly consider a scenario from a previous workshop held in the Florida Keys (Aurand, 2003). This second scenario involved a spill much closer to shore and in shallower water and thus represented a much greater threat to shallow subtidal habitats (especially coral reefs). Participants were asked to consider that scenario, and then decide if their conclusions about dispersant use would have been different for that situation.

At the conclusion of the meeting the entire group developed “lessons learned” and made a list of recommendations for implementation in future oil spill response planning options for the USVI, and for international discussions about cooperative oil spill response in the Caribbean region.

3.0 Exercise Scenario and Basic Analytical Information

3.1 Exercise Scenario

The participants were presented with a spill scenario designed to focus on the environmental decisions that need to be made when an oil spill threatens the shoreline of the USVI, the BVI, and Puerto Rico. The scenario involved a collision during which a tanker suffered a partial loss of cargo. The collision occurred on April 13, 2004 at 16° 35' north, 64° 64' west, approximately 10 miles north of the island of Virgin Gorda in the British West Indies. The cargo was a Venezuelan crude oil (Furrial).

Initially no oil was spilled, but there was the threat of a release and so response resources were mobilized. At 6:00 AM local time on April 15, 2004 there was an initial very small discharge, followed approximately two hours later by the nearly instantaneous loss of approximately 5,000 barrels (bbls) or 210,000 gallons, after which time the leak was secured. Throughout the event the wind was from the north-east at 15 knots.

3.2 Geographic Area of Concern

The general local area of concern was the immediate vicinity of the USVI and the BVI. For some resources there was a regional area of concern, which was defined as the greater Caribbean area. Resources were defined as either "local" or "regional" depending on their distribution, population characteristics and recovery pattern. This information was valuable in interpreting differences in the risk rankings.

3.3 Resources of Concern

Prior to the workshop the facilitators, with the assistance of Charlie Henry of NOAA and Felix Lopez of the US FWS, reviewed the resource table from the Florida Keys ERA (Aurand, 2003). With minor modification, that table was considered to be appropriate for use in this assessment. The proposed table was reviewed with the participants, changed slightly to reflect differences in the coral habitats of the islands compared to the Florida Keys, and then approved for use in the assessment. The final result is presented as Table 3.1.

3.4 Conceptual Model

During discussions about the general analytical process, the participants decided that establishing a detailed model was not necessary for their purposes. They agreed to use the list of seven hazards (air pollution, aqueous exposure, physical trauma, oiling/smothering, thermal, waste and indirect) developed in the San Francisco Bay workshop (Pond *et al*., 2000) to evaluate each of the proposed response options. The list of response options, combined with the resource table, forms the basis for the cells of the conceptual model. The interactions between the two are defined by the hazards.

Table 3.1 Habitat Table for the Virgin Islands Risk Assessment

Habitat	Subhabitat	Resource Category	Example Organisms
Water Surface		Mammals	cetaceans, West Indian manatee
		Birds	Frigate birds, tropic birds, pelican, diving birds, rafting birds
		Fish	pelagic fish
		Aquatic Arthropods	N/A
		Mollusks	pteropods
		Plankton	phytoplankton, fish eggs and larvae, copepods, coral larvae
		Reptiles	sea turtles
Terrestrial		Mammals	bats
		Birds	osprey
		Reptiles	geckos, iguana, boas, anoles
Intertidal	Mangrove Forest	Vegetation	red, white and black mangrove, macroalgae
		Mammals	West Indian manatee
		Birds	great blue heron, willets, pelican, egret, shorebirds
		Fish	bonefish, crevalle jack, mullet, sheepshead, killifish, snook, tarpon, snapper
		Aquatic Arthropods	barnacles, amphipods, grass shrimp
		Mollusks	clams, oysters, mussels, snails
		Epifauna	algae, sponges, bryozoans
	Rocky Shores	Vegetation	macroalgae, button tree
		Birds	boobies, terns, frigate birds, tropic birds
		Aquatic Arthropods	crabs
		Mollusks	topshell snail, mussels
		Epifauna	sponges, sea urchins, sea squirt
	Sand Beach	Birds	shore birds
		Reptiles	sea turtles
		Mollusks	Donax clams

Table 3.1 Habitat Table for the Virgin Islands Risk Assessment (*continued*)

Habitat	Subhabitat	Resource Group	Example Species
Intertidal (continued)	Reef Flats	Vegetation	macroalgae, sea grasses
		Birds	shore birds, wading birds
		Fish	bonefish, mullet, tarpon, snook, other juvenile fish
		Aquatic Arthropods	crabs, barnacles, lobster, snapping shrimp
		Coelenterates	cup coral, fire coral, star coral, anemones
		Mollusks	queen conch, snails, clams, mussels, octopus
		Epifauna	sponges, sea urchins, sea squirt
Subtidal	Submerged Aquatic Vegetation	Vegetation	turtle grass, shoal grass, Halophila
		Mammals	West Indian manatee
		Birds	heron, brown pelican, double-crested cormorant
		Fish	snappers, grunts, barracuda, grey snapper, gobies, pipefish, eel, spot
		Aquatic Arthropods	pink shrimp, spiny lobster, amphipods, grass shrimp, blue crab
		Coelenterates	cup coral, anemones
		Mollusks	queen conch, snails, clams, mussels, octopus
		Reptiles	green, loggerhead, hawksbill sea turtles
		Epifauna	algae, sponges, bryozoans, algae, snails, sea urchins, sea stars
	Shallow Coral Reef Community (<5 m)	Vegetation	macroalgae
		Fish	snappers, grunts, barracuda, reef sharks, butterfly fish, wrasses, parrotfish
		Aquatic Arthropods	spiny lobsters, snapping shrimp, amphipods, crabs
		Coelenterates	elkhorn coral, fire coral, star coral, staghorn coral, brain coral
		Mollusks	snails, clams, octopus
		Reptiles	green, loggerhead and hawksbill sea turtles
		Epifauna	algae, sponges, bryozoans, algae, snails, sea urchins, sea stars

Table 3.1 Habitat Table for the Virgin Islands Risk Assessment (*concluded*)

