Hawaii Net Environmental Benefit Analysis: Consensus Evaluation of Tradeoffs Associated with Oil Spill Response Options

A Report to the Oceania Regional Response Team

Photo credit: Clean Islands Council http://www.cleanislands.com/locationinfo_barberspoint.php

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Sponsor

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Acknowledgement

On behalf of the Steering Committee, we would like to gratefully acknowledge the leadership and commitment of Bill Robberson, the EPA Oceania Regional Response Team Coordinator, in developing and guiding this project. Bill has been a consistent champion of applying science to inform technically-sound environmental decisions. He has long recognized the complexity regarding the use of dispersants and the need to be inclusive of key stakeholders in developing regionally-meaningful policies and contingency planning for their appropriate use to mitigate the potential effects of marine oil spills. Bill's passion for the environment, reducing threats to the marine resources, while protecting the public has been evident in this project and previous ecological risk assessments. We sincerely thank you, Bill, for your guidance, extra effort, and constant support in assuring that the documentation of the process was thorough and would provide value to response decision makers.

Key Findings:

NEBA-derived Tables with Caveats for Use during Pre-spill Planning and Response

The primary focus of this net environmental benefits analysis (NEBA) was evaluating the risk to ecological resources of concern (ROC) from spilled oil and five response options that could be implemented in the first 72 hours, specifically to limit oil spread and reduce oil landfall on shore as much as practicable.

Caveats

A NEBA is a qualitative, not quantitative, process that ranks the relative risks to ROC from oil and response options.

Participants compared the relative risks of natural attenuation and monitoring (leaving the spilled oil in the environment) to: surface application of dispersants (at 50% effectiveness); mechanical containment and recovery (offshore containment boom, skimming, and recovery operations); resource protection (specifically protective/exclusion and diversion booming, anchored nearshore); and shoreline cleanup. These tables are for a Kona-winds scenario. Refer to data sheets (Appendix D) for seasonal implications.

The consensus scores in the NEBA reflect an abundance of caution about potential spill-related risks, given uncertainty, e.g., gaps in research or findings, applicability to Hawaii-specific ROCs, and different kinds and levels of knowledge among participants.

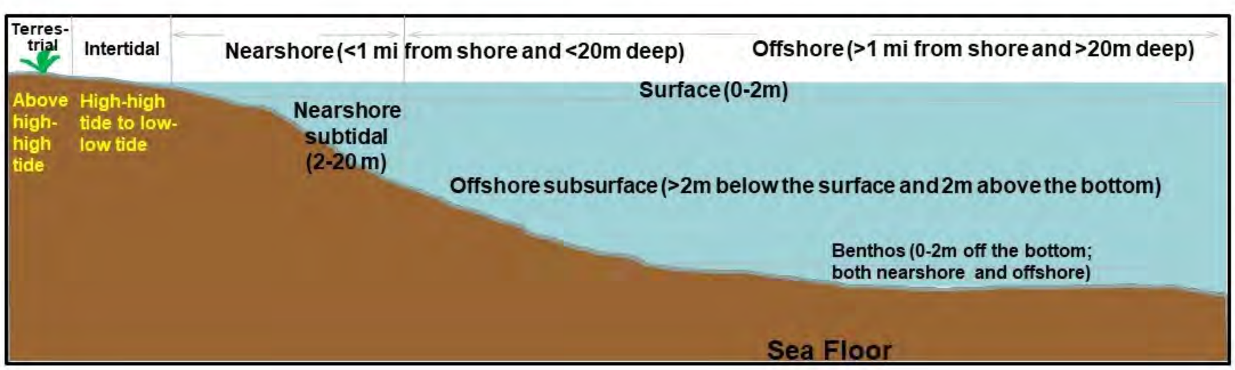

Diagram of scenario habitats and sub-habitat locations

Hawaii NEBA Risk Ranking Legend

			RECOVERY			
			VERY SHORT	**SHORT**	**INTER-MEDIATE**	**LONG**
			< 1 year (4)	1 to 3 years (3)	3 to 7 years (2)	> 7 YEARS (1)
SEVERITY	**Unlikely to Adversely Affect**	(D)	**4D**	**3D**	**2D**	**1D**
	Impaired	(C)	**4C**	**3C**	**2C**	**1C**
	Significantly Impaired	(B)	**4B**	**3B**	**2B**	**1B**
	Dysfunctional	(A)	**4A**	**3A**	**2A**	**1A**

No Adverse Effect

Limited Level of Concern

Moderate Level of Concern

High Level of Concern

Ranking Not Applicable in the Matrix

Red cells represent a "High" level of concern, orange cells represent a "Moderate" level of concern, yellow cells represent a "Limited" level of concern, and green cells represent a "No Adverse Effect" level of concern; light blue color (N/A) represents "Ranking Not Applicable in the Matrix." NOTE: The ranking of "red" does not mean to stop actions during response, but rather to consult with resource managers to review and revise response actions to minimize impacts to the affected ROC. Ideally during pre-spill planning, best management practices will be developed to provide specific guidance to responders on how to mitigate or avoid impacts on T/E species.

Final summary relative risk matrix for resources of concern that utilize the surface waters during the Kona Winds Scenario

Habitat: Intertidal

Resources of Concern	Vegetation	Crustose Coraline Algae	Sponges	Coral and Live Rock	Non-T/E Birds	Non-T/E Mammals - feral cat, mongoose	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	3B	3B	4C	2B	3B	4D	3C	3C	3B 2A N/A 2B N/A	N/A	N/A N/A 4B N/A
Summary Risk for Sub-habitat											
Mechanical Containment and Recovery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat											
Chemical Dispersion	3B	3C	4B	2A	3C	4D	3B	3B 3B	3C 2B N/A 2B N/A	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat											
Resource Protection	3C	3C	4B	2B	3B	N/A	4C	3C	3B 4C N/A 2B N/A	N/A	N/A N/A 4B N/A
Summary Risk for Sub-habitat											
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat											

Habitat: NEARSHORE - Water Surface

Resources of Concern	Vegetation, Floating Algae	Crustose Calcified Algae on the bottom	Sponges on the bottom	Coral and Live Rock on the bottom	Non-T/E Birds	Non-T/E Mammals	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	Critical Habitat
Natural Attenuation and Monitoring	3C	3C	4C	2C	3B	2B	4C	4C	2A 2A N/A 1A 2C	N/A N/A 4C N/A
Summary Risk for Sub-habitat										
Mechanical Containment and Recovery	3C	N/A	N/A	N/A	4D	4D	4D	4D	4D 4D N/A 4C 4D	N/A N/A 4D N/A
Summary Risk for Sub-habitat										
Chemical Dispersion	3C	3B	3B	1B	3C	2B	4B	4B	2A 2A N/A 1B 2C	N/A N/A 4C N/A
Summary Risk for Sub-habitat										
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat										
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat										

Habitat: OFFSHORE - Water Surface

Resources of Concern	Plankton	Non-T/E Birds	Non-T/E Mammals	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	Critical Habitat
Natural Attenuation and Monitoring	4C	2B	2B	4C	4C	2B 2A 1B 2B 3C	N/A N/A N/A 4B
Summary Risk for Sub-habitat							
Mechanical Containment and Recovery	4D	4D	4D	4D	4D	4D 4D 4D 4C 4D	N/A N/A N/A 4D
Summary Risk for Sub-habitat							
Chemical Dispersion	4B	2C	2B	4B	4C	2C 2A 1B 2B 3B	N/A N/A N/A 4B
Summary Risk for Sub-habitat							
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat							
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat							

T/E species – ANIMALS

Reporting order:

- Birds
- Marine Mammal – HI Monk Seal
- Marine Mammal – cetaceans
- Reptiles – Sea Turtles
- Fish - Manta Ray

Critical Habitat

Reporting order:

- Insects CH
- Plants CH
- HI Monk Seal CH

Insular False Killer Whale

Final summary relative risk matrix for resources of concern that utilize the water column during the Kona Winds scenario

Habitat	NEARSHORE – Water Column							
Resources of Concern	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	3B	3C	N/A	4C	4C	3C 3B 3C 3C 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat								
Mechanical Containment and Recovery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat								
Chemical Dispersion	3B	3B	N/A	4C	4C	2C 3B 3C 3C 2B	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat								
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat								
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat								

Habitat	OFFSHORE – Water Column								
Resources of Concern	Plankton	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	4D	3C	3C	N/A	4C	4C	3B 3B 3C 3C 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat									
Mechanical Containment and Recovery	4C	3B	3C	N/A	4C	4C	3B 3A 4C 3C 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat									
Chemical Dispersion	4C	3C	3B	N/A	4C	4C	3B 3B 3C 3C 2B	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat									
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat									
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat									

T/E species – ANIMALS
Reporting order:
- Birds
- Marine Mammal – HI Monk Seal
- Marine Mammal – cetaceans
- Reptiles – Sea Turtles
- Fish - Manta Ray

Critical Habitat
Reporting order:
- Insects CH
- Plants CH
- HI Monk Seal CH
- Insular False Killer Whale

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ACRONYMS

ACP	Area Contingency Plan
ADIOS	Automated Data Inquiry for Oil Spills
BMP	Best Management Practices
CERCLA	Comprehensive Environmental Response Compensation & Liability Act
CERA	Consensus Ecological Risk Assessment
CIC	Clean Islands Council
DWH	Deepwater Horizon
DAR	Department of Aquatic Resources
DOH	Department of Health
DLNR	Department of Land and Natural Resources
DOI	Department of the Interior
EPA or US EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ERD	Emergency Response Division
ESA	Endangered Species Act
FOSC	Federal On-scene Coordinator
GNOME	General NOAA Oil Modeling Environment
GRS	Geographic Response Strategy
HACP	Hawaii Area Contingency Plan
HMS	Hawaiian Monk Seal
IRC	Inouye Regional Center
ISB	In-situ Burning
IUCN	International Union for Conservation of Nature
LOA	Letter of Agreement
MMPA	Marine Mammal Protection Act
MSRC	Marine Spill Response Corporation
NAM	Naturally Attenuate with Monitoring
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NEBA	Net Environmental Benefit Analysis
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPREP	National Preparedness for Response Exercise
NRDA	National Resource Damage Assessment
NRC	National Response Corporation
NRT	National Response Team
OPA90	Oil Pollution Act of 1990
ORRT	Oceania Regional Response Team
OSRV	Oil Spill Recovery Vessel
PENCO	Pacific Environmental Corporation
ppm	Parts per million
ROC	Resources of Concern

T/E	Threatened and Endangered
TPH	Total Petroleum Hydrocarbons
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
UVR	Ultraviolet Radiation
WCD	Worst Case Discharge

Net Environmental Benefits Analysis: Hawaii Consensus Workshops

Executive Summary

This report summarizes the Net Environmental Benefits Analysis (NEBA) conducted for Hawaii to improve preparedness in United States Coast Guard (USCG) Sector Honolulu's jurisdiction for a nearshore area that routinely receives large volumes of crude oil by tanker. The findings will be considered by the Hawaii Area Committee and Oceania Regional Response Team (ORRT) in future updates of the Area and Regional Contingency Plans. This NEBA was guided by a Steering Committee comprised of members of the Sector Honolulu Area Committee, notably representatives from the USCG, U.S. Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish and Wildlife Service (USFWS), Hawaii Department of Health (DOH) and Hawaii Department of Land and Natural Resources (DLNR), Division of Aquatic Resources (DAR) and consultant support. Consultant support was provided by SEA Consulting Group and Weston Solutions, Inc.

To provide a detailed context for this NEBA, the Steering Committee selected a scenario involving an oil spill from the Barbers Point Mooring area off the southwest coast of Oahu. Oil spill trajectory modeling and oil budget calculations under different response options (i.e., with and without the use of chemical dispersants) were used to facilitate NEBA discussions. Three workshops were held in 2017 and 2018. Participants comprised a broad group of subject matter experts and stakeholders. They assessed the relative risks of spilled oil and response options on identified ecological and human resources of concern (ROCs), with focus on Threatened and Endangered species, and designated critical habitats.

The NEBA process compares the relative risks of natural attenuation and monitoring (leaving the spilled oil in the environment) to: surface application of dispersants (at 50% effectiveness); mechanical containment and recovery (offshore containment boom, skimming, and recovery operations); resource protection (specifically protective/exclusion and diversion booming, anchored nearshore); and shoreline cleanup.

Participants evaluated all ecological resources of concern (ROCs) using a risk ranking that was developed for the species / habitats which would be exposed to the five response options. The rankings are presented in the summary risk ranking spreadsheet in **Figure 14**; Appendix G provides the full risk ranking matrix. In order to more readily compare the rankings made by the participants and tradeoff implications for the ROCs, two sub-sets of the entire spreadsheet were developed: surface water (**Figure 15**) and water column (**Figure 16**).

Through the NEBA process, the sponsors achieved a current understanding of the concerns of natural resource trustees, response agencies, academia, and non-governmental organizations (NGOs) that have interests in mitigating the threat of oil spills on the Hawaii ecosystems. Highlights of the Hawaii NEBA, further discussed in this report, include:

- The existing geographic response strategy for Barbers Point will be insufficient to recover a 5,000 barrel spill. It is recommended that the current strategy be reviewed for efficacy.
- The use of mechanical containment and recovery operations will be of limited effectiveness in the nearshore and offshore waters due to typical wind and wave operating conditions.
- Undispersed oil, whether it comes ashore or not or goes offshore, could be potentially-encountered by sea birds, cetaceans, pinnipeds, and sea turtles.
- The use of dispersants would reduce the longevity of oil remaining in the environment by enhancing biodegradation.
- Tourism and cultural concerns are significant drivers in Hawaii and need to be fully considered and understood; both may directly influence decision making when dealing with spilled oil in the scenario impact area.
- A limitation of this NEBA is uncertainty, in part due to the absence of research syntheses relevant to oil, dispersants, and dispersed oil on ROCs, conducted following the Deepwater Horizon oil spill.
- Assessments of the risk posed by spilled oil to aquatic species of concern are often based on standard toxicity tests, which in most cases are not representative of the typical exposures that occur following an oil spill. While the assessments in this NEBA are conservative in nature, discussions based on toxicity results from standard tests are still valuable in informing the NEBA process.
- The consensus scores in the NEBA reflect an abundance of caution about potential spill-related risks, given uncertainty, e.g., gaps in research, research findings, applicability of research to Hawaii ROCs, and the different kinds/levels of knowledge among participants.

1.0 Objectives

1.1 Background and Process

Since the 1990s, the U.S. Environmental Protection Agency (EPA) and U.S. Coast Guard (USCG) have sponsored preparedness projects using comparative risk methodology to examine the relative advantages and disadvantages of the primary response options available in the early stages of an oil spill to mitigate oil spill impacts. The NEBA is a management tool involving a structured approach intended to improve the quality and results of environmental decision-making. It is a consensus-based process that integrates the scientific findings, field knowledge, and experience from natural resource managers, scientists, and oil spill decision-makers. The process incorporates a series of analytical tools specifically designed for use in a group environment. A steering committee tailors the tools for use in a specific area which are then reviewed and completed by participants in, typically, two or three workshops. Oil spill NEBAs are designed as a contingency planning and training tool, because the deliberative process uses currently available science and produces shared knowledge among the workshop participants. Although not intended for use during an actual spill event, the knowledge gained by participants helps build a technical foundation about complex impact relationships, which in turn could facilitate real-time decision making.

NEBA has its origins in an oil spill response, i.e., the 1989 *Exxon Valdez* oil spill, where it was used to consider a novel cleanup technology (Shigenaka 2011). NEBA has been used since that time and is well described in the literature (Efroymson et al., 2004). When applied, NEBA provides a means to:

- Consider proposed environmental actions such as those implemented during an oil spill response,
- Compare the advantages and contrast the disadvantages, i.e., the tradeoffs, and environmental implications of those actions, and then
- Prioritize the outcomes through a risk-ranking exercise.
- Identify knowledge gaps and sources of uncertainty; and prioritize knowledge needs requiring further attention.

This NEBA project is consistent with the USCG preparedness practice used since the late 1990s to examine the tradeoffs of offshore response options for marine oil spills (Aurand et al., 2000). Supported by NOAA, the Consensus Ecological Risk Assessment (CERA) is a NEBA-based process and has been implemented for more than 20 areas throughout the U.S., including three tropical environments (Aurand and Coelho, 2003a and b, 2007). For the first time, the most recent oil spill ecological risk assessment (ERA) specifically focused on threatened and endangered (T/E) species (Walker et al., 2016a; 2016b), which is an important component of this Hawaii NEBA. The USCG and EPA Federal On-scene Coordinators (FOSCs), must specifically consider T/E species, and any designated critical habitat, potentially affected by response actions, in accordance with the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), and USCG policy (Gelzer 2013).

Conducting a NEBA during preparedness is important because when an incident occurs, rapid decisions must be made to implement the optimal response actions intended to mitigate environmental risks from the oil and ensuing response actions, as well as ensure public safety and the safe conduct of commerce. Given multiple regulatory authorities and response options, it is most practical to consider and reach agreement among those with inter-jurisdictional responsibility about the potential limitations and benefits of available risk mitigation options *BEFORE* time-critical decisions must be made during response. Due to the length of time involved to conduct the entire process (i.e., several months), conducting an incident-specific NEBA is impractical for the emergency phase of an actual spill of oil on water / in the environment. Notwithstanding, knowledge gained by participants in the NEBA process facilitates real-time decision-making by enabling a review of significant risk factors in relation to previously considered response options; some of which may still be generally applicable and/or could be modified to implement during an actual incident.

When used by natural resource scientists, managers, and spill management decision-makers, the NEBA process creates an open, honest dialogue of the capabilities and limitations inherent in resource management and the decision-making tradeoffs faced by resource managers today through cross-response comparisons. In this structured, qualitative, analytical approach, participants develop a shared understanding and basis for evaluating impacts. Moreover, through this process, participants develop technically-feasible rationale to support their consensus findings that can be used to develop appropriate response strategies to include in the Area Contingency Plan (ACP).

Preparing to conduct a NEBA includes: setting the goals of assessment; selecting a limited and feasible suite of alternative actions; defining the temporal and spatial scope of assessment; identifying contaminant and remediation stressors; selecting environmental services and other ecological properties of interest; selecting metrics and methodologies for the comparison of alternatives; selecting a reference baseline; establishing plausible links between stressors and services (conceptual model); and developing an analysis plan. As such, the NEBA planning phase is consistent with EPA ERAs. For this NEBA the alternative actions are the identified response options and the baseline for comparison is natural attenuation with monitoring of the spilled oil.

ERAs for oil spills use a series of matrices and other tools to structure discussions and capture group consensus about risk management options (i.e., response options), stressors, resources at risk, and the impact of stressors on identified resources. The oil spill ERA process typically involves 2-3 months of planning followed by two or more facilitator-led workshops. The ideal size is around 20-30 participants, including representatives of spill response managers, natural resource managers and trustees, subject matter experts, and non-governmental organizations. The goal is to achieve consensus interpretations of potential risks and benefits associated with selected response options based on scenarios developed by local participants. Time between individual workshops, usually at least one month, is used by participants to research issues of concern before developing final conclusions. The process focuses heavily on achieving a consensus interpretation of available scientific data and technical information. Therefore, it is important to have broad representation in the assessment process to build joint support for and credibility in the findings.

The oil spill ERA process includes three primary phases — ***problem formulation, analysis,*** *and* ***risk characterization*****,** plus a fourth post-workshop phase of ***documenting and applying results***. Details of the process are described in the USCG *Guidebook* (Aurand et al., 2000). In the first phase, problem formulation, participants develop a scenario for analysis, identify ROC along with associated assessment thresholds, and prepare a conceptual model to guide subsequent analysis. In the analysis phase, participants characterize the potential exposure and ecological effects to the identified ROC for the chosen scenario(s). The risk characterization phase directs the assessment using standard templates and simple analytical tools that define and summarize the assessment for the ROC against the evaluated response options. Finally, participants complete a risk characterization — during this phase, participants interpret their results in terms of the advantages and disadvantages of each response option being evaluated relative to the impacts of leaving the oil in place to naturally attenuate with monitoring (NAM). The risks of impacts from oil alone are compared to the risk of each category of response action on various resources at risk from the spill. The desired outcome of the workshops is consensus among the participants in ranking the relative risks of the response options when compared to the risks of spilled oil only, i.e., no active response (natural attenuation and monitoring). That is, which response options are most likely to mitigate the net impacts of the oil spill on the environment? In the most recent oil spill ecological risk assessment, and this one, participants also have been tasked to consider the impacts of spilled oil on human uses and resources, e.g., tourism, in their deliberations.

1.2 Participants and Responsibilities

The project's overall goal is to improve preparedness in Hawaiian waters for a nearshore area that routinely receives large volumes of crude oil by tanker. Findings will be considered by the Hawaii Area Committee and Oceania Regional Response Team (ORRT) in subsequent updates of the Area and Regional Contingency Plans. Through the NEBA process, the sponsors intend to facilitate a better understanding of the concerns of natural resource trustees, response agencies, academia, and NGOs that have interests in mitigating the threat of oil spills on the Hawaii coastal ecosystem.

This NEBA was guided by a Steering Committee comprised of members of the Sector Honolulu Area Committee, notably representatives from the USCG, EPA, NOAA, USFWS, Hawaii DOH and Hawaii DLNR, Hawaii DAR and consultant support. Consultant support was provided by SEA Consulting Group and Weston Solutions, Inc. Twenty-eight conference calls were held with the Steering Committee between November 2016 and August 2018 to design the process and the workshops.

Approximately 30 individuals participated in and informed the NEBA process. **Appendix A** contains the list of all the project participants, including their affiliation and technical specialty, representing the following stakeholder groups:

- Spill response decision-makers and response managers (Federal and State agency and potential Responsible Party representatives)
- Natural resource managers and technical specialists
- Subject matter experts
- Federal and State resource trustee representatives
- Local emergency manager
- NGOs
- Academia

The ORRT and Hawaii Area Committee complied with the 1994 National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 CFR 300) regarding the use of dispersants by establishing pre-authorization conditions. Currently, pre-approval of dispersants is granted for all waters deeper than 10 fathoms (60 ft.; 18.3m), with the exception of the Maui County four-island area bounded by La'au Point, Molokai to Kaena Point, Lanai; Kamaiki Point, Lanai to Cape Kuikui, Kahoolawe; Cape Kuikui, Kahoolawe to Cape Hanamanioa, Maui; and Lipoa Point, Maui to Cape Halawa, Molokai. (Oceania Regional Response Team, 2010). A Letter of Agreement (LOA) was signed by EPA, USCG, NOAA, Department of Interior (DOI), and the State of Hawaii in 1999 (Martin et al., 2001). Now 18 years later, response decisions made today under this regional policy would likely be challenged. Following the 2010 Deepwater Horizon (DWH) dispersant use controversy, there are many advances in scientific and technical research about dispersant use, but the implications for decisions about Hawaii conditions and relevance to ecological resources have yet to be assessed.

While mechanical recovery of spilled oil at sea is generally the preferred response strategy in the U.S., experience has demonstrated repeatedly that recovery of more than 15-25% is rare. As an island state, Hawaii is too distant from the mainland U.S. to rely on a cascading approach for bringing in additional on-water recovery equipment at the time of a major spill. The ORRT recognizes that practical contingency plans must be developed with the response resources available on each island.

Therefore, to continue viability of dispersants as an offshore response tool in Hawaiian waters, EPA sponsored a project involving the FOSC for marine oil spills (USCG) and agencies in the concurrence network (EPA, state, and resource trustees), and other agreed oil spill stakeholders to:

1. Refresh and document the rationale for authorizing the use of dispersants in Hawaiian waters,
2. Use a consensus approach to examine tradeoffs through a NEBA, and
3. Incorporate current science, consider T/E species, and be transparent.

2.0 Scenario and Analytical Information

An oil tanker moored at the anchorage off Barbers Point, along the southwest cost of Oahu, poses the greatest risk of a serious oil spill in Hawaiian waters. Tankers regularly deliver crude oil for refining in Hawaii to supply energy for the island. Variables which influence potential risk include primarily the volume spilled, the type of oil, the time of year, and the wind conditions under which a spill occurs. In Hawaii, two wind conditions occur most often: Trade Winds out of the northeast, which predominate, and Kona Winds out of the southwest, as shown in **Figure 1**. Kona Wind conditions, which generally occur during the winter months, were selected for the NEBA because the Kona Wind conditions pose a greater threat of oiling to the highly-populated southern shore of Oahu as high winds result in large surf and swells pushed onto shore.

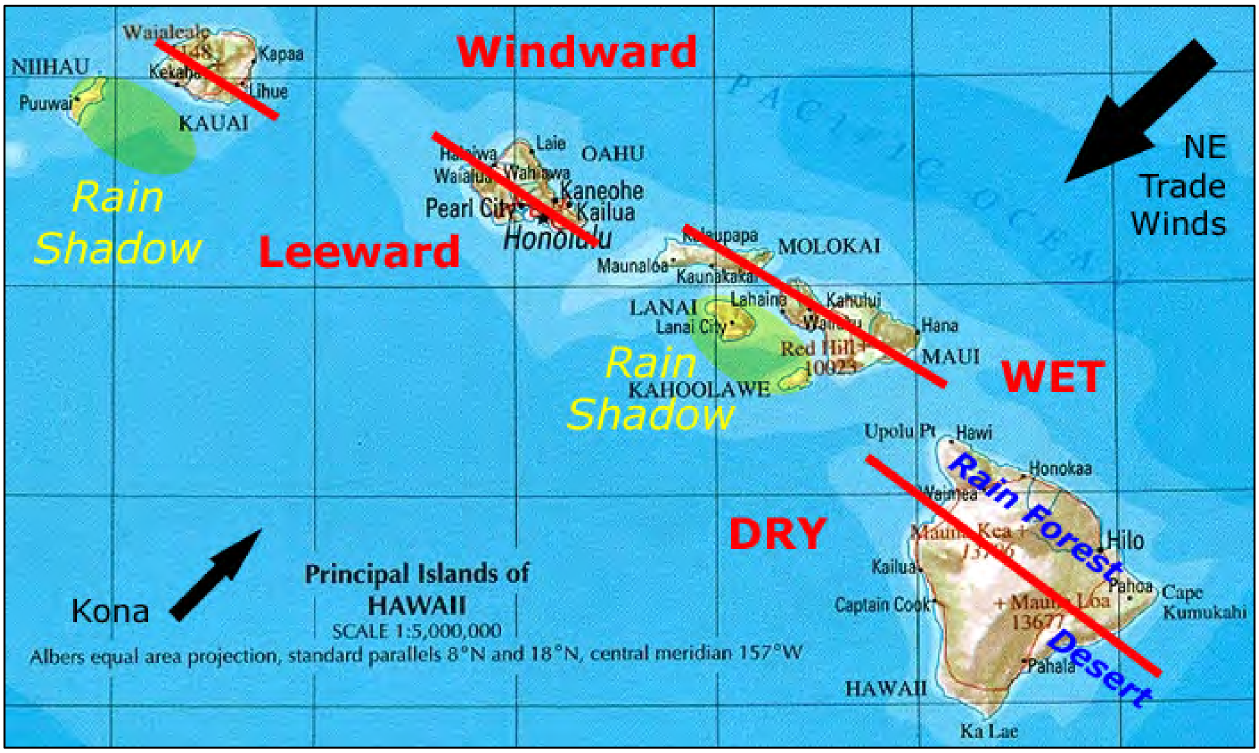

Figure 1. Direction of both Kona and Trade Winds (Source: Climate – The Sandwich Islands; http://www.sandwichislands.com/climate.htm)

2.1 Exercise Scenario

The project Steering Committee recommended selecting a realistic scenario that would provide a practical context for the NEBA. The Steering Committee considered the worst-case discharge (WCD) in Section 9000 of the Hawaii Area Contingency Plan (HACP), which is the total loss of cargo from an entire ship, over 1 million barrels (42,000,000 gallons). Although a WCD spill may be possible, a smaller spill size was chosen because it provided a practical context for evaluating the potential advantages and risks of each response option. In addition, the chosen scenario allowed participants to evaluate which response options might result in a net benefit to the environment, when compared to not using them. The WCD scenario was considered too overwhelming and would not allow the NEBA participants to effectively evaluate the response options.

After looking at several scenarios, the Steering Committee chose a scenario which would be realistic for Hawaiian participants and which would focus on the tradeoff decisions that need to be made when a spill threatens the coast of Oahu. The scenario was from the 2011 National Preparedness for Response Exercise (NPREP) and involved the discharge of a partial loss of oil cargo from a tanker moored at the Barber's Point single point mooring approximately 1.5 miles off the southwest coast of Oahu (**Figure 2**). The single point mooring site is a floating buoy used to transfer crude oil and refined products between ships and the refinery on shore.

The scenario discharge occurred on April 14, 2011 at 0500 with an instantaneous release of 5,000 barrels (210,000 gallons) of a medium crude oil, Alaska North Slope crude, under Kona Wind conditions (out of the southwest). Kona Winds create wind from the west, south-west at Barbers Point with a general onshore movement of surface waters. NOAA's Emergency Response Division (ERD) developed a computer trajectory model to graphically display the potential impacts from the surface slicks (refer to **Section 3.0** for more information).

For comparison, during the third workshop participants also discussed the influence of Trade Winds (out of the northeast) on impacts in this scenario, which would move spilled oil away from the Oahu shore.

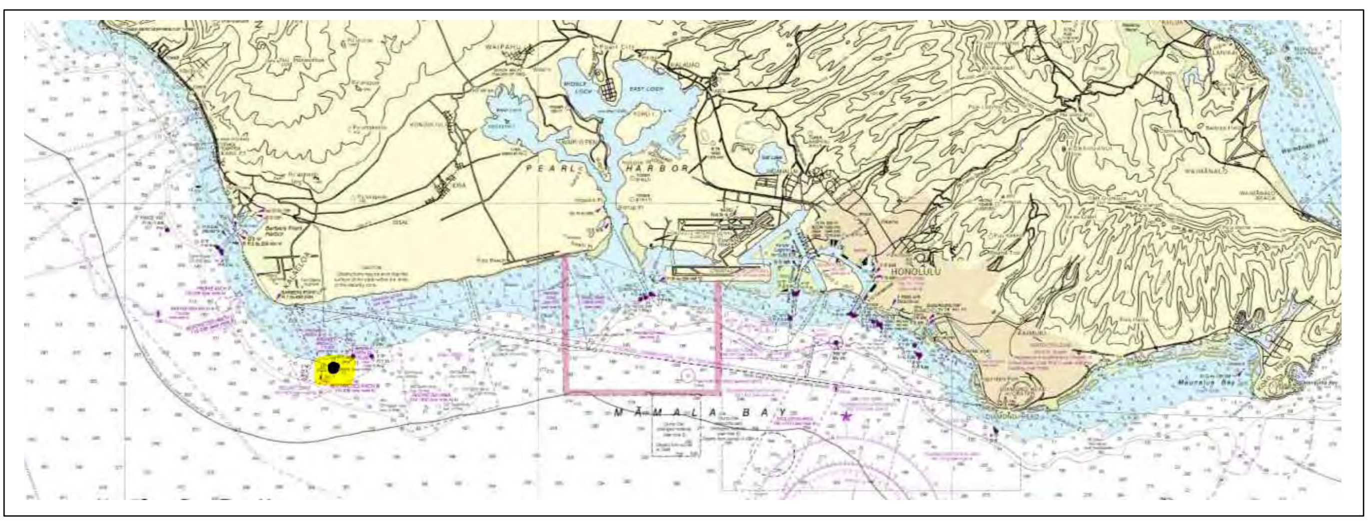

Figure 2. Scenario location

2.2 Geographic Area of Concern

The chosen scenario was expected to have impacts to the nearshore and shoreline areas from Barbers Point to Diamond Head, with heaviest impacts in the Honolulu Harbor, Ala Wai basin and Waikiki areas on Oahu's southern coast. The spill size was sufficiently large to threaten the ecological and human ROC on Oahu, including multiple T/E species.

2.3 Response Options

During the pre-workshop conference calls, the Steering Committee discussed which response options would be assessed during the Hawaii NEBA workshops. Some response actions, like source control and mechanical containment and recovery, are always implemented to mitigate the effects of an oil spill. Dispersants and controlled burning of spilled oil in-situ (in-situ burning/ISB) may also be appropriate options to mitigate spilled oil threats to ROC, depending upon the situation.

Assumptions made in selecting the response options evaluated in the Hawaii NEBA include:

1. The NEBA risk rankings are intended to inform decision-makers of the tradeoffs inherent in the potential effects of the different response options, particularly those that could be implemented during the early stages of a spill, i.e., first 72 hours. Specifically, this NEBA examines the relative risks and potential benefits of the response options that can be implemented to limit spilled oil spreading and extent of contamination on surface waters, water column, benthos and shoreline.
2. Participant consensus in ranking the risks helps inform the tradeoffs associated with the use of each response option.
3. All response options would be implemented to be effective and appropriate using best management practices.
4. Equipment and trained personnel on Oahu are available and can be operational within a few hours of incident notification.
5. Source control efforts will always be initiated immediately, therefore source control is a standard action rather than an "option."
6. As defined in the HACP, geographic response strategies (GRS) have been developed by Clean Islands Council[1] for Barber's Point, Pearl Harbor and Honolulu Harbor and could be initiated immediately in accordance with the incident-specific trajectory and weather conditions. In this regard, protection of these shorelines is considered a standard action rather than an "option."

Given the scenario and proximity to shore, choices made while the oil is waterborne in the first 72 hours are most likely to affect the outcome of the response. Source control (e.g., booming the vessel, securing the source of the spill) is not viewed as optional. This will be initiated as quickly as possible. However, source control does not prevent the initially spilled oil from spreading in the environment.

The final list of response options developed by the Steering Committee before the second workshop and used in the risk rankings include:

[1] http://www.cleanislands.com/locationinfo_barberspoint.php

- Natural attenuation with monitoring, no other response action,
- Mechanical containment and recovery (offshore containment boom, skimming, and recovery operations),
- Chemical dispersants,
- Resource protection (specifically protective/exclusion and diversion booming, anchored nearshore), and
- Shoreline cleanup.

Controlled burning of oil in-situ, on water or on land, is another response option that was considered. For this scenario, however, due to the highly populated coastal areas of Oahu and limited resources for conducting an on water burn, participants agreed that it would not be a viable option. Under other circumstances, e.g., if an oil spill occurred in the vicinity of the Northwestern Hawaiian Islands, on shore in-situ burning could become a viable option.

Appendix B presents the Response Options Table developed for workshop participants to understand existing equipment capabilities on and near Oahu, e.g., how much equipment would be available and in what time frame. Cascading resources from other locations, including the other islands, to Oahu might be initiated but probably would not be operational in the first 72 hours due to the time delays in shipping all off-island equipment to Oahu.

Because some of the participants were ecological resource managers and seldom involved in spill response, it was also important to define each response option. Information presented in the table for each response option that was considered includes:

- Use of response option and definition,
- Examples,
- Availability on Oahu and logistical considerations,
- Limitations,
- Effectiveness, and
- Photographs.

2.4 Resources of Concern

The Steering Committee developed an initial list of ecological and human ROC after reviewing the ROC developed for previous ecological risk assessments that dealt with tropical environments of the Florida Keys, Puerto Rico and the U.S. Virgin Islands. T/E species were a significant focus of the Hawaii NEBA; separate categories were added to the ROC for T/E species. The draft ROC tables presented at the first workshop were discussed in detail and participants made numerous revisions to them in the first workshop.

2.4.1 Ecological

Participants revised both the categories and definitions of habitats and sub-habitats to reflect the coastal ecosystem on Oahu, then added specific examples of important Hawaiian resources, such as crustose coralline algae. The final consolidated ROC table in **Appendix C** shows examples of plants and animals that could be present in any season and life stage, rather than limited to only those that are present on the dates of the scenario. Representative species include those that are: common in Hawaiian waters such as reef fish; listed by federal and state agencies as T/E, or protected (e.g., protected under the MMPA), including designated and not yet designated critical habitat; culturally significant; and/or incidental in Hawaii. Approximately 8,000 species in Hawaii are endemic. Of those, 7% are federally listed and 77% are managed, according to the State of Hawaii.[2]

The following are the categories of ecological ROCs which could be at risk for the scenario. They are grouped according to habitat, sub-habitat, and resource categories, e.g., mammals. **Figure 3** displays the boundaries for the Hawaii NEBA habitats and sub-habitat as developed for this project. One change was made during the third workshop to the definition of offshore, which is reflected in the figure below. A Hawaii DLNR participant commented that, in Hawaii, waters 60 feet deep can be close to shore, therefore offshore areas would be more accurately described as 1 mile from shore and 60 feet or deeper. The Hawaii DLNR participant strongly recommended that the boundaries be modified to reflect that consideration. The final definition of habitats and sub-habitats used in the assessment are:

- Terrestrial (on land above the high, high tide line)
- Nearshore Environments (within fringing reefs, photic zone) <1 mile from shore:
    - Intertidal shorelines (supratidal to the mean low, low tide line, e.g., reef flats, rocky platforms, tidal flats, sand beaches, man-made structures, anchialine ponds)
    - Subtidal shallow water (lower, low tide line to the bottom, less than 20m)
        - Water surface (0 to 2m water)
        - Water column (>2m but 2m above the bottom)
        - Benthos (includes bottom and 2m above the bottom)
- Offshore Environments (open water coastal, outside fringing reefs, >1 mile from shore):
    - Water surface (0 to 2m water)
    - Subsurface water column (>2m from the surface)
    - Subsurface benthos (includes bottom and 2m above the bottom)

[2] Available from: https://dashboard.hawaii.gov/stat/goals/5xhf-begg/4s33-f5iv/a3ea-237y

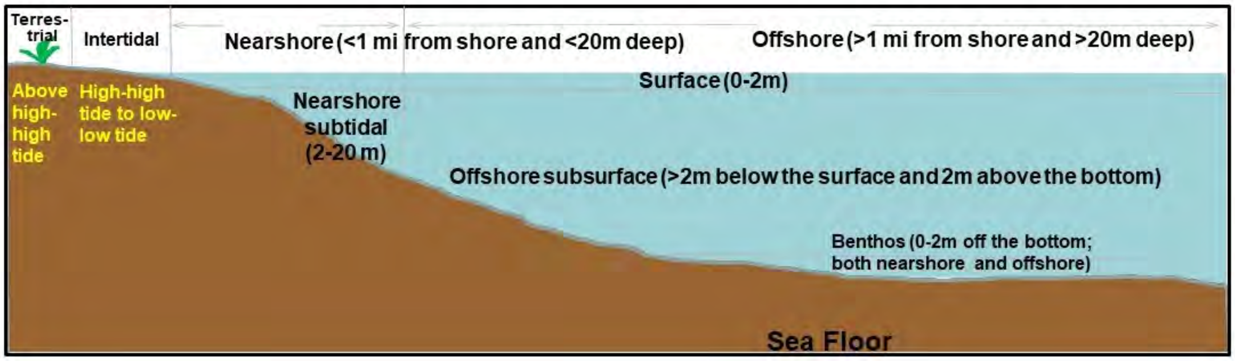

Figure 3. Diagram of scenario habitats and sub-habitats locations

Categories of Ecological ROC (specific species in each category vary among habitats) include:

- Vegetation
- Non-T/E Birds
- Non-T/E Mammals
- Non-T/E Reptiles
- Non-T/E Insects
- Crustose coralline algae
- Sponges
- Corals and live rock
- Non-T/E Fish
- Non-T/E Shellfish and other invertebrates
- T/E ANIMALS
- T/E PLANTS
- Critical Habitat

Some marine mammals, e.g., bottlenose dolphins, are protected but not federally listed as threatened or endangered. The National Marine Fisheries Service (NMFS) maintains a list of federally-protected species in Hawaii.[3] .