Habitat	Subhabitat	Resource Group	Example Species
Subtidal (continued)	Deep Coral Reef Community	Birds	macroalgae
		Fish	snappers, grunts, barracuda, reef sharks, butterfly fish, wrasses, parrotfish
		Aquatic Arthropods	spiny lobsters, snapping shrimp, amphipods, crabs
		Coelenterates	elkhorn coral, fire coral, star coral, staghorn coral, brain coral
		Mollusks	snails, clams, octopus
		Reptiles	green, loggerhead, leatherback and hawksbill sea turtles
		Epifauna	algae, sponges, bryozoans, algae, snails, sea urchins, sea stars
Water Column	Shallow Water (<5 m)	Mammals	West Indian manatee
		Birds	black-legged kittiwake, northern gannet
		Fish	snappers, grunts, barracuda, eel, seatrout, spot, snappers, grunts, sharks, butterfly fish, wrasses, parrotfish
		Aquatic Arthropods	pink shrimp
		Mollusks	squid
		Plankton	fish eggs and larvae, invertebrate eggs and larvae, copepods, diatoms, green algae
		Reptiles	green, loggerhead and Kemp's ridley sea turtles
	Deep Water (>5 m)	Mammals	bottlenose dolphins, Risso's dolphins, West Indian manatee
		Birds	common loon, black-legged kittiwake, northern gannet
		Fish	snappers, grunts, barracuda, eel, seatrout, spot, snappers, grunts, sharks, butterfly fish, wrasses, parrotfish
		Aquatic Arthropods	pink shrimp
		Mollusks	squid
		Plankton	fish eggs and larvae, invertebrate eggs and larvae, copepods, diatoms, green algae
		Reptiles	green, loggerhead and Kemp's ridley sea turtles

3.5 Modeling Results

The NOAA HAZMAT Modeling Group used the basic information in the scenario to develop a surface trajectory and a dispersed oil trajectory analysis for the workshop. Basic weathering information was calculated using the Automated Data Inquiry for Oil Spills (ADIOS) II program for the oil under consideration. Trajectory calculations were made using the General NOAA Oil Modeling Environment (GNOME) model. The model results were presented as short video clips prepared using QuickTime® software.

Table 3.2 presents a fate table for the oil with and without dispersant use over the five days (120 hours) of the simulation. Dispersant use, at either 80 or 40 percent efficiency, would significantly reduce, but not prevent, shoreline oiling.

While the trajectory model was run for 120 hours, Figures 3.2 through 3.4 show selected results for 4 times during the first 73 hours or less. These snapshots were selected to illustrate the period of highest potential risk, but do not fully describe the results. QuickTime® movies of the entire spill trajectories are included on the CD which contains this report, and should be reviewed for more detailed information.

Under the conditions in this scenario, an untreated surface slick would rapidly move to the southwest, making its initial landfall on small islands east of Tortola and then on the central northern coast of Tortola approximately 24 hours after the release (Figure 3.1). For the next 24 hours the slick moves between the remaining islands, heavily oiling the rest of Tortola, and the north and east cost of Jost Van Dyke. The slick reaches St. John and St. Thomas within 36 hours, with the north coast of both being heavily oiled, as are the smaller islands along the trajectory.

Snapshots of the estimated average concentrations of dispersed oil as parts per million (ppm) of total petroleum hydrocarbons (TPH) in the top one meter of the water column through time with 80% dispersant efficiency are shown in Figure 3.2. Immediately after application, maximum average concentrations are 5 to 10 ppm in a small area (approximately 1 mi^2) near the center of the plume. Over the next ten hours, these concentrations decreased and after ten hours maximum concentrations were 1 to 5 ppm, with the majority of the top one meter concentrations being 1 ppm or less. No longer driven by the wind, the dispersed oil plume remains to the east of Jost Van Dyke and moves slowly to the north as it dilutes. At the end of the model run (120 hours) the plume was still discernable, and while most concentrations were below 1 ppm, there were small areas where concentrations were in the range of 1 to 5 ppm.

Figure 3.3 shows snapshots of the estimated average concentration of dispersed oil in the top five meters of the water column (80% efficiency). In this case the plume trajectory is essentially the same as in Figure 3.2, but concentrations do not exceed 5 ppm, and the majority predicted throughout the 120 hours of the simulation are less than 1 ppm.

Figure 3.4 shows snapshots of the estimated average concentration of dispersed oil in the bottom one meter of the water column (80% efficiency). This would represent the approximate exposure of corals and other benthic organisms. In this case, only very limited areas are exposed to any dispersed oil, and then only concentrations below 0.5 ppm for very short periods (usually one to three hours for any given location).

Data available to the participants included trajectory analysis for both surface and subsurface oil, oil budgets with and without dispersant use, habitat maps, information on species of concern, toxicological information, depth profiles of modeled dispersed oil concentrations and also plots showing the extent to which consensus thresholds of concern (see Table 4.1) were exceeded or not.

Table 3.2 Estimated Oil Budget in US gallons for the Virgin Islands Oil Spill Scenario With and Without Dispersant Use

No Use of Dispersant

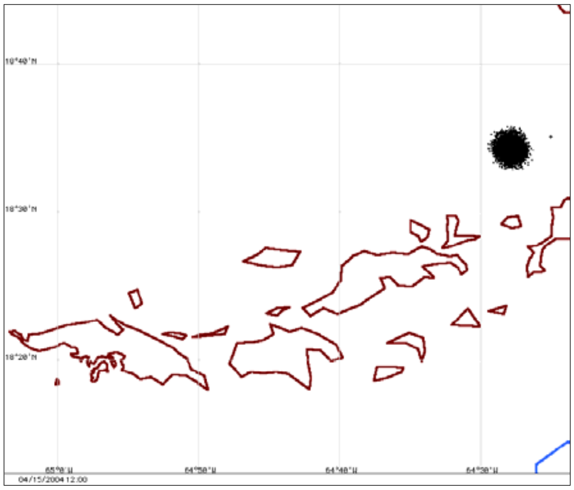
Hours After Release	Floating	Beached	Evaporated and Dispersed	Total
0	210,000	0	0	210,000
24	165,228	84	44,688	210,000
48	60,837	81,236	67,927	210,000
72	15,645	115,836	78,519	210,000
96	7,224	117,222	85,554	210,000
120	4,851	114,996	90,153	210,000

Use Dispersant at 24 Hours at 40% Effectiveness

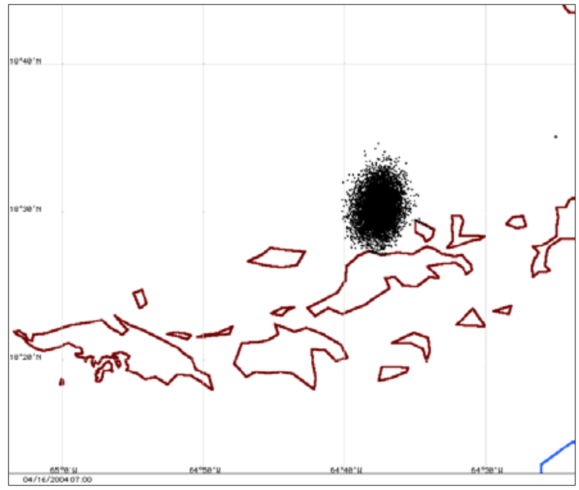
Hours After Release	Floating	Beached	Evaporated and Dispersed	Total
0	210,000	0	0	210,000
24	165,228	84	44,688	210,000
48	37,821	50,526	121,653	210,000
72	9,303	72,114	128,541	209,958
96	4,830	72,051	132,951	209,832
120	2,877	71,358	135,324	209,559

Use Dispersant at 24 Hours at 80% Effectiveness

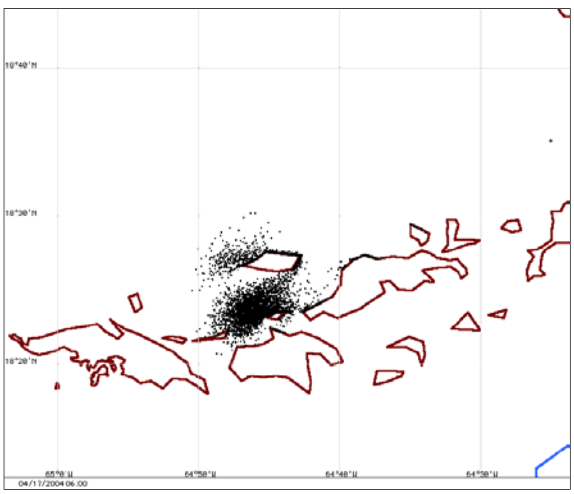
Hours After Release	Floating	Beached	Evaporated and Dispersed	Total
0	210,000	0	0	210,000
24	165,228	84	44,688	210,000
48	15,624	19,677	174,699	210,000
72	3,885	28,518	177,576	209,979
96	1,785	28,938	178,857	209,580
120	1,092	28,413	179,739	209,244



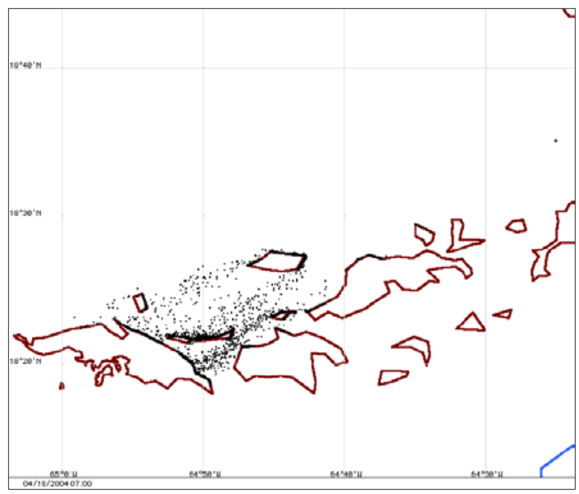
A: 6 Hours (End of Release)



B: 25 Hours (Initial Dispersion)

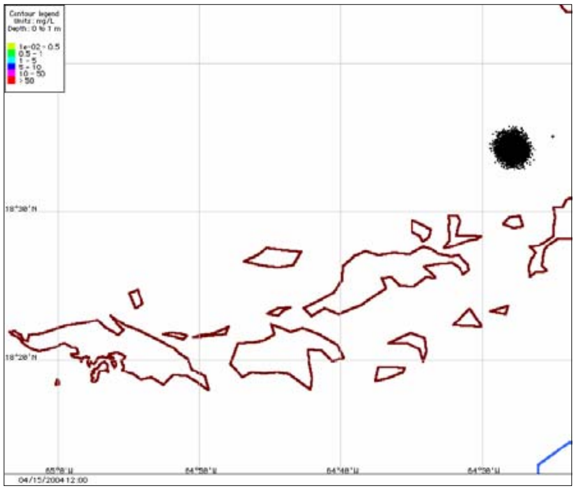


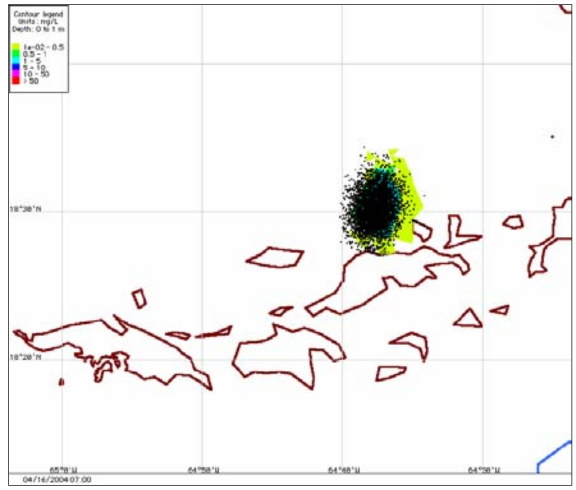
C: 49 Hours (D + 24 Hours)



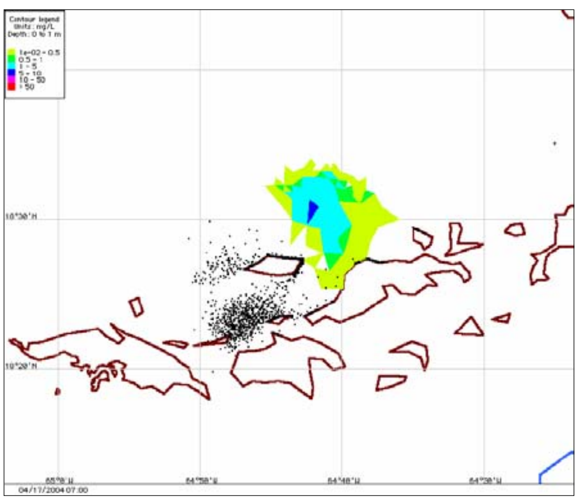
D: 73 Hours (D + 48 Hours)