2.4.2 Human

During pre-workshop conference calls, the Steering Committee decided to consider the potential oil spill impacts on human ROC and the tradeoffs associated with various response options. Participants during the first workshop agreed without hesitation that human ROC were important to consider in discussions about tradeoffs. They reviewed and revised the draft Human ROC. On-land (i.e., above the mean high, high tide line, potential spill-affected and nearby areas) and on-water (i.e., below the mean high, high tide line, potential spill-affected and nearby areas) areas or

[3] Available from: http://www.fpir.noaa.gov/PRD/prd_marine_protected_species_and_habitat_of_the_hawaiian_islands_list.html.

locations of human use and/or significance were categorized. Categories of identified human ROCs include:

- Responders, e.g., workers
- Tourism/commerce
- Recreational use
- Transportation, i.e., on land or air
- Industry
- Military
- Historic, cultural, spiritual locations, including subsistence and personal use
- Residential community
- Sensitive or vulnerable populations, e.g., elderly, and including under-served
- Management areas

The Human ROC table was distributed with stressors identified so that workshop participants could consider Human ROCs in the risk ranking and tradeoff discussions (**Appendix C**). Later in the process, participants decided to focus on ecological ROCs.

2.4.3 Threatened/Endangered Species

Categories for T/E species were developed early in the process and incorporated into the evaluation of resources at risk from the oil spill scenario. Data sheets, presented in **Appendix D**, were developed to describe the baseline (current) status of eighteen federally-listed species potentially at risk from the scenario on Oahu; the Giant Manta Ray was determined to be federally-listed as Threatened throughout its range in January 2018 and was incorporated into this evaluation. Participants referred to the data sheets during the second workshop in ranking relative risks of the available response options on the identified federally-listed T/E species.

To consider revisions to ACP response strategies, this NEBA is relevant to a FOSC who will evaluate a spill incident and consider how the response strategies could affect federally-listed T/E species and their habitats. The goal of Section 7 consultations, which will occur separately, is to evaluate the response options and determine the best management practices (BMPs) that should be implemented to mitigate, minimize, or have no adverse effect on the protected resources.

State-listed species were also included in the identified representative species in the ROC. The State of Hawaii developed extensive lists of their state-identified fauna and flora having the "greatest conservation need."[4] Additionally, the State of Hawaii developed individual species fact sheets that are also available at that link. The state fact sheets contain a Species Status section to indicate whether the species is endemic to Hawaii, and its listing status:

- Federally-listed as Endangered
- State-listed as Endangered

[4] Available from: http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/

- IUCN Red list – Critically Endangered[5]

2.5 Conceptual Model

A **conceptual model** is a depiction of how various ROC might respond when exposed to stressors (e.g., oil and response options). The workshop participants reviewed the ecological conceptual model that was prepared for the San Francisco Bay workshop (Pond et al., 2000) and the matrix used in previous ecological risk assessments. Participants updated and expanded the definitions of potential stressors to align better with the response options and ROC. The final Hawaii NEBA ecological conceptual model is presented in **Appendix E** as a detailed matrix that defines the relationships between exposure of identified biological ROC to stressors, resources, and hazards.

Development of a conceptual model for Human ROC was initiated and human stressors from oil spills were defined. The Steering Committee determined that the priority focus of workshop discussions should remain on ecological ROCs. Therefore, the Human Conceptual Model was not completed.

As described in the USCG Guidebook (Aurand et al., 2000), the use of response options is a source of potential ecosystem stress, or hazard, in addition to stresses caused by the spilled oil itself. The mechanisms that cause this stress may differ in magnitude among options. Identified hazards determine potential exposure pathways, both direct and indirect, that link the stressors (including natural recovery) to resources. The hazards, that have been defined for use in the Hawaii NEBA, are shown in **Table 1**. Not Applicable (N/A) represents the absence of a connection between a potential hazard and the resource of concern. Participants also defined possible hazard/stressor relationships on human ROCs, as shown in **Appendix C,** prior to deciding to focus the risk assessment on ecological ROCs.

Appendix E presents the final Hawaii NEBA conceptual model developed by the project consultant team for review and use by the workshop participants. The numbers in the cells (1-9) represent the exposure pathway by which a hazard can affect a resource. The conceptual model was reproduced and displayed as a poster for easy reference by participants when considering potential pathways of exposure to hazards and/or stressors leading to spill-related impacts. This model does not rank the relative types of exposure or their effects, e.g., acute, chronic, sub-acute, or sub-chronic.

[5] Available from: http://www.iucnredlist.org/about/overview

Table 1. Hazards/Stressors for the Hawaii NEBA Conceptual Model

Hazards/Stressors (direct and indirect)
1. **Inhalation** – direct effects from respiratory tract exposure to oil and oil components (vapors) in the air; breathing in particulates in the air.
2. **Dermal Absorption** (atmospheric) – direct effects from dermal/skin exposure to oil and oil components dissolved and chemically dispersed in the air; via skin contact and skin absorption.
3. **Physical trauma** (mechanical impact from equipment, aircraft, people, boats, etc.) – direct effects from physical impact on individual species at various life stages. This includes hazing.
4. **Direct contact/smothering/toxic effects** – direct effects from dermal contact with oil; skin (hypothermia), mucosal membranes (eyes, nose, etc.); indirect effects or secondary impacts could include ingestion (from preening).
5. **Thermal** – direct effects from heat exposure from ISB; impacts are limited to directly under the location of the burn.
6. **Waste** – direct effects from being removed (lost) to the system; no longer part of the food web – exposure of these individuals does not affect other individuals.
7. **Indirect** via food web, etc. – resources exposed to oil or oil compounds, provide food source to other species—this results in indirect exposures to the oil.
8. **Indirect** via relocation of plants or turtle nests.
9. **N/A** - no interaction or no effect expected.

2.6 Risk Ranking Matrix

The risk characterization of a NEBA is a qualitative, not quantitative, process that ranks the relative risks to ROC from oil and response options. The Steering Committee reviewed the risk matrices from previous ecological risk assessments and proposed a modification that would improve its utility for characterizing threshold levels of concern for the impacts on environmental ROCs for this scenario. ***Risk*** is defined as the probability of an impact occurring; participants must qualitatively consider if there is a high, medium, or low probability of the impact occurring, and then determine the severity and the duration of the impact.

Using the conceptual model, the goal was for workshop participants to apply their knowledge about resources and consider their susceptibility to spilled oil risk in the scenario. Susceptibility has two components, sensitivity and exposure. **Sensitivity** refers to *how readily a resource is affected by a stressor*; it is related to the proposed mode of action of the stressor as well as to variability in individual and life history stages. **Exposure** refers to *co-occurrence, contact, or the* *absence of contact*, depending on the nature of the stressor and the properties of the ecological resource in question. One central assumption of risk assessment is that *effects are directly related to exposure*. However, effects on an organism can vary with life stage, e.g., plankton/larval, juvenile, and adult. These life history considerations in relation to hazard exposure are complex and important in determining susceptibility and sensitivity.

During an incident, responders tend to make decisions about impacts that are relatively short-term and based upon what has been learned from previous studies and response events. For example, in temperate environments, responders try to protect marshes from stranded oil since studies have shown the longer-term severity and duration of oil impacts are in those environments. The response community now recognizes that protecting marshes from oiling is a response best practice; this knowledge guides preparedness and response decisions.

The risk ranking matrix has scales based on recovery time and the level of severity of a potential impact on an affected population. The updated risk matrix, with alphanumeric scale, is presented in **Table 2.** This matrix serves as the legend for the risk ranking tables completed at the workshops. The Steering Committee approved this risk ranking matrix during their conference call on September 11, 2017, prior to the second workshop. As can be seen in the risk matrix, the groups used alphanumeric scores to scale the anticipated impact severity and recovery time. Colors were assigned to the alphanumeric scales, to visually differentiate between the summary levels of concern. The color coding orders the presentation of levels of concern from lowest (green on upper left side of the matrix) to highest (red on the lower right side). The levels of concern are applicable to ecological ROC, and generally to human ROC.

Participants used this risk ranking matrix during the second and third workshops to estimate the level and duration of ecological impact of the response actions compared to the impact of the spilled oil alone. They drew on the best available information from literature, their prior experience with oil spills in the area, and their knowledge of resources in the scenario area. The assigned risk scores represent a consensus on the part of the participants that such consequences could occur under the scenario. The consensus scores in the NEBA reflect an abundance of caution about potential spill-related risks, given uncertainty, e.g., gaps in research, research findings, and/or applicability of research to Hawaii ROCs, and the different kinds and levels knowledge among participants.

Table 2. Hawaii NEBA Risk Ranking Matrix

			RECOVERY			
			VERY SHORT	**SHORT**	**INTER-MEDIATE**	**LONG**
			< 1 year (4)	1 to 3 years (3)	3 to 7 years (2)	> 7 YEARS (1)
SEVERITY	**Unlikely to Adversely Affect**	(D)	4D	3D	2D	1D
	Impaired	(C)	4C	3C	2C	1C
	Significantly Impaired	(B)	4B	3B	2B	1B
	Dysfunctional	(A)	4A	3A	2A	1A

- Green: No Adverse Effect
- Yellow: Limited Level of Concern
- Orange: Moderate Level of Concern
- Red: High Level of Concern
- Light blue: Ranking Not Applicable in the Matrix

The definitions of ecological severity used by participants in assessing risk in the Hawaii NEBA are:

- **Unlikely to Adversely Affect**: Impacts are considered negligible, trivial, or a minor inconvenience; *e.g., birds flew off nest but came back and landed.*
- **Impaired***:* Modestly adverse impacts that alter habitats or life cycles. It may not be terribly significant or long-term, but it is an impact.
- **Significantly Impaired**: Sustained and substantive adverse impacts that are potentially lethal or highly damaging to a natural resource(s). *Effects that are potentially life altering or may disrupt a breeding cycle; those that can affect a community, e.g., all blooms knocked down, impacts reproductive cycle. Impacts would be evaluated for individuals (e.g., endangered Hawaiian Monk Seals; HMS) or for an affected population (e.g., a non-endangered species like red-footed boobies).*

- **Dysfunctional**: Damage that prohibits a natural resource from living, reproducing, or providing an ecological service(s). *Juveniles wiped out; habitat completely smothered; reproductive cycle not occurring/ceased; adults wiped out. Due to corals recovery times (50+ years), an impact to a coral reef would be considered dysfunctional.*

Duration of impact begins from the time of the oil discharge. Severity considers the significance of individual organisms relative to the scale of population.

Several assumptions were made to guide the consistent application of levels of concern during the ranking of relative risks. Regarding individual vs. population severity and level of concern, it was assumed that all T/E species would be assessed as individuals, while other non-T/E species would be assessed as a population. A lethal impact to a single T/E individual was considered dysfunctional in terms of severity because recovery would be long term (> 7 years) and potentially could lead to extinction of population.

All other species, e.g., non-T/E seabirds, were assessed as a component of the local population. Generally, participants considered populations of organisms at the local scale, and assumed no impacts on a regional or national scale for that species. For example, if an organism had recovery about 70% one year, but would take 10 years for 100% recovery, then the risk could be ranked as significant, in the 1 to 4 year duration. Local populations that could be killed by a spill would receive a dysfunctional score. Detailed notes were taken regarding whether the impact scale on the affected population was local or regional.

The reasoning of adding a Not Applicable ranking (blue-gray squares as seen in **Table 2**) was:

- A severity rating of "*unlikely to adversely affect*" for the ROC would not result in a recovery period longer than 1 year; therefore, 3D, 2D, 1D levels of concern are **Not Applicable.**
- A severity rating of "*impaired*" would not be consistent with a "*long*" recovery period (taking longer than 7 years for the ROC to recover); therefore 1C, is **Not Applicable**.
- An impact that is "*dysfunctional*" cannot also be a "*very short*" recovery; therefore, 4D is **Not Applicable**.

For a T/E species, any harm qualifies as a ***take***[6] and is significant. As generally applied in this NEBA, non-T/E plants would recover in 4 to 5 years and non-T/E fish would recover in 1 to 2 years.

The ranking measures were also intended to be appropriate for characterizing risks qualitatively to human ROCs. For example, inhalation and dermal impacts might be ranked as significant.

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[6] Endangered Species Act (ESA), Section 7, and Incidental Take of Endangered and Threatened Species in U.S. Lands or Waters. Being listed on the ESA makes it illegal to "take." Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to do these things (50 CFR § 3(19), 2009) to any of these protected species, whether endangered or threatened or adversely modify or destroy designated critical habitat under Section 9 – Prohibited Acts. NOTE: Under ESA, 'take' prohibitions under Section 9 are not automatic for threatened species; the USFWS and NMFS must conduct a Section 4 process to address threatened species.

However, additional definitions would be required to be appropriate for all the human ROCs, such as damage to spiritual connections and assets.

Unlike the NEBA, quantitative risk assessments that focus on the actual injury to the environment (habitats and organisms) are carried out following an oil spill through Natural Resource Damage Assessment (NRDA) activities. ***Injury*** is a legal term defined in the OPA90 (Oil Pollution Act) regulations and under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), known also as Superfund. Injury is defined as a linkage between cause and effect beyond a reasonable doubt.

3.0 Oil Spill Trajectory Modeling Results

NOAA's ERD provided a suite of trajectory 3-D modeling products for the scenario, including:

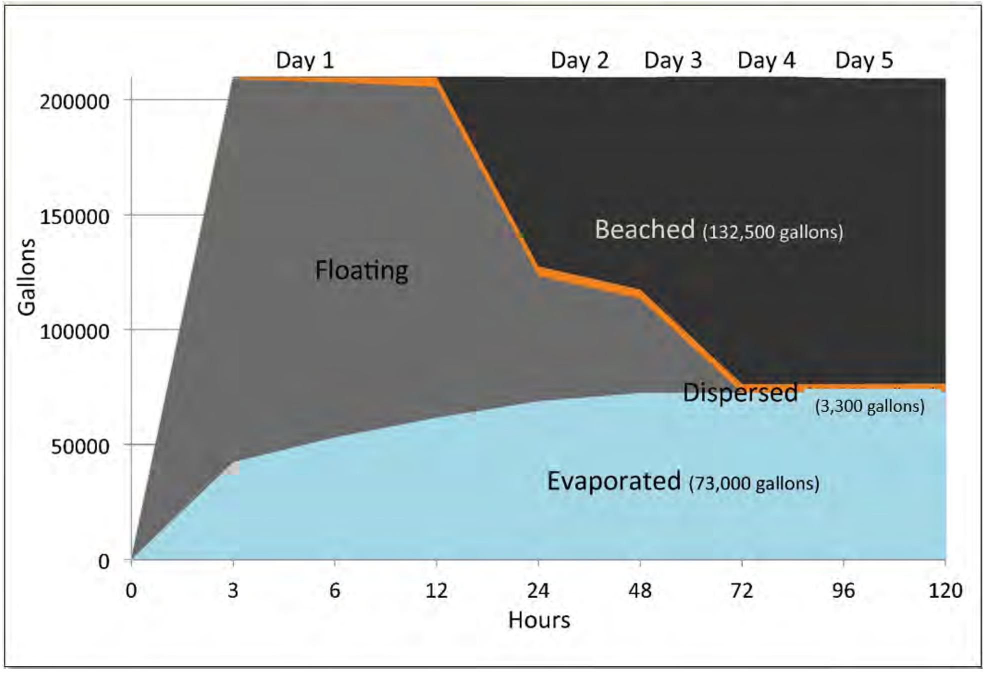
- Surface oil spread forecasts with and without (oil only) dispersant, at time intervals 0, 3, 6, 12, 24, 24 72, 96, and 120 hours, as well as
- Oil mass balance across several environmental compartments (i.e., floating on the water surface, evaporated into the atmosphere, beached on shorelines, and dispersed into the water column) under these two scenarios, and
- Predictions of naturally and chemically dispersed oil concentrations in the water column.

The trajectory models of surface oil show the extent of contamination with no intervention. The effectiveness of mechanical countermeasures is not estimated, i.e., no estimation is provided for the amount of oil removed by mechanical recovery. In the runs that illustrate extent of contamination with chemical dispersant use, dispersant effectiveness was set at 50% with dispersants applied at 3.5 hours into the response. This is the dispersant application timeframe that was established following a 2011 field exercise when Clean Islands Council demonstrated that chemical dispersant operations could be airborne and applied within 3.5 hours near the Barbers Point mooring. This site is located at the 11 fathoms (20m) depth contour, which was set as a minimum water column mixing depth for all simulations.

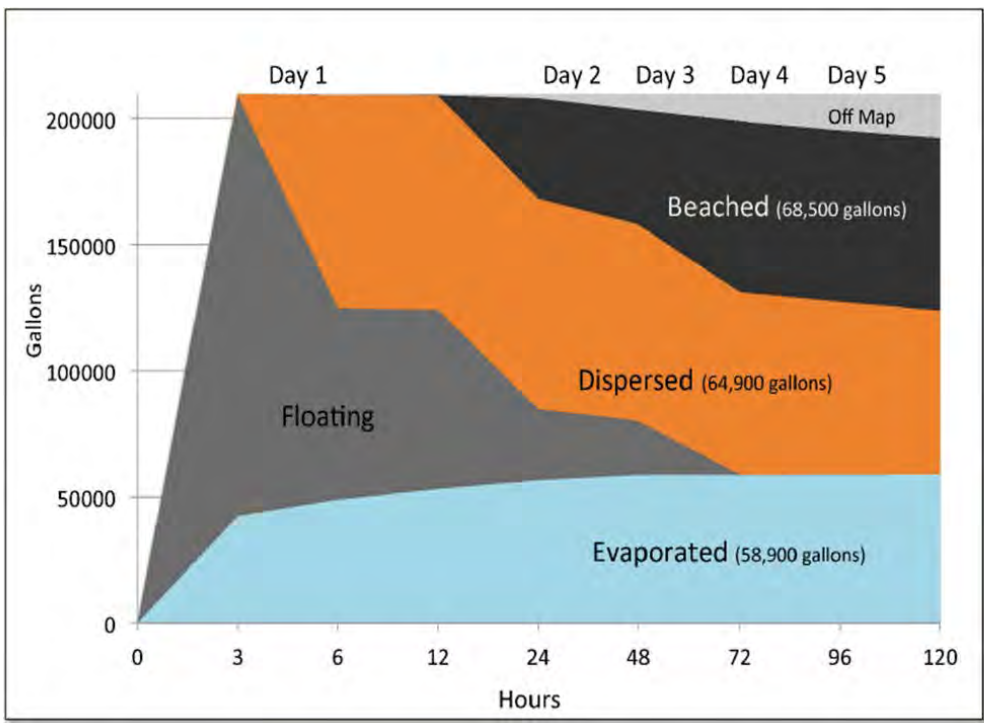
Basic oil weathering information and mass balance was calculated using the Automated Data Inquiry for Oil Spills (ADIOS) II program for Alaska North Slope crude oil. Trajectory calculations were made using the General NOAA Oil Modeling Environmental (GNOME) model. The model results were presented as snapshots of the extent of contamination in time and depth intervals, and video clips. The snapshots displayed depth contours of 5, 10, 30, 60, 100, and 200m throughout the geographic extent over 120 hours to indicate the water column depths beneath the surface oil slicks. Water depth is important when evaluating the natural and chemical mixing of the oil into the water column when determining the potential exposure effects on natural resources.

The snapshots also displayed oil concentrations in the slick area for the upper meters of the water column with the heaviest initial concentrations of the oil dispersion appearing within the top 1 to 3m and rapidly mixing and diluting within the water column over time. Different colors were used to show six levels of oil concentrations in the upper meters, from a lower limit of 0.01 – 0.05 ppm to a maximum of 50 ppm, displayed in concentration polygons. The snapshots also presented a mass balance of oil fate with and without chemical dispersants in the following categories: released, evaporated, dispersed, beached, off map, and floating.

Figures 4a and 4b (next page) present the mass balance for oil with and without chemical dispersants added over the modeling duration. With chemical dispersant effectiveness set 50%, reduction in shoreline oiling was predicted. For this scenario, a 48% decrease in the quantity of oil was shown, indicating a definite benefit to shorelines by applying dispersants compared to not applying them. This reduction represents a change in shoreline oiling from 3.8 gallons of oil per linear meter of shoreline (without dispersants) to two gallons of oil per linear meter of



4a. Kona winds scenario with natural dispersion only



4b. Kona Winds scenario with chemical dispersant applied at 3.5 hours at 50% effectiveness

Figure 4. Mass balance for the April 14, 2011 trajectory model run for a 5,000-barrel instantaneous release of Alaska North Slope crude oil from the Oahu Barbers Point single point mooring over a 120-hour period.

shoreline (with dispersants). **Appendix I** provides the detailed mass balance for oil with and without chemical dispersants added over the modeling duration.

Figure 5 through **Figure 8** show selected results for four timeframes (3, 24, 48, and 120 hours). These snapshots were selected to illustrate various changes in potential risk over time and allow for comparing the final extent of contamination with and without the influence of dispersants. The spill video clips show slick transport minute by minute over the entire 120 hours duration, i.e., first five days of the spill.

3.1 3-Hour Snapshot

At three hours following the discharge, floating oil extended as a cohesive slick from the Barbers Point single point mooring buoy toward the northwest passing Kalaeloa (**Figure 5a**). No shoreline oiling had taken place at this time. Water column concentrations from natural dispersion, primarily located directly under the slick footprint, were in the 0.01 to 0.5 ppm range. Peak concentration was approximately 0.15 ppm approximately four hours post-release. The maximum oil concentrations were limited to the top two meters of the water column. The application of chemical dispersants at 3.5 hours occurs after the 3-Hour Snapshot, therefore **Figure 5b** is identical to **Figure 5a**.

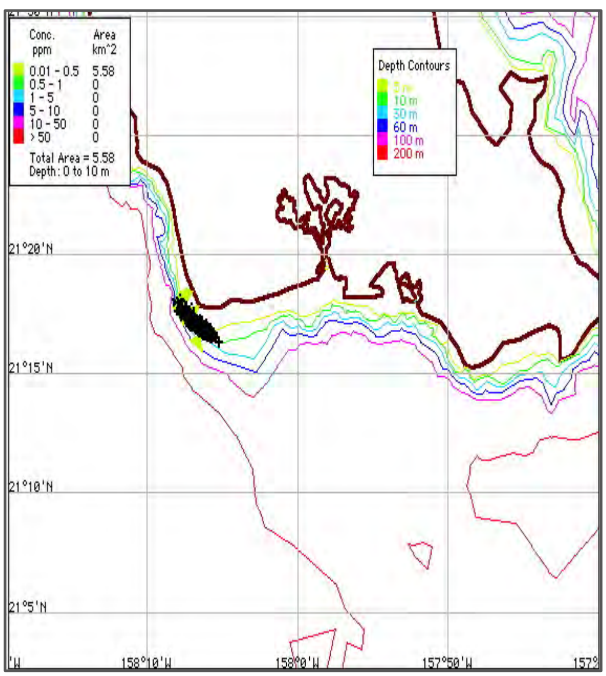
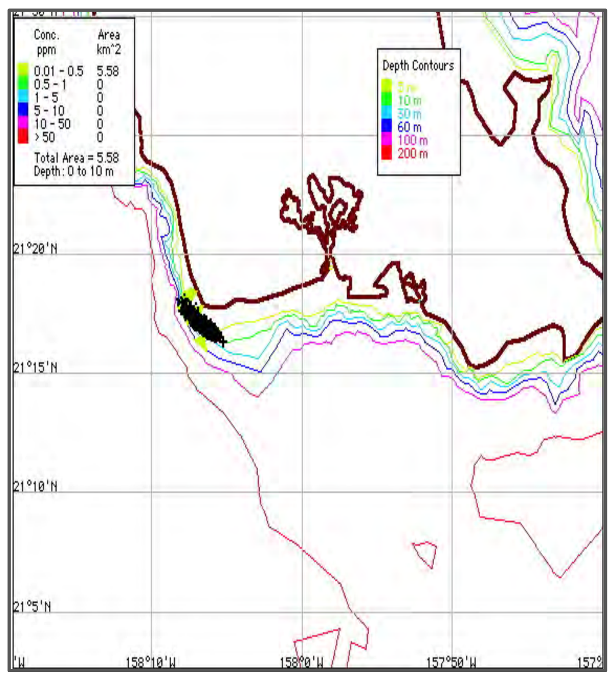


Figure 5a. Oil trajectory snapshot at 3 hours; Kona Wind scenario, without dispersants (Source: NOAA GNOME 2011)



Figures 5b. Dispersed oil trajectory snapshot at 3 hours; Kona Wind scenario (Source: NOAA GNOME 2011)

3.2 24-Hour Snapshot

3.2.1 Oil Only

At the 24-hour snapshot (**Figure 6a**) following the discharge, floating oil would be subject to surface winds, currents, and headed in the direction of Pearl Harbor. Shoreline oiling (beached oil) extended along the southern Oahu shoreline from Barbers Point along Ewa Beach to Keahi Point and into Pearl Harbor. These are important human-use areas of high industrial, recreational, tourism, and spiritual value. At the 24-hour snapshot, detectable[7] water column concentrations from natural dispersion were shown to be separating from the surface oil slicks due to tidal currents, with the highest concentrations located in the restricted anchorage sites B and C adjacent to the spill discharge site (see **Figure 4a**). The water-column oil concentrations from natural dispersion remained in the 0.01 to 0.5 ppm range primarily in the upper two meters of the water column.

3.2.2 With Chemical Dispersants

With the application of chemical dispersants at 3.5 hours (**Figure 6b**), the chemically dispersed 24-hour snapshot shows a reduction in the overall extent of surface oiling contamination (1,296 barrels remaining). The slick movement is in the same general direction as the no response snapshot (**Figure 6a**) for the same time. The concentration of oil estimated to be in the surface slick had decreased 50% (from 1,296 barrels to 671 barrels). Additionally, the estimated quantity of oiling on the shorelines had also decreased nearly 52 % (from 1,961 barrels to 947 barrels). As expected, the application of chemical dispersants increased the quantity of oil mixing into the water column with detectable water column concentrations increasing in the upper 10m of the water column, ranging from 0.01 to 0.5 ppm (75% of the affected water column area) to areas with 1.0 to 5.0 ppm (7% of the affected water column area) (**Figure 6b**). Those higher oil concentrations are limited to the top two meters of the water column, with concentrations rapidly declining as a function of water column depth.

[7] The GNOME 3-D model calculations of naturally and chemically dispersed oil concentrations (where applicable) within the upper 10 meters of the water column were limited to 0.01 ppm and greater concentrations as the lower detectable levels. Concentrations of less than 0.01 ppm are recorded as non-detectable and are given a null value.

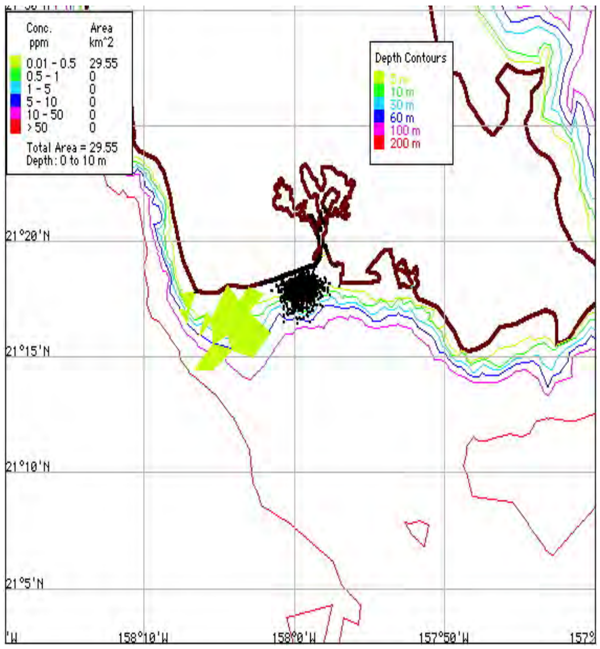
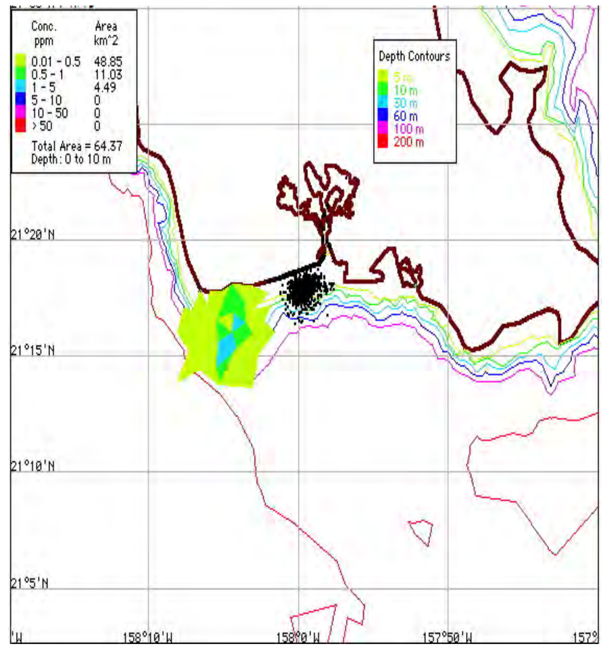


Figure 6a. Oil trajectory snapshot at 24 hours; Kona Wind scenario, without dispersants (Source: NOAA GNOME 2011)



Figures 6b. Dispersed oil trajectory snapshot at 24 hours; Kona Wind scenario with dispersants applied at 3.5 hours at 50 % effectiveness (Source: NOAA GNOME 2011)

3.3 48-Hour Snapshot

3.3.1 Oil Only

In the 48-hour snapshot for surface oiling with no response (**Figure 7a**), the floating oil slicks continue to spread westward away from Ewa Beach. The largest slicks are located off Honolulu and Sand Island in Māmala Bay. At 48 hours, only 977 barrels of the oil remain in surface slicks. The oil has stranded (beached) onshore, extending from Kalaeloa to Diamond Head, with the heaviest oiling in Ewa Beach, Pearl Harbor, and the Honolulu beaches. Within 48 hours, an estimated 2,196 barrels of oil is on the shoreline. These areas are very important for human use, including industrial, recreational, tourism areas, as well as areas of cultural/spiritual value. Water column concentrations from natural dispersion (oil only) were predicted in the 0.01 to 0.5 ppm range. Approximately 95 barrels of naturally dispersed oil remains in the upper 10m of the water column, primarily in the vicinity of the spill site (restricted anchorages B and C) (see **Figure 4a**).

3.3.2 With Chemical Dispersants

With the application of chemical dispersants at 3.5 hours (**Figure 7b**), the chemically dispersed 48-hour snapshot shows only 512 barrels of oil remaining on the surface. The surface slick extent has the same general footprint as the no-response snapshot (**Figure 7a**) for the same timeframe. As result of dispersant application, surface slicks would be patchy and thinner. The concentration of oil estimated to be in the surface slicks would decrease by nearly 50% (from 977 barrels to

512 barrels with chemical dispersants applied), relative to the no-response model run. The estimated quantity of oiling on the shorelines also decreased by nearly 50% (from 2,196 barrels for no response to 1,080 barrels with chemical dispersants applied). The application of chemical dispersants would increase the quantity of oil mixed into the water column with detectable concentrations in the upper 10m, ranging from 0.01 to 0.5 ppm (89% of the affected water column area) to areas with 1.0 to 5.0 ppm (1% of the affected water column area) (**Figure 7b**). Those higher oil concentrations are limited to the top two meters of the water column, with concentrations rapidly declining as a function of water column depth. The chemically-dispersed, water-column concentrations would remain in the same general area as those that were naturally dispersed. Chemically-dispersed concentrations, however, would extend through a much larger subsurface area (104.64 km^2 when chemically dispersed versus 21.49 km^2 for natural dispersion).

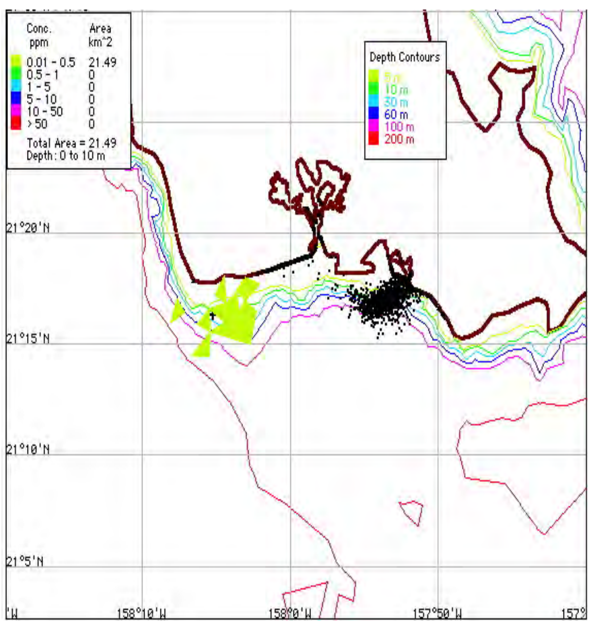
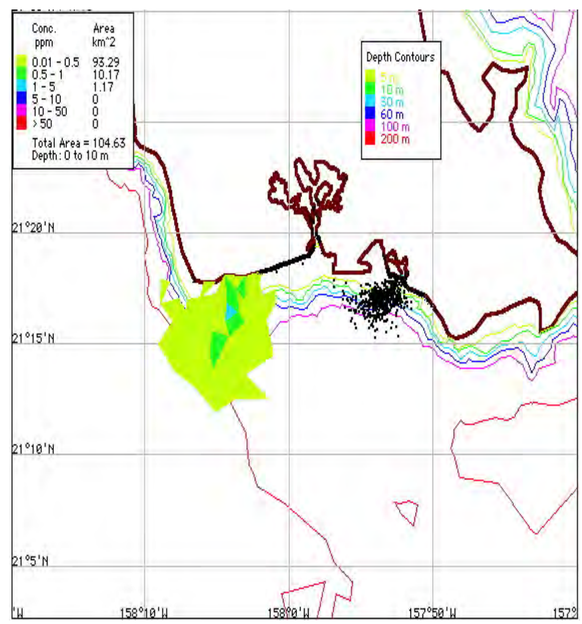


Figure 7a. Oil trajectory snapshot at 48 hours; Kona Wind scenario, without dispersants (Source: NOAA GNOME 2011)



Figures 7b. Dispersed oil trajectory snapshot at 48 hours; Kona Wind scenario with dispersants applied at 3.5 hours at 50 % effectiveness (Source: NOAA GNOME 2011)

3.4 120-Hour Snapshot

3.4.1 Oil Only

Five days (120 hours) after the initial release, **Figure 8a** shows the extent of contamination of the modeled spill with no-active response. By this time, no large cohesive oil slicks remain, and only six barrels of the original slick are predicted to remain as small, patchy surface slicks. The shoreline (beached) oil extends from Kalaeloa around Diamond Head to Kūpikipiki'ō Point, with the heaviest oiling on Ewa Beach, Pearl Harbor and the Honolulu beaches. The model predicts that 3,156 barrels of oil remain on these shorelines; these shorelines have been determined by participants to have high industrial, recreational, tourism, and spiritual values. Over the previous 72 hours, the quantity of naturally dispersed oil within the upper 10m of the water column had decreased 17%; from 95 barrels to approximately 79 barrels, remaining mainly within the spill site location (restricted anchorages B and C). Detectable water column concentrations from natural dispersion remain in the 0.01 to 0.5 ppm range over an area less than $20km^2$ for the upper two meters of the water column.

3.4.2 With Chemical Dispersants

At 120 hours, the chemically-dispersed oil snapshot (**Figure 8b**) shows that only two barrels of oil remain on the surface. The estimated quantity of oil remaining on the shorelines would also decrease nearly 50 % (from 3,156 barrels for no response to 1,631 barrels with chemical dispersants applied). The application of chemical dispersants increases the quantity of oil mixed into the upper 10m of the water column, ranging from 0.01 to 0.5 ppm (99.3% of the affected water column area) to areas with 1.0 to 5.0 ppm (less than 0.2% of the affected water column area) (**Figure 8b**). Those higher oil concentrations are limited to the top two meters of the water column, with concentrations rapidly declining as a function of water column depth. The chemically-dispersed water column concentrations remain in the same general vicinity as those that were naturally dispersed, however, chemically-dispersed oil could be detected in a subsurface area 82% than larger than naturally-dispersed oil ($19.44km^2$ for natural dispersion versus $151.29km^2$ when chemically dispersed).

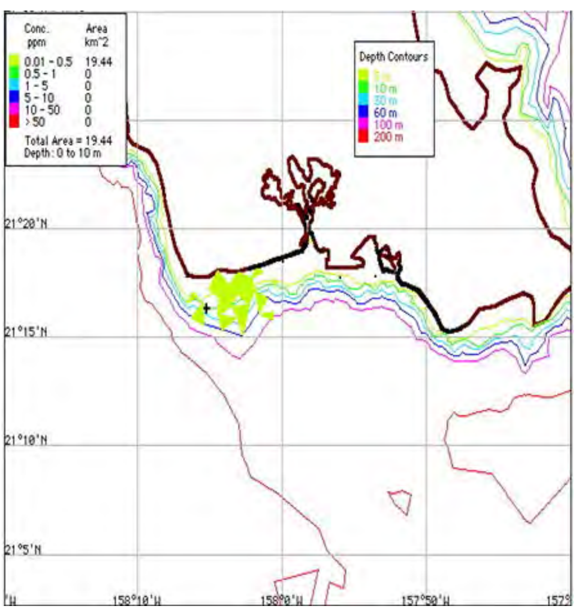
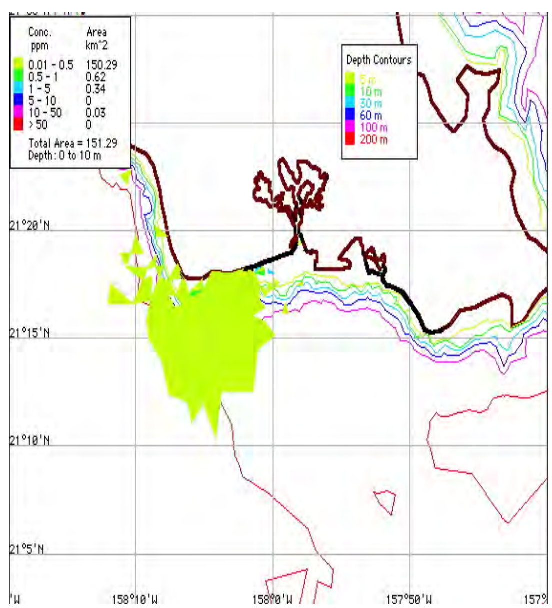


Figure 8a. Oil trajectory snapshot at 120 hours; Kona Wind scenario, without dispersants (Source: NOAA GNOME 2011)



Figures 8b. Dispersed oil trajectory snapshot at 120 hours; Kona Wind scenario with dispersants applied at 3.5 hours at 50 % effectiveness (Source: NOAA GNOME 2011)

3.5 Trade Winds Scenario

To fully consider the potential risks from an oil spill which originates at the anchorage of Barbers Point, it's useful to compare what could occur if the same volume of oil spilled at the same time and time of year but under Trade Wind conditions. Under the influence of the Trade Winds, spilled oil would move under the influence of the winds — the oil would move toward the southwest — and surface currents. For this NEBA, NOAA ERD ran the GNOME model in 2017, for the same date and location as the Kona Wind model runs, i.e., April 17, 2011 with a discharge start time of 0500. Snapshots of the model runs were taken of the dispersed oil trajectory, with a dispersant application close in time to, but not an exact match to, the snapshots shown above.

For the Trade Winds, dispersant application in the model occurred 7 hours post release with a 50% effectiveness. To facilitate comparison, **Figures 9** through **Figure 12** below show the Kona Winds output with dispersant use is shown on the left and the Trade Winds output on the right.

3.5.1 3-Hour Snapshot – Oil Only

Figures 9a and **9b** provide a snapshot of the oil three hours after discharge for both the Kona Wind and Trade Wind scenarios. No dispersants have been applied in either trajectory and the surface oil is moving at the direction of the surface currents and the winds. Natural dispersion is taking place in both scenarios.