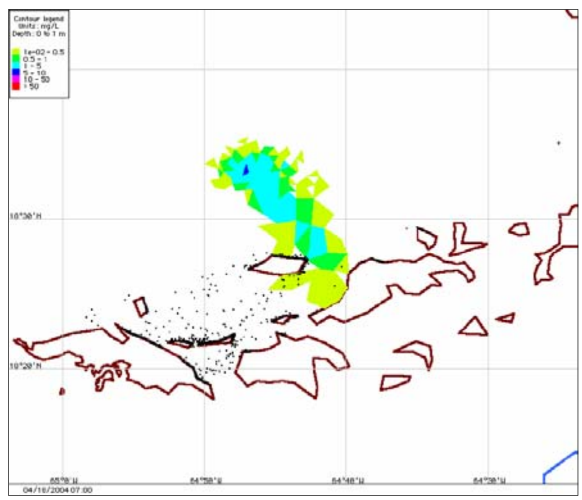
Figure 3.1 *Results from the NOAA scenario modeling for the Virgin Islands surface oil slick trajectory*





A: 6 Hours **B: 25 Hours (Initial Dispersion)**



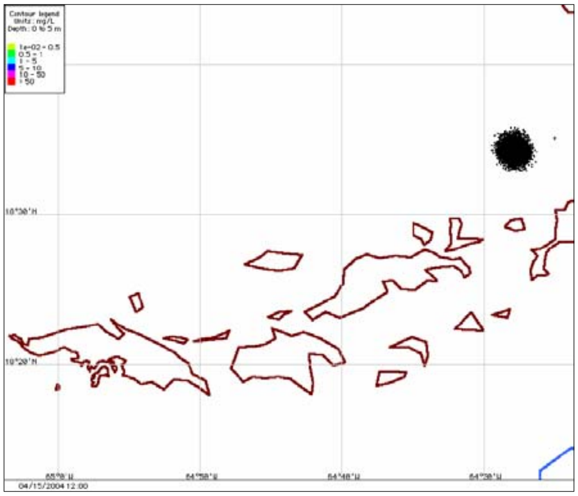


C: 49 Hours (D + 24 Hours) **D: 73 Hours (D + 48 Hours)**

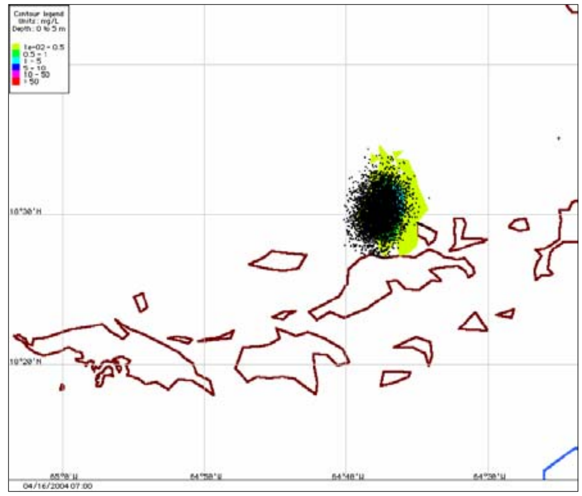
Key:

Light green	<0.5 ppm
Medium green	0.5 - 1 ppm
Light blue	1 - 5 ppm
Dark blue	5 - 10 ppm
Pink	10 - 50 ppm
Red	>50 ppm

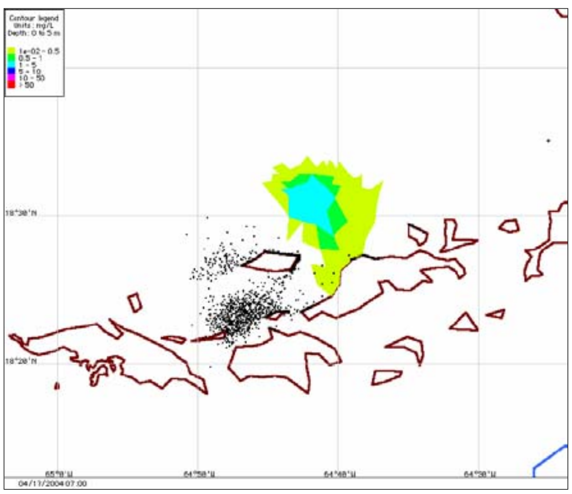
Figure 3.2 *Results from the NOAA modeling for the Virgin Islands scenario for dispersant use at 80% efficiency showing average dispersed oil concentrations (in ppm) from 0 to 1 meter and surface oil remaining after application*



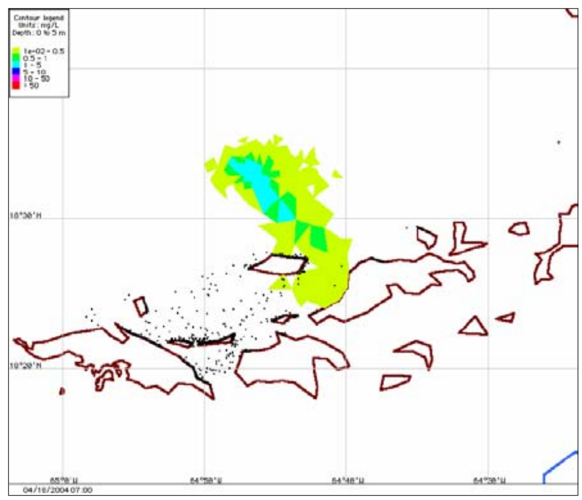
A: 6 Hours



B: 25 Hours (Initial Dispersion)



C: 49 Hours (D + 24 Hours)

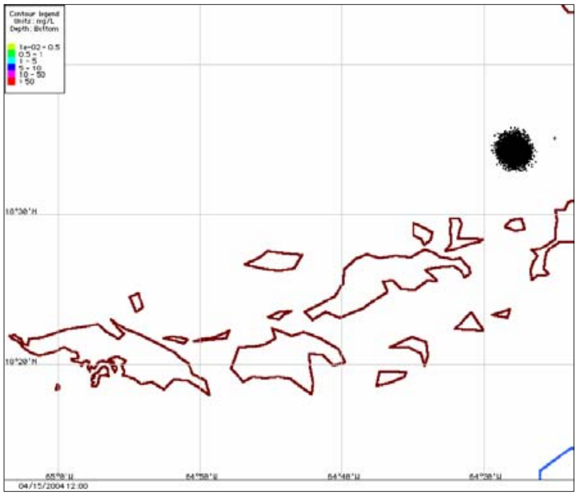


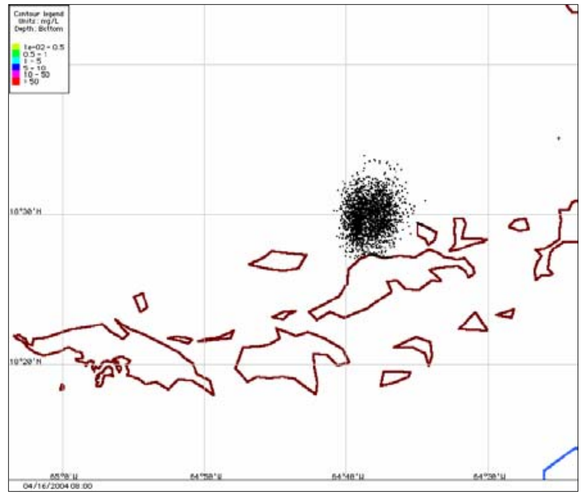
D: 73 Hours (D + 48 Hours)

Key:

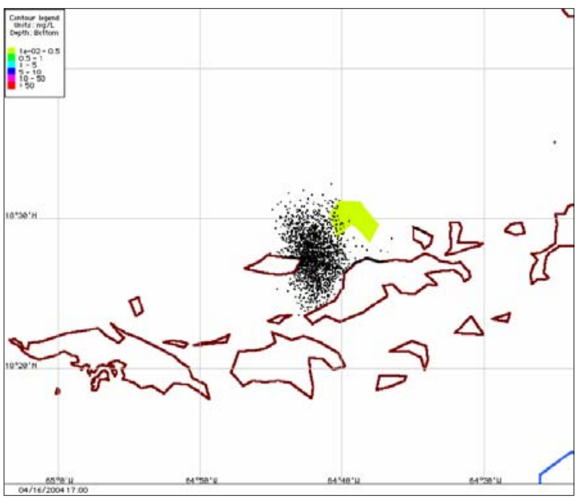
Light green	<0.5 ppm
Medium green	0.5 - 1 ppm
Light blue	1 - 5 ppm
Dark blue	5 - 10 ppm
Pink	10 - 50 ppm
Red	>50 ppm

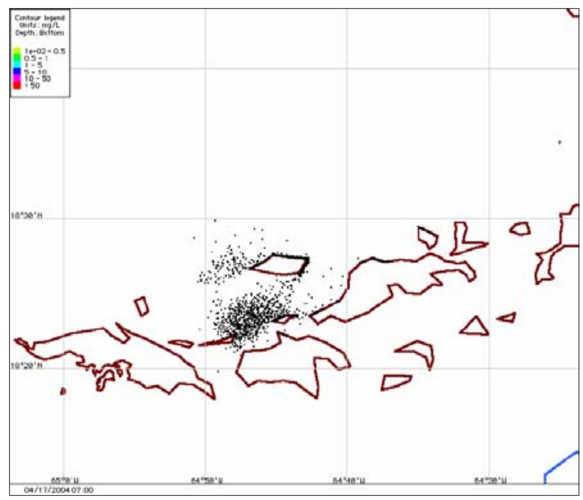
Figure 3.3 *Results from the NOAA modeling for the Virgin Islands scenario for dispersant use at 80% efficiency showing average dispersed oil concentrations (in ppm) from 0 to 5 meters and surface oil remaining after application*





A: 6 Hours **B: 25 Hours (Initial Dispersion)**





C: 35 Hours (D + 10 Hours) **D: 49 Hours (D + 24 Hours)**

Key:

Light green	<0.5 ppm
Medium green	0.5 - 1 ppm
Light blue	1 - 5 ppm
Dark blue	5 - 10 ppm
Pink	10 - 50 ppm
Red	>50 ppm

Figure 3.4 *Results from the NOAA modeling for the Virgin Islands scenario for dispersant use at 80% efficiency showing average dispersed oil concentrations (in ppm) in the bottom 1 meter and surface oil remaining after application*

4.0 The Results of the Risk Analysis Process

The risk analysis matrix used by the focus groups is presented in Figure 4.1. Each focus group was tasked with reviewing the scenario, the modeling results, information on exposure and sensitivity to oil and dispersed oil, and basic life history and distribution information to estimate the percent of each resource affected and the time of recovery. In the initial evaluation the groups used the various alphanumeric codes to rate the level of concern. At the end of the workshop the various color codes were used to develop summary levels of concern.

RECOVERY

% of RESOURCES AFFECTED	> 25 yrs (1) (VERY SLOW)	11-25 yrs (2)	6-10 yrs (3)	1-5 yrs (4)	< 1 yr (5) (RAPID)
> 50% (A)	1A	2A	3A	4A	5A
30-50% (B)	1B	2B	3B	4B	5B
10-30% (C)	1C	2C	3C	4C	5C
<10 % (D)	1D	2D	3D	4D	5D

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 *Definition of levels of concern for the Virgin Islands assessment*

Using the ranking matrix requires that the participants develop estimates of the proportion of the resource affected and how long it will take the resource to recover. A key factor in determining whether or not a resource is affected is to apply thresholds at which impacts, either acute or chronic, would be expected to occur for the various resource groups under consideration. This perhaps the most difficult part of the consensus process, and it has been discussed in detail at all of the workshops. In this case, as in other workshops, very conservative assumptions were presented by the facilitator and accepted by the participants. For shoreline resources and habitats, damage was assumed if oil contacted the habitat. Impacts to birds, mammals, and turtles on the water surface were assumed if there was a high probability of any contact with the surface oil slick. The nature of these impacts was developed during the focus group discussions. The only thresholds which can be generally quantified are those related to aquatic toxicity. Table 4.1, reproduced from the Guidebook, presents a series of concentration thresholds which were made available to the participants. These values are based on a summary of published toxicity information initially developed based on a summary of published toxicity information initially developed during the early workshops.

It is important to keep in mind that the participants used the information available to them to develop levels of concern about the risk, and 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 under the scenario under consideration.

Table 4.1 Consensus Exposure Thresholds of Concern (in ppm) for Dispersed Oil in the Water Column

Exposure	Level of Concern	Protective of Sensitive Life Stages	More Protective Criteria	Protective of Adult Fish	More Protective Criteria	Adult Crustacea/ Invertebrates	More Protective Criteria
0-3 hours	Low	<5	<1-5	<10	<10	<5	<5
	Medium	5-10	5-10	10-100	10-100	5-50	5-50
	High	>10	>10	>100	>100	>50	>50
0-24 hours	Low	<1	<0.5	<2	<0.5	<2	<0.5
	Medium	1-5	.5-5	2-10	.5-10	2-5	.5-5
	High	>5	>5	>10	>10	>5	>5
0-96 hours	Low	<1	<0.5	<1	<0.5	<1	<0.5
	Medium			1-5	.0-5	1-5	.5-1
	High	>1	>0.5	>5	>5	>5	>1

4.1 Results for the Virgin Islands Scenario

The detailed results from the four focus groups for natural recovery are shown in Figure 4.2. No group rated the risk from the oil spill to any habitat as “high” for this scenario. This ranking was primarily a function of the size of the spill (5,000 bbls), which was recognized as a dangerous, but not overwhelming release. This was the first workshop (out of eight held to date) where no “high” risk scores occurred for natural recovery. The concerns identified for the habitats with no active response (natural recovery) are defined below. This is the baseline which was used in evaluating the consequences of the response options.