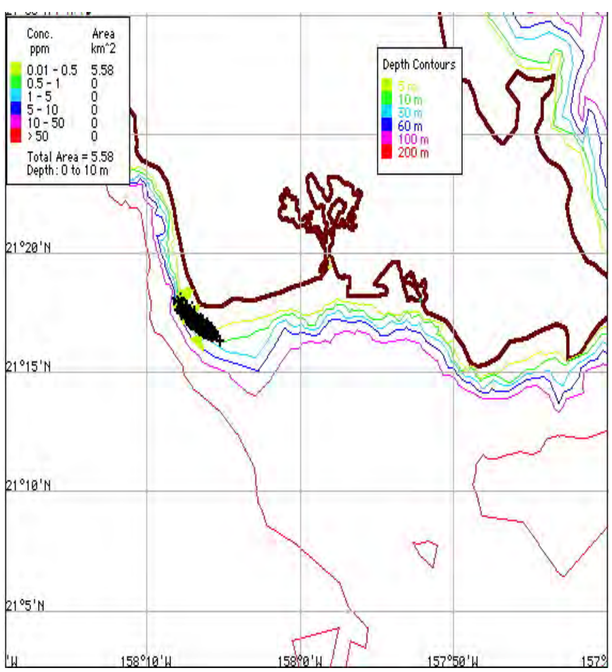


Figure 9a. Oil trajectory snapshot at 3 hours; Kona Wind scenario (Source: NOAA GNOME 2011)

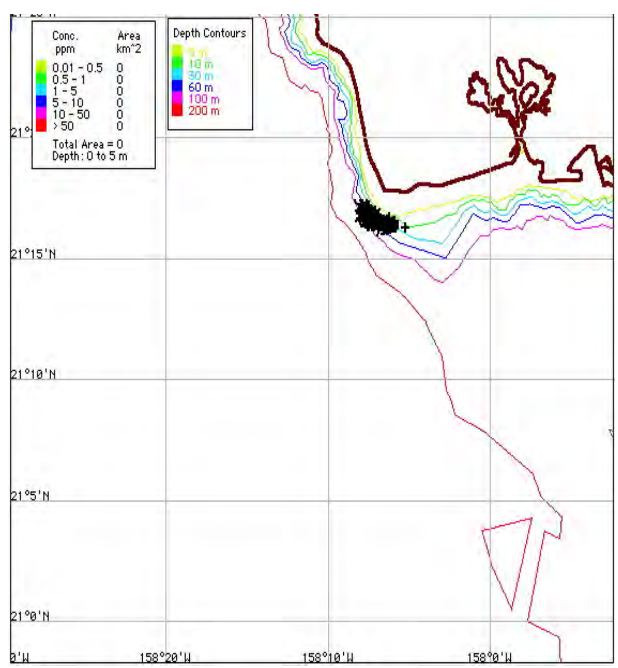


Figure 9b. Oil trajectory snapshot at 3 hours; Trade Wind scenario (Source: NOAA GNOME 2017)

3.5.2 24-Hour Snapshot– With Chemical Dispersants

Figures 10a and **10b** visually depict the trajectory variations of surface oil and dispersed oil in the water column between the Kona Winds scenario and the Trade Winds scenario; the model shows the variations in dispersion because the dispersant applications were at 3.5 hours for Kona Winds and 7 hours post-discharge for the Trade Winds scenario. At 24 hours post release, both models show that significant quantities of oil have dispersed into the water column. **Appendix I** provides the detailed mass balance for both scenarios, showing both the oil with and without chemical dispersants added over the modeling duration for both Kona and Trade Wind scenarios.

As expected, the application of chemical dispersants increased the quantity of oil mixing into the water column for both scenarios. Detectable water column concentrations are increasing in the upper five meters of the water column for the Trade Winds scenario, ranging from 0.01 to 0.5 ppm (63% of the affected water column area) to areas with 1.0 to 5.0 ppm (21% of the affected

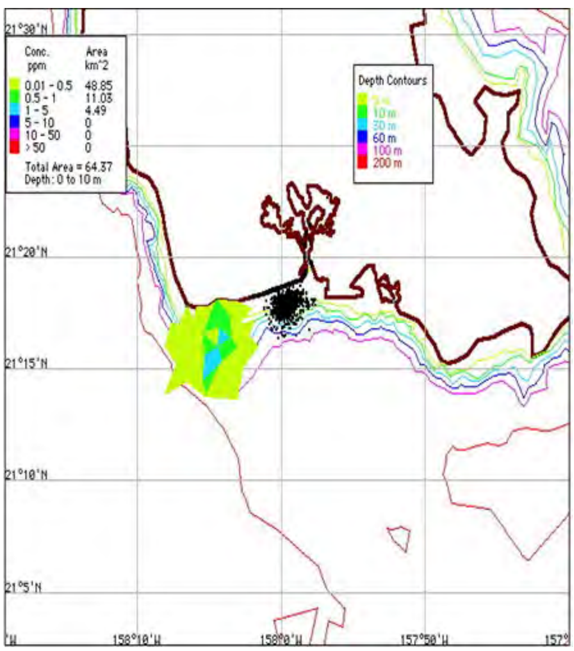


Figure 10a. Dispersed oil trajectory snapshot at 24 hours; Kona Wind scenario, with dispersants applied at 3.5 hours at 50 % effectiveness (Source: NOAA GNOME 2011)

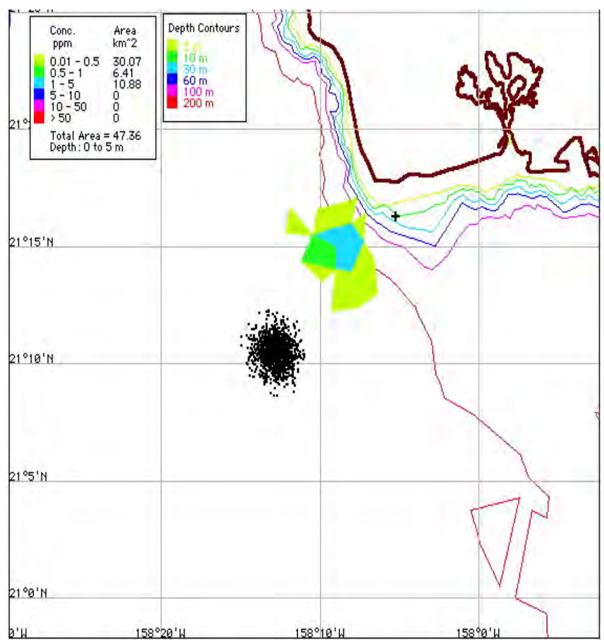


Figure 10b. Dispersed oil trajectory snapshot at 24 hours; Trade Wind scenario with dispersants applied at 7 hours at 50 % effectiveness (Source: NOAA GNOME 2017)

water column area) (**Figure 10b**). The average peak concentration of dispersed oil in the water column is approximately 1 ppm immediately following dispersant application for the Trade Winds Scenario. Maximum oil concentrations are limited to the top two meters of the water column, rapidly declining as a function of water column depth.

3.5.3 48-Hour Snapshot – With Chemical Dispersants

With the application of chemical dispersants at 3.5 hours (**Figure 11a**) and 7.0 hours (**Figure 11b**), the chemically dispersed 48-hour snapshots shows only 512 barrels (Kona Winds) and 1,878 barrels (Trade Winds) of oil remaining on the surface (**Appendix I**). The surface slick extent has the oil reaching the shoreline for the Kona Winds scenario and the Trade Winds scenario has the surface slick moving away from shore and heading out to sea (**Figure 11b**) for the same timeframe. As result of dispersant application, surface slicks would be patchy and thinner. The concentration of oil estimated to be in the surface slicks would decrease by nearly 50% and 44% respectively; the variation in percentages is likely an artefact of the four hour time variable for dispersant application in the model. The estimated quantity of oiling on the shorelines is only found in the Kona Winds scenario; no oil is expected to come ashore during the Trade Winds scenario. The application of chemical dispersants would increase the quantity of oil mixed into the water column with detectable concentrations in the upper 10m, ranging from 0.01 to 0.5 ppm (89% – Kona Winds and 78.6% – Trade Winds of the affected water column area) to areas with 1.0 to 5.0 ppm (1% – Kona Winds and 7.6% – Trade Winds of the affected water column area) (**Appendix I**). Those higher oil concentrations are limited to the top two meters of the water column, with concentrations rapidly declining as a function of water column depth. The chemically-dispersed, water-column concentrations in both scenarios would remain in the same general area. Chemically-dispersed concentrations, however, would extend through a much larger subsurface area (104.63 km^2 – Kona Winds and 74.19 km^2 – Trade Winds when chemically dispersed versus 21.49 km^2 – Kona Winds for natural dispersion).

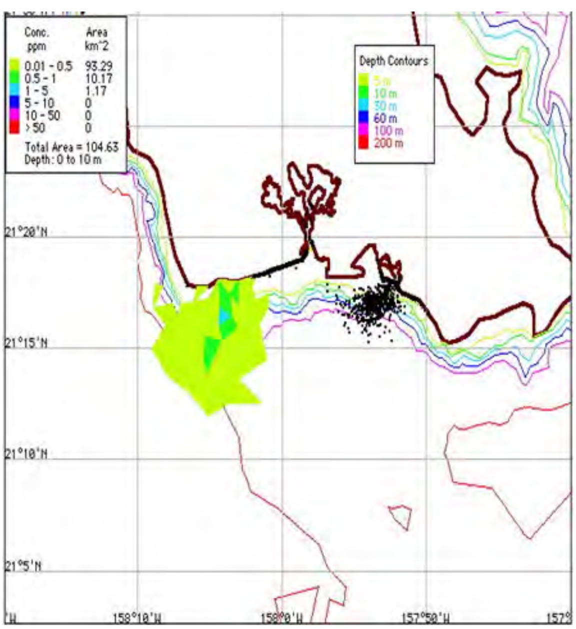


Figure 11a. Oil trajectory snapshot at 48 hours; Kona Wind scenario, without dispersants (Source: NOAA GNOME 2011)

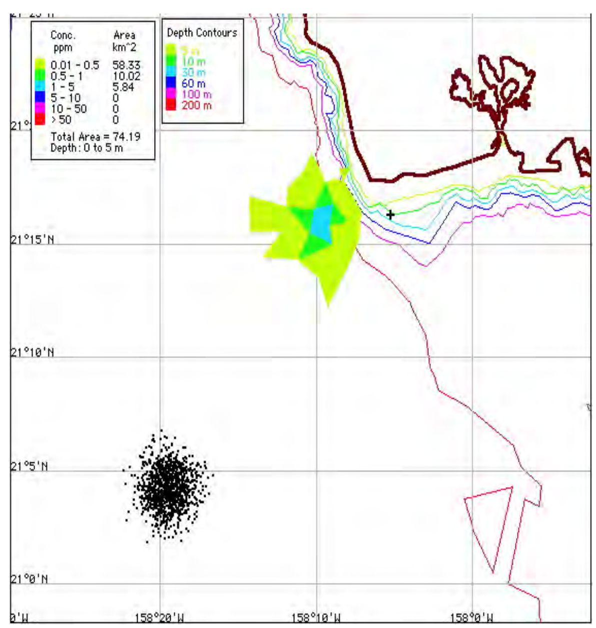


Figure 11b. Dispersed oil trajectory snapshot at 48 hours; Trade Wind scenario with dispersants applied at 7 hours at 50 % effectiveness (Source: NOAA GNOME 2017)

3.5.4 120-Hour Snapshot – With Chemical Dispersants

At 120 hours, the chemically-dispersed oil snapshots (**Figures 12a** and **12b**) show that only two barrels of oil remain on the surface (Kona Winds) and 1,823 barrels have drifted off the scenario parameters (Trade Winds). The estimated quantity of oil remaining on the shorelines would also decrease nearly 50 % (from 3,156 barrels for no response to 1,631 barrels with chemical dispersants applied); there are no expected shoreline impacts from the Trade Winds scenario. The application of chemical dispersants increases the quantity of oil mixed into the upper 10m of the water column, ranging from 0.01 to 0.5 ppm (99.3% – Kona Winds and 94.5% – Trade Winds of the affected water column areas for the two scenarios) to areas with 1.0 to 5.0 ppm (less than 0.2% – Kona Winds and undetectable – Trade Winds of the affected water column areas) (**Appendix I**). Those higher oil concentrations are limited to the top two meters of the water column in both models, with concentrations rapidly declining as a function of water column depth. The chemically-dispersed water column concentrations remain in the same general vicinity as the initial dispersant application, undergoing additional dilution from moving with the tides and currents.

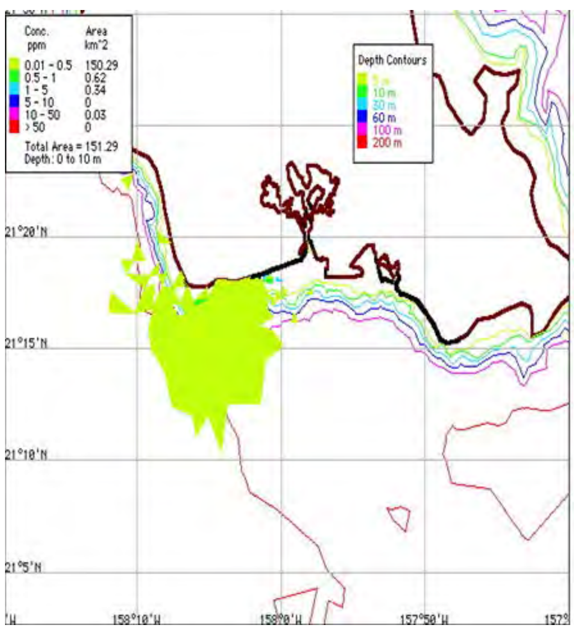
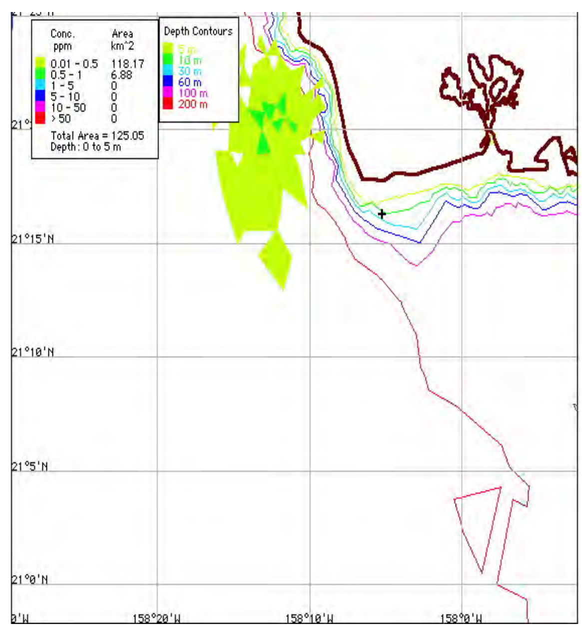


Figure 12a. Oil trajectory snapshot at 120 hours; Kona Wind scenario, without dispersants (Source: NOAA GNOME 2011)



Figures 12b. Dispersed oil trajectory snapshot at 120 hours; Trade Wind scenario with dispersants applied at 7 hours at 50 % effectiveness (Source: NOAA GNOME 2017)

4.0 Review of Workshop Activities

The portion of the NEBA process used by EPA and the USCG is a planning and training tool that develops consensus through participation by the Steering Committee and a workshop process led by facilitators—in this case, SEA Consulting Group. As discussed previously, the NEBA process typically involves four phases of activities, two of which take place during the workshops.

- **PHASE 1: Problem Definition/Formulation** (Steering Committee, **pre-workshop**)
- **PHASE 2: Analysis Plan and Initiation (**All participants, **Workshop 1**)
- **PHASE 3: Analysis and Risk Characterization** (All participants, **Workshops 2 and 3**)
- **PHASE 4. Document and Apply Consensus Findings** (**Post-workshop** report; Steering Committee and ORRT)

The Hawaii NEBA process was designed to carry out activities in Phases 2 and 3 with participants in two workshops, separated by at least a month to enable participants to research issues of concern prior to completing the risk characterization. Due to multiple concurrent activities in Hawaii at the end the federal fiscal year around the time of the second workshop, a third workshop was added in 2018 to complete the risk characterization and develop consensus among all participants about the findings.

The NEBA process is heavily focused on achieving a consensus interpretation of the best available information among workshop participants. To this end, the workshops needed to engage a broad representation of potential stakeholders in the decision process, i.e., risk characterization and decision-making about tradeoffs. Fifty-three subject matter experts and decision makers participated in the three workshops. Not all participants attended the three workshops as indicated in **Appendix A**. In addition to federal and state agencies routinely involved in oil spill preparedness, response, and damage assessment, representatives also attended from:

- Office of Hawaiian Affairs
- Indigenous and International Issues, NOAA Office for Coastal Management
- City and County of Honolulu, Dept. of Emergency Management
- NGO – Hawaii Wildlife Center
- Academia – University of Hawaii (multiple departments), NOVA Southeastern University (coral and oil pollution researcher)
- Industry – Hawaiian Electric, Par Hawaii Refinery
- Contractor organizations – Clean Islands Council (CIC), PENCO

The agendas for the three workshops are provided in **Appendix F**. Special effort was made to document the discussions by participants and the rationale for the rankings. **Appendix H** contains the final, synthesized notes that capture the reasoning for the risk ranking in each cell.

The workshops were held at the Inouye Regional Center (IRC), Ford Island, Oahu. A traditional Hawaiian blessing by Kai Markell, from the Office of Hawaiian Affairs initiated the discussions.

4.1 Workshop 1

The first workshop was held on August 9-10, 2017. On the first day, context-setting presentations were made by Steering Committee members as well as interested stakeholders to describe the workshop need, background, and scenario. Other presentations included an overview of the NEBA process in general and specific pre-workshop activities of the Steering Committee for this NEBA; information on the scenario oil type, behavior, transport, and model outputs (NOAA); overview of response options and equipment (Clean Islands Council); an overview presentation on ROC for the Hawaii NEBA (U.S. Fish and Wildlife Service); the proposed habitat and sub-habitat categories and representative species for participant consideration, and information on human ROC. The Workshop 1 participants spent a great deal of time discussing the ROC and made many revisions to both lists of ecological and human ROC.

Presentations on the conceptual model, its purpose and hazards/stressor, were given on the second day of the workshop. Participants again fully engaged to understand and refine the definitions for the hazards associated with the selected response options, listed below, in relation to the discussions on the Hawaii ROC.

- Natural Attenuation and Monitoring
- Source / Spread control (e.g., oil containment - on water containment)
- On-water Oil Recovery, e.g., skimmers, vacuum trucks
- Chemical Dispersion (targeted for slicks heading towards shorelines and other protected resources)
- Resource Protection through exclusionary or diversionary booming
- Shoreline Cleanup (oil collection and removal)

The risk ranking matrix was then presented to participants with some discussion about the duration and severity of impact definitions. The risk ranking matrix was discussed and significantly revised by the Steering Committee between the first and second workshops before being presented (**Table 2**) during the second workshop. Compared to the standard risk ranking matrix used in previous projects, the Hawaii risk ranking matrix changed the recovery time and severity definitions and added another element of scale (not applicable), as described in **Section 2.6** of this report.

The list of response options initially consisted of a larger set but was further refined and narrowed prior to the second workshop to focus on initial response options only available for the scenario. Due to the extensive discussion with participants, not all parts of the agenda for Workshop 1 were completed, specifically the conceptual model and the risk ranking for oil only.

The ranking of ecological risks to spilled oil only (natural attenuation and monitoring) is always evaluated first because it establishes a baseline against which the other response options are compared. SEA Consulting Group completed the conceptual model in between the first two workshops, using the stressor definitions developed by participants in the first workshop. It was vetted by members of the Steering Committee before presenting the completed conceptual model and using it at the second workshop.

4.2 Workshop 2

The agenda of the second workshop was developed to continue, and complete if possible, the consensus work for the NEBA project. It was also held in the same IRC on September 26 and 28, 2017. A special introductory session was conducted on the afternoon of September 25, 2017 for participants who were unable to attend the first workshop in order to review the work conducted in the first workshop to give them an equivalent level of familiarity with the process and facilitate their participation in Workshop 2.

Presentations were made on the morning of the first day to review the agenda for the second workshop. During day one, a presentation was provided to consolidate the participants' understanding on oil and dispersant toxicity, estimated oil and dispersed oil concentrations in scenario trajectory, sensitive species distributions, and presentation of baseline data sheets developed for federal threatened and endangered species (see **Appendix D**). The intention was to provide all participants with current, relevant information about oil and dispersant aquatic toxicity and levels of concern to be used later during the workshop when reviewing the completed draft conceptual model and conducting the risk characterization. A key element of this presentation was the slide showing the consensus value for sensitive species toxicity threshold (**Figure 13**).

Participants were next presented with the final ecological ROC list that were incorporated into the conceptual model (**Appendix E**). The conceptual model as presented was used in the remainder of the workshop. Next, the final risk ranking matrix was presented to participants, allowing time for questions and discussion.

After lunch, participants remained in plenary initially to discuss and characterize the risks of spilled oil (natural attenuation and monitoring) for terrestrial ecological ROC. Once the participants understood the reasoning process, they were assigned to breakout groups to independently assign their consensus levels of concern from one another. Each breakout group's detail of reasoning underlying the final ranking in each cell was documented. The final completed risk ranking matrix is presented in **Appendix G**.

By the end of the first day, the two breakout groups had completed the risk characterization for ecological ROCs in the intertidal zone only. To help expedite the process, the risk ranking for all the habitats was completed and presented to participants as a draft when they resumed discussions on Sept. 28th. The completed matrix showed the rankings of the two breakout groups that were discussed in plenary to achieve a consensus ranking.

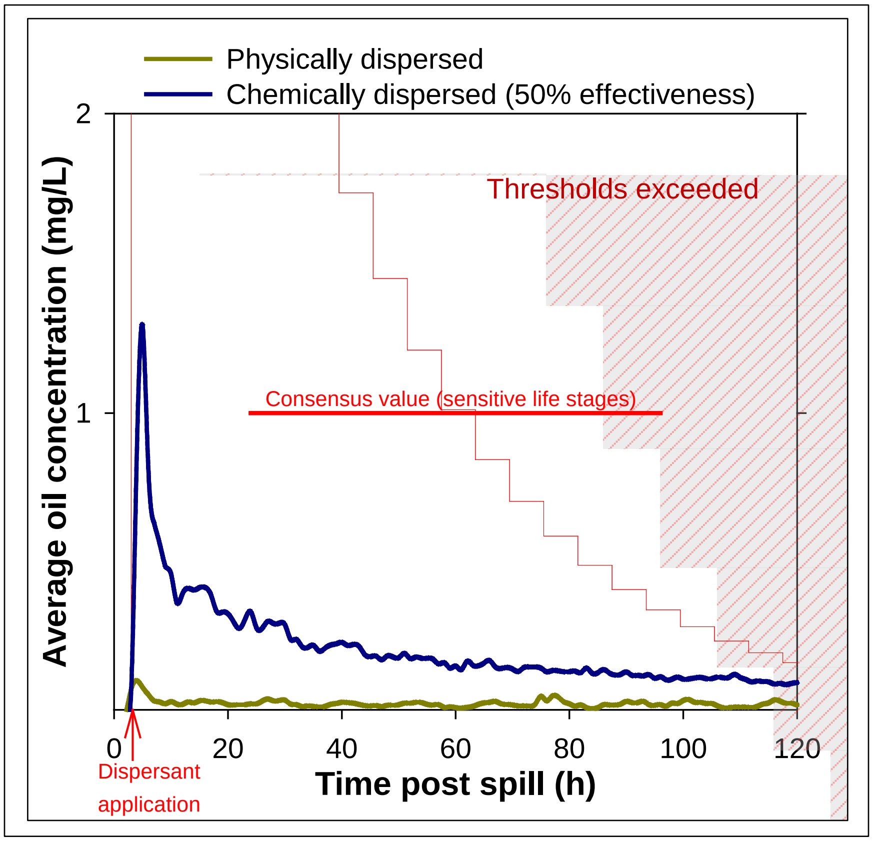


Figure 13. Aquatic toxicity values (based on TPH concentrations) for both naturally dispersed and chemically dispersed products for the Hawaii NEBA Scenario (2017) (Source: Bejarano, 9/26/17). The red horizontal line shown is a consensus threshold for sensitive life stages (i.e., zooplankton, fish and invertebrate eggs and larvae) under a 96 h exposure (Source: Mearns et al., 2001). The step-red line represents aquatic toxicity threshold values that accounting for exposure duration and developed from acute and chronic toxicity values reported in the scientific literature for various ROC, including their sensitive life stages (Source: Bejarano and Mearns 2015).

The second day of the workshop began with a presentation and review of the group scores and new scores to the participants in plenary. In the interest of time, the agenda was modified, e.g., no toxicity refresher presentation was provided, and participants remained in plenary the remainder of the day. By the end of the second day, participants completed risk ranking of the ecological ROC habitats for the following response options: oil only, offshore mechanical and recovery, and dispersants.

Participants decided not to complete the ranking of risks for the ISB response option because, given the proximity to shore and populations in the scenario, it was determined that ISB would not be used.

At the end of the second day, participants agreed that follow up after the workshop would be necessary.

4.3 Workshop 3

Workshop 3 was held May 8 through 10, 2018 at the IRC. The Agenda for Workshop 3 was developed to finalize the evaluation and comparison of the potential benefits and limitations of the response strategies for the Kona Wind scenario. The goal of the first day was to complete the rankings for the nearshore environments and the risk ranking for the Kona Winds scenario by the end of the day.

On May 8th, the workshop began with introductions and a quick review of the Workshops 1 and 2 including a review of the NEBA Process, the Kona Winds scenario and response options being evaluated, ROC tables, and the conceptual model as was developed during first and second workshops. A brief refresher on oil and aquatic toxicity, mechanism of oil toxicity and toxicity endpoints was provided for the participants. In particular, the discussion focused on the toxicity of the oil and dispersed oil and levels of concern for use during the third workshop when reviewing the completed draft conceptual model and conducting the risk characterization. **Figure 13** shows the consensus value for sensitive species toxicity threshold that was used as the basis for likelihood of effects over time for the Kona Wind scenario.

Using the scenario trajectories, participants reviewed the likely impacts of oil and dispersed oil concentrations in the spill area. Oil budget information was again reviewed under Kona Winds conditions: natural dispersion only, and the application of chemical dispersants at hour 3.5 to the surface slicks (see **Figure 4a** and **4b**). Further discussions on the sensitive species distributions within the scenario area also took place.

Next, the participants remained as a single group and reviewed the existing risk ranking values for the response options for the Kona Winds scenario in offshore environments.

By the end of the first day, the participants had completed the risk characterization for ecological ROCs in the nearshore and offshore environments for all response options. Notes of the group discussions were recorded to ensure documentation of the group discussions, reasoning and final ranking of risks (**Appendix H**).

On Day 2 (May 9th), the participants discussed the typical shoreline cleanup methods, the pre-scripted geographic response strategies for the Barber's Point area in the HACP, and the likely effects of shoreline cleanup response methods on the ecological ROCs. Participants discussed and completed the risk characterization for the ecological ROCs for shoreline cleanup methods on the shoreline environments (**Appendix C**).

During Day 3 (May 10th) the participants were tasked with completing the risk rankings for the offshore mechanical containment and recovery response options for the nearshore, subtidal habitats (water surface, water column, and benthos). Participants also discussed the various zones where response options could be deployed, relative to the spill source for the scenario, given available response equipment in Hawaii for the first five days of the incident. Facilitators asked participants questions to promote a thorough discussion about the drivers and influencing factors for the response options in Hawaii, especially with regard to the operating conditions faced by oil spill responders. Mr. Rusty Nall and USCG members summarized the response deployment timelines and potential equipment effectiveness/realities for the response equipment pre-staged in Oahu.

As a final task, the participants examined how the Trade Winds scenario (same spill conditions, time of release, but dispersants were applied at seven hours after the discharge with a conservative 50% effectiveness rate at application) would change their evaluation of the risk rankings. The three-dimensional trajectory was reviewed for the Trade Winds scenario. [**NOTE**: *The NOAA Trade Winds trajectory model run only calculated concentrations of the oil and chemically dispersed oil for the upper 5m of the water column instead of the upper 10m as was modeled for the Kona Winds scenario*.] The Trade and Kona Winds scenarios had identical modeling results for the first 6 hours of the run. After 12 hours post discharge, Kona Winds moved surface slicks eastward along the southern shoreline, but the Trade Winds moved surface oil out to sea, away from the shoreline, and remaining at sea. After 72 hours, surface oiling moved outside of the model parameter areas. The chemically-dispersed oil remained in the water column around the Barbers Point area, undergoing mixing and natural dilution that was similar to what was shown during the Kona Winds scenario.

Facilitators asked participants questions to thoroughly evaluate risk to resources from the Trade Winds scenario, relative to their reasoning of the Kona Winds scenario. Participants were asked if there were any greater adverse risks to the ROC than those for the Kona Winds scenario. In general, the discussion identified the impacts of surface oiling on several key species in the offshore environment – birds, and protected marine mammals, reptiles and fish. Participants who were spill decision makers indicated they might utilize chemical dispersants to mitigate the risk of surface oil impacts offshore ROCs that feed or breathe at the water surface, e.g., marine birds, mammals, turtles. Discussions pointed to a lack of shared understanding or research synthesis of post DWH research findings about how dispersed oil could impact marine mammal activity. Additional research is needed to define the potential impacts of dispersant use far offshore.

5.0 Results of the Risk Analysis Process – Consensus Scoring and Drivers

Five response options were assessed: natural attenuation and monitoring; on-water mechanical containment and recovery; dispersant application at 50% effectiveness; nearshore resource protection; and shoreline cleanup. The primary scenario used for the risk assessment was for the Kona Winds scenario (winds blowing the oil toward shore; see **Figure 1**). A Trade Winds scenario was also developed and discussed to determine the primary drivers for decision-making under different conditions, i.e., when Trade Winds moved the oil away from shore.

Appendix G presents the summary rankings reached during the three workshops for the Kona Winds scenario. This matrix is based on the detailed examination of the data and other information discussed in **Section 4** and enables a summary comparison across response options. Levels of concern (LOC) about the ecological risks associated with each of the five response options varied within each habitat category, i.e., on land, nearshore, and offshore. For every ranked cell in the matrix, participants spent considerable effort evaluating the effect of the response option given the anticipated extent and/or concentration of oil calculated by the NOAA GNOME trajectory model, on the specific ROC in each sub-habitat to inform the assigned level of concern. The complexity of the tradeoff choices is clearly evident. All options offered some benefit when compared to the effects from exposure to the oil (natural attenuation with monitoring) in the various habitats. However, no single response option is able to reduce the risks to all ROCs, whether in the water surface, water column or benthos from spilled oil.

It's important to understand the way participants considered the effect of the response option on the oil and organisms in each habitat when viewing the scores. Significant effort was provided to document the discussions and decision making by the participants during this evaluation.

- **N/A** - First, N/A means that the resource does not occur in that sub-habitat category and/or the response option would not be used in that habitat category. For example, N/A is assigned for the Shoreline Cleanup option in nearshore and offshore habitats; Mechanical Containment and Recovery, which is carried out offshore by the large oil spill recovery vessels (OSRVs), is N/A for shoreline and intertidal habitats. N/A could also mean that oil or dispersed oil would be too unlikely to reach a ROC (i.e., there is no likely pathway of exposure). For example, since the critical habitat of Insular False Killer Whale has been designated as water from 45m to 3,200m in depth, N/A was assigned for all response options offshore because oil or dispersed oil spilled from a ship would be unlikely to reach those water column depths from the Kona Winds scenario. Also, for dispersants, participants considered that their use could increase the risk to ROC offshore where applied, while reducing the risk of oil exposure to ROC in the nearshore habitats.
- **Patchiness** - Scientists (McGillicuddy 2001) recognize that patchiness is an important issue for marine ecosystems. Responders are well aware of the importance of patchiness when evaluating the potential exposure to oil and dispersed oil, both in water and on shorelines, e.g., charts to estimate percent coverage (NOAA 2007, 2013). Once oil is discharged, it does not spread in uniform thickness, area, or concentration due to the influence of water movement by winds and currents on the oil. Within a few minutes to

hours following the initial discharge and/or treatment by dispersants, the extent of spilled oil would become patchy, meaning that organisms and habitats may or may not encounter and be exposed to the oil. For this assessment, workshop participants assigned rankings very conservatively; they generally assumed that ROC would be exposed to oil on the water surface, water column or shoreline if the model showed any oil in that sub-habitat. That is, *patchiness was not recognized as limiting the exposure potential* in this assessment. For example, if the model showed any dispersed oil in the water column, it was assumed that a manta ray, HMS, or cetacean could ingest dispersed oil droplets if they opened their mouths to feed in the water column, *and* that this possible exposure would be detrimental, rather than be "unlikely to adversely affect" when assigning the LOC for T/E or protected species. This assumption influenced the rankings assigned; exposure during an actual incident could be different.

- **Recent Scientific Literature Findings** - Likewise, if recent scientific papers spotlighted a new oil spill or dispersant finding that could be relevant to this risk assessment, the finding *conservatively* influenced the ranking. For example,

    - ***Microdroplets*** - Recent papers (Gopolan et al., 2010; Murphy et al., 2015) have shown in laboratory studies that oil and dispersed oil microdroplets can form above an oil slick, which could then become an inhalation hazard for all ROC which breathe at the water surface. Again, if the model showed any oil at the water surface, it was assumed that if treated with dispersants, then the dolphins, cetaceans, monk seals, and sea turtles could inhale dispersed oil microdroplets if they encountered that oil slick soon after treatment by dispersants, *and* that this possible exposure would be detrimental, rather than be "unlikely to adversely affect" when assigning the LOC for these species.

      It is important to note that this laboratory study was conducted on fresh oil immediately after release into the test tank. Personal communication with one of the authors (Walker, 2018) revealed that the studies were designed in part to help develop algorithms for future models. Furthermore, the studies found that within 30 minutes, the oil in the tank formed a "skin", which is typical of oil weathering, and could reduce the formation of microdroplets. The experimental condition is different from expected field conditions. Oil that would be treated with dispersants in Hawaii will have undergone weathering in open-water conditions for at least 3.5 hours. A review of recent studies on the effects of oil (Shigenaka 2016), which was not a reference used during the workshop, noted that previous research has shown cetaceans do not necessarily avoid surface oil and could be affected by exposure to oil, with potential short- and long-term consequences at the individual and population levels.

    - ***Ultraviolet Radiation (UVR)*** - Participants considered the possible influence of tropical environments on oil weathering, fate, and behavior relative to the interactions with ROCs. There is evidence that sunlight (specifically ultraviolet radiation/UVR) can impact larvae and coral reef organisms (Banaszak and Lesser 2009) in the upper water column. It is unknown how an oil slick would affect the

UVR, but it is possible that oil particles would attenuate UVR, reducing its penetration into the water column. In Hawaii, UVR reflects off the clouds adjacent to the mountains near the coast and increases nearshore impacts on species in shallow water and/or near the surface, especially when the water is clear as it is in Hawaii, generally up to 30m.

- ***Photo-chemical Oxidation*** - Participants also discussed the potential for photo-chemical oxidation to reduce dispersant effectiveness (Ward et al., 2018) and the potential for photo-enhanced toxicity of petroleum on aquatic invertebrates (Barron 2017). Photo-enhanced toxicity occurs after oil is absorbed into tissues. Naturally-dispersed oil and chemically-dispersed oil in the water column will vary with depth and is likely to be more concentrated in the upper water column. This will increase the toxicity to organisms located near the surface, in particular, for species and life stages that are translucent (i.e., plankton) and that remain entrained within the water column.

  For chemically-dispersed oil, studies have shown that the risk of chemically dispersed oil in open waters (with circulation / not enclosed) is primarily in the upper few meters (generally less than 3m) and dilutes rapidly in open waters due to water column mixing (Bejarano et al., 2013; 2014). In the case of the Kona Winds dispersant scenario with the conservative 50% effectiveness, oil concentrations were elevated within the top two meters of the water column. In Hawaii, the long-term policy has been to apply dispersants only when water depth exceeds 10 fathoms (18m or 60 ft.). The water depth in the anchorage where the scenario occurs, ranges from 9 to 64 fathoms (54 to 384 ft.), approximately 1 to 2 miles from shore.

- ***Toxicity of oil and dispersed oil*** - Toxicity of the oil and dispersed oil, particularly on corals, also received detailed consideration during workshop discussions. An aquatic eco-toxicologist on the project team helped prepare for the workshops and participated in Workshop 2. Presentations about toxicity of oil and dispersed oil were given at all three workshops (Bejarano and Mearns, 2015; Bejarano and Barron, 2014; Bejarano et al., 2014; Bejarano et al., 2013). One slide in particular summarizes toxicity concepts to help inform risk ranking scores for the Hawaii NEBA discussions (**Figure 13**). This figure displays a consensus threshold value that is used to protect sensitive species and other entrained organisms traveling with a water mass containing oil that will continue to dilute in space and time due to water column mixing.

  While the values are based on lethal endpoints, it is assumed that the threshold is conservative as it is based on exposures lasting 96 hours. Although large impacts to entrained organisms may not be observed, concerns exist about sensitive embryonic stages of aquatic resources. Thresholds of concern developed from data under laboratory conditions by exposure duration and combining data across multiple species into species sensitivity distributions (step-red line; **Figure 13**) (Bejarano and Mearns 2015), provide the means for developing time-dependent thresholds that indirectly account for dilution. These thresholds are based on the

5th percentile (HC5) of the species sensitivity distribution, which are assumed to be protective of other species (i.e., untested species including some T/E species). In contrast with the conservative threshold values, time-dependent thresholds included both lethal (LC50) and sublethal (EC50) endpoints, and therefore are anticipated to encompass sensitive developmental endpoints. Nonetheless, during the third workshop participants expressed concern that the risk evaluation did not address developmental toxicity specifically, which could lower the thresholds of toxicity presented in **Figure 13**, therefore participants agreed to lower the threshold by 10-fold. The overarching rationale being that although dilution will alter the exposure, exposure does not alter the intrinsic sensitivity of the organism.

- ***Coral Exposures*** - A coral researcher (Renegar 2017 a, 2017b; and Turner and Renegar 2017) from the NOVA Southeastern University participated in Workshops 1 and 2 to help inform discussions about possible coral oil and dispersed oil interactions. She commented that the physical exposure of spilled oil (i.e., oil coating and smothering) would be more deleterious to intertidal corals than the oil dispersed in the water column and that the impacts on calcified algae would be similar to the coral — both being resilient. The corals that are capable of producing mucous are capable of depurating and removing small amounts of oil from their surfaces. She commented that the level of impact on the coral does not significantly change for the better if the surface oiling is reduced by 50% (e.g., using dispersants). Dispersants are designed to remove the oil from the water surface by increasing the concentration of the oil in the water column. With additional oil mixing into the water column following dispersant application, the potential risk of coral exposure will increase in areas where coral reside. Use of dispersant may therefore increase the risk and impacts for some species. Corals 10m or deeper in open, offshore waters (not sheltered areas) would be unlikely to be affected by the oil or dispersed oil.

  The coral species in affected shallower areas could be killed, but recruitment from other areas would likely happen in three to seven years. Best management practices would be in place to mitigate any impacts resulting from the use of dispersants in the proximity of coral reefs. Furthermore, a traveling water mass containing dispersed oil would continue to dilute, further lowering the coral exposure to the oil in the water column.

- ***Laboratory and Field Studies*** - Participants also discussed the differences between laboratory studies, the type of lab study, and field conditions, and the implications their reported research results would have when evaluating risk. The exposure conditions in the laboratory could be very different from the conditions found during an actual spill. In the field, constant exposure to oil in open water is unlikely to occur. Participants acknowledged that laboratory exposures seldom account for dilution, and thus assessments based on constant exposures with lethal or sub-lethal endpoints are still conservative of possible field exposures. Recent research involving marine snow was also discussed by participants; marine snow is defined as a shower of organic material falling from upper waters to the deep ocean (Passow et al., 2012; Passow et al., 2016). Depending on water depth, type of oil, effectiveness of dispersants, and other conditions (e.g., suspended sediment and particles that could promote the formation of marine snow), could lead to benthic contamination. It is possible that sessile bottom organisms, especially filter feeders, could be at greater risk to oil in the water column and near the bottom, than organisms which are mobile and are able to leave an area affected by oiled marine snow.