There are very few terrestrial species that might come into contact with the oil, and no group viewed this as a serious issue. Moderate or moderate/low levels of concern existed for the water surface, rocky shores, sand beaches, reef flats, submerged aquatic vegetation beds, and especially the shallow coral reef community. There was a low/moderate level of concern for mangroves because the trajectory generally did not threaten large mangrove areas. There was agreement that in other locations this could have been a serious concern. The concerns for the rocky shores centered on potential risk to mollusks, while the potential presence of sea turtles was the key risk factor for sandy beaches. Initially, Group 2 ranked sea turtles as a high concern for beaches, but after discussion by all participants about the actual distribution of turtles (very few nesting beaches) in the area reduced their score. The risk to organisms on the water surface was due to potential impacts to birds, and also to sea turtles. The most consistent concern was for coral communities near the shore. Group 2 felt that there were no true "reef flats" in the vicinity of the spill, and so did not score that category. The other three groups felt that very shallow reef areas could be viewed as reef flats and ranked them as a moderate/low concern. All four groups were concerned that shallow, nearshore coral communities would be affected, both by dissolved or physically dispersed oil, or by sediment contaminated with oil that might erode from the shoreline. Organisms in the water column and benthic communities at depths greater than five meters were considered to be at low risk.

Under the given scenario, on-water mechanical recovery (Figure 4.3) was not viewed by any group as providing significant ecological benefit, although all participants agreed that any oil collected would be worthwhile. The overall consensus was that the amount recovered would be in line with that observed historically, probably less than 10 percent, which did not reduce their concerns for shallow water and shoreline habitats. Some groups felt that on-water mechanical recovery, if done improperly, could increase the potential risk to mangrove forests and sand beaches, and could pose a hazard to birds or turtles on the water surface.

Dispersant use was evaluated (Figure 4.4) and the consensus scores indicate a reduced level of concern for the water surface, mangrove forests, rocky shores, and sand beaches without an increased concern for shallow coral reefs, and a very small increase in concern for deep coral communities and the upper water column (both remained in the low level of concern category). The groups all reached this conclusion because the dispersant application was in an area of fairly deep water where dilution was judged to be rapid enough that the risk to the water column and deep benthic community was low, based on the data in Table 4.1. Since some oil would still reach shore (see Table 3.2), there was still concern for shoreline habitats, albeit reduced. This was the only option of the three investigated that significantly reduced the risk scores.

On-shore mechanical recovery (Figure 4.5) was viewed as a necessary activity, and one that could reduce the potential for long-term consequences, but it was considered unlikely to reduce the overall level of concern, which was primarily driven by the initial impacts of oiling. The exception to this conclusion was for turtle nesting beaches and bird nesting areas. While these were not common in the area, and were only seasonally at risk, there was a consensus that cleaning such areas, and adjacent areas that could contaminate them, was very important and could prevent subsequent damage.

4.2 Results of a Review of the Molasses Reef (Florida Keys) Scenario

Near the end of the meeting the participants were given a brief overview of the Molasses Reef scenario used in an earlier workshop in the Florida Keys (Aurand, 2003). That scenario was closer to shore, in much shallower water, and was very close to valuable coral habitat. At the same time extensive mangrove forests were also at risk. After a review of the basic scenario and the spill trajectory results (for dispersed and surface oil) the groups were asked to review the same four options and decide what they would recommend as a response. Details of the scenario are available in Aurand (2003). Despite concerns for the risk to the coral communities, all four groups recommended that all three options be used, with the emphasis on dispersant application and on shoreline protection. There was a strong consensus that extensive monitoring would be important during the dispersant operation, since the area was so shallow. Two of the groups felt that dispersant application should be limited to only the deeper areas, or to areas as far offshore as possible, and they recommended that resource maps be used to avoid the areas of coral in the more shallow areas. All agreed, however, that the potential long-term risk to the mangrove forests appeared to be more significant than the short term risk to the coral community, provided that the dispersant application was targeted as much as possible.

Habitats	Water Surface							Terrestrial			Intertidal																					
Subhabitats											Mangrove Forest							Rocky Shores					Sand Beach			Reef Flats						
Response Options	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles	Mammals	Birds	Reptiles	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Vegetation	Birds	Aquatic Arthropods	Mollusks	Epifauna	Birds	Reptiles	Mollusks	Vegetation	Birds	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Epifauna
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	4B	5D	5D	5D	5C	2D	5D	4D	5D	4D	NA	4D	4D	4D	4D	4D	5D	4D	4D	4D	4D	4D	5D	5D	5D	5D	4D	4D	4D	4D	4D
	2D							4D			4D							4D					5D			4D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	4D	4B	5D	NA	NA	5B	2D	5D	5D	5D	4D	NA	4C	5D	5D	4D	4C	5D	4C	4B	4B	4B	4C	2D	5D	NA	NA	NA	NA	NA	NA	NA
	4D							5D			4D							4C					2D			NA						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	3D	4D	5D	5D	5D	5D	2D	4D	4D	4D	2D	NA	4D	4D	4D	4D	4D	4B	4C	4B	4B	4B	4D	2D	4C	4D	4D	4D	4D	3D	4D	4D
	4D							4D			2D							4B					3D			3D						
Habitat Scaling	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 4	5D	3C	5D	NA	5D	5D	5C	5D	5D	5D	4D	NA	4D	5D	5D	4D	5D	5D	4D	4D	4C	4C	4D	5D	4D	5D	5D	4D	4D	3D	5D	4D
	3D							5D			4D							4D					4D			3D						

Habitats	Subtidal																							Water Column													
Subhabitats	SAV									Shallow Coral Reef Community (<5m)							Deep Coral Reef (>5m)							Shallow (<5m)							Deep (>5m)						
Response Options	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Vegetation	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Vegetation	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	NA	4D	4D	4D	5D	4D	2D	4D	5D	5D	5D	3D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	3D									3D							5D							5D							5D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	5D	NA	5D	5D	5D	5D	5D	2D	5D	5C	4C	4D	3C	4D	2D	5D	5D	4D	4D	4D	4D	4D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	5D									3C							4D							5D							5D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	4D	NA	4D	4D	4D	3D	3D	2D	4D	4D	4D	4D	3D	3D	2D	4D	5D	5D	5D	5D	5D	5D	5D	5D	5D	4D	4D	4D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	3D									3D							5D							4D							5D						
Habitat Scaling	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	R	L	L	L	L	L	L
Group 4	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	4C	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	5D									4C							5D							5D							5D						

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

Habitats	Water Surface							Terrestrial			Intertidal						
Subhabitats											Mangrove Forest						
Response Options	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles	Mammals	Birds	Reptiles	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	4B	5D	5D	5D	5C	2D	5D	4D	5D	2D	NA	4D	3D	3D	3D	3D
	2D							4D			2D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	4D	4B	5D	NA	5D	5B	2D	5D	5D	5D	3D	NA	4D	5D	5D	4D	4C
	4D							5D			4D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	3D	4C	4D	NA	NA	5D	2D	4D	4D	4D	2D	NA	4D	4D	4D	4D	4D
	4C							4D			2D						
Habitat Scaling	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 4	5D	3C	5D	NA	5D	5D	5C	5D	5D	5D	4D	NA	4D	5D	5D	4D	5D
	3C							5D			4D						

Habitats	Intertidal														
Subhabitats	Rocky Shores					Sand Beach			Reef Flats						
Response Options	Vegetation	Birds	Aquatic Arthropods	Mollusks	Epifauna	Birds	Reptiles	Mollusks	Vegetation	Birds	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Epifauna
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	4D	4C	4C	4C	4D	2D	5D	5D	5D	4D	4D	4D	4D	4D
	4C					2D			4D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	5D	4D	4B	4B	4B	4D	2D	5D	NA	NA	NA	NA	NA	NA	NA
	4B					2D			NA						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	4B	4C	4B	4B	4B	4D	2D	4C	4D	4D	4D	4D	2D	4D	4D
	4B					2D			3D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 4	5D	4D	4D	4C	4C	4D	4D	4D	5D	5D	4D	4D	3C	5D	4D
	4C					4D			3C						

Habitats	Subtidal															
Subhabitats	SAV									Shallow Coral Reef Community (<5m)						
Response Options	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Vegetation	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	NA	4D	4D	4D	5D	4D	2D	4D	5D	5D	5D	3D	5D	5D	5D
	3D									3D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	5D	NA	5D	5D	5D	5D	5D	2D	5D	5C	4C	4D	3C	4D	2D	5D
	5D									3C						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	4D	NA	4D	4D	4D	3D	3D	2D	4D	4D	4D	4D	3D	3D	2D	4D
	3D									3D						
Habitat Scaling	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 4	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	4C	5D	5D	5D
	5D									4C						

Habitats	Subtidal							Water Column													
Subhabitats	Deep Coral Reef (>5m)							Shallow (<5m)							Deep (>5m)						
Response Options	Vegetation	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	5D							5D							5D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	5D	4D	4D	4D	4D	4D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	4D							5D							5D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	5D	5D	5D	5D	5D	5D	5D	5D	5D	4D	4D	4D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	5D							4D							5D						
Habitat Scaling	L	L	L	L	L	L	L	R	L	L	L	L	L	L	R	L	L	L	L	L	L
Group 4	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	5D							5D							5D						

Figure 4.3 *Detailed focus group risk analysis results for on-water mechanical recovery*

Habitats	Water Surface							Terrestrial			Intertidal																					
Subhabitats											Mangrove Forest							Rocky Shores					Sand Beach			Reef Flats						
Response Options	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles	Mammals	Birds	Reptiles	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Vegetation	Birds	Aquatic Arthropods	Mollusks	Epifauna	Birds	Reptiles	Mollusks	Vegetation	Birds	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Epifauna
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	4C	5D	5D	5D	5C	2D	5D	4D	5D	4D	NA	4D	4D	4D	4D	4D	5D	4D	4D	4D	4D	4D	2D	5D	5D	5D	4D	4D	4D	4D	4D
	4C							4D			4D							4D					2D			4D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	5D	4C	5D	NA	NA	5C	4D	5D	5D	5D	5D	NA	5D	5D	5D	5D	5D	5D	5D	4C	4C	4C	5D	4D	5D	NA	NA	NA	NA	NA	NA	NA
	5D							5D			5D							4C					4D			NA						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	3D	4D	5D	5D	5D	5D	2D	4D	4D	4D	3D	NA	4D	5D	4D	4D	4D	4C	4D	4C	4C	4C	4D	2D	4D	4D	4D	4D	4D	2D	4D	4D
	4D							4D			3D							4C					3D			2D						
Habitat Scaling	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 4	5D	4D	5D	NA	5D	5D	5D	5D	5D	5D	5D	NA	5D	5D	5D	5D	5D	5D	5D	5D	5D	3D	5D	5D	5D	5D	5D	5D	3D	3D	3D	5D
	5D							5D			5D							5D					5D			3D						

Habitats	Subtidal																							Water Column													
Subhabitats	SAV									Shallow Coral Reef Community (<5m)							Deep Coral Reef (>5m)							Shallow (<5m)							Deep (>5m)						
Response Options	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Vegetation	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Vegetation	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	NA	4D	4D	4D	5D	4D	2D	4D	5D	5D	5D	3D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5C	5D	5D	5D	5D	5D	5D	5D	5D
	3D									3D							5D							5D							5D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	5D	NA	5D	5D	5D	5D	5D	5D	5D	5D	5C	5D	3D	5D	3D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5C	5D	5D	5C	5D	5D	5D	5D	5D	5D	5D	5D
	5D									4D							5D							5D													
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	5D	NA	4D	5D	4D	3D	3D	2D	4D	5D	4D	4D	3D	3D	2D	4D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	4D									3D							5D							5D							5D						
Habitat Scaling	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	R	L	L	L	L	L	L
Group 4	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	4C	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	5D									4C							5D							5D							5D						

Figure 4.4 *Detailed focus group risk analysis results for dispersant application at 80% effectiveness*