- ***Vertical Migration of Plankton*** – Another exposure and toxicity consideration discussed by the participants related to the diurnal vertical movement of zoo-phytoplankton in open water; some species feed near the surface during the day and could bring ingested oil to the depths at night (or vice versa depending upon the species). While this could occur, the participants determined that effect is likely to be very localized with rapid recovery.

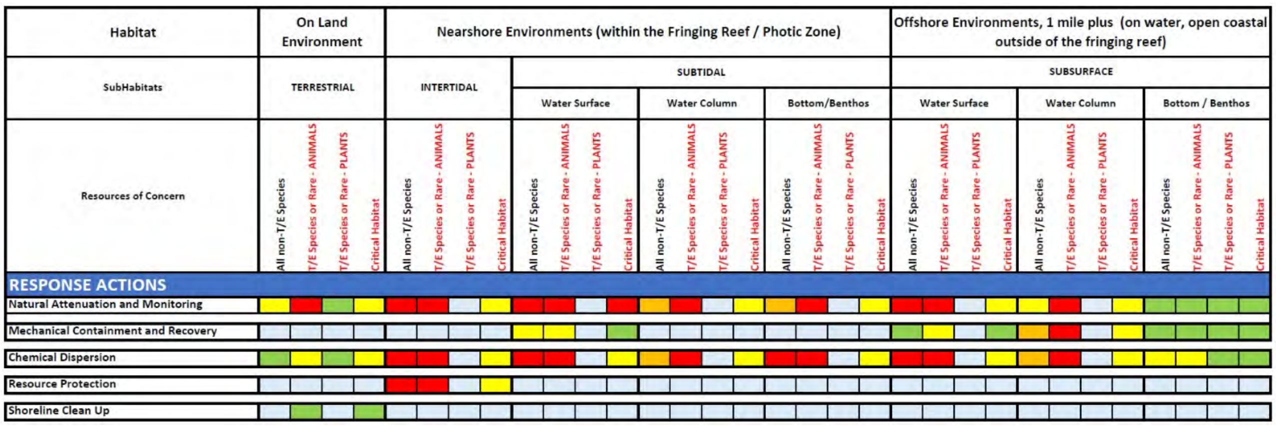
The knowledge of resource assessors with oil spill experience and their familiarity with their respective areas of research was vital. As noted above, a number of research papers were referred to by some participants to inform ranking scores, but research papers generally were not reviewed by all workshop participants as part of the process. It was difficult to apply absolutely consistent reasoning in large part because of gaps in current and *synthesized* scientific findings of fate and effects of oil, dispersants, and dispersed oil on all the identified ROC in tropical, island environments. Oil fate and effect research applicable to each of ROC in Hawaii does not exist. Participants relied upon the best professional judgment of subject matter experts to guide the relevance of the research which was applied in the assessment. Nevertheless, empirical data is lacking for all the oil and dispersed oil fate and effect interactions which were examined in this risk assessment. Recognizing the various uncertainties, participants exercised an abundance of caution in assigning risk ranking scores.

5.1 Kona Winds Scenario

The key drivers for decision making in the Kona Winds scenario were corals and crustose coralline algae and marine mammals and reptiles, i.e., sea turtles. The corals and crustose coralline algae play a fundamental role as ecosystem engineers of highly diverse communities and are the preferred substrate for settlement of invertebrate larvae (Vasquez 2017). Marine mammals and sea turtles are protected under the Endangered Species Act and Marine Mammal Protection Act. Hawaiian corals were discussed in detail. Coral heads which are over three feet in diameter are very old and need to be protected from oil and dispersed oil. Subsequent to the workshop, queries were made to determine whether large corals are present in the area around Barbers Point where dispersants would be applied. As of September 20, 2018, NMFS is considering a petition to list the cauliflower coral (*Pocillopora meandrina*) in Hawaii as an endangered or threatened species under the Endangered Species Act.

Participants evaluated all ROCs, using the risk ranking in the legend, that would be exposed to the five response options: oil only (NAM), mechanical containment and recovery, dispersants, resource protection and shoreline cleanup. The rankings are presented in the summary risk ranking spreadsheet in **Figure 14**; all non-T/E species are grouped. **Appendix G** provides the complete risk ranking matrix with separate groups of non-T/E species. In order to more readily compare the rankings made by the participants and tradeoff implications for the ROCs, two sub-sets of the entire spreadsheet were developed: surface water (**Figure 15**) and water column (**Figure 16**). Risks to individual species were also evaluated and highlights of the discussions are presented below.

Appendix H provides notes explaining the rationale for the rankings shown in the summary figures below. The names of participants who made key comments have been retained in the notes to facilitate additional questions and clarifications if needed.



Legend: Red cells represent a "High" level of concern, orange cells represent a "Moderate" level of concern, yellow cells represent a "Limited" level of concern, and green cells represent a "No Adverse Effect" level of concern; light blue color (N/A) represents "Ranking Not Applicable in the Matrix." NOTE: The ranking of "red" does not mean to stop actions during response, but rather to consult with resource managers to review and revise response actions to minimize impacts to the affected ROC. Ideally during pre-spill planning, best management practices will be developed to provide specific guidance to responders on how to mitigate or avoid impacts on T/E species.

Figure 14. Final summary relative risk matrix for the Kona Winds scenario

5.1.1 Surface Waters

Figure 15 provides an overview of the participants' decision making for the ROC inhabiting surface waters that could potentially be affected by the five response options. Mechanical recovery is the only response option that is unlikely to affect T/E species in offshore and nearshore surface water habitats.

Habitat: Intertidal Resources of Concern	Vegetation	Crustose Coraline Algae	Sponges	Coral and Live Rock	Non-T/E Birds	Non-T/E Mammals - feral cat, mongoose	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	3B	3B	4C	2B	3B	4D	3C	3C	3B 2A N/A 2B N/A	N/A	N/A N/A 4B N/A
Summary Risk for Sub-habitat											
Mechanical Containment and Recovery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat											
Chemical Dispersion	3B	3C	4B	2A	3C	4D	3B	3B 3B	3C 2B N/A 2B N/A	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat											
Resource Protection	3C	3C	4B	2B	3B	N/A	4C	3C	3B 4C N/A 2B N/A	N/A	N/A N/A 4B N/A
Summary Risk for Sub-habitat											
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat											

Habitat: NEARSHORE - Water Surface Resources of Concern	Vegetation, Floating Algae	Crustose Calcified Algae on the bottom	Sponges on the bottom	Coral and Live Rock on the bottom	Non-T/E Birds	Non-T/E Mammals	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	Critical Habitat
Natural Attenuation and Monitoring	3C	3C	4C	2C	3B	2B	4C	4C	2A 2A N/A 1A 2C	N/A N/A 4C N/A
Summary Risk for Sub-habitat										
Mechanical Containment and Recovery	3C	N/A	N/A	N/A	4D	4D	4D	4D	4D 4D N/A 4C 4D	N/A N/A 4D N/A
Summary Risk for Sub-habitat										
Chemical Dispersion	3C	3B	3B	1B	3C	2B	4B	4B	2A 2A N/A 1B 2C	N/A N/A 4C N/A
Summary Risk for Sub-habitat										
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat										
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat										

Habitat: OFFSHORE - Water Surface Resources of Concern	Plankton	Non-T/E Birds	Non-T/E Mammals	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	Critical Habitat
Natural Attenuation and Monitoring	4C	2B	2B	4C	4C	2B 2A 1B 2B 3C	N/A N/A N/A 4B
Summary Risk for Sub-habitat							
Mechanical Containment and Recovery	4D	4D	4D	4D	4D	4D 4D 4D 4C 4D	N/A N/A N/A 4D
Summary Risk for Sub-habitat							
Chemical Dispersion	4B	2C	2B	4B	4C	2C 2A 1B 2B 3B	N/A N/A N/A 4B
Summary Risk for Sub-habitat							
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat							
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat							

T/E species – ANIMALS
Reporting order:

- Birds
- Marine Mammal – HI Monk Seal
- Marine Mammal – cetaceans
- Reptiles – Sea Turtles
- Fish - Manta Ray

Critical Habitat
Reporting order:

- Insects CH
- Plants CH
- HI Monk Seal CH

Insular False Killer Whale

Legend: Red cells represent a "High" level of concern, orange cells represent a "Moderate" level of concern, yellow cells represent a "Limited" level of concern, and green cells represent a "No Adverse Effect" level of concern; light blue color (N/A) represents "Ranking Not Applicable in the Matrix." NOTE: The ranking of "red" does not mean to stop actions during response, but rather to consult with resource managers to review and revise response actions to minimize impacts to the affected ROC. Ideally during pre-spill planning, best management practices will be developed to provide specific guidance to responders on how to mitigate or avoid impacts on T/E species.

Figure 15. Final summary relative risk matrix for resources of concern that utilize the surface waters during the Kona Winds scenario

In general, the coral, live rock, and T/E animals are the drivers for decision making for the five response options. In the water surface habitat, the following was determined to be beneficial or provide no change in LOC for the following relative to natural attenuation with monitoring:

- **Vegetation** – No changes in level of concern from any response strategy use in the intertidal or nearshore surface waters.
- **Crustose coralline algae** – Dispersants and resource protection considered beneficial in the intertidal zone; however, there was increased risk in the nearshore surface waters.
- **Plankton** – Minimal increase of recovery time from chemical dispersant use; mechanical containment and recovery is not expected to result in an adverse effect.
- **Non-T/E birds** – Considered beneficial for birds on the water surface in all zones.
- **Non-T/E mammals** (terrestrial and marine) – No expected effects from the response options in surface waters in the intertidal and nearshore waters.

- **Non-T/E fish –** Increased risk of effects from chemically-dispersed oil in the intertidal zone surface waters; decreased recovery for fish from resource protection in the intertidal surface waters; no effect expected on fish from mechanical recovery in the nearshore and offshore surface waters; small increase in severity for fish from chemical dispersants and dispersed oil in the nearshore and offshore surface waters.
- **Non-T/E shellfish and other invertebrates –** Increased risk of effects from chemically dispersed oil in the intertidal surface waters; no change with resource protection use in the intertidal zone; no adverse effect expected from mechanical containment and recovery in the nearshore and offshore surface waters; little to no increase in severity for shellfish and other invertebrates from chemical dispersants and dispersed oil in the nearshore and offshore surface waters.
- **T/E species (or Rare) - ANIMALS** – In all cases, the use of chemical dispersants either benefitted the T/E ROC or provided no discernable change in the intertidal, nearshore and offshore surface waters; mechanical containment and recovery was not expected to negatively affect the T/E resources and was thought to be beneficial for the ROC — showing reduced risk in the nearshore and offshore waters. There was minimal benefit to T/E ROC when deploying resource protection (boom and skimmers) in the intertidal zone. In general, due to the high sensitivity of the T/E resources, none of the response actions were expected to more negatively impact the ROC than the oil itself.
- **Critical Habitats** – In all cases, the use of chemical dispersants was determined to benefit or have no greater impact than the oil itself on the critical habitats for HMS in the intertidal, nearshore and offshore waters; mechanical containment and recovery was thought to provide a benefit to the critical habitat in the nearshore and offshore waters; there was no discernable benefit to the Highly Migratory Species Critical Habitat when deploying resource protection in the intertidal zone.

5.1.2 Water Column

Impacts from naturally and chemically dispersed oil in the water column on crustose coralline algae was determined to be small but could be more significant on corals and live rock, sponges, meiofauna and infauna, fish, shellfish and invertebrates. Impacts to vegetation is likely to be minimal. Organisms that are not mobile (sessile) and are filter feeders will be more impacted from naturally and chemically dispersed oil. Mobile species in general will not be as impacted as they can evacuate an affected area for cleaner water.

Figure 16 provides an overview of the participants' risk ranking for the ROC inhabiting the water column (two meters below the water surface extending to two meters above the sea bottom) for the five response options. In general:

- **Plankton** – Minimal increase of recovery time from mechanical containment and recovery and chemical dispersant use; localized impacts may result, but the population would quickly recover.

Habitat	NEARSHORE Water Column								OFFSHORE Water Column								
Resources of Concern	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat	Plankton	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	3B	3C	N/A	4C	4C	3C 3B 3C 3C 2C	N/A	N/A N/A 4C N/A	4D	3C	3C	N/A	4C	4C	3B 3B 3C 3C 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat																	
Mechanical Containment and Recovery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4C	3B	3C	N/A	4C	4C	3B 3A 4C 3C 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat																	
Chemical Dispersion	3B	3B	N/A	4C	4C	2C 3B 3C 3C 2B	N/A	N/A N/A 4C N/A	4C	3C	3B	N/A	4C	4C	3B 3B 3C 3C 2B	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat																	
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat																	
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat																	

T/E species – ANIMALS
Reporting order:
- Birds
- Marine Mammal – HI Monk Seal
- Marine Mammal – cetaceans
- Reptiles – Sea Turtles
- Fish - Manta Ray

Critical Habitat
Reporting order:
- Insects CH
- Plants CH
- HI Monk Seal CH
- Insular False Killer Whale

Legend: Red cells represent a "High" level of concern, orange cells represent a "Moderate" level of concern, yellow cells represent a "Limited" level of concern, and green cells represent a "No Adverse Effect" level of concern; light blue color (N/A) represents "Ranking Not Applicable in the Matrix." NOTE: The ranking of "red" does not mean to stop actions during response, but rather to consult with resource managers to review and revise response actions to minimize impacts to the affected ROC. Ideally during pre-spill planning, best management practices will be developed to provide specific guidance to responders on how to mitigate or avoid impacts on T/E species.

Figure 16. Final summary relative risk matrix for resources of concern that utilize the water column during the Kona Winds scenario

- **Non-T/E birds** – No expected risk to birds that swim and dive in the water column from the use of chemical dispersant use in nearshore and offshore waters; exposure risk is considered to be greater in the nearshore water column (moderate) than in the offshore water column (limited).
- **Non-T/E mammals** (marine) – Minor increase in risk for ROC with use of chemical dispersants in the nearshore waters and offshore water column; no expected effect from

the use of mechanical containment and recovery in the offshore water column relative to just the oil itself.

- **Non-T/E fish –** No impacts are expected for fish in the water column from any of the response options being considered compared to the oil alone in nearshore and offshore waters.
- **Non-T/E shellfish and other invertebrates –** No impacts are expected for shellfish and other invertebrates in the water column from any of the response options being considered relative to the oil alone in nearshore and offshore waters
- **T/E species (or Rare) ANIMALS** – The use of chemical dispersants increases risk to T/E birds and the Giant Manta Ray in the nearshore water column compared to oil only; in the offshore water column, chemical dispersants are likely to increase possible exposure risks to the manta ray; all other species are not considered to have increased risk from the use of response options relative to the oil itself; mechanical containment and recovery in the offshore water column is also not expected to impact resources.
- **Critical Habitats** – In all cases, the use of response options in the nearshore and offshore water column was determined to have no greater impact than the oil itself on the critical habitats for Hawaiian Monk Seals or Insular False Killer Whale.

5.2 Trade Winds Scenario

On May 10th of Workshop 3, the participants discussed potential risk for a scenario that initiated in the same location as the previously discussed Kona Winds scenario, however using a Trade winds condition for the model run. The Trade Winds typically blow from the northeast to the southwest, picking up moisture from the ocean waters (warmed by the sun) and carrying that moisture toward the mountainous islands (see **Figure 1**). Occurring about 75% of the year, the Trade Winds exhibit an average wind speed of approximately 16 mph.[8]

A Trade Winds scenario for a discharge at the Barbers Point Lightering buoy is the Worst-Case Discharge for the HACP. NOAA ERD provided a trajectory to graphically display the potential impacts from the surface slicks under the Trade Winds scenario (refer to **Section 3.5** for more information); dispersants were applied at hour seven in this model run. The model results were presented as snapshots of the extent of contamination in time and depth intervals, and video clips. Like the Kona Winds scenario, the trajectory snapshots displayed depth contours of 5, 10, 30, 60, 100, and 200m throughout the geographic extent over 120 hours to visually show the surface oil slicks. The snapshots also displayed oil concentrations in the slick area for the upper 5m of the water column. The Trade Winds trajectory model showed the surface oil being blown out to sea towards the southwest.

The remaining surface oil was determined to be the most impactful to seabirds and marine mammals in the offshore waters; the potential impacts to the species in contact with the surface slicks were considered severe, with a longer recovery period. Mechanical containment and recovery operations at sea are unlikely to be effective because of the limited number of open

[8] From: http://www.soest.hawaii.edu/coasts/nps/waveClimate.php

water response resources that are available in Oahu and because open ocean conditions and offshore logistics would likely limit oil recovery.

Furthermore, participants indicated they might promote additional offshore chemical dispersant applications to remove oil from the water surface, especially when known ROCs are in the area. Further use of chemical dispersants for this scenario in the offshore waters would be applied in waters deeper than 20m.

5.3 Summary Observations

The focus of this NEBA was primarily evaluating the risk to ecological ROC from spilled oil and five response options that could be implemented in the first 72 hours, specifically to limit oil spread and reduce oil landfall on shore as much as practicable. Rankings were assigned for risks to ecological ROC (**Appendix C**).

Based on these results and group discussions, the participants developed summary conclusions throughout the final workshop. These represent the consensus of the participants. Highlights of participants comments below convey important issues to consider in future oil spill response planning and decision making for the Hawaiian Islands and Oahu in general. The Coast Guard intends to present these results to the Hawaii Area Committee and the U.S. unincorporated Pacific territories (i.e., Guam, Northern Mariana Islands, and American Samoa) for further consideration.

The first action to be taken for an incident taking place at the Barbers Point mooring, in accordance with existing planning, is to implement the GRS at Barbers Point, as shown in **Figure 17**. This GRS was determined to be insufficient to recover a 5,000 barrel spill at or near the mooring.

Following active evaluation and discussion, the participants determined that the use of mechanical containment and recovery operations will be of limited effectiveness in the nearshore and offshore waters, partly due to the limited number of large OSRVs relative to the spill size in this scenario and partly due to operating conditions. Offshore of the Hawaiian Islands, the seas are moderately rough, with significant wave heights of 3 to 14 ft. (1 to 4m), varying seasonally and intensity of the Trade Winds, which are greatest in winter and spring; southern shores receive smaller swells (3 to 9 ft. or 1 to 3m) from southern hemisphere storms in summer. During winter, however, the winds can shift to the northwest or to the southwest, creating unusual sea conditions. Between the islands where the winds are funneled, the seas are intensified. An oceanographer from the University of Hawaii, who attended all three workshops observed that only the top portion of the water column will be impacted by currents, bringing dispersed oil into the intertidal and shoreline habitats.[9]

Recognizing these limitations and the urgent need to prevent oil spreading, participants recommended that chemical dispersants would provide value, but that they only be applied in waters greater than one mile from shore. Currently, the HACP specifies that dispersant

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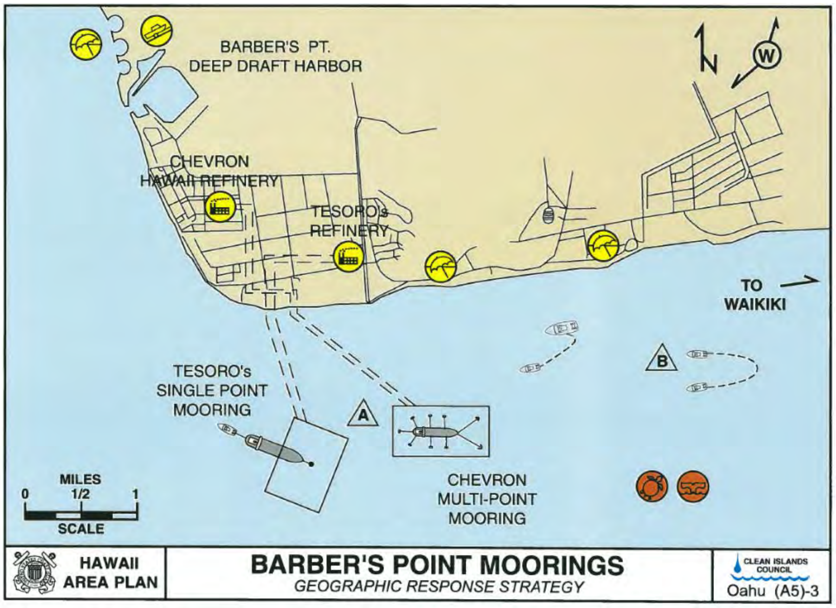
[9] https://www.pacioos.hawaii.edu/voyager/info/sea_surface_wave_significant_height.html.

applications should be applied to waters deeper than 60 feet; the potential aerial dispersant "drift" has been modeled to be approximately 1,600 ft. A one mile set back would ensure that the 60-foot water depth requirement and shoreline protection from potential dispersant drift would be adequately addressed in the nearshore and shoreline habitats. In many places around the Hawaiian Islands, the 60-foot water depth contour is adjacent to the shoreline. Furthermore,



Barber's Pt. Equipment List

Location	Equipment Type	Description	Quantity	Units
BARBER'S PT.	API SEPARATOR	VERSITEK API SEPARATOR	1	EACH
BARBER'S PT.	BOOM BOAT	21 FT. BOSTON WHALER WITH TWIN O/B'S	1	EACH
BARBER'S PT.	BOOM CONTAINER	CONTAINER W/ 1000' HARBOR BOOM	1000	FEET
BARBER'S PT.	PACKAGE	PPE BOAT PACKAGE - 4 PERSON	6	SETS
BARBER'S PT.	PACKAGE	MEDIUM WORKVEST PACK 30 SETS	30	EACH
BARBER'S PT.	PACKAGE	PPE SITE PACKAGE - 12 PERSON	18	SETS
BARBER'S PT.	PUMP	DIESEL POWERED PHP	754	DeratedBBLS/day
BARBER'S PT.	SKIFF	8 FT. UNDER PIER SKIFF WITH PADDLES	1	EACH
BARBER'S PT.	SKIMMER	SKIM PACK MODEL 4200	754	DeratedBBLS/day
BARBER'S PT.	SKIMMER	KAISER AG OELA MODEL 3	754	DeratedBBLS/day
BARBER'S PT.	SORBENT	SORBENT PADS	10	BALE
BARBER'S PT.	SORBENT	8" SORBENT BOOM	10	BALE
BARBER'S PT.	SORBENT	SORBENT SWEEP	10	BALE
BARBER'S PT.	SORBENT	VISCOUS SWEEP/DRAG NET	10	BALE
BARBER'S PT.	STORAGE SYSTEMS	2500 GALLON QUICKTANK W/ HOOD	1	EACH
BARBER'S PT.	STORAGE SYSTEMS	2400 GALLON FAST TANK	1	EACH
BARBER'S PT.	STORAGE SYSTEMS	2500 GALLON QUICKTANK W/ HOOD	1	EACH

Figure 17. Geographic Response Strategy with equipment list for the Barbers Point Moorings (SOURCE: Clean Islands Council http://www.cleanislands.com/locationinfo_barberspoint.php)

the water depth in the anchorage is 9 fathoms (54 ft) in one location. The presence of corals and the HMS are the significant drivers for this recommendation.

Trajectory models show that: 1) when using dispersants, detectable dispersed oil concentrations may be found in the upper 10 to 20m of the water column but the most significant concentrations are limited to the top few meters of the water column in open waters; 2) concentrations of dispersed oil decline rather quickly (i.e., temporally and spatially); and 3) concentrations of dispersed oil are below "consensus" concentrations of concern (see **Figure 13**) except in the case of coral eggs/larvae and sensitive life stages (plankters) if present at the time of the incident.

An important tradeoff would be that undispersed oil, whether it comes ashore or not, or goes offshore, is on open water where it could be potentially encountered by sea birds, cetaceans, pinnipeds, and sea turtles. Whole oil affects (i.e., coating and smothering) are well known to be detrimental and very persistent, and thus the use of dispersant can mitigate the effects for some species and habitats/sub-habitats. Birds, sea turtles and cetaceans that may rise through a heavy slick to breathe at the water surface are likely to benefit from the use of dispersants. Participants also generally agreed that dispersants would reduce the longevity of oil remaining in the environment by enhancing biodegradation.

Participants acknowledged that the goal of the response is to "get it [the oil] while its small" and "keep it off the shoreline." They reached consensus that the surgical application of dispersants as soon as possible and as close to the source in waters a mile from shore, via boat spray or helicopter, is a viable, even preferred response action to protect ecological and human ROCs along the southern coast of Oahu.

The participants also developed risk rankings to human ROC (also in **Appendix C**). Tourism is essential to the Hawaiian economy and, should a large spill occur like this scenario, pressure to prevent oil from impacting the shoreline will be immense. The City and County of Honolulu representative noted that this pressure may result in actions being taken for "optics" and could conflict with accepted spill practices. In past spills, Unified Command was pressured to implement booming strategies which were known to be ineffective, and some shorelines have been cleaned to remove oil which could increase erosion or cause greater impacts to intertidal organisms than leaving some residual oil in place.

Cultural concerns are significant in Hawaii and need to be fully considered and understood; cultural concerns may directly influence decisions about the best ways to deal with the spilled oil. The Office of Hawaiian Affairs representative noted that the 2nd most important cultural site in all of the Hawaiian Islands is the burial location of King Kamehameha's mother, located in the nearshore habitat near Barbers Point. He strongly urged the participants on the importance of avoiding *any* disturbance of that burial area, especially when considering nearshore resource protection strategies or shoreline cleanup activities. Subsistence fishing and limu gathering activities are also significant in the scenario impact area.

Another culturally important and unique environment in Hawaii are anchialine pools — land-locked bodies of water of varying salinity that are adjacent to the ocean. These pools have indirect, underground connections to the sea, and exhibit tidal fluctuations and may be impacted by surface oiling and chemically dispersed oil due to the natural water transport and mixing in and out of the pools. Impacts will depend on the proximity of the dispersant applications to the pools. Furthermore, these pools are the only habitat for at least eight different lineages of pool shrimp (ʻōpae ʻula) found statewide, a Federally-Endangered species. Several of the anchialine pools are located in the scenario impact area.

Participants determined that corals deeper than 10m were unlikely to be adversely affected. Post-Workshop 3, Cardno marine scientists, who have done field work in the area and are familiar with the benthic habitats a couple of kilometers up the leeward coast from the moorings, shared the photos of the benthos in **Figures 18a and 18b**.

They commented that mid-depth reefs in the area (~50 to 120 ft.) offer fewer ecosystem services than socioeconomic resources that would be at risk during Kona Winds. It is unconfirmed at the time of this report whether or not large coral heads are present in the immediate vicinity of Barbers Point. Mapping of nearshore benthic habitats and access to this information would also be important for future NEBA discussions/response planning.

Impacts from night operations to adult sea turtles, manta ray and birds from floating oil was discussed as a particular issue that is difficult to resolve because of the limited available data.

Figure 18a. Occasional clump of *Porites lobata* at 70 ft., Kahe Telcom corridor (Photo credit: John Ford, Pacific Operations Manager, Cardno)	**Figure 18b.** Coral rubble at 100 ft., Kahe Telcom corridor (Photo credit: John Ford, Pacific Operations Manager, Cardno)

Outstanding planning issues that warrant additional consideration by the ORRT include:

1. Further definition of an initial concept of operations for Barbers Point, especially should a spill occur in Kona Wind conditions. **Table 3** presents a starting point for this planning, based on workshop discussions.
2. Address night operations. Can they be conducted? If so, define any special requirements. For example, lights used during night operations can be detrimental for sea turtles and manta rays; birds may also be attracted to the lights on boats and could be affected by the spilled oil.
3. Update and develop additional details for existing GRS on Oahu, with specific mention of the initial assignments of the OSRVs and other offshore containment and recovery resources that are currently available near the Barbers Point mooring.
4. Identify temporary waste disposal of recovered waterborne oil and oily waste to assure continuous operations of containment and recovery systems, both offshore and nearshore.
5. Develop BMPs for T/E resources for the potential use of dispersants per the concept of operations.

Table 3. Initial concept of operations and additional planning considerations identified by participants for Barbers Point GRS update

Response Option	Description
Source Control	• Deploy boom per Vessel Response Plan (amount?) and Barbers Point GRS
Dispersants – Helo, Boat	• Apply dispersants surgically ASAP by boat spray (potentially possible at night and day) and/or helo • Pre-stage boat spray capability on board the service vessels at the lightering point • The boat spray capability at CIC needs to be transferred to MSRC and moored at same location as emergency boom per the vessel response plan
Dispersants – C130 / other plane	• NRC Dispersant spray capability needs to be incorporated into the Area Plan after approval
Mechanical Containment and Recovery	• Deploy OSRVs to capture surface oils outside the dispersant spray area. • Separate assigned operating areas either by time sequence or physical zone
Nearshore Resource Protection – existing GRS	• Implement pre-defined GRS for: Barbers Point, Kahe Point, Pearl Harbor, Honolulu Harbor
Nearshore Resource Protection - other	• Given available equipment on Oahu (see **Appendix B**), develop additional GRS
Shoreline Clean Up	• Agree on shoreline cleanup methods for shoreline types on the southern coast of Oahu • Identify staging areas, access points, personnel resources and priority cleanup areas

The Hawaii NEBA has examined potential response tradeoffs and updated scientific knowledge about response options through stakeholder engagement. The exchange of questions and knowledge was beneficial for all participants. A participatory approach enhances the legitimacy and quality of decision-making processes, especially under uncertain conditions. Stakeholders can provide useful roles in knowledge production in the areas of: gathering knowledge; legitimizing knowledge; identifying and defining problems; reflecting on knowledge; and distributing knowledge (Hage et al. 2008). Knowledge production and relationship building among oil spill planners and responders during preparedness clearly contributed to the development of the Hawaii regional preauthorization policy in the 1990s (Walker et al. 2018). The detailed discussions by the Hawaii NEBA workshop participants in 2017-18 updated shared knowledge about the use of response options and their potential advantages and limitations in Hawaii, based on current information and research. We hope this report conveys the participants' thorough examination of tradeoff considerations in reaching their conservative consensus about potential risks, and that it may provide value to oil spill risk managers and assessors in other areas dealing with similar response choices.

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Appendix A:
List of Hawaii NEBA Steering Committee Members and Participants

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LAST NAME	FIRST NAME	Workshop 1	Workshop 2	Workshop 3	ORGANIZATION	TITLE	SPECIALTY (area of expertise)	ROLE	EMAIL
Barron	Mace			X	EPA NHEERL	Research Toxicologist	Petroleum and dispersant toxicology	Federal	Barron.Mace@epa.gov
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Browning	Joy		X	X	USFWS	Fish and Wildlife Biologist	turtles, waterbirds, coastal areas	Federal	joy_browning@fws.gov
Carter	Dave	X			PENCO, AMSG	Senior Response Manager	response: field, technology, ICS, equipment	Industry	dc@amsghq.com
Coleman	Patty	X	X		USN	NOSC - Pearl Harbor	response coordination	Federal	patricia.coleman@navy.mil
Conmy	Robyn			X	EPA Oil Research Program	Reseach Scientist	spill response research (dispersants oil behavior)	Federal	conmy.robyn@epa.gov
Cook	Anna Marie		X	X	EPA Region 9	Environmental Engineer	superfund	Federal	cook.anna-marie@epa.gov
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Fry *	Michael	X	X	X	USFWS	Seabirds, Oil toxicity, Risk Assessment	seabirds, oil toxicity, risk assessment	Federal	michael_fry@fws.gov
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Gewecke	Catherine	X	X	X	State of Hawaii DLNR, Division of Aquatic Resources	Aquatic Biologist- Special Activity Permits/Technical Review	Marine Technical Guidance-Research Proposal Assessment and Evaluation-AIS-Fish/Benthic	State	catherine.a.gewecke@hawaii.gov
Goggins	Justin	X			State of Hawaii DLNR, Division of Aquatic Resources	Aquatic Invasive Species Biologist	estuaries and coral reefs	State	justin.r.goggins@hawaii.gov
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Harter	Robert	X	X	X	City & County of Honolulu Dept. of Emergency Mngt.	Emergency Management Staff Officer (HAZMAT)	emergency management, hazardous materials	State	rharter@honolulu.gov
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LAST NAME	FIRST NAME	Workshop			ORGANIZATION	TITLE	SPECIALTY (area of expertise)	ROLE	EMAIL
		1	2	3					
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Manuel	Mark	X			NOAA	Pacific Islands Regional Coordinator	Marine debris impacts on wildlife (ingestion, entanglement)	Federal	mark.manuel@noaa.gov
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Markell	Elliott "Kai"	X	X		Office of Hawaiian Affairs-State of Hawaii	Compliance Enforcement Manager	Natural, Cultural and Historical Resources/Native Hawaiian Culture	State	kaim@oha.org
Maye	Gregg	X	X		USCG	USCG Sector Honolulu, LCDR	Operations Section Chief	Federal	gregg.j.maye@uscg.mil
McIntosh *	Randy	X	X	X	NMFS	Endangered Species Biologist	Endangered species, habitats	Federal	randy.mcintosh@noaa.gov
Meer	Dan		X	X	EPA Region 9	Oceania Regional Response Team	Co-Chair	Federal	meer.daniel@epa.gov
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Appendix B:
Hawaii NEBA Response Options

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Appendix B:

Overview of Response Options in the Hawaii NEBA (Initial stages; first 72 hours)

Spill response resources have been well stockpiled in the islands due to geographic distance from the mainland and the recognition that cascading in resources from outside the islands if needed would constrain an effective response.

Source control actions would be implemented automatically; they are not optional. Resources to control and limit the source of spilled oil include onboard vessel actions (e.g., cargo transfer inside the ship); cargo lightering to another vessel; and ship salvage actions (e.g., pumps, hoses, lift bags, air compressors, generators, welding, hot tap, hull repair) to prevent/limit further damage to, and stabilize, the vessel. Salvage equipment is available on Oahu from Clean Islands Council (CIC), USN SUPSALV in Pearl Harbor, Pacific Environmental Corporation (PEC) and American Marine Corp.

Active Monitoring and Natural Attenuation of Spilled Oil ("No response")	
Use of Response Option and Definition:	Natural attenuation relies on natural processes to decrease and "attenuate" concentrations of contaminants (oil) in soil, groundwater, and water. Often includes "set-asides" or areas that are not to be cleaned over a specific timeline due to sensitivity, T/E resource presence (e.g., tern nesting, sea turtle nests), etc. Monitoring typically involves collecting soil, groundwater, water samples to analyze them for the presence of contaminants (oil) and other site characteristics. Natural attenuation relies on natural processes (including biodegradation, dispersion, dilution, sorption, evaporation, etc.) to achieve site-specific remedial objectives within a timeframe that is reasonable compared to that offered by other response activities (EPA, 1999), i.e., there is no attempt to remove stranded oil or minimize impacts to the environment. The decision to use natural attenuation may take place for cases in which: 1) oil is not accessible or recoverable; 2) when oiling has occurred on high-energy beaches or shorelines where wave action will remove a majority of the oil in a short period; 3) when there is a human health or worker safety issue (e.g., fast-moving water, rocky coastline, high-energy environment); 4) when it is determined (e.g., through a Net Environmental Benefit Analysis) that responding to the oil may do more harm than good, or 5) effective response options are unavailable (remote areas). "For areas in which a spill is logistically inaccessible for reasons of remoteness (e.g., the Arctic), stormy weather, or lack of equipment and manpower, natural attenuation might be the only option available" (National Research Council, 2013).
Examples:	Monitoring of oil would occur by taking air, water, soil, benthos, and/or biological samples using various methods. Likely to involve physical presence of samplers, observers, equipment deployment, e.g., core samples, and sampling protocols. Laboratories would likely need to be EPA-certified.
Availability in HI and Logistical Considerations:	Sufficient resources (personnel and equipment) are probably available on Oahu from government agencies, academia, and the private sector, e.g., contractors, to carry out monitoring of natural attenuation; long-term monitoring requirements would be established for "how clean is clean", NRDA, etc.
Limitations:	Environmental damage occurs from the spilled oil and may result from potential physical trauma impacts from monitoring and sampling activities if not done remotely. Public dissatisfaction with the oil spill response managers if no oil removal occurs; potential fisheries impacts. Debris and waste removal may occur.
Effectiveness:	Attenuation can be preferred in situations when the oil moves out to sea, or strands on remote, unpopulated shorelines, and where there are no spilled oil threats to TE species.

Monitoring of oil spill impacted marsh areas that had no oil recovery / treatment (Source: NOAA)

Air monitoring for atmospheric pollution adjacent to population centers (Source: EPA)

Monitoring impacts to natural resources, including seafood safety (Source: USCG)

Mechanical Containment & Recovery / Removal (primarily booming and skimming operations offshore)

Use of Response Option and Definition:

Physical barriers contain spilled oil and mechanical devices remove the contained oil from the water surface to mitigate environmental threats. This usually is the preferred method of oil spill response containment and recovery operations physically removes the oil from the environment.

- **Containment**: Boom is a floating, physical barrier placed on the water to contain, divert, deflect, or exclude oil. Implement booming strategies, methods, and resources to limit and control the spread of spilled crude oil on water; in offshore, as well as and nearshore environments.
- **Recovery / Removal** - Skimming systems are mechanical devices that physically remove the free or contained oil from the surface of the water. They are placed at the oil/water interface to remove, or skim oil from the water and can be operated independently from shore, be mounted on vessels, or be completely self-propelled. Recovery / removal operations are used to eliminate oil from the water surface to prevent or minimize sensitive shoreline resources and habitat.

Examples:

- **Containment** – Ocean boom (skirts >42") are used to contain oil in open, offshore waters. Tow boats are used to corral the oil. Consists of containment/ deflection boom, sorbents, pneumatic curtains, turbidity curtain, dams/dikes, interceptor trenching, underflow dams, pre-staged boom. Range from small, lightweight models suitable for small spills in very sheltered waters that can be deployed manually to large, open ocean boom that require vessels, cranes, and personnel to handle them.
- **Recovery / Removal** – Skimmers are rated by their rate of recovery and storage capacity, i.e., D rating. Some boom systems have integrated skimmers. Skimmers can also be separate. They must either decant or offload to temporary storage to enable continuous operations. System consists of booms, self-propelled skimmers, stationary skimmers, advancing skimmers, (brush, drum, weir, dynamic, inclined plane). Under some conditions, nets, trawls, pumps, dredge, divers, vacuum system, airlift, bottom trawls can also be used to remove oil from the water.

Availability in HI and Logistical Considerations:

Many resources are available on Oahu to initiate a response to a significant spill. Refer to the Hawaii Area Contingency Plan (HACP) Section 5000: Logistics for the Response Resource Inventory (RRI). Summary: Approx. 31,344' of ocean boom (42"-76") and 46 skimmers/systems (varying D rated capacity) are available from CIC, USN, MSRC, USCG DRAT, PEC. Offshore storage systems also available; CIC has 3 oil/water separators. Some boom is staged at Barbers Pt. and Kahe Pt.

Limitations:

Containment and recovery amount is dependent on the encounter rate of the containment/skimmer system. The encounter rate is the rate (area x speed) at which spilled oil can be accessed by the response option. For most oil spills on water, time and incident-specific conditions limit the effectiveness of containment operations. By the time response personnel and equipment arrive on scene, significant spreading of the oil has begun taking place. Requires permanent disposal of potentially large volumes of recovered oil and oily water.

- **Containment** - Sufficient quantity and speed of boom deployment is critical to reduce spread of oil on the water surface. Wind, waves, and currents affect the containment capabilities; boom typically fails (i.e., entrainment, oil escapes) in currents greater than 0.7 knots; tow boats operate to avoid entrainment.
- **Recovery/Removal** - Weather impacts skimming; skimming is less effective in rough water (waves greater than 2-3 ft. in height) and strong currents. Rising wind and waves, debris, and seaweed will reduce recovery efficiency. The Type of skimming system must be selected for the type of oil. In cases involving heavy or submerged oil, it will be difficult to locate and remove.

Effectiveness:

On average, a 10 to 15% recovery rate of the spilled oil from the water surface is considered effective; the maximum is 20-30% which has been for heavy, floating oil spilled nearshore and response equipment.

- **Containment** - Very effective if deployed correctly based on current speed. Turbidly, silt, and pneumatic curtain effectiveness may be impacted by current, and difficult to hold in place.
- **Recovery/Removal** - Skimmers can be used in all water depths. Skimming vessels are slow moving, aimed at surface water, and typically deployed in areas where the floating oil is aggregated, either naturally or by other response activities. Brush skimmers are very effective and efficient for heavy oils. DIP and drum skimmer very effective for light oils. Diver effectiveness impaired by low visibility, and differentiating oil from mud.

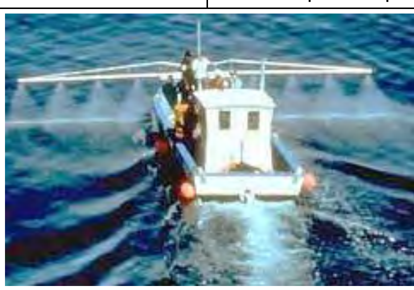
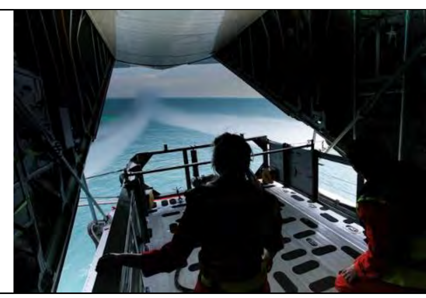
Deploying boom for containment operations (Source: USCG)

Large vessel on water recovery operations skimming system (Source: Clean Gulf Associates)

On water recovery operations using a weir-type skimming system (Source: USCG)

Chemical Dispersion (applied to water surface offshore in accordance with NCP and regional policy)

Use of Response Option and Definition:	Applications of NCP-listed, stockpiled, chemical dispersants are applied to targeted floating oil on the water surface to reduce floating oil slicks and potential shoreline oiling. If mechanical containment and recovery response measures can't effectively or safely "remove" the oil, and it is determined that allowing a surface slick to remain poses risk of harm to (in particular) seabirds, marine mammals, and sea turtles which are likely to encounter the oil at the surface interface, then shifting the oil threat from the water surface to the upper water column through the application of chemical dispersants is a legal response option, according to national and regional/Hawaii policy (HACP-Section 4350 and 40 CFR 300.910(d)). The decision to use chemical dispersants will be based on the location and nature of the spill, prevailing environmental conditions, and the concept of net environmental benefit (NEBA).
Examples:	Water surface applications allowed in Hawaii by fixed-wing aircraft, helicopter, boats – each with differing encounter rates/swath width and ability to operate offshore.
Availability in HI and Logistical Considerations:	Dispersant application capability and response equipment available on Oahu: • USCG Sector Honolulu owns the C-130 aircraft that is used for dispersant response program in Hawaii • Clean Islands Council (MSRC) maintains two Simplex helicopter buckets, an ADDS Pack dispersant application system to allow rapid deployment into a USCG C-130 aircraft based at Barbers Pt. and SMART monitoring capability https://response.restoration.noaa.gov/smart • State of Hawaii owns 27,080 gallons of Corexit 9500 The Oceania Regional Response Team (ORRT) preauthorized use of dispersants in 1997, as defined in Section 4530 of the ORRT Dispersant Plan. Interim revised agreement (2017) adds new conditions. The authority for use of dispersants in these preauthorized areas rests with the FOSC; NOAA may make recommendations within 6 hours. Resources in Hawaii would enable approximately six (6) sorties to apply dispersants via C-130. Aerial dispersants generally applied at dispersant-to-oil-ratio (DOR) of 1:20, usually 5-gals/acre, droplet size 300-500 microns (human hair is ~100 microns), and at spray height of 75-150 feet.
Limitations:	Generally, not effective on heavy or emulsified oil or high winds. Requires observers to monitor using SMART protocols and avoid possible TE species in the area. Applicator needs to be close enough, and have sufficient quantity to sustain coverage. No aerial applications at night. Boat spray may be possible at night, if required, with sufficient lighting.
Effectiveness:	Most effective when applied to non-weathered oil. 50% effectiveness is assumed in trajectory for this scenario. In actual situations, appearance post-treatment of café-au-lait color indicates higher effectiveness approaching 100%. In Hawaii, with pre-staged resources, aerial application of dispersants likely to deliver the fastest and highest encounter rate of initial response options to control spilled oil.

		
Boat spray dispersant application (Source: NOAA)	*Aerial fixed wing dispersant application (Source: USCG)*	*Aerial dispersant application from inside a C-130 Hercules using an ADDS dispersant application system*

Appendix B:

NOTE: In-situ Burning / ISB was ultimately removed from the list of response options being evaluated during the Hawaii NEBA process; refer to Section 4.2 for more details.

***In-situ* Burning/ISB (in accordance with NCP and regional policy)**	
Use of Response Option and Definition:	Controlled burning of oil in-situ can remove oil on the water surface offshore (sufficient distance from populations) or on shore in remote locations, e.g., NW Hawaiian Islands. The preferred method for *in-situ* burning on water uses a burn or fire boom to surround an oil slick, move it away from the source, concentrate the oil, and ignite it. The Oceania Regional Response Team (ORRT) has approved the preauthorized use of *in-situ* burning by the FOSC in response to oil discharges on waters around the State of Hawaii when, human life is threatened or when all of the following three conditions are met (refer to the HACP, Section 4350(C)): • *In-situ* burning is a viable option for removal of the oil with appropriate weather parameters (i.e., sea state) and if fire boom can be effectively used; • Winds are blowing offshore; or if winds are variable or blowing onshore, the State of Hawaii Department of Health advises that the potential plume caused by the burn will not expose human populations to more than 150 ug/m3 of particulate less than 10 microns in diameter averaged over a one-hour period as determined by the OSC; and • The plume or heat from the burn will not result in greater impact to sensitive wildlife resources than would the spilled oil. SMART monitoring required https://response.restoration.noaa.gov/smart On land *in-situ* burn equipment is not addressed in the HACP.
Examples:	Fire boom, boom boats, igniters, air monitors, possibly equipment to recover any floating or onshore tarry residues. *In-situ* burning on land is not addressed in this scenario.
Availability in HI and Logistical Considerations:	• 1,000 feet of (reusable) fire boom and SMART capability is available from CIC/MSRC. If requested, another boom can be used for *in-situ* burning, but it will not be reusable. • In general, *in-situ* burning operational monitoring easily established to provide feedback for if/when to halt a burn, can be conducted at night, and results in: • High efficiency oil removal rates from the water or on land; minimal disposal – residual oil only • Less equipment and labor intensive than other countermeasures
Limitations:	• Ineffective on weathered/emulsified oil • Physical containment (boom, barriers, herding agents) is typically necessary to maintain thickness on water. Same encounter rate as offshore booming; no skimming needed. • Lower wind speeds required for ignition, to sustain a burn, and a sea state of less than 3 to conduct a burn. • Access to fire boom, igniter, and tender boats is often the limiting factor. • Requires trained operators, PPE, SMART and air monitoring, and includes spotters to direct containment of oil on water. • Requires observers to monitor and avoid possible TE species in the area. • Once ignited, the burn will continue until the slick is 1-2 mm on water, so there will often be a burn residue for burns on water; residues can sink in burn area and directly affect resources associated with the bottom • Smoke could travel toward land and become an inhalation hazard to the public, responders, and resources of concern.
Effectiveness:	Effectiveness on water is determined by ability to contain oil inside boom, sea state, non-weathered oil of sufficient thickness to sustain a burn. High rates of effectiveness during DWH.

		
In-situ *burning operations for the MC252 response (Source: USCG)*	*Oil being collected within a fire boom for* in-situ *burning, prior to ignition (Source: USCG)*	*Deploying the slick ignition device to initiate an* in-situ *burn (Source: USCG)*

Resource Protection (nearshore exclusion and diversion booming, resource removal and relocation, hazing)

Use of Response Option and Definition:	HACP identifies protection strategies (ACP) using anchored, stationary exclusion and deflection booming to protect sensitive areas, water intakes, and fisheries. The Geographic Response Plans (GRPs) identified for Sector Honolulu have been developed to includes tactical response strategies to protect specific shoreline or waterway area at risk of injury from oil. GRPs have two main objectives: • Identify sensitive natural, cultural or significant economic resources at risk of injury from oil spills; and • Describe and prioritize response strategies to reduce injury to sensitive natural, cultural, and certain economic resources at risk from oil spills. Resource protection can also include wildlife protection activities to move (or physically remove) wildlife from locations that are in the predicted path of the spilled oil removal, relocation, and hazing operations for potentially impacted resources (e.g., relocation of sea turtle nests; hazing of birds, removal of individual Hawaiian monk seals on a beach).
Examples:	Harbor boom (12- to 18-inch) for protection/deflection due for shallow water and ease of use; 18-inch boom for deeper water areas. Turbidity and silt curtain may be used for submerged oil. Recovery of contained oil would occur via skimmers or vacuum devices. Wildlife hazing, frightening methods, techniques and removal options are directed by many species, such as migratory birds, are federally protected. Hazing of these species may violate federal law. Hazing should not be used during the nesting season. No single technique or tool will deter birds in every instance or situation; successful bird dispersal involves a combination of tools and timing of use, as well as the skill and persistence of biologists and wildlife control operators (WCOs).
Availability in HI and Logistical Considerations:	Many resources are available on Oahu to initiate a response to a significant spill. Refer to the Hawaii Area Contingency Plan (HACP) Section 5000: Logistics for the Response Resource Inventory (RRI). Summary: Approx. 54,250 feet of harbor boom available from CIC, MSRC, DRAT, USN Pearl Harbor; 46 skimmers/systems (varying D rated capacity) are available from CIC, USN, MSRC, USCG DRAT, PEC; CIC has 3 oil/water separators; 19 vacuum tanker trucks and trailers are in the RRI.
Limitations:	Damage to substrate by anchors to hold boom in place; requires 24/7 tending for tidal currents. Many sensitive areas identified in the ACP. Nearshore corals may impact placement of protection boom. Current and tide necessitates boom to be tended at every tide cycle. For ESA-listed marine mammals, any response actions such as hazing, rescue, euthanasia and carcass recovery are direct takes that would be covered by the Marine Mammal Health and Stranding Response Program's permits. Any takes that occur incidental to response activities (flushes of endangered pinnipeds off a beach due to human presence, large whales changing course to avoid skimmers, etc.) would either need to be considered under emergency consultation or covered under an existing biological opinion for response planning.
Effectiveness:	Effectiveness depends on: proper anchoring, 24-hr. tending, equipment type, oil type, wind and wave conditions, and weather. The Geographic Response Plan (GRP) protection strategies are designed to address floating oils. Many of these strategies have been tested through various equipment deployment exercises and during actual responses. The protection strategies, tactics, and equipment listed in the GRP are based on the simple principle that oil floats. However, oil does not always float--sometimes it suspends in the water column; sometimes it sinks to the bottom of the water body; and sometimes it does all three. Currently, the GRP does not address submerged or sunken oil. Example resources and strategies for sunken oil detection and recovery are outlined in API's (2016) Sunken Oil Detection and Recovery Operational Guide; API Technical Report 1154-2.

Exclusion booming strategy (Source: MCB Kanehoe)

Sea turtle egg removal and relocation in advance of a spill (Source: NOAA)

Hawaiian monk seal pup successfully relocated by a team of expert handlers and veterinarians (Source: HI DLNR)

Shoreline Clean-up (Onshore oil collection and removal)

Use of Response Option and Definition:	Removal of oil from the shoreline for disposal to limit further contamination of human use area and ecologically-sensitive areas and habitat. Involves implementation of Shoreline Cleanup Assessment Technique (SCAT). Key issues include: • Can use of dispersants reduce the amount of oil on the shore? If so, how important is that in Hawaii? Does removing oil do more ecological harm than leaving it? How clean is clean enough? • Does any residual oil constitute a perception of risk by the public? See NOAA publications on SCAT https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/shoreline-cleanup-and-assessment-technique-scat.html and Shoreline Treatment Manual for Tropical Environments https://response.restoration.noaa.gov/sites/default/files/shoreline_countermeasures_tropical.pdf
Examples:	Different types of equipment and strategies can be used to promote evaporation, weathering or removing oiled material off a beach or shoreline. Can involve manual removal, motorized vehicles to pull the equipment or conduct the activity, or mechanical equipment to clean or remove sand/sediments >1-inch deep. Example techniques: • Manual Removal / Cleaning of Oil, Oiled Sediment, Debris, or Vegetation – use of hand tools, vacuum trucks, storage tanks, sorbent, laborers with PPE for removal of oiled sand, debris, etc. and other oiled material directly off a shoreline / beach and hauls it to a loading area. Used on mud, sand, gravel, cobble when oil is light, sporadic, and/or at or near the beach surface, or when there is no beach access for heavy equipment (Exxon Mobil, 2014) • Mechanical Recovery - oiled sediment and debris are removed by specialized mechanical sand cleaning or excavation equipment (beach cleaners). Equipment removes only the top 1 inch of sediment. • Flushing – use of ambient water sprayed at low pressures to flush an affected area for recovery; higher temperature / high pressure water may also be used to mobilize the oil. • Steam Cleaning – steam or very hot water sprayed with hand-held wands at high pressure to remove heavy residual oil from solid substrates or man-made structures, e.g., bulkheads in harbor. • Sandblasting - removal of heavy residual oil from solid man-made structures, e.g., bulkheads in harbor, via sand moving at high velocity.
Availability in HI and Logistical Considerations:	Consult the Hawaii Area Contingency Plan – Section 5000 – Logistics for a list of the Oil Spill Response Organization (OSRO) equipment lists from the Response Resource Inventory (RRI). CIC has specific shoreline equipment for oil spill use, e.g., beach rakes, flushing, steam cleaning. Other general use mechanical equipment is also available from various sources.
Limitations:	Always requires some degree of incident-specific choice of cleanup methods, and determination of cleanup endpoints (i.e., how clean is clean decision making without causing additional damage). Debris removal, recovery method based on shoreline type and oil type, access may be difficult, impact habitats, and will require temporary and long-term disposal. Habitat and/or wildlife disturbance or loss from noise, crushing, presence of people; Can distribute the contamination deeper into sediments and across the shoreline (including long-term, low-level exposure to PAHs if contaminated sediments are moved deeper into the beach).
Effectiveness:	Depends on many factors; oil type – heavy vs. light oils, degree of oiling, amount of debris, tide range impacts work schedule.

		
Mechanical recovery systems for removing oil from shorelines / beaches (Source: USCG)	*Shoreline cleanup operations with removal (Source: USCG)*	*Manual shoreline cleanup operations (Source: USCG)*

Appendix C:
Ecological and Human Resources of Concern

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Appendix C: Hawaii NEBA - ENVIRONMENTAL RESOURCES OF CONCERN

Habitat	Sub-habitat	Resource Category	Example Representative (keystone or surrogate) Species that could be impacted by oil or the response
Key: **E – Endangered species (federal or state listed)** **P – Protected species (federal or state listed)** **C – Resource of cultural significance**			**T – Threatened species (federal or state listed);** **I – Incidental in Hawaii**
On Land Environments (above the high, high tide line)			
TERRESTRIAL	On shore, above mean high, high tide line	**Vegetation**	• Trees (coconut) • Grasses, shrub, scrub • Kamani (**C**) • Kukui: wetlands (**C**)
		Non-T/E Birds	• Shorebirds • Songbirds (in trees and shrubbery) • Wading birds • Water birds (néné) • Raptor (owl & hawk) • Seabird (burrows/ cliffside; nesting)
		Non-T/E Mammals	• Invasives: rats, feral cats, mongoose • Other, e.g., domesticated animals
		Non-T/E Reptiles	• Lizards, land turtles
		Non-T/E Insects	• Yellow-faced bees (**E**), • Other pollinators
		T/E Species - ANIMALS	• Mammals: Hawaiian Monk Seal (**E**) basking • Birds: Wading Birds - Hawaiian stilt (**E**), Hawaiian moorhen (**E**), Hawaiian duck (**E**), Hawaiian coot (**E**) • Reptiles: Sea Turtles (Green and Hawksbill);
		T/E (or Rare) Species - PLANTS[1]	• Example: *Sesbania tomentosa* (**E** / **E**) (State/Federal Endangered)
		Critical Habitat	• Hawaiian Monk Seal designated Critical Habitat • Not yet designated - Sea Turtle nests

[1] State lists: http://dlnr.hawaii.gov/dofaw/rules/endangered-plants/ ; federal list https://ecos.fws.gov/ecp0/reports/species-listed-by-state-report?state=HI&status=listed

Appendix C: Hawaii NEBA - ENVIRONMENTAL RESOURCES OF CONCERN

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Key: **E – Endangered species (federal or state listed)** **P – Protected species (federal or state listed)** **C – Resource of cultural significance**			**T – Threatened species (federal or state listed);** **I – Incidental in Hawaii**

Nearshore Environments (within the Fringing Reef / Photic Zone)			
INTERTIDAL **Supratidal line to the mean low, low tide line**	May include: Reef flats, Rocky platforms, Tidal flats, Sand beaches, Man-made structures, e.g., fish ponds, bulkheads, Anchialine ponds	**Vegetation**	• Seaweed / algae (C) • Seagrasses • Stranded seaweed
		Calcified Algae	• Crustose coralline algae
		Sponges	• Only near hard bottom, not near beaches
		Corals and Live Rock	• Species at < 5-meter water depth (P) • Live Rock (P) • Spawning periods
		Non-T/E Birds	• Shorebirds • Wading Birds • Waterfowl
		Non-T/E Mammals	• Feral cats, mongoose
		Non-T/E Reptiles	• Not present
		Non-T/E Fish	• Estuarine-dependent fish • Reef fish
		Non-T/E Shellfish and Other Invertebrates	• Mobile species (e.g., A'ama) • Sessile / sedentary species (e.g., Opihi) • Crustaceans • Echinoderms
		T/E (or Rare) Species – ANIMALS	• RARE: 8 genetically distinct lineages at the Anchialine pool shrimp only in Waianae • Birds: Wading birds - Hawaiian stilt (E), Hawaiian moorhen (E); Waterfowl – Hawaiian duck (E), Hawaiian coot (E) • Mammals: Hawaiian Monk Seal (E) • Reptiles: Sea Turtles - Green sea turtle (T); Hawksbill sea turtle (E) • Anchialine pond shrimp (E) (note: potential exposure via tidal flushing subsurface, not surface connection to open water
		T/E (or Rare) Species – PLANTS	• None federally listed
		Critical Habitat	• Hawaiian Monk Seal designated Critical Habitat (specific sandy beaches – basking habitat) • Anchialine ponds Critical Habitat • Not yet designated - Sea Turtle habitat (also specific sandy beaches for basking habitat, and clean waters)

Habitat	Sub-habitat	Resource Category	Example Representative (keystone or surrogate) Species that could be impacted by oil or the response
Key: **E – Endangered species (federal or state listed)** **P – Protected species (federal or state listed)** **C – Resource of cultural significance** **T – Threatened species (federal or state listed);** **I – Incidental in Hawaii**			
Nearshore Environments (within the Fringing Reef / Photic Zone), Continued			
SUBTIDAL Shallow water (lower low tide line to the bottom, up to 20-meters water depth	**WATER SURFACE** Based on mixing zones and where the life is 0 to 2-meter water depths	**Vegetation**	• Seaweeds (C) • Seagrasses
		Calcified Algae	• Crustose coralline algae
		Coral and Live Rock	• < 5-meter water depth (E) • Live Rock (E)
		Sponges	•
		Non-T/E Birds	• Seabirds
		Non-T/E Mammals	• Cetaceans: Spinner dolphin (P); other protected species under MMA but not TE listed
		Non-T/E Reptiles	• Not present
		Non-T/E Fish	• Reef fish
		Non-T/E Shellfish and Other Invertebrates	• Gastropod molluscs • Bivalve molluscs • Crustaceans • Echinoderm
		T/E Species - ANIMALS	• Birds: Seabirds - Hawaiian petrel (E); Newell's shearwater (E) • Fish: Giant Manta Ray (T) • Mammals: Hawaiian Monk Seal (E) • Reptiles: Green sea turtle (T); Hawksbill sea turtle (E); Leatherback sea turtle (E, I); Loggerhead sea turtle (E, I); Olive Ridley sea turtle (E, I)
		T/E (or Rare) Species - PLANTS	• None federally listed
		Critical Habitat	• Hawaiian Monk Seal Critical Habitat • Not yet designated - Sea Turtle habitat
	WATER COLUMN >2-meters water depth but 1- to 2-meters above the bottom	**Non-T/E Birds**	• Seabirds: boobies, non-endangered shearwaters, white terns
		Non-T/E Mammals	• Cetaceans: Spinner dolphin (P), • Other protected species under MMA but not TE listed
		Non-T/E Reptiles	• Sea Turtles: Green sea turtle (T); Hawksbill sea turtle (E); Leatherback sea turtle (E, I); Loggerhead sea turtle (E, I); Olive Ridley sea turtle (E, I)
		Non-T/E Fish	• Reef fish • Pelagic fish
		Non-T/E Shellfish and other Invertebrates	• Mobile species (squid, cuttlefish, octopi) • Crustaceans
		T/E Species - ANIMALS	• Birds: Seabirds - Hawaiian petrel (E); Newell's shearwater (E) • Fish: Giant Manta Ray (T) • Mammals: Hawaiian Monk Seal (E) • Reptiles: Green sea turtle (T); Hawksbill sea turtle (E); Leatherback sea turtle (E, I); Loggerhead sea turtle (E, I); Olive Ridley sea turtle (E, I)
		T/E (or Rare) Species - PLANTS	• None federally listed
		Critical Habitat	• Hawaiian Monk Seal Critical Habitat • Seagrass (*e.g., Halophila*) – not listed; unique and a habitat for other species • Essential Fish Habitats • Not yet designated - Sea Turtle habitat

Habitat	Sub-habitat	Resource Category	Example Representative (keystone or surrogate) Species that could be impacted by oil or the response
Key: E – Endangered species (federal or state listed) P – Protected species (federal or state listed) C – Resource of cultural significance			T – Threatened species (federal or state listed); I – Incidental in Hawaii
Nearshore Environments (within the Fringing Reef / Photic Zone), Continued			
SUBTIDAL **Shallow water (lower low tide line to the bottom, up to 20-meters water depth**	**BENTHOS** Includes the bottom and 1 to 2-meters of water column above the bottom	**Vegetation**	• Seaweeds (C) • Seagrasses
		Calcified Algae	• Crustose coralline algae
		Corals and Live Rock	• < 5-meter water depth (E) • Live rock (E)
		Sponges	•
		Non-T/E Birds	• Shorebirds • Wading Birds • Waterfowl
		Non-T/E Mammals	• Cetaceans – spinner dolphin (P); other species (P, I)
		Non-T/E Reptiles	• Not present
		Non-T/E Fish	• Bottom fish
		Non-T/E Shellfish and other Invertebrates	• Mobile species (squid, cuttlefish, octopi) • Sessile/stationary species • Crustaceans • Echinoderms
		T/E Species - ANIMALS	• Fish: Giant Manta Ray (T) • Mammals: Hawaiian Monk Seal (E) • Reptiles: Green sea turtle (T); Hawksbill sea turtle (E); Leatherback sea turtle (E, I); Loggerhead sea turtle (E, I); Olive Ridley sea turtle (E, I)
		T/E (or Rare) Species - PLANTS	• None federally listed
		Critical Habitat	• Hawaiian Monk Seal Critical Habitat • Seagrass (*e.g., Halophila*) – not listed; unique and a habitat for other species • Essential Fish Habitat • Not yet designated - Sea Turtle habitat

Appendix C: Hawaii NEBA - ENVIRONMENTAL RESOURCES OF CONCERN

Habitat	Sub-habitat	Resource Category	Example Representative (keystone or surrogate) Species that could be impacted by oil or the response
Key: E – Endangered species (federal or state listed) P – Protected species (federal or state listed) C – Resource of cultural significance			T – Threatened species (federal or state listed); I – Incidental in Hawaii
Offshore Environments (> 1 mi. on water, open coastal outside of the fringing reef)			
	WATER SURFACE Based on mixing zones and where the life is 0 to 2-meter water depths	**Plankton**	• Zooplankton • Phytoplankton
		Non-T/E Birds	• Seabirds: boobies, non-endangered shearwaters
		Non-T/E Mammals	• Cetaceans: Spinner dolphin (P); Other protected species under MMA but not TE listed (e.g., Humpback whales (P));
		Non-T/E Reptiles	• Not present
		Non-T/E Fish	• Pelagic fish
		Non-T/E Shellfish and other Invertebrates	• Nekton • Squid at night • Mobile species • Crustaceans
		T/E Species - ANIMALS	• Birds: Seabirds - Hawaiian petrel (E); Newell's shearwater (E); • Fish: Giant Manta Ray (T); • Marine Mammals: Hawaiian Monk Seal (E); Hawaiian Insular False Killer Whale (E); Other cetaceans – sperm and transient humpbacks (E, T, P, I); • Reptiles: Green sea turtle (T); Hawksbill sea turtle (E); Leatherback sea turtle (E, I); Loggerhead sea turtle (E, I); Olive Ridley sea turtle (E, I)
		T/E (or Rare) Species - PLANTS	• None federally listed
		Critical Habitat	• Hawaiian Monk Seal Critical Habitat • Hawaiian Insular False Killer Whale • Hawaiian Humpback whale sanctuaries • Not yet designated - Sea Turtle habitat
SUB-SURFACE over 2-meter water depth	**WATER COLUMN** Based on mixing zones and where the life is From 2-meter water depth up to 10 fathoms (20 meters); Does not include 1 to 2 meters of water column above the bottom	**Vegetation**	• Zooplankton • Phytoplankton
		Calcified Algae	• Crustose coralline algae
		Coral and Live Rock	•
		Sponges	•
		Non-T/E Birds	• Seabirds (boobies, sheerwaters, petrels)
		Non-T/E Mammals	• Cetaceans – spinner dolphin (P); other species (P, I) • Mobile species • Crustaceans (shrimp)
		Non-T/E Reptiles	• Not present
		Non-T/E Fish	• Pelagic fish
		Non-T/E Shellfish and other Invertebrates	• Nekton • Squid at night • Mobile species • Crustaceans
		T/E (or Rare) Species - ANIMALS	• Marine mammals: Hawaiian Monk Seal (E); Humpback whales (E); Hawaiian Insular False Killer Whale (E) • Reptiles: Green sea turtle (T); Hawksbill sea turtle (E); Leatherback sea turtle (E, I); Loggerhead sea turtle (E, I); Olive Ridley sea turtle (E, I)

Habitat	Sub-habitat	Resource Category	Example Representative (keystone or surrogate) Species that could be impacted by oil or the response
Key: E – Endangered species (federal or state listed) P – Protected species (federal or state listed) C – Resource of cultural significance T – Threatened species (federal or state listed); I – Incidental in Hawaii			

		T/E (or Rare) Species - PLANTS	• None federally listed
		Critical Habitat	• Hawaiian Monk Seal Critical Habitat • Hawaiian Insular False Killer Whale (coming soon) • Not yet designated - Sea Turtle habitat
Offshore Environments (> 1 mi. on water, open coastal outside of the fringing reef), Continued			
SUB-SURFACE over 2-meter water depth	**Bottom / Benthos** On the bottom; Includes 1 to 2-meters of water column above the bottom	**Vegetation**	• Seaweeds (C) (*Halimeda kanaloana*[2] - meadows similar to sea grasses) turtle feeding areas • Seagrasses • 4 New species of deep water algae – with spiritual connection (C)
		Crustose Algae	• Crustose coralline algae
		Corals and Live Rock	• < 5-meter water depth (E) • < 5-meter water depth (E) • Live rock (E)
		Sponges	•
		Meiofauna and Infauna	•
		Non-T/E Mammals	• Cetaceans – Other species (P, I), sperm whale,
		Non-T/E Reptiles	• Not present
		Non-T/E Fish	• Reef fish • Bottom fish • Pelagic fish
		Non-T/E Shellfish and other Invertebrates	• Mobile species • Sessile species • Crustaceans • Echinoderms
		T/E Species - ANIMALS	• Marine Mammals: Hawaiian Monk Seal (E); Hawaiian Insular False Killer Whale (E); Other species (E, T, P, I) • Fish – Giant Manta Ray (T) • Reptiles: Green sea turtle (T); Hawksbill sea turtle (E); Leatherback sea turtle (E, I); Loggerhead sea turtle (E, I); Olive Ridley sea turtle (E, I)
		T/E (or Rare) Species - PLANTS	• None federally listed
		Critical Habitat	• Hawaiian Monk Seal Critical Habitat (up to 200m isobaths) • Hawaiian Insular False Killer Whale Critical Habitat • Restricted deep-water coral habitat • *Halimeda* Algae – deep water • Essential Fish Habitat • Not yet designated - Sea Turtle habitat

[2] https://oceanexplorer.noaa.gov/explorations/04algae/background/algal_meadows/algal_meadows.html

Appendix C: Categories of Human Resources of Concern at Potential Risk from Oil Spills in Hawaii

Habitat	Sub-habitat	Resource Category	Examples
On-land and On-Water – Areas and Uses	**On Land, spill-affected and nearby areas** *(e.g. tourist beaches and sites, parks & recreational areas, port areas).*	**Response Workers**	• Adults only. • Spill responders (on land) involved in safety monitoring, oil recovery operations (on land), oil contamination monitoring/SCAT, wildlife recovery/rehabilitation
		Tourism / Commerce	• Hotels, restaurants, beaches, retail, tourist destinations; other shoreline commercial facilities; other recreational & commercial on-water facilities) • Tourism-based services (boating, charter fishing, snorkeling, scuba diving, parasailing, dinner cruise, beach bars, photography)
		Recreational Use	• Lost human use (parks, recreational boating, recreational fishing, etc.) • Personal watercraft displaced
		Transportation, On land & Air	• Commercial/military marine transportation, public transportation: bus, rail, interisland vessel: drivers, passengers; nearby airports); • Commercial goods movement for ship
		Industry	• Nearby power plants, ports/harbors; commercial port facilities, e.g., vessel services, lightering, wharfs, etc.) • Proprietary information • Security and access
		Military	• Military bases; • Security and access
		Historic / Cultural Issues; Subsistence / Personal Use	• Protected sites; • Locations of cultural value and/or significance; places where like communities gather • Personal consumption; • Fishing (e.g., limu/seaweed gathering, a'ama crabs), Lokos, etc.; • Social Cultural sites; • Spiritual (Aumakua)
		Residential Community	• single and multi-family residences); • US live-aboards & Foreign (domestic fishing fleet) live-aboards
		Sensitive or Vulnerable (under-represented and underserved) in terms of Resiliency	• Children, pregnant women, elderly, sick in daycare centers, hospitals, nursing homes • Chemo-sensitives and Immuno-compromised • Transient Communities • Low income/poverty/unemployed • High population densities • Declining social capital communities – encompass the same values and live together • Domestic disharmony
		Management Areas	• State and Federally management areas established for the protection of natural resources (e.g., national refuges, state special management areas, etc.)

Appendix C: Categories of Human Resources of Concern at Potential Risk from Oil Spills in Hawaii

Habitat	Sub-habitat	Resource Category	Examples
On-land and On-Water – Areas and Uses	**On Water, spill affected and nearby areas** *(e.g., nearshore and on water areas, beaches, marine recreational boating, commercial vessels, port, subsurface water intakes, etc.)*	**Response Workers**	• Adults only • Spill responders involved in safety monitoring, oil recovery operations on water, oil contamination monitoring; wildlife recovery
		Tourism / Commerce (paid for services)	• Cruise ships and whale watching • Tourism-based services (boating, charter fishing, snorkeling, scuba diving, parasailing, dinner cruise, photography)
		Recreational Use (not paid for services; on own nickel)	• Lost human use (parks, recreational boating, recreational fishing, surfing, snorkeling, scuba diving • Personal watercraft displaced
		Transportation, Maritime	• Potentially all (commercial/military marine transportation, public transportation: bus, rail, interisland vessel: drivers, passengers; nearby airports) • Ship at anchorages • Ships transiting the area (big ships that can't enter because of incident)
		Industry	• Adults (Nearby power plants, ports/harbors; military bases; commercial port facilities, e.g., vessel services, lightering, wharfs, etc.)
		Military	• Adults (Nearby power plants, ports/harbors; military bases; commercial port facilities, e.g., vessel services, lightering, wharfs, etc.)
		Historic / Cultural Issues; Subsistence / Personal Use	• Protected sites; locations of cultural value and/or significance • Personal consumption; fishing (e.g., recreational fishing, limu/seaweed gathering, a'ama crabs), Lokos, etc. • Hawaiian canoe paddling • Personal consumption; • Fishing (e.g., limu/seaweed gathering, a'ama crabs), Lokos, etc.; • Social Cultural sites and family fishing sites (e.g., Ko'a) – passed down by family; • Spiritual (Aumakua) and general aesthetic losses (spinner dolphin)
		Residential Community	• US live-aboards and Foreign (domestic fishing fleet) live-aboards
		Sensitive or Vulnerable (under-represented and underserved) in terms of Resiliency	• Children, pregnant women, elderly, sick in daycare centers, hospitals, nursing homes • Chemo-sensitives and Immuno-compromised • Transient Communities (including homeless and hard to communicate populations) • Low income/poverty/unemployed • Declining social capital communities – encompass the same values and live together • Domestic disharmony
		Management Areas	• State and Federally management areas established for the protection of natural resources (e.g., national marine sanctuaries, state special management areas, etc.)

Appendix C: Categories of Human Resources of Concern at Potential Risk from Oil Spills in Hawaii

Habitat	Sub-habitat	Resource Category	Examples

<u>Human Hazards/Stressors and Definitions</u>

(pathways of exposure to hazards and/or stressors leading to spill-related impacts[1])

[1] The conceptual model defines links/pathways between hazards/stressors and impacts while oil is mobile on water, or when oil has stranded on shore. Stressors are not ranked.

[2] The physical hazards below include only those related to spilled oil and response options. Other physical hazards such as but not limited to slips, trips, falls, sunburn, heat stress, biologicals, e.g., stings, are excluded.

[3] OSHA HAZWOPER for marine oil spills addresses personal protective equipment (PPE) and training to protect workers from physical hazards 1-4 below. Therefore, these hazards assume *accidental* exposure for workers

Physical Hazards[2,3] - direct and indirect

1. **Inhalation** – direct affects from respiratory tract exposure to oil and oil components (vapors) in the air; breathing particulates in the air.
2. **Dermal Absorption (atmospheric)** – direct effects from dermal/skin exposure to oil and oil components dissolved and chemically dispersed in the air; via skin contact and skin absorption.
3. **Dermal Absorption / Ingestion (in water)** – direct affects from dermal contact with oil, chemical dispersant, chemically-dispersed oil, or other contaminant associated with the response; this includes skin, mucosal membranes (eyes, nose, etc.) and direct ingestion exposure (e.g., swimming) from water column contaminants.
4. **Ingestion** – indirect hazard, accidental exposure, and impact to digestive tract via consumption of oil or chemically-dispersed oil-affected resources (e.g., seafood) or water from the contaminated areas.
5. **Perceived risk of physical hazards** – indirect stressor, not validated by science but perceived as real, e.g., disbelief that seafood is safe to purchase, harvest, consume.
6. **Allostatic Load** – **"**the wear and tear on the body" that accumulates as an individual is exposed to repeated or chronic stress. It represents the physiological consequences of chronic exposure to fluctuating or heightened neural or neuroendocrine response that results from repeated or chronic stress) - multiple stressors can impact physical health and corrode relationships among families, communities, e.g., interpersonal toxicity.

Socioeconomic Stressors - direct and indirect

7. **Closures (prohibition of use), loss (temporary, permanent)** – loss of livelihood (e.g., commercial fishing), subsistence/personal use fishing; water intakes; tourism/recreation; cultural and/or spiritual value/use.
8. **Uncertainty/ambiguity/unfamiliarity** – uncertainty regarding nature, extent and duration of damage; ambiguity of harm; oil spills are less familiar than natural disasters, e.g., storms.
9. **Compensation/claims processes and outcomes** – typically adversarial and protracted; potential inequitable compensation.
10. **Recreancy** – the failure of institutional actors to carry out their responsibilities with the degree of vigor that is necessary to merit the societal trust they enjoy; loss of trust in authorities and risk managers.
11. **N/A** – no interaction or no effect

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Appendix D:
Biological Data Sheets

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Appendix D:

Fact Sheets for Federally Threatened and Endangered Species for the Hawaii Oceania Regional Response Team Net Environmental Benefits Analysis (NEBA) Scenario – Barbers Point, Oahu

Table of Contents:

Species Name	Species Category	ESA Designation (Year)	Critical Habitat in Hawaii	Page Number
15. Hawaiian Petrel	Bird	Endangered (1967)	N/A	D-33
16. Hawaiian Coot	Bird	Endangered (1970)	CH - 2003	D-35
17. Oahu Riverhemp	Plant	Endangered (1994)	N/A	D-37
18. Giant Manta Ray*	Fish	Threatened (2018)	N/A	To be developed

*The Giant Manta Ray was listed as "Threatened" effective February 21, 2018.

NEBA Data Sheets for T/E Resources- Pinnipeds

Common Name:	Hawaiian Monk Seal (‘Ilio holo I ka uaua)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1976) FR listing for T/E – 41 FR 51611 51612
Scientific Name:	*Neomonachus schauinslandi*	**Critical Habitat:**	FR listing report ID – 80 FR 50925 (2015)

Appearance: Adult and juvenile Monk Seals

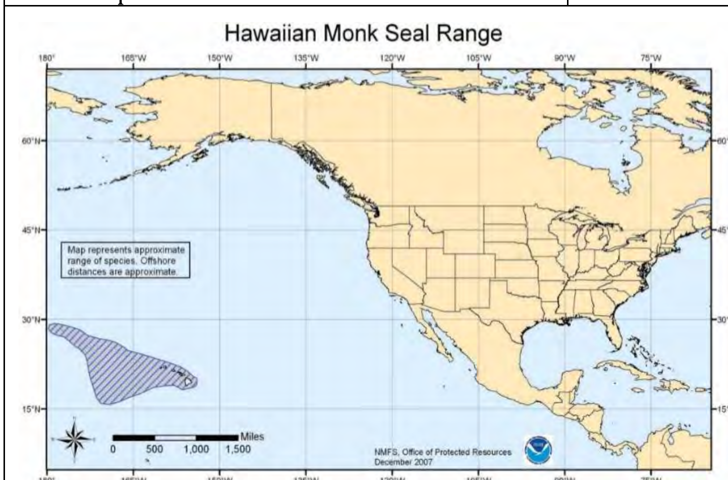
Life Cycle: The life expectancy of Hawaiian Monk Seals is 25-30 years. Monk Seals shed their hair and the outer layer of their skin in an annual catastrophic molt. Seals remain on the beach during the most active period of the molt (~10 days).

Biological Processes: Hawaiian Monk Seals mate in the water between June and August. The gestation period lasts 9 months, and females give birth to one pup at 4-10 years old. Births occur throughout the year, but primarily between March and August. Females nurse their pups on the shore for 4-5 weeks after birth, losing about 136 kg in body mass. During this period, pups grow from ~16 kg at birth to 68-91 kg when weaned. Males are polygynous, and are commonly found patrolling waters adjacent to rookeries or land near females with pups.

Trophic Level / Food Web Interactions: Hawaiian Monk Seals are generalist feeders. However, they primary feed on species that live on or near the ocean floor, and that hide in the sand or under rocks. Common prey include fish, squid, octopus, eels and crustaceans (crabs, shrimp and lobster). Juveniles and sub-adults prey on smaller octopus species, nocturnal octopi species, and eels, while adults feed mostly on larger prey. Feeding grounds are primarily in waters of 18-90 m, but animals can be found foraging in reefs and in waters up to 450 m.