Habitats	Water Surface							Terrestrial			Intertidal																					
Subhabitats											Mangrove Forest							Rocky Shores					Sand Beach			Reef Flats						
Response Options	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles	Mammals	Birds	Reptiles	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Vegetation	Birds	Aquatic Arthropods	Mollusks	Epifauna	Birds	Reptiles	Mollusks	Vegetation	Birds	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Epifauna
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	4B	5D	5D	5D	5C	2D	5D	4D	5D	4D	NA	4D	4D	4D	4D	4D	5D	4D	4D	4D	4D	4D	5D	5D	5D	5D	4D	4D	4D	4D	4D
	2D							4D			4D							4D					5D			4D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	4D	4B	5D	NA	NA	5B	2D	5D	5D	5D	4D	NA	4C	5D	5D	4D	4C	5D	4C	4B	4B	4B	4C	2D	5D	NA	NA	NA	NA	NA	NA	NA
	4D							5D			4D							4C					2D			NA						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	3D	4D	5D	5D	5D	5D	2D	4D	4D	4D	2D	NA	4D	4D	4D	4D	4D	4B	4C	4B	4B	4B	4D	2D	4C	4D	4D	4D	4D	3D	4D	4D
	4D							4D			2D							4B					3D			3D						
Habitat Scaling	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 4	5D	3C	5D	NA	5D	5D	5C	5D	5D	5D	4D	NA	4D	5D	5D	4D	5D	5D	4D	4D	4C	4C	4D	5D	4D	5D	5D	4D	4D	3D	5D	4D
	3D							5D			4D							4D					4D			3D						

Habitats	Subtidal																							Water Column													
Subhabitats	SAV									Shallow Coral Reef Community (<5m)							Deep Coral Reef (>5m)							Shallow (<5m)							Deep (>5m)						
Response Options	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Vegetation	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Vegetation	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Reptiles	Epifauna	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 1	5D	NA	4D	4D	4D	5D	4D	5D	4D	5D	5D	5D	3D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5C	5D	5D	5D	5D	5D	5D	5D	5D
	3D									3D							5D							5D							5D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 2	5D	NA	5D	5D	5D	5D	5D	3D	5D	5D	4D	4D	3D	4D	3D	5D	5D	4D	4D	4D	4D	3D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	5D									3D							4D							5D							5D						
Habitat Scaling	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Group 3	5D	NA	4D	5D	4D	3D	3D	2D	4D	5D	4D	4D	3D	3D	2D	4D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	4D									3D							5D							5D							5D						
Habitat Scaling	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	R	L	L	L	L	L	L
Group 4	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	4D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D	5D
	5D									5D							5D							5D							5D						

Figure 4.5 *Detailed focus group risk analysis results for on-shore mechanical recovery*

5.0 Summary Risk Analysis Results and Lessons Learned

Figure 5.1 presents the summary results for this workshop. Four response options were analyzed; natural recovery, on-water mechanical recovery, dispersant application at 80% effectiveness, and on-water mechanical recovery. This table is based on the detailed data in Section 4 and allows an easy comparison across response alternatives. Dispersant application showed the most improvement over natural recovery, although all options were potentially useful.

	Water Surface				Terrestrial				Intertidal							
									Mangrove Forest				Rocky Shores			
Response Options	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Natural Recovery																
Mechanical Recovery																
Dispersants	+	+								+	+	+		+	+	+
Shoreline Cleanup				+										+		

	Intertidal								Subtidal							
	Sand Beach				Reef Flats				Submerged Aquatic Vegetation				Shallow Coral Reef Community (<5m)			
Response Options	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Natural Recovery																
Mechanical Recovery																
Dispersants			+	+			-	+								
Shoreline Cleanup			+					+						+		

	Subtidal				Water Column							
	Deep Coral Reef Community (>5 m)				Shallow (<5m)				Deep (>5m)			
Response Options	1	2	3	4	1	2	3	4	1	2	3	4
Natural Recovery												
Mechanical Recovery												
Dispersants		+					+					
Shoreline Cleanup							+					

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 habitat type (columns). A + indicates reduced concern within the broad risk category, while a – indicates an increased concern within the category.

Figure 5.1 *Final relative risk matrix for the Virgin Islands risk assessment*

Based on these results and their focus group discussions, the participants developed summary conclusions in a group session at the end of the meeting. These represent the consensus of the participants and represent suggestions for improving oil spill response planning for the USVI and the Caribbean region in general. The Coast Guard intends to present these results to the Area Committee and to appropriate international organizations for further consideration.

- Now that participants are more educated on dispersant effects, organizations may want to consider dispersants as more of an "option" in the wider Caribbean.
- A "combination" of response tools should be considered rather than any single method. Organizations need to accept the reality that mechanical recovery is the primary response strategy, however, the limitations of effectiveness must be considered when revising response plans and integrating its use with other response options.
- More studies on oil/dispersed oil effects on local organisms and unique environments of special concern (e.g., coral reefs, sea turtles) are needed.
- The NOAA trajectory model is useful tool for ERA, however, there is a need to link the output to GIS sources or environmental sensitivity data.

- Organizations should consider use of stochastic models and overall value of resources in lower probability events.
- The group endorses the further development and improvement of real-time oil/dispersed oil models.
- Scaling of the risk matrix needs to be flexible to suit the specific region (e.g., 10-30% was a broad range in which to resolve subtle changes in levels of concern for this scenario). The group recommends that we develop the risk matrix scaling “after” the scenario is presented. It is important to capture the basis for the rankings.
- The oil industry should consider more research trials in tropical waters, in order to resolve some of the resource manager concerns; there may be suitable sites available within Caribbean waters.
- Toxicity of dispersants is still a big concern for many; this can be addressed in part through “education” processes; this outreach process needs to be coordinated within the wider Caribbean region and Latin America (not just U.S. territories); IMO or UNEP could possibly take the lead on this effort.
- In this region, multi-national agreements need to be prepared “in advance” of an actual spill, in order to facilitate an integrated response during a real spill.
- In the USVI and Puerto Rico, where dispersant use pre-approval plans currently have depth and distance offshore restrictions, the RRT should discuss if depths or distances should be revised.
- Participants identified a need to challenge the environmental/scientific community to defend current concerns over dispersed oil impacts.
- Toxicity testing thresholds that were utilized for this workshop should be more closely examined to determine applicability to species of concern in this region; consider further scientific peer-review of this data.
- Sea turtles were a significant issue in this workshop, and there is a need for additional information on dispersed oil and oil impacts to sea turtles since they are protected species; the lack of data forced participants to rank sea turtles very conservatively.
- Because of trade-offs involved in the sensitive habitats in this region, near-shore dispersant use should be accompanied by detailed monitoring to ensure that the associated impacts can be clearly documented and evaluated “post-spill.”
- There is a need to establish education programs and appropriate regulations to encourage the use of environmentally safe boat cleaner products.

6.0 References

Note: References marked by an asterisk (*) were not cited in this document, but were provided to workshop participants on CD-ROM (see page 7 of this report for further details).

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Appendix A

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