Population Status: Monk Seals are one of the most endangered species in the world. Within the Monk Seal’s range, two regions are often distinguished: the Northwestern Hawaiian Islands (NWHI), comprising eight subpopulations located on remote atolls and small islands, and the Main Hawaiian Islands (MHI), comprising eight large high islands and associated small islets.

The population in the NWHI declined at a rate of 4% annually from 1998 to 2006, but it has stabilized in the last decade. The best estimate of the current population is ~1,400 seals: ~1,100 in the NWHI and ~300 in the MHI. Annual population assessments show that numbers have increased by 3% annually in the past three years, but long-term decline in abundance at the six main NWHI sites remains concerning.



Temporal Distribution: Monk Seals are non-migratory, but animals some have been tracked traveling hundreds of miles in the open ocean.

Spatial Distribution: Hawaiian Monk Seals occur throughout the Hawaiian Island chain. Their six main reproductive sites are in the NWHI at Kure Atoll, Midway Atoll, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and French Frigate Shoals. They are mostly solitary, with individuals often remaining near the atoll where they were born. However, approximately 10% of seals temporarily or permanently relocate to other sites. They spend two-thirds of their time in the ocean, but rest on sandy beaches or volcanic rock, and sometimes shelter in beach vegetation.

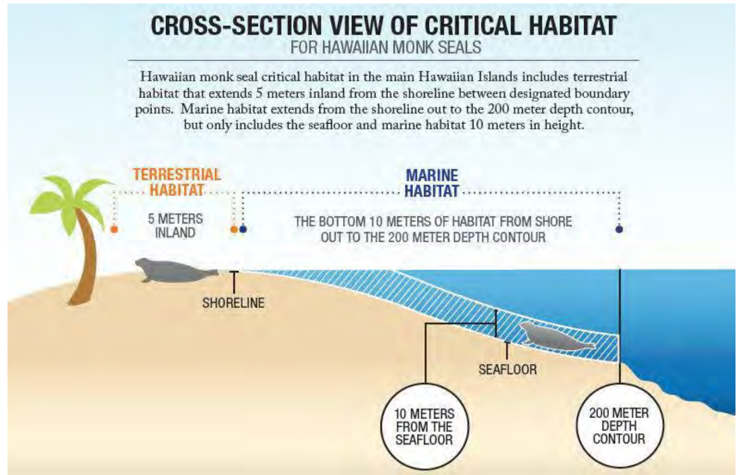
Common Name:	Hawaiian Monk Seal ('Ilio holo I ka uaua)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1976) FR listing for T/E – 41 FR 51611 51612
Scientific Name:	*Neomonachus schauinslandi*	**Critical Habitat:**	FR listing report ID – 80 FR 50925 (2015)

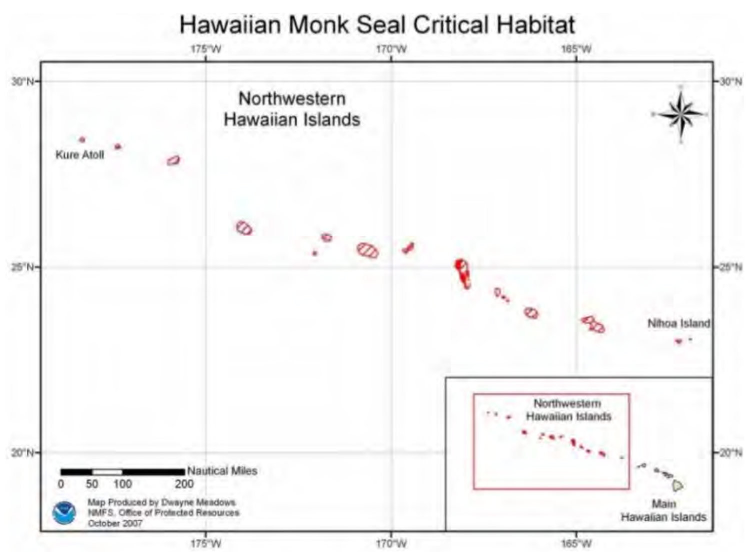
Critical Habitat Description: Critical habitat includes 16 occupied areas within the range of the Hawaiian Monk Seal. These areas contain one or a combination of essential features: preferred pupping and nursing areas, significant haul-out areas, and/or marine foraging areas, that will support conservation for the species.

In the NWHI Monk Seal critical habitat includes beach areas, sand spits and islets, and beach crest vegetation to its deepest extent inland. This habitat also includes the seafloor and marine habitat 10 m in height above the seafloor, and from the shoreline out to the 200 m depth contour around: Kure Atoll, Midway Atoll, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, French Frigate Shoals, Necker Island, and Nihoa Island.

In the MHI critical habitat includes the seafloor and marine habitat to 10 m above the seafloor from the 200 m depth contour through the shoreline and extending into intertidal habitat 5 m above high tide line between identified boundary points around: Kaula Island (marine habitat only), Niihau (marine habitat from 10m-200 m in depth), Kauai, Oahu, Maui Nui (Kahoolawe, Lanai, Maui, and Molokai), and Hawaii

For detailed maps of the Hawaiian Monk Seal Critical Habitat see 80 FR 50925 (2015)





Factors of Decline: Current threats to this species vary depending on location, but generally include limited prey availability (particularly in the NWHI), shark predation on pups, male aggression, human disturbance on beaches (especially in the MHI), entanglement in marine debris and fishing gear, habitat loss (haul-out and pupping beaches) due to climate change (e.g., beach erosion) and human development, and infectious disease (i.e., toxoplasmosis) and biotoxins. There is also low genetic diversity in the population.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the amount of oil on the water surface, the amount of toxic volatile compounds at the water-air interface, and the volume stranded on shorelines. Under the current scenario, floating oil, the evaporation of toxic volatile compounds and oiled shorelines would be reduced with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species (via direct contact/smothering and inhalation of vapors) and its critical habitat (via direct contact/smothering) than the chemically dispersed oil.

References:

Littnan, C., Harting, A. & Baker, J. 2015. *Neomonachus schauinslandi*. The IUCN Red List of Threatened Species 2015: e.T13654A45227978. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T13654A45227978.en.
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USFWS, 2012. Endangered Species in the Pacific Islands (https://www.fws.gov/pacificislands/fauna/HImonkseal.html)

NEBA Data Sheets for T/E Resources- Cetaceans

Common Name:	Humpback Whale (koholā)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1970), *excluding* the Hawaii Distinct Population Segments (DPS) FR listing for T/E – 50 CFR 223/224 (2016)
Scientific Name:	*Megaptera novaeangliae*	**Sanctuary Designation:**	Subtitle C of Public Law 102-587, as amended by Pub. L. 104-283 (1992)

Appearance: Adult humpback whale

Photo Credit: NOAA/NMFS

Life Cycle: The lifespan of humpback whales ranges from 45 to 100 years. Northern hemisphere humpbacks reach an average length of 15-16 m, with females being generally larger than males. The body mass of a mature adult ranges from 35 to 50 tons.

Biological Processes: Hawaiian waters are an important wintering grounds for humpback whales, where they congregate in large numbers and engage in mating activities. These areas may be suitable because of the warm waters (19-25 °C), high underwater visibility, a variety of ocean depths, the presence shallow banks (<200 m depth) and the lack of natural predators.

Most female humpback whales reach sexual maturity at the age of 4 to 6 years, with breeding usually occurring once every 2 to 3 years. Gestation lasts for ~11 months, and weaning occurs between 6 and 10 months after birth. This species is generally polygynous with males exhibiting a competitive behavior. This competition may be the result of a larger proportion of mature males than fertilizable females during the breeding season.

Trophic Level / Food Web Interactions: Humpbacks feed primarily during the summer and live off fat reserves during winter. They feed only rarely and opportunistically in their wintering waters, including Hawaii. When feeding, they filter feed on tiny crustaceans (mostly krill), plankton, and small fish, preferably in shallow waters. They frequently employ a feeding behavior called bubble net feeding in which they surround a school of schooling fish with a curtain of bubbles.

Population Status: The global population of humpbacks was depleted by the commercial whaling industry at the start of the 20th century. Since its listing, it has been determined that Hawaii DPS is not in danger of extinction throughout all or a significant portion of its range or likely to become so within the foreseeable future. Thus, this DPS is not warranted for listing under the Endangered Species Act.

Temporal Distribution: As many as 10,000 Individuals humpback whales of the Central North Pacific population migrate to Hawaii during winter to mate, give birth, and nurse their young. Most individuals are found in Hawaii from December through April, with peak abundance between February and March. Mature males appear to spend a significantly longer time in the region.

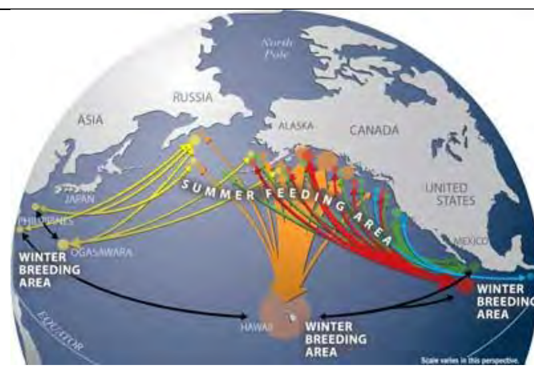

Image Credit: NOAA

Common Name:	Humpback Whale (koholā)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1970), *excluding* the Hawaii Distinct Population Segments (DPS) FR listing for T/E – 50 CFR 223/224 (2016)
Scientific Name:	*Megaptera novaeangliae*	**Sanctuary Designation:**	Subtitle C of Public Law 102-587, as amended by Pub. L. 104-283 (1992)

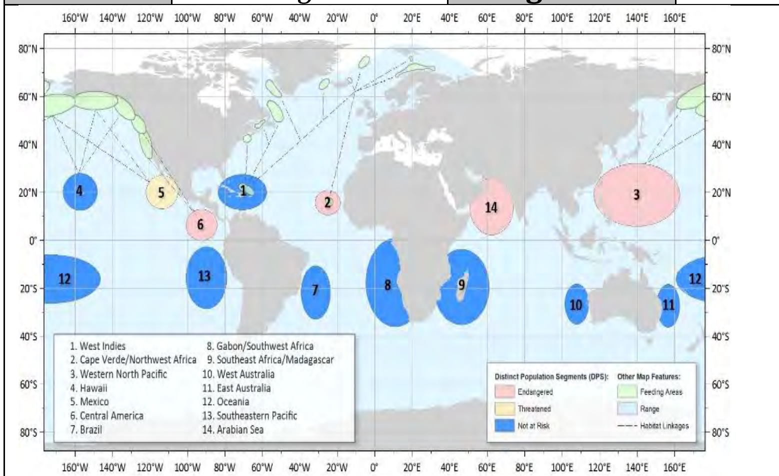

Image Credit: NOAA

Spatial Distribution: The humpback whale is distributed worldwide in all ocean basins. They occupy tropical areas during the winter months when they are breeding and calving, and polar areas during the spring, summer and fall, when they are feeding.

Shallow waters around the Hawaiian Islands are known to be wintering grounds for this species, where they appear to move freely among islands. Cows with newborn calves spatially separate themselves from areas with mating activity by occupying shallower inshore waters than the adult/mating population.

Hawaiian Islands Humpback Whale National Marine Sanctuary: The Sanctuary was created by Congress in 1992 to protect humpback whales and their habitat in Hawaii. It covers the shoreline to the 100-fathom isobath in the four island area of Maui, Penguin Bank, and off the north shore of Kauai, the north and south shores of Oahu, and the north Kona and Kohala coasts of the Big Island.

Activities prohibited in the Sanctuary include (except as authorized under the Marine Mammal Protection Act and the Endangered Species Act): 1) approaching, or causing a vessel or other object to approach within 100 yards of any humpback whale; 2) operating any aircraft above the sanctuary within 300 m of any humpback; 3) taking any humpback whale in the sanctuary; 4) possessing any living or dead humpback whale or part; 5) discharging or depositing any material or other matter; altering the seabed, or discharging or depositing any material or other matter outside the sanctuary that subsequently enters and injures a humpback whale or humpback whale habitat; and 6) interfering with, obstructing, delaying or preventing an investigation, search, seizure or disposition of seized property in connection with enforcement of either of the Acts or any regulations issued under either of the Acts.

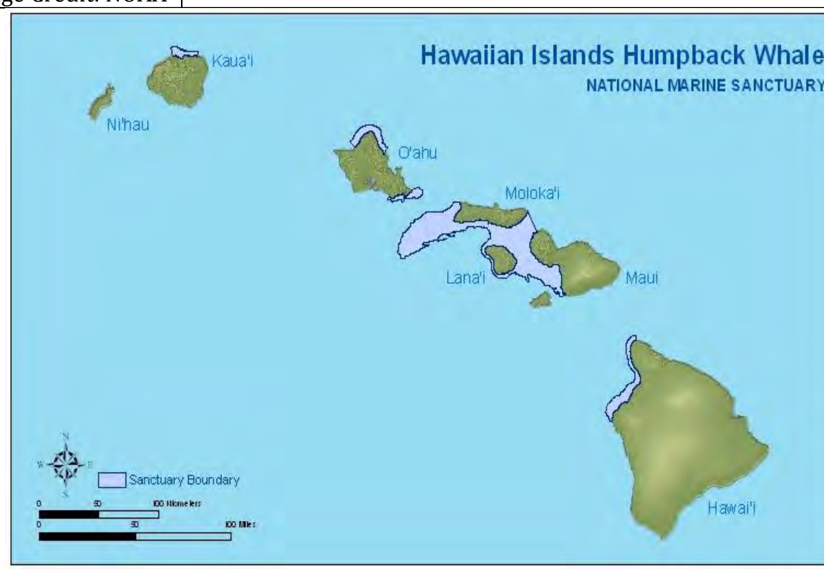

Image Credit: NOAA

Factors of Decline: Over the past decades, humpback whales have steadily recovered from whaling losses, resulting in an increase in the number of whales wintering in Hawaii. While whaling no longer threatens the species, individuals are vulnerable to collisions with ships, entanglement with fishing gear and noise pollution, whale watch harassment and habitat impacts.

In Hawaii, humpbacks have been observed entangled in longline gear, crab pots and other non-fishery-related lines, and ship strikes have been reported. Acoustic impacts from vessels, oceanographic research using sonar and military operations are of increasing concern.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the amount of oil on the water surface, the amount of toxic volatile compounds at the water-air interface, and the volume in nearshore environments. Under the current scenario, evaporation of toxic volatile compounds and the amount of floating oil would be reduced with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species

Common Name:	Humpback Whale (koholā)	Conservation Status:	T/E (federal and/or state) – **Endangered** (1970), *excluding* the Hawaii Distinct Population Segments (DPS) FR listing for T/E – 50 CFR 223/224 (2016)
Scientific Name:	*Megaptera novaeangliae*	**Sanctuary Designation:**	Subtitle C of Public Law 102-587, as amended by Pub. L. 104-283 (1992)

(via direct contact/smothering and inhalation of vapors) and its critical habitat (via direct contact/smothering) than the chemically dispersed oil.

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Common Name:	Main Hawaiian Islands Insular False Killer Whale Distinct Population Segment (DPS)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (2012) FR listing for T/E – 77 FR 70915 (2012)
Scientific Name:	*Pseudorca crassidens*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult false killer whale

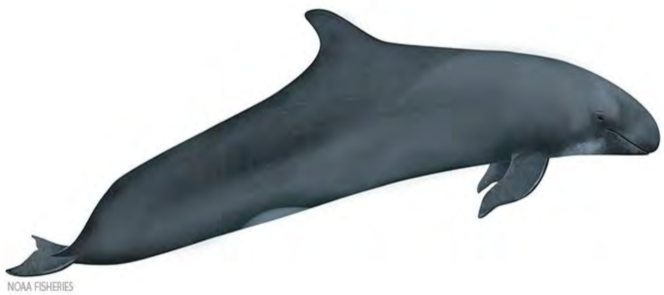


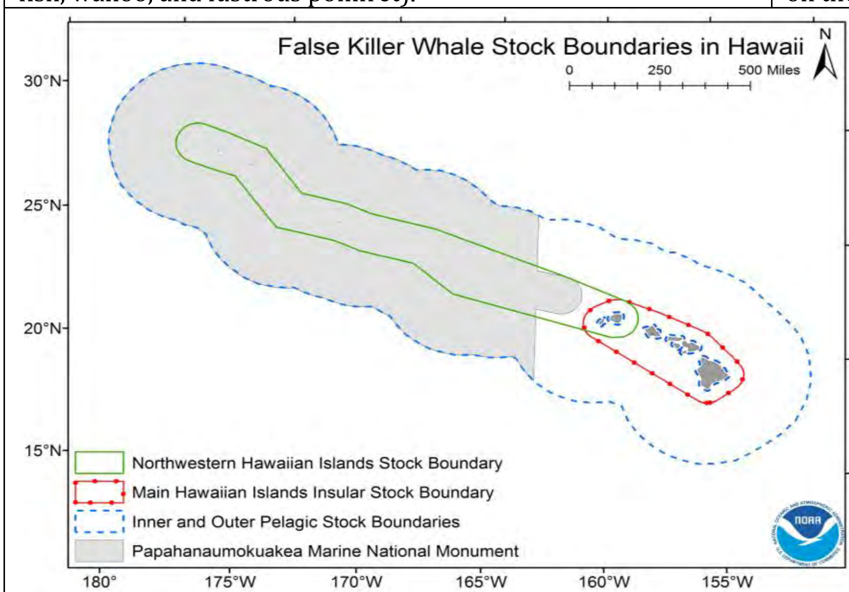
Photo Credit: NOAA

Life Cycle: The maximum lifespan of false killer whales is estimated at 63 years for females and 58 years for males. Individuals stop growing between 25 and 30 years of age.

Biological Processes: There are significant gaps in knowledge on the Hawaiian populations of false killer whales, and most life history information is inferred from individuals in other parts of the world. Individuals mature slowly, reproduce infrequently, and are long-lived. Sexual maturity occurs between 8 and 11 years of age, age at first reproduction range from 9 to 12 years, and gestation is estimated to last between 15 and 16 months. Calves stay with their mothers for 18 to 24 months after birth. Although this species breed year-round, their breeding peaks in late winter to early spring.

Trophic Level / Food Web Interactions: False killer whales forage cooperatively to feed primarily on fish and squid found near the water surface. Ten species of pelagic fish have been documented as prey of false killer whales from the insular stock around the main Hawaiian Island, including several species of commercial and recreational importance (yellowfin tuna, albacore tuna, skipjack tuna, broadbill swordfish, dolphin fish, wahoo, and lustrous pomfret).

Population Status: The Main Hawaiian Island (MHI) insular population of false killer whales appears to have declined during the past two decades at a rate of 9% per year. The minimum population estimate is 92 individuals, with an estimated effective population size (number of adults contributing offspring to the next generation) of approximately 46 insular adults. There is not information on the net productive rate for this species.



Temporal Distribution: False killer whales are year-round residents, with individuals traveling hundreds of miles between islands.

Spatial Distribution: Three populations of false killer whales have been identified in Hawaii: the MHI insular population, the pelagic population, and the Northwestern Hawaiian Islands population. The MHI insular population is the only population of false killer whales officially designated a DPS and listed under the ESA.

The spatial range of the MHI insular population is defined by a 72 km radius extending around the MHI, with the offshore extent of the radii connected on the leeward sides of Hawaii Island and Niihau.

Common Name:	Main Hawaiian Islands Insular False Killer Whale Distinct Population Segment (DPS)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (2012) FR listing for T/E – 77 FR 70915 (2012)
Scientific Name:	*Pseudorca crassidens*	**Critical Habitat:**	None currently designated in Hawaii

High Use Areas: Critical habitat has not been designated, but there are three high-use areas currently identified: 1) off the north half of Hawaii Island, 2) north of Maui and Molokai, and 3) southwest of Lanai.

Individuals appear to extend their range farther offshore on the leeward, and prefer areas that may exhibit higher productivity. Although currently unknown, these areas may represent important feeding areas.

Factors of Decline: There are several threats to the MHI insular false killer whale. The most significant threat is hooking or entanglement in fishing gear, particularly gear used in commercial and recreational non-longline fisheries (i.e., troll, handline, shortline, and kaka line).

In addition, the confined range, genetic isolation, social complexities, mating potentially restricted within each of three separate social clusters, and small and declining abundance, pose threats to the recovery of the MHI insular DPS. These factors may contribute to a limited gene flow within the population, inbreeding depression and loss of social integrity.

Other threats include environmental contaminants, competition with fisheries for food, reduced food quantity and quality, increase in disease vectors, intentional harm fisheries, and sonars and seismic exploration.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the amount of oil on the water surface, the amount of toxic volatile compounds at the water-air interface, and the volume in nearshore environments. Under the current scenario, evaporation of toxic volatile compounds and the amount of floating oil would be reduced with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species (via direct contact/smothering and inhalation of vapors) than the chemically dispersed oil.

References:

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NEBA Data Sheets for T/E Resources- Terrestrial Mammals

Common Name:	Hawaiian Hoary Bat ('Ope'ape'a)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1970) FR listing for T/E – FR 35(199) 16047-16048
Scientific Name:	*Lasirus cinereus semotus*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult Hawaiian hoary bat

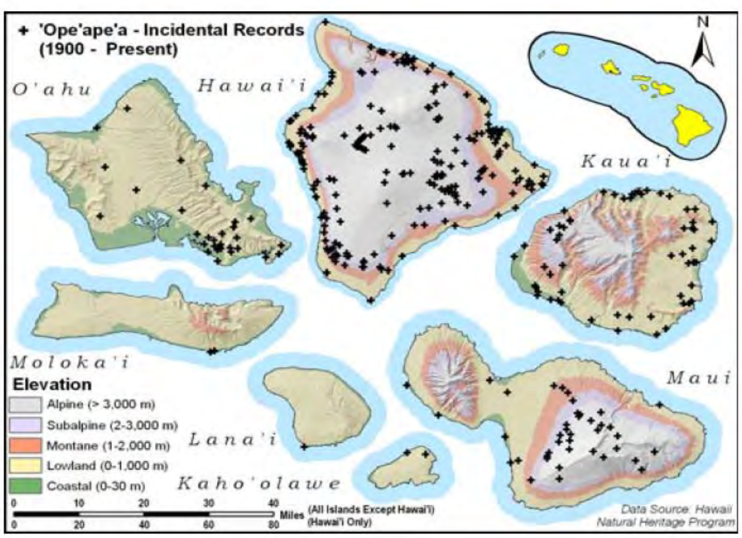
Photo Credit: USFWS

Life Cycle: The Hawaiian hoary bat is endemic to Hawaii, but there is limited information on its life cycle. Males and females have a wingspan of 1/3 m, and females are typically larger than males. This species is largely solitary.

Biological Processes: Breeding of the Hawaiian hoary bat has only been documented on Hawaii and Kauai. Mating most likely occurs between September and December, and females give birth to twins between May and June. Female bats stay with their pups until they are 6 to 7 weeks old. Fewer than 30 accounts of roosting are known statewide, but these sightings indicate that this species roosts in native and nonnative vegetation from 1 to 9 m above ground.

Trophic Level / Food Web Interactions: This species feeds on a variety of native and nonnative night-flying insects including moths, beetles, crickets, mosquitoes, and termites. Water courses and edges (e.g., intertidal coastlines and forest/pasture boundaries) appear to be important foraging areas.

Population Status: There is little information on the population status and trends of the Hawaiian hoary bat. Population estimates have ranged from hundreds to a few thousand, but these are based on limited and incomplete data. Kauai and the island of Hawaii may support the largest numbers. Although the magnitude of population declines is unknown, this species is absent from historically occupied ranges. More recent studies indicate that the population is stable and potentially increasing.



Temporal Distribution: The Hawaiian hoary bat undergoes seasonal altitudinal migrations associated with reproduction. Lowland areas are generally most important during the pupping season, which coincides with warmer air temperatures. Upland areas are more frequently used during winter and spring.

Spatial Distribution: The Hawaiian hoary bat has been seen on the islands of Hawaii, Maui, Molokai, Oahu, and Kauai, but may only live on Hawaii, Maui, and Kauai. Bats are found primarily from sea level to 2,288 m and they have been observed in coastal areas, above wetlands and streams, rainforest, and dry forest habitats. However, there is little information on its habitat.

Studies have shown that they have distinct core-use areas with a mean size of 25 hectares, with no overlap among adults. Individuals may travel as far as 11 to 13 km one-way in a night to forage.

Factors of Decline: This species is believed to be threatened by habitat loss as its decline appears to be driven primarily by a reduction in tree cover. It may also be threatened by pesticides, predation, and roost disturbance. More recently, bat mortality has been associated with collision with barb wire fences. Bat collision and mortality related to wind farms may also pose additional threats.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species (via direct contact/smothering) than the chemically dispersed oil.

References:

Common Name:	Hawaiian Hoary Bat (‘Ope’ape’a)	Conservation Status:	T/E (federal and/or state) – **Endangered** (1970) FR listing for T/E – FR 35(199) 16047-16048
Scientific Name:	*Lasirus cinereus semotus*	**Critical Habitat:**	None currently designated in Hawaii

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Gorresen, M.P., F.J. Bonaccorso, C.A. Pinzari, C.M. Todd, K. Montoya-Aiona, and K. Brinck. 2013. A Five-Year Study of Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) Occupancy on the Island of Hawaiʻi. Technical Report HCSU-041 (https://dspace.lib.hawaii.edu/bitstream/10790/2623/1/TR41_Gorresen_Bat_occupancy.pdf).

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NEBA Data Sheets for T/E Resources- Reptiles

Common Name:	Hawksbill Turtle ('Ea)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1970) FR listing for T/E – 35 FR 8491
Scientific Name:	*Eretmochelys imbricata*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult hawksbill

Photo Credit: NOAA

Life Cycle: There is relatively little data on the biology and life cycle of hawksbills, and their life span is largely unknown. A conservative generation length of 45 years is estimated for individuals in the Indo-Pacific region. Unlike other marine sea turtles, hawksbills in the North Pacific may not have a clear oceanic development, as individuals tend to occupy coastal pelagic waters and shallow reefs in remote atolls.

Biological Processes: Hawksbills nest on insular and mainland sandy beaches throughout the tropics and subtropics. The age of first reproduction (sexual maturity) is approximately 20 to 29 years. In Hawaii, 20 to 25 females nest each year on beaches along south Maui and eastern Molokai, with the majority of nesting occurring on the Big Island of Hawaii. Since 1991, a total of 72 nesting females have been tagged on beaches including Kamehame, Pohue, Punaluu, Apua Point, Keauhou, Halape, Horseshoe, Koloa, Ninole, Kawa, Kahakahakea, Awili Point, and Waimanu.

Adult females may nest every 2 to 8+ years, returning to their natal beaches. Each female may lay 1 to 6 nests per reproductive season, with clutches containing 130 to 180 eggs. Incubation lasts 62 days depending on temperature. The nesting/hatching season spans from May to December.

Trophic Level / Food Web Interactions: The Hamakua Coast of Hawaii and waters west of Maui have been identified as an important foraging habitat for Hawaiian hawksbills. They depend on healthy coral reef habitats and feed primarily on sponges, invertebrates (crabs) and algae.

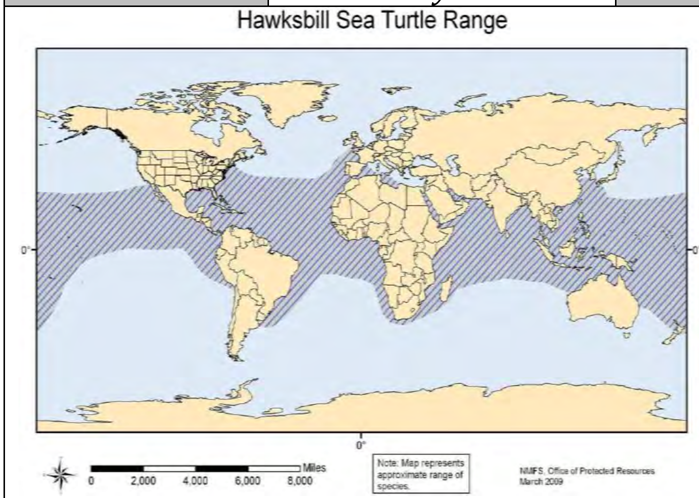
There is some evidence that Hawaiian hawksbills distribute themselves by size class according to the depth of foraging habitat, and thus, occupy separate foraging locations. Adult are usually found in open marine habitats feeding on deeper reefs, whereas immature individuals (0–4 years of age; carapace length of 8-34 cm) are most commonly found in shallow coral reef systems, where they are mostly pelagic feeders.

Population Status:This species can be found nesting and foraging in the Pacific U.S. territories. Hawaiian hawksbills are one of the smallest distinct populations of sea turtles on the planet, yet their occurrence and abundance are not well known, and research on their population status and trends is on-going. A delayed age of sexual maturity likely affects the population's slow growth rate.

Temporal Distribution: Hawksbills are migratory and individuals undertake complex movements through geographically disparate habitats during their lifetimes. However, there is little information on the migration patterns of Hawaiian hawksbills, but the available information suggests that this population may not exhibit long migrations.

Spatial Distribution: Hawksbills can be found in tropical and sub-tropical regions throughout the world. Hawksbills within the Hawaiian Islands travel from 90 to 345 km between nesting and foraging areas, and appear to have relatively short-ranged movements (estimated home-range 0.5-2 km^2; based on limited data).

Common Name:	Hawksbill Turtle (‘Ea)	Conservation Status:	T/E (federal and/or state) – **Endangered** (1970) FR listing for T/E – 35 FR 8491
Scientific Name:	*Eretmochelys imbricata*	**Critical Habitat:**	None currently designated in Hawaii



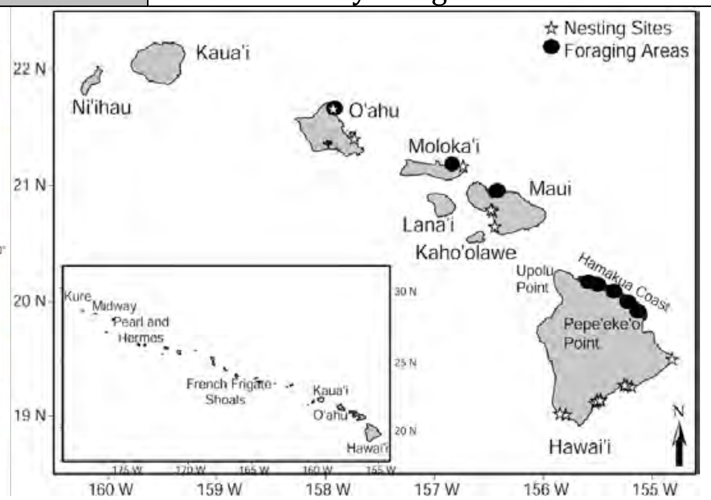


Image Credit: Parker et al., 2009

Factors of Decline: There are several factors that may be contributing to the decline of this population. The relatively small number of hawksbills residing in Hawaiian waters are primarily threatened by loss of habitat caused by increased human presence, beach erosion and sea level rise, which impact the quality of nesting habitats. Coastal construction, beach armoring, artificial lighting, nesting beach obstructions (i.e., trash, debris) and nest predation by introduced species also pose threats to hawksbill nesting beaches.

Tourism development can also have detrimental effects on the coral reef feeding habitats in the main Hawaiian Islands and throughout the region. Direct harvest of adult turtles is still a threat in some Pacific islands. Other threats also include accidental bycatch in recreational shore-based fisheries (hook & line, crab trap, and gillnet) and boat strikes.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the amount of oil on the water surface, the amount of toxic volatile compounds at the water-air interface, and the volume in nearshore environments (used by immature individuals). Under the current scenario floating oil, the evaporation of toxic volatile compounds and oil in nearshore environments would be reduced with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species (via direct contact/smothering and inhalation of vapors) than the chemically dispersed oil.

References:

Mortimer, J.A & Donnelly, M. (IUCN SSC Marine Turtle Specialist Group). 2008. *Eretmochelys imbricata*. The IUCN Red List of Threatened Species 2008: e.T8005A12881238. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T8005A12881238.en

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Parker DM, Balazs GH, King CS, Katahira L, Gilmartin W. 2009. Short-range movements of Hawksbill turtles (*Eretmochelys imbricata*) from nesting to foraging areas within the Hawaiian Islands. Pacific Science 63(3): 371-382.

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Van Houtan KS, Kittinger JN, Lawrence AL, Yoshinaga C, Born VR, Fox A. 2012. Hawksbill sea turtles in the Northwestern Hawaiian Islands. Chelonian Conservation and Biology 11(1): 117-121.

Van Houtan KS, Francke DL, Alessi S, Jones TT, Martin SL, Kurpita L, King CS, Baird RW. 2016. The developmental biogeography of hawksbill sea turtles in the North Pacific. Ecology and Evolution. 6(8):2378-2389.

Common Name:	Olive Ridley Turtle	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1978) FR listing for T/E – 43 FR 32800
Scientific Name:	*Lepidochelys olivacea*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult olive ridley

Photo Credit: NOAA/PIFSC

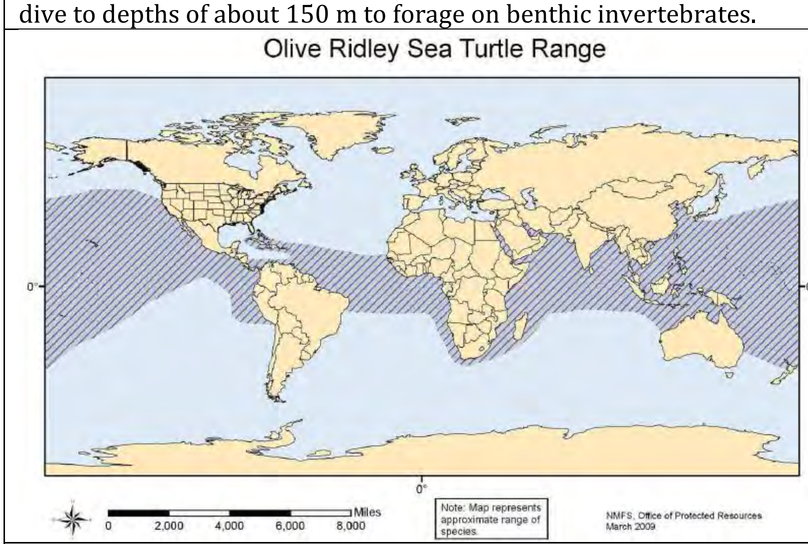
Life Cycle: There is relatively little information on the biology and life cycle of olive ridleys, and their life span is largely unknown.

Biological Processes: The age of first reproduction (sexual maturity) for olive ridleys is approximately 11-16 years. Adult females may nest every 1 to 2 years. Each female may lay 2 to 3 nests per reproductive season, with clutches containing 105 eggs. Incubation lasts 55 days depending on temperature.

Pacific nesting grounds include the Pacific coasts of Mexico and Central America. The species does not nest in the Hawaiian Islands.

Trophic Level / Food Web Interactions: Olive ridleys can be found feeding in a variety of habitats including deep water, pelagic habitats, soft bottom and shallow benthic waters. This species feeds on a variety of prey including fish, salps, and invertebrates, as well as mollusks, crustaceans, algae, bryozoans and fish eggs. Olive ridleys dive to depths of about 150 m to forage on benthic invertebrates.

Population Status:The olive ridley is considered the most abundant sea turtle in the world. However, this species is rare in Hawaiian waters.



Temporal Distribution: There is little information of the temporal distribution of this species in Hawaii. However, water temperature appear to play a primary role in their influencing distribution.

Spatial Distribution: Olive ridleys occur worldwide in tropical and warm temperate ocean waters, and it is mostly pelagic. This species occurs only incidentally in Hawaii as it travels between nesting and foraging grounds

Factors of Decline: While rare in Hawaii, olive ridleys have occasionally been killed by commercial fishing vessels. Entanglement of juveniles and adults in marine debris has also been reported.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the amount of oil on the water surface and the amount of toxic volatile compounds at the water-air interface. Under the current scenario floating oil and the evaporation of toxic volatile compounds would be reduced with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species (via direct contact/smothering and inhalation of vapors) than the chemically dispersed oil.

References:

NOAA/NMFS, 2017. Protected Resources of the Pacific Islands (http://www.nmfs.noaa.gov/pr/species/turtles/oliveridley.html)
NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.

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Common Name:	Anchialine Pool Shrimp (ʻōpae ʻula)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (2013) FR listing for T/E – 78 FR 64637 64690
Scientific Name:	*Vetericaris chaceorum*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Illustration of the anchialine pool shrimp

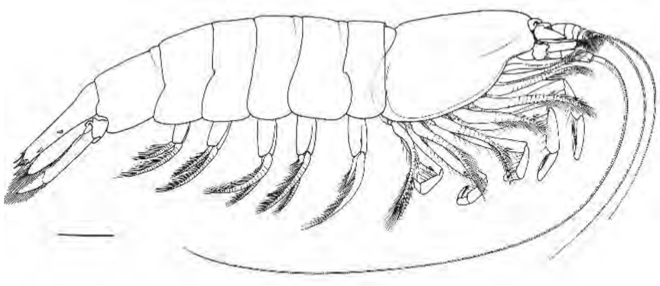

Image Credit: Encyclopedia of Life

Life Cycle: There is limited information on the life cycle of the anchialine pool shrimp. This species, which is endemic to Hawaii, is a member of the family Procarididae and is considered one of the most primitive shrimp species in the world. This species is relatively large in size (adults are 5 cm in total body length), and it has a lifespan of 10 to 15 years.

Biological Processes: There is limited information on the biology of the anchialine pool shrimp.

Trophic Level / Food Web Interactions: Although the trophic ecology of this species is not well known, it appears that anchialine pool shrimp are carnivores that prey on crustaceans and other species associated with anchialine pools.

Population Status:The anchialine pool shrimp is only known to inhabit two locations on the island of Hawaii: Lua o Palahemo (14 m depth), a submerged lava tube located on the southernmost point of the island, and in Manuka (0.5 m depth). Because this species inhabits the interstitial and crevicular spaces in the water table bedrock surrounding anchialine pools, it is difficult to accurately estimate its population size. Few individuals have been observed during surveys of these locations.

Temporal Distribution: The anchialine pool shrimp is a non-migratory species, and thus, its distribution remains constant regardless of seasonality.

Spatial Distribution: This species is only found at two locations in Hawaii.

Factors of Decline: This species faces threats from habitat degradation and destruction (e.g., excessive siltation and collapse of the lava tube system at Lua o Palahemo), as well as from predation.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species (via direct contact/smothering) than the chemically dispersed oil.

References:

NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.

USFWS, 2017. Species Profile for Anchialine Pool shrimp (*Vetericaris chaceorum*) (https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=K03C#lifeHistory)

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NEBA Data Sheets for T/E Resources- Terrestrial Invertebrates

Common Name:	Yellow-Faced Bee	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (2016) FR listing for T/E – 50 FR 67786
Scientific Name (seven sub-species):	*Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. kuakea, H. longiceps* and *H. mana*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Male yellow-faced bee (*H. anthracinus*)

Photo Credit: Jason Graham, University of Hawaii, Manoa

Life Cycle: There is limited information on the life cycle of all Hawaiian *Hylaeus* species.

Biological Processes: Hawaiian *Hylaeus* species are grouped within two categories: ground nesting species that require relatively dry conditions (*H. assimulans*, *H. facilis, H. longiceps*) and wood-nesting species that are often found in wetter areas (*H. anthracinus*, *H. kuakea, H. mana*). Female *Hylaeus* bees lay eggs in brood cells constructed in nests and lined up with a self-secreted, cellophane-like material. *H. hilaris* does not construct nests but it lays eggs in nests of *H. anthracinus, H. assimulans* and *H. longiceps*

Trophic Level / Food Web Interactions: Adult *Hylaeus* bees feed on flower nectar. They almost exclusively visit native plants to collect nectar and pollen, and are almost absent from habitats dominated by nonnative plants. The diet of the larvae is unknown, but it is presumed that they feed on stores of pollen and nectar collected and deposited in the nest by the female.

Population Status:There is little information on the population status and trends of all Hawaiian *Hylaeus* species. The population size of *H. hilaris* is estimated to be smaller than its host species.

Temporal Distribution: There is no information available on the temporal distribution of Hawaiian *Hylaeus* species.

Factors of Decline: Habitat destruction and modification by urbanization and land use conversion have led to fragmentation of foraging and nesting areas, contributing to population declines.

These species may also be threatened by brood colonization by encyrtid and eupelmid parasitoid wasps, and predation by ants.

Spatial Distribution: Hawaiian *Hylaeus* bees are found at elevation from 880 to 2,400 m, and are less common at lower elevations. However, there are slight differences in the habitat occupied by each sub species.

Coastal habitats (sea level to ~300 m in elevation) are known to be occupied by *H. anthracinus, H. assimulans, H. facilis, H. hilaris* and *H. longiceps*.

Lowland dry habitats (shrublands and forests below ~1,000 m in elevation that receive less than 127 cm annual rainfall) are known to be occupied by *H. anthracinus, H. assimulans, H. facilis* and *H. longiceps.*

Lowland mesic habitats (grasslands, shrublands, and forests below ~1,000 m in elevation that receive between 127 and 191 cm annual rainfall) are known to be currently occupied by *H. kuakea* and *H. mana.*

Lowland wet habitats (found below ~1,000 m in elevation on the windward sides of the main Hawaiian Islands) are known to be currently occupied by *Hylaeus facilis.*

Only a single individual of *H. anthracinus* has been found on montane dry habitats (shrublands, grasslands, forest found at elevations between 1,000 and 2,000 m on the leeward sides of the islands of Maui and Hawaii) were annual precipitation is less than 127 cm.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species (via direct contact/smothering) than the chemically dispersed oil.

References:

USFWS, 2011. 12-Month Finding on Five Petitions To List Seven Species of Hawaiian Yellow-faced Bees as Endangered (https://www.gpo.gov/fdsys/pkg/FR-2011-09-06/pdf/2011-22433.pdf)

Magnacca KN. Conservation status of the endemic bees of Hawai ʻi, Hylaeus (Nesoprosopis) (Hymenoptera: Colletidae). Pacific Science. 2007 Apr; 61(2):173-90.

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Common Name:	Blackburn's Sphinx Moth	Conservation Status:	T/E (federal and/or state) – **Endangered** (2000) FR listing for T/E – 65 FR 4770 4779
Scientific Name:	*Manduca blackburni*	**Critical Habitat:**	FR listing report ID – 68 FR 34710 34766 (2003)

Appearance: Adult blackburn's sphinx moth

Photo Credit: USFWS

Life Cycle: Blackburn's sphinx moth is Hawaii's largest native insect, with a wing span of up to 12 cm. Adult moths are known to be strong fliers.

Biological Processes: A female moth can lay upwards of 700 eggs during her life time. Development of the moth from egg to adult can take 56 days, but pupae may remain dormant in soil for several months during hot and dry conditions. However, moths emerge within six weeks of pupation. There is a low survival rate expected for eggs becoming adult moths.

Trophic Level / Food Web Interactions: Larvae of blackburn's sphinx moth feed on native aiea trees and other plants in the Solanacea family. They have also been found to feed on non-native plants including tree tobacco, and tomato plants.

Population Status: The moth is a short-lived, extremely mobile and rare species. These characteristics make determinations of population densities difficult. A few specimens have been seen since 1940, but there are four known populations with an unknown number of individuals.

Temporal Distribution: This species does not make significant seasonal migration. Adult moths can be found year round, but seem to be most active during January to April and September to November.

Spatial Distribution: Historical records of this species are mostly from coastal, lowland, and dryland forests in areas receiving less than 120 cm of rainfall, though they have been collected from sea level to 1,525 m in elevation. The species currently occupies 18% of its known historic range, and it is known to exist only on Maui, Kahoolawe, and the island of Hawaii.

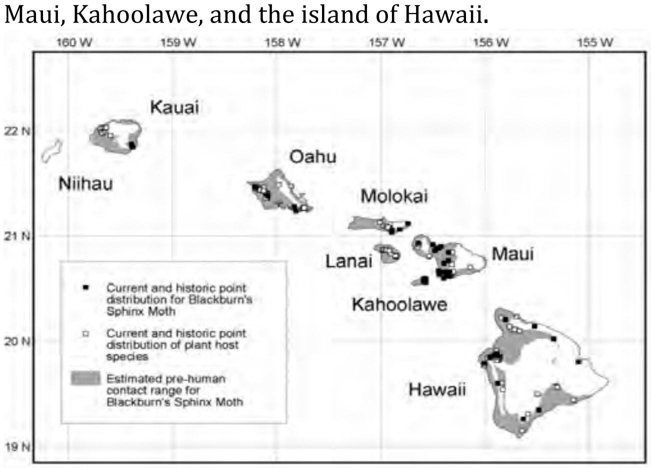


Image Credit: USFWS

Critical Habitat Description: The designate critical habitat for the moth includes seven sites located on the islands of Hawaii, Kahoolawe, Maui, and Molokai. This habitat include ~40,240 hectares, the majority of which is State-owned land.

The primary constituent elements required by moth larvae for foraging and maturation are two endemic larval host plant species, and the dry and mesic habitats. The primary constituent elements required by moth adults for foraging, sheltering, dispersal, breeding, and egg production are native, nectar-supplying plants, and the dry and mesic habitats.

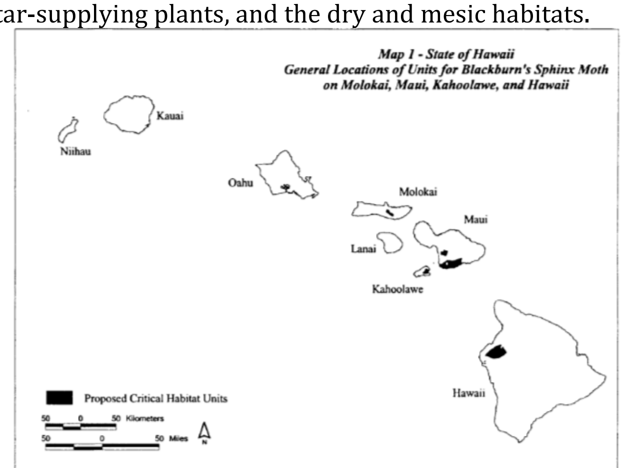


Image Credit: USFWS

Factors of Decline: Threats to the moth include habitat loss from urban and agricultural development, habitat fragmentation and degradation, and increased wildfire frequency. Introduced ants and parasitic wasps that prey on the eggs and caterpillars also pose a significant threat. The loss of its native host plant, aiea, found in dry and mesic forests has also contributed to the reduction of its distribution range and population decline.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of

Common Name:	Blackburn's Sphinx Moth	Conservation Status:	T/E (federal and/or state) – **Endangered** (2000) FR listing for T/E – 65 FR 4770 4779
Scientific Name:	*Manduca blackburni*	**Critical Habitat:**	FR listing report ID – 68 FR 34710 34766 (2003)

dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species (via direct contact/smothering) than the chemically dispersed oil. There is no exposure pathway of critical habitat to chemically dispersed oil.

References:

Rubinoff, D. and San Hose, M., 2010. Life history and host range of Hawaii's endangered Blackburn's sphinx moth (*Manduca blackburni* Butler). Proceedings of the Hawaiian Entomological Society. 42:53–59

NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.

USFWS, 2003. Designation of Critical Habitat for the Blackburn's Sphinx Moth: final rule. 68 FR 34710. Honolulu, (HI).

USFWS, 2005. Recovery plan for the Blackburn's Sphinx Moth (*Manduca blackburni*). (https://ecos.fws.gov/docs/recovery_plan/050926.pdf)

Common Name:	Hawaiian Black-Necked Stilt (Ae'o)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1970) FR listing for T/E – 35 FR 13519 13520
Scientific Name:	*Himantopus mexicanus knudseni*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult stilts

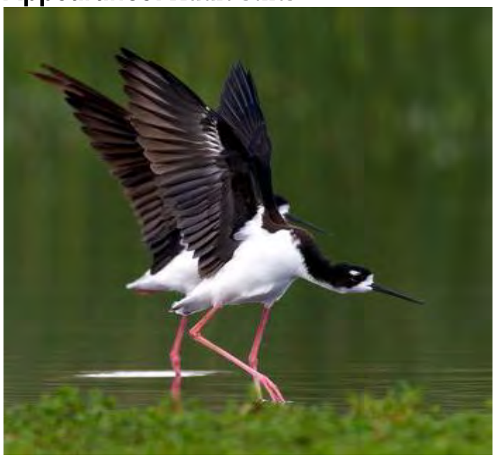


Photo Credit: USFWS

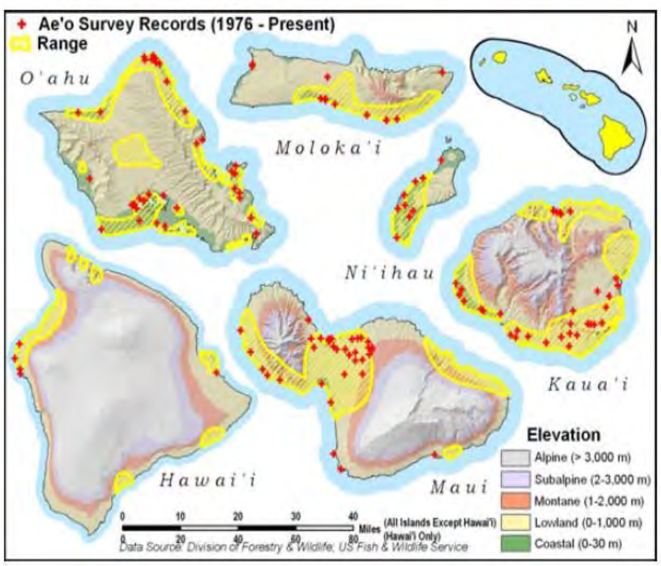
Life Cycle: Little is known about the lifespan or survivorship of the Hawaiian stilt. Based on limited studies, the first-year survival ranges between 0.53 and 0.6, while second-year survival is 0.81. The lifespan of captive stilts is 15 years, and between 15 and 17 years for banded wild individuals.

Biological Processes: Nesting occurs between March and August and peaks in May and June, but varies among years depending on water levels. Generally 3 to 4 eggs are laid, with chicks hatching approximately 24 days later. Both parents incubate eggs and brood young, and fledglings remain with their parents for several months. Nesting sites are adjacent to or on low islands within bodies of fresh, brackish, or salt water.

Trophic Level / Food Web Interactions: Stilts are opportunistic feeders that prey on a wide variety of invertebrates and other aquatic organisms, including polychaete worms, small crabs, insects, and small fish. Feeding habitats are generally shallow water bodies and mudflats. Preferred foraging habitat occurs in water depths of less than 24 cm.

Population Status: Stilts were historically known to be on all the major islands except Lanai and Kahoolawe. Historic numbers are unknown, but it is believed that there were ~1,000 individuals in the late 1940s. Stilt numbers varied between 1,100 in 1997 and 1,783 in 2007, with Maui and Oahu accounting for 60-80% of the entire population. The population appears to have stabilized or may be slightly increasing.

Temporal Distribution: There are small seasonal migrations among islands primarily driven by water level. Stilts move annually between Kauai and Niihau in response to water level changes in Niihau's ephemeral lakes.



Spatial Distribution: Stilts are found in wetland habitats below 200 m elevation on all the main Hawaiian Islands, except for Kahoolawe. They use a variety of aquatic habitats, but are limited by water depth and vegetation cover.

Oahu: most of the population is found on the north and windward coast. Smaller numbers use wetland habitats associated with Pearl Harbor and along the leeward coast.

Kauai: stilts are found in large river valleys, reservoirs and sugarcane effluent ponds.

Maui: most individuals use coastal wetlands, while smaller numbers use reservoirs and aquaculture habitats.

Molokai: important habitats include southern coastal wetlands and lakes.

Lanai: a small number of individuals are permanent residents of the city's wastewater treatment ponds.

Hawaii: the largest number of stilts are found on the Kona coast.

Factors of Decline: The primary causes of the decline of stilts have been loss and degradation of wetland habitat and introduced predators (e.g., rats, dogs, cats). Other factors include the introduction of plants, fish, bull frogs, as well as disease.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants.Thus, the untreated oil would pose a greater risk of exposure to this species, including adults, nests, eggs and chicks (via direct contact/smothering) than the chemically dispersed oil.

References:

Common Name:	Hawaiian Black-Necked Stilt (Ae'o)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1970) FR listing for T/E – 35 FR 13519 13520
Scientific Name:	*Himantopus mexicanus knudseni*	**Critical Habitat:**	None currently designated in Hawaii

NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.
USFWS, 2011. Recovery plan for Hawaiian waterbirds. (https://www.fws.gov/pacificislands/CH_Rules/Hawaiian%20Waterbirds%20RP%202nd%20Revision.pdf)

Common Name:	Hawaiian Common Gallinule ('alae 'ula)	Conservation Status:	T/E (federal and/or state) – **Endangered** (1967) FR listing for T/E – 32 FR 4001
Scientific Name:	*Gallinula galeata sandvicensis*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult Hawaiian gallinule

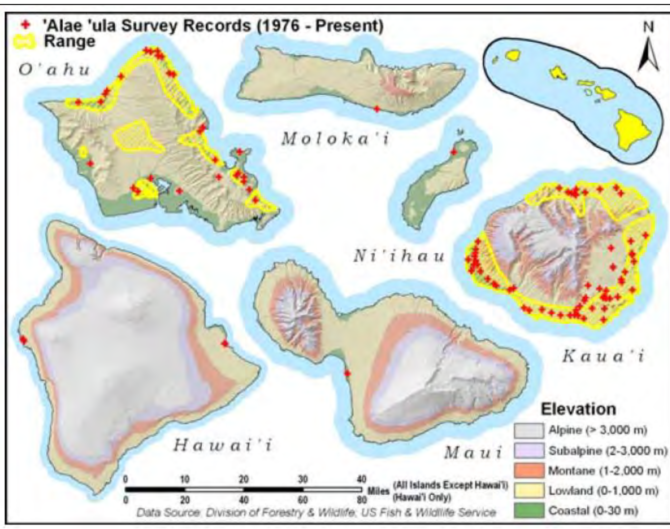
Photo Credit: USFWS

Life Cycle: The Hawaiian gallinule is an endemic subspecies of the common gallinule. Little is known about the ecology and breeding biology of this species. However, a banded wild individual was recaptured at an age of approximately 10.5 years.

Biological Processes: Nesting occurs year-round, but most activity extends from March through August and is influenced by water levels and vegetation growth. Generally between 5 to 6 eggs are laid, with chicks hatching approximately 19 to 22 days later. Both parents incubate eggs and brood young, and fledglings remain with their parents for several weeks. Re-nesting and multiple broods during one season have been observed. Most nests are inconspicuously placed within dense emergent vegetation over shallow water (standing freshwater less than 60 cm deep) or directly placed on the ground.

Trophic Level / Food Web Interactions: Little information is available on the feeding habits of the Hawaiian gallinule. These birds are apparently opportunistic feeders, with a diet composition influenced by prey items in their foraging habitat (dense emergent vegetation). Food items may include algae, aquatic insects, and mollusks. Grass seeds, parts of various plants, and other invertebrates are probably also included in their diet.

Population Status: The Hawaiian gallinule was found on all of the main Hawaiian Islands except Lanai. Because of its secretive nature, this species is difficult to study and rough population estimates were lacking until the 1950s. Long-term population trends are largely unknown. Currently, this species is only found on the islands of Kauai and Oahu. Counts of this species have been stable, but remain low, with an average number of 287 birds over 10 years (1998 to 2007). Oahu holds 50% of the entire population.



Temporal Distribution: The Hawaiian gallinule is non-migratory, but it appears to be more mobile during the spring (start of the nesting season).

Spatial Distribution: This species is found in lowland wetland habitats below 125 m elevation on the islands of Kauai and Oahu. Key features of habitats for Hawaiian gallinules are: 1) dense stands of robust emergent vegetation near open water, 2) floating or barely emergent mats of vegetation, 3) water depth less than 1 m, and 4) freshwater.

Its habitat consists of freshwater marshes, taro patches, lotus fields, reedy margins of water courses (natural ponds, streams, irrigation ditches, etc.), reservoirs, grazed wet meadows and wet pastures, and occasionally saline and brackish water areas.

On Kauai, this species is widely distributed in lowland wetlands and valleys, and are also found in wetland agricultural areas such as taro fields.

On Oahu, this species is widely distributed, but are most prevalent on the northern and eastern coasts between Haleiwa and Waimānalo. Small numbers exist in Pearl Harbor, where foraging occurs in semi-brackish water.

Factors of Decline: Historically, the decline of taro farming and increased in rice cultivation apparently contributed to a decline of Hawaiian gallinules. Agricultural, residential and recreational development adversely affected this species through modifications of channel and shorelines, increased siltation, filling of wetlands and changes in water levels (fluctuations or flooding). Predation by introduced species is a current threat. Flooding is a major cause of nest failure.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species, including adults, nests, eggs and chicks (via direct contact/smothering) than the chemically dispersed oil.

Common Name:	Hawaiian Common Gallinule (‘alae ‘ula)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1967) FR listing for T/E – 32 FR 4001
Scientific Name:	*Gallinula galeata sandvicensis*	**Critical Habitat:**	None currently designated in Hawaii

References:

NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.

USFWS, 2011. Recovery plan for Hawaiian waterbirds. (https://www.fws.gov/pacificislands/CH_Rules/Hawaiian%20Waterbirds%20RP%202nd%20Revision.pdf)

Common Name:	Hawaiian Duck (koloa maoli)	Conservation Status:	T/E (federal and/or state) – **Endangered** (1967) FR listing for T/E – 32 FR 4001
Scientific Name:	*Anas wyvilliana*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult Hawaiian duck

Photo Credit: USFWS

Life Cycle: There is no information on the lifespan or survivorship of Hawaiian ducks from wild or captive flocks.

Biological Processes: Hawaiian ducks breed year-round, but the majority of nesting records is from March through June. In Kauai lowlands, Hawaiian ducks form pair bonds between November and May, with pairs dispersing to montane nesting areas. Generally between 2 to 10 eggs are laid, with chicks hatching approximately 30 days later between April and June. Nests are placed on the ground near water, but little else is known about specific nesting habits.

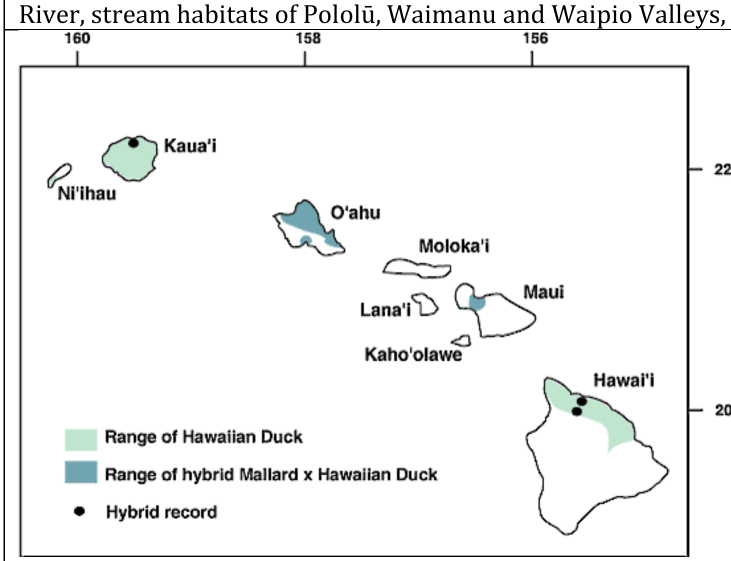
Trophic Level / Food Web Interactions: Hawaiian ducks appear to be opportunistic feeders. Prey includes snails, insect larvae, earthworms, tadpoles, crayfish, mosquito larvae, mosquito fish, aquatic invertebrates including water boatmen, grass seeds, rice, green algae, and seeds and leaf parts of wetland plants. Feeding in wetlands and streams typically occurs in water less than 24 cm.

Population Status: The status of this species is difficult to assess due to the difficulty of distinguishing between Hawaiian ducks, feral mallards, and hybrids. Hawaiian ducks were known historically from all of the main Hawaiian Islands except Lanai and Kahoolawe. There are no population estimates prior to 1940, but in the 1800s they were common in natural and farmed wetland habitats.

Recent estimates indicate that the statewide population of pure Hawaiian ducks is comprised of 2,000 birds on Kauai and 200 birds on Hawaii. The population appears to be increasing in Kauai, but declining in other areas due to hybridization. Hybridization is also occurring in Kauai.

Temporal Distribution: Hawaiian ducks exhibit intra-island movement, but timing and dispersal tendencies are not understood. On Kauai, seasonal movement of birds occurs from lowland wetlands to more secluded habitats in summer. Differences between summer and winter bird counts could represent altitudinal movements, dispersal across stream valleys, or possibly a reclusive post-breeding molt period.

Spatial Distribution: This species occurs on the hottest coasts with suitable ponds as well as in mountains with elevations as high as 3,000 m. On Kauai, this species uses lowland ponds and wetlands primarily for feeding and loafing, and nests along montane streams. On Hawaii, they have been observed using stock ponds in the Kohala Mountains and Wailuku River, stream habitats of Pololū, Waimanu and Waipio Valleys, and on Mauna Kea in ponds and larger montane streams.



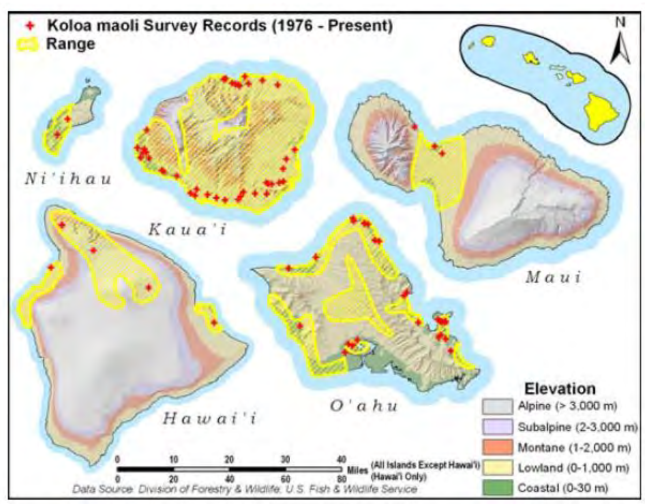


Image Credit: Birds of North America

Factors of Decline: Hybridization with feral mallards is currently the primary threat to the recovery of the Hawaiian duck. Damage to watersheds by pigs, goats, and other feral ungulates may pose direct impacts to nesting habitat.

Predation by introduced species is also a current threat to eggs and ducklings. Flooding is a major cause of nest failure.

Common Name:	Hawaiian Duck (koloa maoli)	Conservation Status:	T/E (federal and/or state) – **Endangered** (1967) FR listing for T/E – 32 FR 4001
Scientific Name:	*Anas wyvilliana*	**Critical Habitat:**	None currently designated in Hawaii

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species, including adults, nests, eggs and chicks (via direct contact/smothering) than the chemically dispersed oil.

References:

Lavretsky, P. A. Engilis, Jr., J.M. Easide, and J.L. Peters. 2015. Genetic admixture supports an ancient hybrid origin of the endangered Hawaiian Duck. Journal of Evolutionary Biology 28: 1005-1015.

NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.

USFWS, 2011. Recovery plan for Hawaiian waterbirds. (https://www.fws.gov/pacificislands/CH_Rules/Hawaiian%20Waterbirds%20RP%202nd%20Revision.pdf)

Common Name:	Hawaiian Crow (ʻAlalā)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1967) FR listing for T/E – 32 FR 4001
Scientific Name:	*Corvus hawaiiensis*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult Hawaiian crow

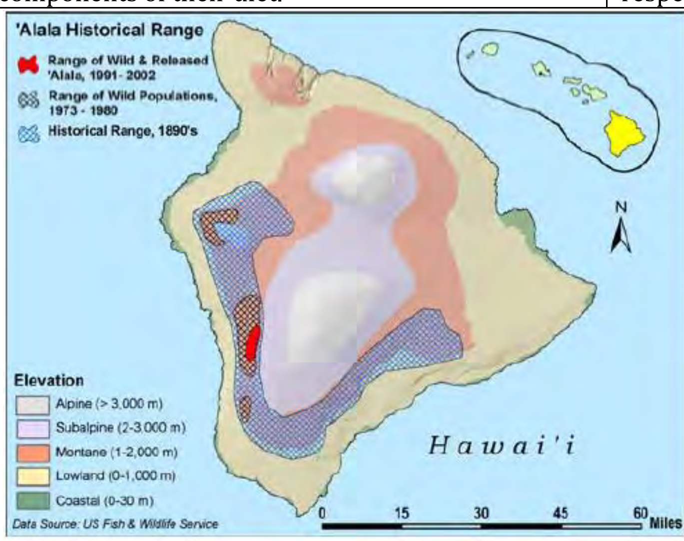
Photo Credit: USFWS

Life Cycle: Most of what is known about the Hawaiian crow comes from observations of highly fragmented and declining populations, rendering incomplete knowledge of the species' habitat requirements, social behavior, movements and life history. This species, which is endemic to the island of Hawaii, is long-lived and has a life span of 18 years in the wild and 25 years in captivity.

Biological Processes: Age at first breeding is approximately 2 years for females and 2 to 3 years for males. Hawaiian crows are monogamous and often have long-term pair bonds, although extra-pair copulations have been observed. This species constructs nests in ʻōhiʻa trees in March. Between 2 to 5 eggs are laid in April, with chicks hatching from 19 to 22 days later. Usually only one or two nestlings fledge 40 days after hatching. Fledglings are poor flyers and remain near the ground for long periods increasing their susceptibility to disease and predation. Juveniles depend on their parents for at least 8 months and remain with their family group until the following breeding season.

Trophic Level / Food Web Interactions: The Hawaiian crow eats native and introduced fruits, invertebrates, and eggs and nestlings of other forest birds. Nectar, flowers and carrion are minor components of their diet.

Population Status: There are no individuals known to exist in the wild. The entire remaining population of the species is currently 56 individuals, which are in captivity at the Keauhou and Maui Bird Conservation Centers on the islands of Hawaii and Maui, respectively.



Temporal Distribution: Seasonal movements of the Hawaiian crow are in response to weather and food availability, particularly fruit and native fruit-bearing plants.

Spatial Distribution: Historically, the species was restricted to dry and mesic forests in the western and southern portions of the island of Hawaii between 300 and 2,500 m in elevation. Because the last wild individuals were confined to a small are of their historical range, specific knowledge of key habitat requirements are unknown.

Factors of Decline: Current threats to this species include predation by non-native mammals and the Hawaiian Hawk, introduced diseases, and habitat loss and fragmentation

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species, including adults, nests, eggs and chicks (via direct contact/smothering) than the chemically dispersed oil.

References:

NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.
USFWS, 2015. Alala 5-year review 2015. (https://ecos.fws.gov/docs/recovery_plan/090417.pdf).

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Common Name:	Newell's Shearwater ('a'o)	Conservation Status:	T/E (federal and/or state) – Threatened (1975) FR listing for T/E – 40 FR 44149
Scientific Name:	*Puffinus auricularis newelli*	Critical Habitat:	None currently designated in Hawaii

Appearance: Adult Newell's shearwater

Photo Credit: Eric VanderWerf, Pacific Rim

Life Cycle: The Newell's shearwater is a pelagic year-round resident endemic to the Hawaiian Islands. However, relatively little is known about its life history.

Biological Processes: This colonial species nests on steep forested mountain slopes, with variable amounts of vegetation. Age at first breeding is likely between 6 and 7 years. During their 9 month highly synchronous breeding season (April through November) they lay a single egg (in early June) in burrows placed at the base of trees or under ferns. These burrows are used during multiple breeding seasons usually by the same pair of birds. Both parents incubate the egg for 62 days. The chick is fed a diet of regurgitated squid and fish by parents that forage hundreds of kilometers offshore, returning every 1 to 3 nights to the colony. Most young fledge in the fall (November). Fledglings spend three years at sea before returning to land.

Trophic Level / Food Web Interactions: The diet of the Newell's shearwater is not well known, but it consists primarily of squid and fish. Preferred prey appear to be of lengths less than 12 cm and commonly associated with the water surface.

Population Status: Population numbers of the Newell's shearwater are difficult to estimate because of the remoteness and terrain of nesting colonies. This species was once abundant on all main Hawaiian islands. In the early 1990s, it is estimated that this species had 84,000 individuals, but between 1993 and 2001, numbers declined by 62%.

Recent estimates suggest a population of 14,600 breeding pairs, 75% of which nest on Kauai. Based on counts of injured or dead fledglings, it appears that this population is in decline.

Temporal Distribution: This highly pelagic species is associated with land only during the breeding season (April-November).

Spatial Distribution: The marine range of the Newell's shearwater extends south and east of the Hawaiian Islands to the eastern tropical Pacific, especially near the Equatorial Counter Current and the Inter-tropical Convergence Zone. During the nonbreeding season they are absent from waters within several hundred kilometers of the Hawaiian Islands.

During the breeding season, some birds forage west and north of the Hawaiian Islands, and the central part of their marine range moves northward. This species breeds primarily on Kauai in mountainous terrain between 160 and 1,200 m in elevation. Breeding also occurs on the islands of Hawaii, Molokai and Lehua. Although not confirmed, breeding may also occur on Oahu, Maui, and Lānai.

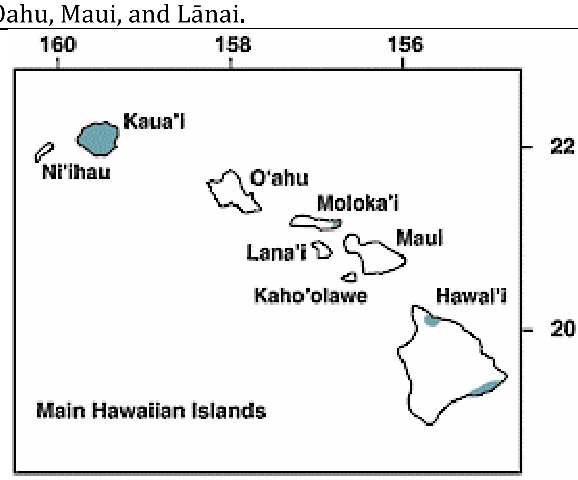

Image Credit: Birds of North America

Factors of Decline: Historically, the introduction predators (mongoose, cat, black rat, and Norway rat) may have played a primary role in the reduction of ground nesting seabirds, including the Newell's shearwater.

A second threat to this species is their attraction to light. Increasing urbanization and the accompanying manmade lighting have resulted in substantial problems for fledgling shearwaters during their first flight to the ocean from their nesting grounds. When attracted to manmade lights, fledglings become confused and often fly into utility wires, poles, trees, and buildings and fall to the ground.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species, including adults, nests, eggs and chicks (via direct contact/smothering) than the chemically dispersed oil.

Common Name:	Newell's Shearwater (ʻaʻo)	**Conservation Status:**	T/E (federal and/or state) – **Threatened** (1975) FR listing for T/E – 40 FR 44149
Scientific Name:	*Puffinus auricularis newelli*	**Critical Habitat:**	None currently designated in Hawaii

References:

Ainley DG, Walker WA, Spencer GC, Holmes ND. 2014. The prey of Newell's shearwater *Puffinus newelli* in Hawaiian waters. Marine Ornithology. 44: 69-72.

Ainley, D. G., R. Podolsky, L. DeForest, G. Spencer, and N. Nur. 2001. The status and population trends of the Newell's Shearwater on Kaua`i: insights from modeling. Studies in Avian Biology 22:108-123.

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USFWS, 2005. Regional seabird conservation plan, Pacific Region. (https://www.fws.gov/pacific/migratorybirds/PDF/Seabird%20Conservation%20Plan%20Complete.pdf)

USFWS, 2011. Newell's shearwater (*Puffinus auricularis newelli*), 5-Year Review Summary and Evaluation. (https://ecos.fws.gov/docs/five_year_review/doc3867.pdf)

Common Name:	Hawaiian Petrel (‘Ua‘u)	Conservation Status:	T/E (federal and/or state) – Endangered (1967) FR listing for T/E – 32 FR 4001
Scientific Name:	*Pterodroma sandwichensis*	Critical Habitat:	None currently designated in Hawaii

Appearance: Adult Hawaiian petrel

Photo Credit: Jim Denny, Hawaii Volcanoes National Park

Life Cycle: Relatively little is known about the life history of the Hawaiian petrel. The marine range of this species extends over the entire central tropical Pacific, but nests only in the Hawaiian Islands. Adult birds may live for 30 years or longer.

Biological Processes: Females lay a single egg (in May) in deep underground burrows (3-30 feet long) on steep slopes. Both parents incubate the egg for 56-60 days and feed the chick until it fledges (November- early December). The chick is fed a diet comprised primarily of regurgitated squid every 2-3 days by parents that forage during the day in offshore deep waters, returning every night to the colony. Young are fed until they are double the size of the parents (September). Once the young are abandoned, adult pairs leave the colony until the next nesting season. Young birds remain at sea for 3-6 years before returning to land. While age at first breeding is unknown, it likely occurs at 5-6 years.

Trophic Level / Food Web Interactions: The diet of the Hawaiian petrel consists primarily of squid, followed by fish (i.e., goatfish and lantern fish) and crustaceans. Prey is taken by dipping, surface-seizing, pattering and scavenging in association with subsurface predators (e.g., tuna).

Population Status: The Hawaiian Petrel was once abundant on all southern islands of the Hawaiian Archipelago including Hawaii, Maui, Lanai, Kahoolawe, Molokai, Oahu, and Kauai. By the 1980s, this population experienced a range contraction and today’s breeding colonies are found only in remote or high elevation areas on the islands of Hawaii, Maui, Lanai and Kauai. Population trends are unknown, but population numbers, including juveniles and sub-adults, are estimated at 20,000 individuals with a breeding population of 4,500-5,000 pairs.

Most known nests are found in Maui, where the estimated number of breeding pairs is 450 to 650. The majority of known nests (50-60 breeding pairs) on Hawaii Island are within Hawaii Volcanoes National Park on the lower alpine and subalpine slopes of Mauna Loa.

Temporal Distribution: This highly pelagic species is found at sea during December and January, and found at their nesting colonies (primarily in Maui) from February through November. Breeding occurs during the early spring.

Spatial Distribution: During the nonbreeding season, this species is found throughout the central tropical Pacific. Largest known nesting colony located at the top of Mount Haleakalä, Maui (8,000-10,000 feet), while smaller numbers nest on the West Maui Mountains, Mauna Loa, Hawaii, Lānai, and Kauai.

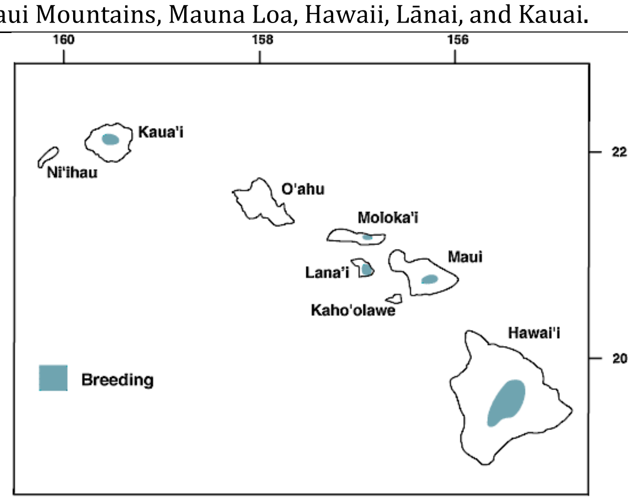

Image Credit: Birds of North America

Factors of Decline: Loss of habitat, land degradation by feral goats and pigs, and the introduction predators (mongooses, cats, rats and dogs) have played a primary role in the decline of this species.

A primary threat to fledglings are bright urban lights that cause them to become disoriented and fall to the ground or collide with structures. Once on the ground fledglings are vulnerable to predation.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species, including adults, nests, eggs and chicks (via direct contact/smothering) than the chemically dispersed oil.

References:

Common Name:	Hawaiian Petrel (‘Ua‘u)	Conservation Status:	T/E (federal and/or state) – **Endangered** (1967) FR listing for T/E – 32 FR 4001
Scientific Name:	*Pterodroma sandwichensis*	**Critical Habitat:**	None currently designated in Hawaii

Ainley, D. G., R. Podolsky, L. DeForest, and G. Spencer. 1997. New Insights into the Status of the Hawaiian Petrel on Kauai. Colonial Waterbirds 20(1): 24–30.

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USFWS, 2017. Hawaiian Petrel 5-year review 2017. (https://ecos.fws.gov/docs/five_year_review/doc5234.pdf)

Common Name:	Hawaiian Coot (ʻAlae keʻokeʻo)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1970) FR listing for T/E – 35 FR 13519 13520
Scientific Name:	*Fulica americana alai*	**Critical Habitat:**	None currently designated in Hawaii

Appearance: Adult Hawaiian coot

Photo Credit: Carl Giometti, Birds of North America

Life Cycle: The Hawaiian coot is endemic to the Hawaiian Islands and a year-round resident. However, relatively little is known about its life history.

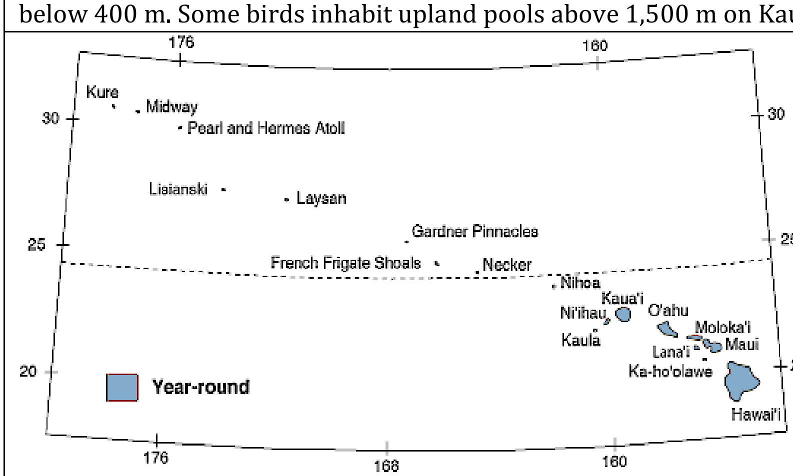
Biological Processes: Hawaiian coot build floating nests in robust emergent plants interspersed with open, fresh or brackish water, fresh and brackish-water marshes less than 1 meter deep. Open water nests are usually composed of mats of water hyssop (*Bacopa monniere*) and Hilo grass (*Paspalum conjugatum*), while nests in emergent vegetation are typically platforms constructed from buoyant stems of species such as bulrush (*Scirpus* spp.). This species does not have a strict breeding season and it may nest in any month of the year. Nesting is most frequent between March and September and it may be triggered by local habitat conditions (e.g., appropriate water level). Nests could contain between 4 and 10 eggs, which are incubated for 23-27 days. Young birds leave the nest soon after hatching.

Trophic Level / Food Web Interactions: The Hawaiian coot feeds on seeds and leaves of aquatic plants, insects, tadpoles and small fish. This species dives for food or forages in mud and sand, but it prefers to feed near nesting areas. The Hawaiian coot is known to fly long distances when food is locally scarce.

Population Status: Historically the Hawaiian coot occurred on all of the main Hawaiian Islands except on island without suitable wetland (Lanai and Kaho`olawe), and were most numerous on Kauai, Maui, and Oahu. In 1939, the population was low due to hunting, and in the 1950s it was on an extinction trajectory. By the 1960s fewer than 1,000 birds remained on the islands. Recent estimates (2011) indicate that the population is comprised of 1,500-2,800 birds mostly on Kauai, Oahu, and Maui. All the main Hawaiian Islands except Kaho`olawe are currently occupied.

Temporal Distribution: This species is a year-round resident of most Hawaiian Islands. Temporal fluctuations in their distribution are commonly associated with wetland flooding and rain events, which influence wetland hydrology.

Spatial Distribution: Hawaiian coot are found in fresh and brackish-water marshes and ponds of the coastal plain, usually below 400 m. Some birds inhabit upland pools above 1,500 m on Kauai and montane stock ponds up to 2,000 m on Hawaii.



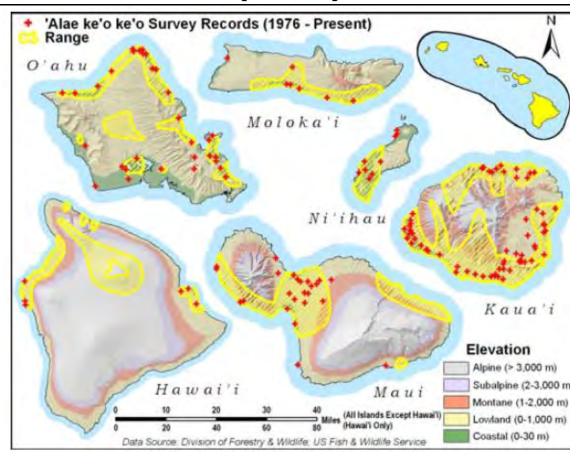


Image Credit: Birds of North America

Factors of Decline: Historically, hunting was the primary cause of population decline. More recently, wetland loss, fragmentation and degradation, hydrological modifications, and the introduction predators (mongooses, cats, rats and dogs) have played a role in their decline. Other factors include alien plants, introduced fish, bull frogs, disease (i.e., avian botulism) and environmental contaminants. Climate change is believed to pose a threat to this species.

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shoreline aquatic vegetation. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species, including adults, nests, eggs and chicks (via direct contact/smothering) than the chemically dispersed oil.

Common Name:	Hawaiian Coot (‘Alae ke‘oke‘o)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1970) FR listing for T/E – 35 FR 13519 13520
Scientific Name:	*Fulica americana alai*	**Critical Habitat:**	None currently designated in Hawaii

References:

Engilis Jr, A. and Pratt, T.K., 1993. Status and population trends of Hawaii's native waterbirds, 1977-1987. The Wilson Bulletin, pp.142-158.

Pratt DH, Brisbin IL. 2002. Hawaiian coot (*Fulica alai*). In The Birds of North America, No. 697 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.

USFWS, 2013. Hawaiian Coot (*Fulia alai*) 5-year review 2013. (https://ecos.fws.gov/docs/five_year_review/doc4543.pdf)

NEBA Data Sheets for T/E Resources- Plants

Common Name:	Oahu Riverhemp (‘Ohai)	**Conservation Status:**	T/E (federal and/or state) – **Endangered** (1994) FR listing for T/E – 59 FR 56333 56351
Scientific Name:	*Sesbania tomentosa*	**Critical Habitat:**	FR listing report ID – 68 FR 28054 28075 (2003)

Appearance: ‘Ohai

Photo Credit: USFWS

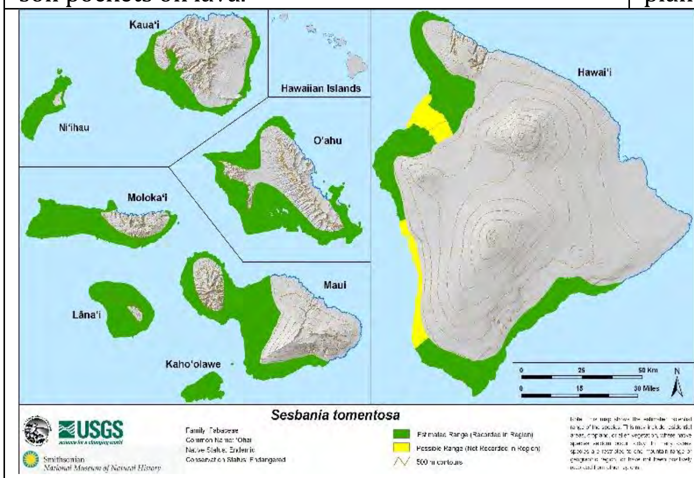
Life Cycle: ‘Ohai are 2.5-6 m tall, have branches up to 14 m in length and color flowers (orange red or scarlet). The life span of these perennial shrubs is greater than 5 years.

Biological Processes: Successful pollination of ‘Ohai is accomplished by native bees of the genus *Hylaeus* . This plant blooms sporadically throughout the year, with peak blooming periods in winter and spring following rainy periods in their natural environment.

Population Status: This rare native shrub occurs in larger numbers only on Nihoa and Necker islands, part of the Papahanaumokuakea Marine National Monument, (~5,500 individuals), with relatively few occurrences persisting on the eight main Hawaiian islands (~1,600 to 2,000 individuals).

Spatial Distribution: This species occurs in elevations below 300 m in areas with less than 500 mm in annual precipitation, including dry shrublands or forests, calcareous beaches and sand dunes, rocky ridges and slopes, deep red soil, and soil pockets on lava.

Critical Habitat Description: The currently known primary constituent elements of critical habitat for this species include, but are not limited to, the habitat provided by: 1) open, dry forest with mixed native grasses, coastal dry shrubland on windswept slopes and weathered basaltic slopes, and containing associated native plant species; and 2) elevations between sea level and 922 m.



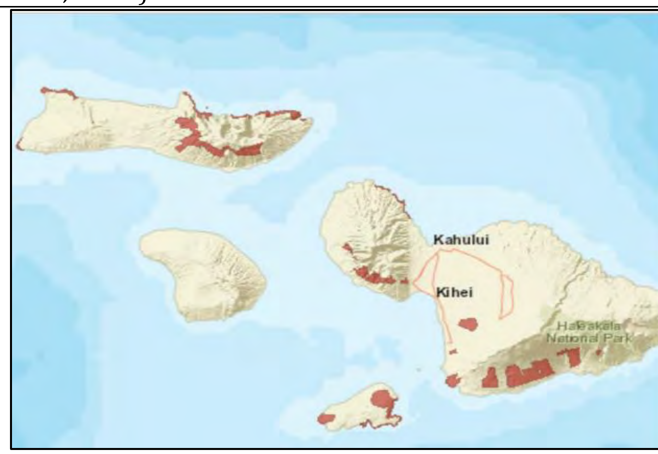


Image Credit: USFWS

Factors of Decline: The most important limiting factors identified for this species are the loss of seeds to rodent predation and low seedling recruitment. Other limiting factors include the loss of flowers to nonnative insect predation and displaying low fruit set caused by either a lack of effective pollination or self-compatibility problems. Other threats to this species include damage from off-road vehicles, cattle and goats, habitat disturbance and costal development

Tradeoff Implications of Dispersant Use: Effective dispersant use in the offshore environment is intended to reduce the volume of oil stranded on shorelines. Under the current scenario this volume would be reduced by half with the use of dispersants. Thus, the untreated oil would pose a greater risk of exposure to this species and its critical habitat (via direct contact/smothering) than the chemically dispersed oil.

References:

NRC. 2005. Oil Spill Dispersants: Efficacy and Effects, National Academies Press, Washington DC. 377.

USFWS, 1999. Recovery Plan for the Multi-Island Plants (https://ecos.fws.gov/docs/recovery_plan/990710.pdf)

Wagner, W.L.; Herbst, D.R.; Sohmer, S.H., 1999. Manual of the Flowering Plants of Hawai'i-- Revised Edition. Honolulu, HI: University of Hawaii Press and Bishop Museum Press. 1853p.

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Appendix E:
Conceptual Model

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Table **E-1**. ENVIRONMENTAL Conceptual Model for 5,000-barrel ANS spill for Barbers Point, HI NEBA

			Active Monitoring and Natural Attenuation - no actions; physical trauma and waste removal not included. Often includes "set-asides" or areas that are not to be cleaned over a specific timeline due to sensitivity, T/E resource presence (e.g., tern nesting, sea turtle nests), etc	Mechanical Containment and Recovery - includes Source Control - offshore only; on or at vessel; Spread Control - includes booming, v-legs, j-leg, etc.; offshore and nearshore; On Water Oil Recovery, e.g., Skimmers, Vac Trucks - assumed only upper 2 m of water column affected by skimming ops; offshore and nearshore	Chemical Dispersion - the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing surface oil to remain would cause more harm than mixing the oil into the water column; overspray, equipment affects, and mixing (dispersant / dispered oil) may be transferred into the nearshore environment	In-situ (controlled on water) burning - used to remove oil from the water surface; only conducted offshore areas under wind speed and wave height limitations; smoke could travel inland; sinking oil only in burn area	Resource Protection - includes sensitive area protection using tactical protection booming strategies, deflection booming to protect sensitive areas, water intakes, and fisheries. Can also include wildlife protection activities to move (or physically remove) wildlife from locations that are in the predicted path of the spilled oil removal, relocation, and hazing operations for potentially impacted resources.	Shoreline Clean Up - removal of oil from the shoreline for disposal to prevent further contamination of human use and ecologically-sensitive areas and habitatassumes affected areas are accessed from shore so no vessel effects or helicopter for transport; includes waste removal
On Land Environment (above the high, high tide line)								
TERRESTRIAL	On shore, above mean high, high tide line	Vegetation	9	9	9	9	4	9
		Birds	1, 4	9	3	1	3, 8	1, 4
		Mammals	1, 4	9	3	1	3	
		Reptiles	1, 4	9	3	1	3, 7	3, 6, 8
		Insects	1, 4	9	9	1	3	3, 6,
		T/E species - ANIMALS	1, 4, 8	9	3, 9	1	3, 7	3, 6, 8
		T/E (or rare) species - PLANTS	1, 4	9	9	9	8	9
		Critical Habitat - habitat can only be oiled or affected by waste removal on shore	4	9	9	9	8	3, 6
Nearshore Environments (within the Fringing Reef / Photic Zone)								
INTERTIDAL	May include: Reef flats; rocky platforms; tidal flats; sand beaches; man-made structures e.g., fish ponds, bulkheads; Anchialine ponds	Vegetation	2, 4	3	3, 4	4, 5	3	9
		Calcified Algae	2,4	3	3, 4	4, 5	3	9
		Sponges	2, 4	3	3, 4	4, 5	3	9
		Corals & Live Rock	2, 4	3	3, 4	4, 5	3	9
		Birds	1, 2, 3, 4, 8	9	3, 4	1, 4, 5	3	9
		Mammals	1, 2, 4, 8	3	3, 4	1, 4, 5	3	9
		Reptiles	1, 2, 4, 8	3	3, 4	1, 4, 5	3	9
		Fish	2, 4, 7	9	4	4, 5	3	9
		Shellfish and Other Invertebrates	2, 4, 7	3	4	4, 5	3	9
		T/E Species (or rare) - ANIMALS	1, 2, 3, 4, 7, 8	9	3, 4	1, 4, 5	3	9
		T/E (or rare) Species – PLANTS	9	9	9	9	9	9
		Critical Habitat - habitat can only be oiled	2, 4	9	9	9	9	9
SUBTIDAL Shallow water (lower low tide line to the bottom, up to 20 meters water depth	WATER SURFACE Based on mixing zones and where the life is 0 to 2-meter water depths	Vegetation	2, 4, 7	3	3, 4	4, 5	3	9
		Calcified Algae	2, 4, 7	3	3, 4	4, 5	3	9
		Coral and Live Rock	2, 4, 7	3	3, 4	4, 5	3	9
		Sponges	2, 4, 7	3	3, 4	4, 5	3	9
		Birds	2, 4, 7	9	3, 4	1, 3, 4, 5	3	9
		Mammals	2, 4, 7	3	3, 4	1, 3, 4, 5	3	9
		Reptiles	2, 4, 7	3	3, 4	1, 3, 4, 5	3	9
		Fish	2, 4, 7	9	4	3, 4, 5	9	9
		Shellfish and Other Invertebrates	2, 4, 7	3	4	3, 4, 5	3	9
		T/E species - ANIMALS	2, 4, 7	3, 9	3, 4	3, 4, 5	3	9
		T/E (or rare) species - PLANTS	9	9	9	5	9	9
		Critical Habitat - habitat can only be oiled	2, 4	9	9	5	9	9
	WATER COLUMN >2-meters water depth but 1 to 2-meters above the bottom (depends upon mixing depth)	Birds	2, 4, 7	9	4	9	3	9
		Mammals	2, 4, 7	3	4	9	3	9
		Reptiles	2, 4, 7	3	4	9	3	9
		Fish	2, 4, 7	9	4	9	9	9
		Shellfish and other Invertebrates	2, 4, 7	9	4	9	3	9
		T/E species - ANIMALS	2, 4, 7	9	4	9	3	9
		T/E (or rare) species - PLANTS	9	9	9	9	9	9
		Critical Habitat - habitat can only be oiled	2, 4	9	9	9	9	9
	BOTTOM / BENTHOS Includes the bottom and 1 to 2-meters of water column above the bottom (depths of mixing to be considered)	Vegetation	2, 4, 7	3	4	4	3	9
		Coraline algae	2, 4, 7	3	4	4	3	9
		Corals and Live Rock	2, 4, 7	3	4	4	3	9
		Sponges	2, 4, 7	3	4	4	3	9
		Fish	2, 4, 7	9	4	9	9	9
		Shellfish and other Invertebrates	2, 4, 7	3	4	4	3	9
		T/E species - ANIMALS	2, 4, 7	9	4	9	3	9
		T/E (or rare) species - PLANTS	9	3	9	9	9	9
		Critical Habitat - habitat can only be oiled	2, 4	9	9	9	9	9
Offshore Environments (on water, open coastal outside of the fringing reef)								
	WATER SURFACE Based on mixing zones and where the life is at the air/water interface down to 2-meter water depths	Plankton	2, 4, 7	9	4	4, 5	9	9
		Birds	1, 2, 4, 7	4	3, 4	4, 5	9	9
		Mammals	1, 2, 4, 7	3, 4	3, 4	1, 3, 4, 5	9	9
		Reptiles	1, 2, 4, 7	3, 4	3, 4	1, 3, 4, 5	9	9
		Fish	2, 4, 7	9	4	3, 4, 5	9	9
		Shellfish and other Invertebrates	2, 4, 7	3	4	3, 4, 5	9	9
		T/E species - Animals	1, 2, 4, 7	3, 4 or 9?	3, 4	3, 4, 5	9	9
		T/E (or rare) species - Plants	9	9	9	5	9	9
		Critical Habitat - habitat can only be oiled	2, 4	9	9	5	9	9
SUBSURFACE 2-meter water depth up to 20 meters water depth	**WATER COLUMN Based on mixing zones and where life is from 2-meter water depth up to 10 fathoms (20 meters) Does not include 1 to meters of water column above the bottom**	Birds	2, 4, 7	9	4	4	9	9
		Mammals	2, 4, 7	9	4	4	9	9
		Reptiles	2, 4, 7	9	4	4	9	9
		Fish	2, 4, 7	9	4	4	9	9
		Shellfish and other Invertebrates	2, 4, 7	9	4	4	9	9
		T/E species - ANIMALS	2, 4, 7	9	4	4	9	9
		T/E (or rare) species - PLANTS	9	9	9	9	9	9
		Critical Habitat - habitat can only be oiled	2, 4	9	9	9	9	9
	BOTTOM / BENTHOS On the bottom; Includes the bottom and 1 to 2-meters of water column above the bottom	Vegetation	2, 4, 7	3	4	4	3	9
		Coraline Algae	2, 4, 7	3	4	4	3	9
		Corals and Live Rock	2, 4, 7	3	4	4	3	9
		Sponges	2, 4, 7	3	4	4	3	9
		Meiofauna and Infauna	2, 4, 7	9	4	4	9	9
		Fish	2, 4, 7	9	4	4	9	9
		Shellfish and other Invertebrates	2, 4, 7	3	4	4	3	9
		T/E species - Animals	2, 4, 7 or 9	9	4	9	9	9
		T/E (or rare) species - Plants	9	3	9	9	3	9
		Critical Habitat - habitat can only be oiled	2, 4	9	9	9	9	9

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Appendix F:
Workshop 1, 2, and 3 Agendas

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Oceania Regional Response Team (ORRT)
Net Environmental Benefit Analysis (NEBA) of
Hawaii Coastal Zone Oil Spill Response Options

WORKSHOP 1
August 9 -10, 2017 in Honolulu – Inouye Regional Center
1845 Wasp Blvd, Honolulu, HI 96818 Tel. (808) 725-6246

Meeting Room: TRAINING ROOM 1651 / 1653

Day 1 – AGENDA (Annotated)August 9, 2017

Hawaii Oil Spill Preparedness - NEBA process

PHASE 1: Problem Definition/Formulation (Steering Committee, **pre-workshop**)

1. Assemble the Steering Committee
2. Develop the scenario(s)
3. Estimate the transport, fate of oil, and exposure potential – with and without response options
4. Define response options for consideration w/ anticipated benefits and limitations
5. Define resources of concern (environmental and socioeconomic)

PHASE 2: Analysis Plan and Initiation (All participants, **Workshop 1: 8/9-10/2017**)

6. Consider exposure pathways – Review/finalize Conceptual Model
7. Thresholds of sensitivity to oil and response options, e.g., dispersants
8. Determine levels of concern about effects
9. Evaluate relative risk to resources of concern for oil only

PHASE 3: Analysis and Risk Characterization (All participants, **Workshop 2: 9/26-28/2017**)

10. Evaluate relative risks of response options (which represents lowest overall risk?)
11. Define uncertainties and limits of the analysis

PHASE 4. Document and Apply Consensus Findings (**Post-workshop** report; Steering Committee and Oceania Regional Response Team)

0830
Registration/check in

0900
Welcome (CDR Bill Robberson, ORRT)

0905
Opening Comments (CAPT Michael Long, USCG Commanding Officer, Sector Honolulu and Federal On-scene Coordinator/FOSC and Terry Corpus, Hawaii Dept. of Health representing State On-scene Coordinator/SOSC)

- Brief introduction to Unified Command

0920
Introductions (Bill Robberson, ORRT)

- Project Steering Committee
- Workshop participants

1000
ORRT Project Needs (William Marhoffer, USCG ORRT Co-chair) – why this is important

- Dispersant pre-approval from 1990s, etc.
- Historical spills review (optional)
- Contemporary documentation required for any use of dispersants
- Dispersant approval process

1030
Break on your own

1050
Background – Bill Robberson (USEPA ORRT)

- NEBA Background
- Project Objectives and scope
    - o Anticipated use, and value, of project results
    - o Planning only – results are not binding during response
    - o Scope

1110
Hawaii NEBA Process (A. H. Walker, SEA)

- Overview of the process
    - o Steps in the process
    - o Opportunities and limitations of the process
    - o What consensus means + value of consensus to project results
- What are the objectives of this workshop in relation to the overall process;
- Information, data sources and references (used to date and sources for risk analysis and characterization to be used in the next workshop)
    - o Value to the process
    - o Uncertainty

1200
LUNCH – on your own

1300
Overview of Pre-workshop Steering Committee Activities (A. H. Walker, SEA)

1320
Scenario (Bill Marhoffer, ORRT Co-chair)

- Description and rationale (why these scenarios)

1335
Human use/public health considerations (Terry Corpus, Hawaii SOSC)

- Important when considering the tradeoffs associated with response options

1350
Response Options (Kim Beasley, Clean Islands Cooperative / CIC)

- Role of CIC in implementing response options for Responsible Party
- Describe each response option, including Active Monitoring and Natural Attenuation (AMNA)
- Resources required (logistics) to implement the option
- Operational limitations
- Anticipated efficiency of each option (single %; or % of the upper and lower range, or other %?)
- Implications of using the option on oil fate

1415
Break on your own

1500
Oil behavior and transport, with and without response options/trajectories (Jordan Stout, NOAA Scientific Support Coordinator / SSC)

- Distribtuion of oil: air/water surface/water subsurface
- Oil type – properties / effects of oil

1545
Resources of Concern: Ecological (Michael Fry, USFWS; Matt Parry, NMFS)

- Categorization of ecological and socio-economic resources of concern in study area
- Threatened/endangered species (T/E)
- Information, data sources and references
- Discussion/refine?

1630
Resources of Concern: Human Use (Ann Hayward Walker, SEA)

- Potential human dimensions affected by spills, e.g., tourism, local culture)
- Discussion

1640
Review the first day and plan for tomorrow (SEA)
Questions/discussion (all)

1700
ADJOURN FOR THE DAY

Day 2 – AGENDA (Annotated)

August 9, 2017

0830 – Sign In

0900
Welcome

0905
Review the results of the first day (A.H. Walker, SEA)
Review process for today

- Breakout group assignments
- Conceptual model
- Oil spill effects
- Using the Risk Ranking Matrix
- Conducting the analysis for oil only (as a baseline for response options)
- Preparation for next workshop

0915
The Conceptual Model: Pathways of Exposure for Resources of Concern (Debra Scholz, SEA)

- Introduction to the proposed Conceptual Model
- Practice – complete the conceptual model for socio-economic resources of concern in plenary
- Discussion/refine?

0945
Conceptual Model for Environmental Resources of Concern: Breakout Groups

- **BREAKOUT ROOMS ARE 1377 LIBRARY CLASSROOM AND 1564 KO'OLAU HAKA CONFERENCE ROOM**
- Complete conceptual model in your breakout groups
- Document assumptions!
- **Break as needed**

1100
Defining Effects (Michael Fry, USFWS): Back in Plenary

- Using fate and effect information
- Using thresholds to estimate the sensitivity to oil of the resources of concern
  - Exposure
  - Sensitivity
  - Effect
- Information, data sources and references

1130
Introduction to the Risk Ranking Matrix (Michael Fry, USFWS)

- Estimating/defining levels of concern
- Evaluating the relative risk for oil spill response options using the risk ranking matrix

1200
LUNCH – on your own

1300
Establishing the Baseline for Effects: OIL ONLY = Active Monitoring and Natural Attenuation / AMNA (Michael Fry, USFWS)

- Context remarks
- Questions?

1315
Begin Risk Scoring for OIL ONLY – Breakout groups for the scenario

- Discussion leader and recorder – need to document assumptions!
- Participants assigned to workgroups and breakout rooms:
- **BREAKOUT ROOMS ARE 1377 LIBRARY CLASSROOM AND 1564 KO'OLAU HAKA CONFERENCE ROOM**

1400
Time Out – Back in Plenary

- Review and compare initial scores
- Course correction/clarification?

1430
Break on your own

1445
Continue preliminary risk scoring for baseline

1600
Review, discussion and revision of baseline (AMNA) scores
Questions/discussion (all)

- Documented assumptions and limitations/uncertainty
- How would different conditions (e.g., volume, date, location) affect what we've done so far?

Preparation for Next Workshop – Assignments

- Gather data/information about resources of concern to characterize effects of response options in the next workshop
- Questions to be addressed before the next workshop
- References/data needed before the next workshop

1700
ADJOURN

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Oceania Regional Response Team (ORRT)
Net Environmental Benefit Analysis (NEBA) of
Hawaii Coastal Zone Oil Spill Response Options

WORKSHOP 2
September 25, 26, and 28, 2017 in NOAA Inouye Regional Center (IRC)
1845 Wasp Blvd, Honolulu, HI 96818 Tel. (808) 725-6246

Plenary Meeting Room: TRAINING ROOM 1651 / 1653

Hawaii Oil Spill Preparedness - NEBA process

PHASE 1: Problem Definition/Formulation (Steering Committee, **pre-workshop**)

1. Assemble the Steering Committee
2. Develop the scenario(s)
3. Define response options for consideration w/ anticipated benefits and limitations

PHASE 2: Analysis Plan and Initiation (All participants, **Workshop 1**)

4. Define Resources of Concern (environmental and socioeconomic)
5. Estimate the transport, fate of oil, and exposure potential – with and without response options
6. Consider exposure pathways – Review/refine the Conceptual Model

PHASE 3: Analysis and Risk Characterization (All participants, **Workshop 2: 9/26-28/2017**)

7. Thresholds of sensitivity to oil and response options, e.g., toxicity
8. Define levels of concern about effects, i.e., risk ranking matrix
9. Assess relative risk to resources of concern for oil only
10. Assess relative risks of response options (which represents lowest overall risk?)
11. Document uncertainties and limits of the analysis

PHASE 4. Document and Apply Consensus Findings (**Post-workshop** report; Steering Committee and Oceania Regional Response Team)

Monday, September 25, 2017
AGENDA: Summary of Workshop 1 for New Participants
Training Room 1651-53

1245
Participants arrive at Arizona Memorial Parking Area, van to IRC

1315
Registration and Check-in outside Room 1651-53

1330
Welcome and Introductions (Dan Meer and Bill Robberson, USEPA ORRT)

1400
Review of Workshop 1 (Ann Hayward Walker and Debbie Scholz, SEA Consulting Group)
- Project Needs: 1. Preparedness (Reginal Contingency Plan) and 2. Response (Unified Command decision makers)
- Overview of NEBA Process
- Pre-workshop Steering Committee Activities
- Workshop Objectives
- Scenario and response options
- Trajectory – extent of contamination for the scenario
- Resources of Concern Tables – Ecological and Human
- What's next?

1600
ADJOURN

Tuesday, September 26, 2017
AGENDA: NEBA Steps 7-9

0745
Participants arrive at Arizona Memorial Parking Area, van to IRC

0815
Registration/check-in outside Room 1651-53

0830
Welcome and Introductions (Dan Meer and Bill Robberson, USEPA, ORRT)
- Project Steering Committee
- Workshop participants

0915
Workshop 2 Goals and Process (Ann Hayward Walker, SEA)
- Updates from Workshop 1, e.g., response options table, references

0945
Thresholds of sensitivity to oil and response options (Adriana Bejarano, RPI)
- Oil and dispersant toxicity
- Estimated oil and dispersed oil concentrations in scenario trajectory
- Sensitive Species Distributions
- Special focus on federal threatened and endangered species – data sheets

1030
Break on your own

1115
Ecological Resources of Concern and Conceptual Model (Debbie Scholz, SEA)

1200
LUNCH on your own

1300
Questions so far?

1315
Introductions to Risk Ranking and Establishing Threshold Levels of Concern (Ann Hayward Walker, SEA and Michael Fry, USFWS)

- Using thresholds to estimate the risk to Resources of Concern from the spilled oil and response options
  - Exposure, Sensitivity, Effect
- Risk ranking matrix = thresholds for levels of concern to use in characterizing risk

1345
Human Resources of Concern – Ann Hayward Walker

- Review agreements from Workshop 1 and subsequent work
- Discuss approach to consider/incorporate into tradeoff discussions

1400
Establishing the Baseline for Effects: OIL ONLY = Active Monitoring and Natural Attenuation (Ann Hayward Walker, SEA)

- Context remarks

1415
Begin Risk Scoring for OIL ONLY – Breakout groups for the scenario

- Discussion leader and recorder – need to document assumptions!
- Participants assigned to workgroups and breakout rooms:
  - **BREAKOUT ROOMS ARE PLENARY ROOM AND 1377 LIBRARY CLASSROOM**

Break on your own

1545
Time Out – Reconvene in Plenary

- Review, discussion and revision of breakout group scores
- Synthesis of baseline (oil only) scores

1645

- Outstanding comments
- Plan for tomorrow

1700
ADJOURN FOR THE DAY

Thursday, September 28, 2017
AGENDA: NEBA Steps 10-11

0745
Participants arrive at Arizona Memorial Parking Area, van to IRC

0815 Sign In

0830
Welcome (Bill Robberson USEPA ORRT)

0835
Review the results of the first day (A.H. Walker, SEA)
Review process for today

- Complete risk characterization (assign levels of concern) for response options
- Capture caveats – uncertainties, limitations
- Questions, comments?
- Summarize recommendations for response planning going forward

0900
Refresher Discussion: Thresholds of sensitivity to oil and response options (Adriana Bejarano, RPI)

- Estimated oil and dispersed oil concentrations in scenario trajectory
- Sensitive Species Distributions
- References

0930
Characterizing the risks to Ecological Resources of Concern from response options: Breakout Groups

- **BREAKOUT ROOMS ARE PLENARY ROOM AND 1377 LIBRARY CLASSROOM**
- Document assumptions!
- **Finish 3 response options before lunch**

Break as needed

1200
LUNCH – on your own

1300
Characterizing the risks to Ecological Resources of Concern from response options: Breakout Groups

- **BREAKOUT ROOMS ARE PLENARY ROOM AND 1377 LIBRARY CLASSROOM**
- Document assumptions!

- **Finish 2 more response options before the break**

1500
Break

1530
Discussion as PLENARY (A. H. Walker and Bill Robberson, USEPA ORRT)
- Compare, reconcile and combine breakout group findings

1630
Feedback and Follow-up (Dan Meer and Bill Robberson, USEPA ORRT)
- Phase 4 of the process – current plan
- How would you like to see the results of this process applied during oil spill preparedness in Hawaii?
- Are you comfortable with the process? The findings?
- What limitations/uncertainties need to be included in the report?
- What if any follow-up actions do you think are important?

1700
ADJOURN

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Oceania Regional Response Team (ORRT)
Net Environmental Benefit Analysis (NEBA) of
Hawaii Coastal Zone Oil Spill Response Options

WORKSHOP 3
May 8-10, 2018 in NOAA Inouye Regional Center (IRC)
1845 Wasp Blvd, Honolulu, HI 96818 Tel. (808) 725-6246

Meeting Room: TRAINING ROOM 1651 / 1653

Hawaii Oil Spill Preparedness - NEBA process

PHASE 1: Problem Definition/Formulation (Steering Committee, **pre-workshop**)

1. Assemble the Steering Committee
2. Develop the scenario(s)
3. Define response options for consideration w/ anticipated benefits and limitations

PHASE 2: Analysis Plan and Initiation (All participants, **Workshop 1**)

4. Define Resources of Concern (environmental and socioeconomic)
5. Estimate the transport, fate of oil, and exposure potential – with and without response options
6. Consider exposure pathways – Review/refine the Conceptual Model

PHASE 3: Analysis and Risk Characterization (All participants, **Workshop 3: 5/8-10/2018**)

7. Thresholds of sensitivity to oil and response options, e.g., toxicity
8. Define levels of concern about effects, i.e., risk ranking matrix
9. Assess relative risk to resources of concern for oil only
10. Assess relative risks of response options (which represents lowest overall risk?)
11. Document uncertainties and limits of the analysis

PHASE 4. Document and Apply Consensus Findings (**Post-workshop** report; Steering Committee and Oceania Regional Response Team)

Workshop 3 – Agenda Overview

Tuesday, May 8th (full day)

- Review previous risk rankings for Kona scenario in offshore environments with a toxicity focus, revise if needed
  - Complete remaining rankings for nearshore environments
- Goal – complete risk ranking for *both Kona and Trade wind scenarios*

Wednesday, May 9th (full day)

- Complete anything remaining from the previous day
- Complete rankings for on-land environments for *both Kona and Trade wind scenarios*

Thursday, May 10th (half day)

- Complete anything remaining from the previous day
- Document key points, decision drivers, and any critical areas of uncertainty

Tuesday, May 8, 2018
AGENDA

0830
Non-federal participants picked up at Arizona Memorial Parking Area, van to IRC (be on time!)

0845
Registration and Check-in outside Room 1651-53

0900
Introductions

0930
Welcome and Workshop Goals
- **Dan Meer and Bill Robberson, USEPA ORRT**
- **William Marhoffer, USCG ORRT**
- **Fenix Grange, Hawaii Dept. of Health, ORRT and SOSC**

1000
Quick Review of Workshops 1 and 2 - Ann Hayward Walker, SEA Consulting Group
- NEBA Process
- Scenario and response options
- Resources of Concern Tables – Ecological and Human
- Conceptual Model

1030
Break on your own

1045
Quick Toxicity Review - Debbie Scholz
- Surface and subsurface trajectory predictions of oiling with and without dispersants through 120 hours post-discharge
- Thresholds of sensitivity to oil and chemical dispersants
    - Oil and dispersant toxicity
    - Estimated oil and dispersed oil concentrations in scenario trajectory
    - Sensitive Species Distributions

1115
Review of previous rankings of offshore environments with new toxicity supporting statements
Participant discussion facilitated by Debbie Scholz – consider both scenarios
- Special focus on federal threatened and endangered species – refer to updated data sheets!
- New rankings to be developed for all response options in subtidal shallow water

1215
LUNCH on your own – suggest café in IRC lobby

1315
Resume discussion
Continue risk rankings for nearshore environments

1515
Break on your own

1530
Resume discussion
GOAL – finish ranking risks of all response options for offshore and nearshore environments and for both Kona and Trade wind scenarios by 1630 if possible

1630
Outstanding issues or points

1645
Adjourn for the day

Wednesday, May 9, 2018
AGENDA

0830
Non-federal participants picked up at Arizona Memorial Parking Area, van to IRC (be on time!)

0845
Sign in, outside Room 1651-53

0900
Process for the day

0930
Participant discussion facilitated by Debbie Scholz – ALL

- Special focus on federal threatened and endangered species – refer to updated data sheets!
- Complete risk rankings for any nearshore environments remaining from Day 1
- Begin risk rankings for on-land environments for shoreline cleanup
- **GOAL – finish ranking risks of all response options for all shoreline habitats by 1630 if possible**

1030
Break on your own

1045
Resume discussion

1200
LUNCH on your own – suggest café in IRC lobby

1300
Resume discussion

1500
Break on your own

1515
Resume discussion
GOAL – finish ranking risks of all response options for on-land environments by 1630 if possible

1630
Outstanding issues or points

1645
Adjourn for the day

Thursday, May 10, 2018
AGENDA

0830
Non-federal participants picked up at Arizona Memorial Parking Area, van to IRC (be on time!)

0845
Sign in, outside Room 1651-53

0900
Process for the day

0930
Complete any remaining risk rankings for shoreline cleanup in on-land environments

1200
Summary and key points (Dan Meer and Bill Robberson, USEPA ORRT)

- How would you like to see the results of this process applied during oil spill preparedness in Hawaii?

- Are you comfortable with the process? The findings?
- What limitations/uncertainties need to be included in the report?
- What if any follow-up actions do you think are important?

1230
ADJOURN and THANK YOU!

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Appendix G:
Final Risk Ranking Scores

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Appendix G: Final Environmental Risk Ranking Scores

Habitat: On Land Environment (above the high, high tide line)

SubHabitat: Terrestrial – On shore, above mean high, high tide line

RESPONSE ACTIONS / Resources of Concern	Vegetation	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Insects	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring - no actions; physical trauma and waste removal not included. Often includes "set-asides" or areas that are not to be cleaned over a specific timeline due to sensitivity, T/E resource presence (e.g., tern nesting, sea turtle nests), etc.	4D	4C	4C	4B	4C	3A 4C N/A 4C N/A	4D	4D 4D 4B N/A
Summary Risk for Sub-habitat								
Mechanical Containment and Recovery - includes Source Control - offshore only; on or at vessel; Spread Control - includes booming, v-legs, j-leg, etc.; offshore and nearshore; On Water Oil Recovery, e.g., Skimmers, Vac Trucks - assumed only upper 2 m of water column affected by skimming ops; offshore and nearshore	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat								
Chemical Dispersion - the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing surface oil to remain would cause more harm than mixing the oil into the water column; overspray, equipment affects, and mixing (dispersant / dispersed oil) may be transferred into the nearshore environment	4D	4D	4D	4D	4D	4C 4C 4C 4C N/A	4D	4D ? 4B N/A
Summary Risk for Sub-habitat								
Resource Protection - includes sensitive area protection using tactical protection booming strategies, deflection booming to protect sensitive areas, water intakes, and fisheries. Can also include wildlife protection activities to move (or physically remove) wildlife from locations that are in the predicted path of the spilled oil removal, relocation, and hazing operations for potentially impacted resources.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat								
Shoreline Clean Up - removal of oil from the shoreline for disposal to prevent further contamination of human use and ecologically-sensitive areas and habitat assumes affected areas are accessed from shore so no vessel effects or helicopter for transport; includes waste removal	N/A	4D	N/A	N/A	N/A	4D	N/A	4D
Summary Risk for Sub-habitat								

Habitat: Nearshore Environments (within the Fringing Reef / Photic Zone)

SubHabitat: Intertidal – Reef flats; rocky platforms; tidal flats; sand beaches; man-made structures e.g., fish ponds, bulkheads; Anchialine ponds

RESPONSE ACTIONS	Vegetation	Crustose Coraline Algae	Sponges	Coral and Live Rock	Non-T/E Birds	Non-T/E Mammals - feral cat, mongoose	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	3B	3B	4C	2B	3B	4D	N/A	3C	3C	3B 2A N/A 2B N/A	N/A	N/A N/A 4B N/A
Summary Risk for Sub-habitat												
Mechanical Containment and Recovery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat												
Chemical Dispersion	3B	3C	4B	2A	3C	4D	N/A	3B	3B 3B	3C 2B N/A 2B N/A	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat												
Resource Protection	3C	3C	4B	2B	3B	N/A	N/A	4C	3C	3B 4C N/A 2B N/A	N/A	N/A N/A 4B N/A
Summary Risk for Sub-habitat												
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat												

Subtidal - Shallow water (lower low tide line to the bottom, up to 20 meters water depth)

Water Surface – Based on mixing zones and where the life is; 0 to 2-meter water depths

RESPONSE ACTIONS	Vegetation, Floating Algae	Crustose Calcified Algae on the bottom	Sponges on the bottom	Coral and Live Rock on the bottom	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	3C	3C	4C	2C	3B	2B	N/A	4C	4C	2A 2A N/A 1A 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat												
Mechanical Containment and Recovery	3C	N/A	N/A	N/A	4D	4D	N/A	4D	4D	4D 4D N/A 4C 4D	N/A	N/A N/A 4D N/A
Summary Risk for Sub-habitat												
Chemical Dispersion	3C	3B	3B	1B	3C	2B	N/A	4B	4B	2A 2A N/A 1B 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat												
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat												
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat												

Water Column – >2-meters water depth but 1 to 2-meters above the bottom (depends upon mixing depth)

RESPONSE ACTIONS	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	3B	3C	N/A	4C	4C	3C 3B 3C 3C 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat								
Mechanical Containment and Recovery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat								
Chemical Dispersion	3B	3B	N/A	4C	4C	2C 3B 3C 3C 2B	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat								
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat								
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat								

BOTTOM / BENTHOS – Includes the bottom and 1 to 2-meters of water column above the bottom (depths of mixing to be considered)

RESPONSE ACTIONS	Vegetation	Crustose Coraline Algae	Sponges	Coral and Live Rock	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	4C	3B	4B	3B	4C	3C	N/A	4C	4C	4C 2B 4B 3B 3C	N/A	N/A N/A N/A 4C
Summary Risk for Sub-habitat												
Mechanical Containment and Recovery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat												
Chemical Dispersion	4B	2A	1A	4B	4C	3C	N/A	4B	4B	3C 2B 3B 3B 3C	N/A	N/A N/A N/A 4C
Summary Risk for Sub-habitat												
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat												
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat												

Habitat: Offshore Environments, 1 mile plus (on water, open coastal outside of the fringing reef)

Subsurface

Water Surface – Based on mixing zones and where the life is at the air/water interface down to 2-meter water depths

RESPONSE ACTIONS	Plankton	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	4C	2B	2B	N/A	4C	4C	2B 2A 1B 2B 3C	N/A	N/A N/A N/A 4B
Summary Risk for Sub-habitat									
Mechanical Containment and Recovery	4D	4D	4D	N/A	4D	4D	4D 4D 4D 4C 4D	N/A	N/A N/A N/A 4D
Summary Risk for Sub-habitat									
Chemical Dispersion	4B	2C	2B	N/A	4B	4C	2C 2A 1B 2B 3B	N/A	N/A N/A N/A 4B
Summary Risk for Sub-habitat									
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat									
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat									

Water Column – Based on mixing zones and where life is from 2-meter water depth up to 10 fathoms (20 meters) Does not include 1 to meters of water column above the bottom

RESPONSE ACTIONS	Plankton	Non-T/E Birds	Non-T/E Mammals	Non-T/E Reptiles	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	4D	3C	3C	N/A	4C	4C	3B 3B 3C 3C 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat									
Mechanical Containment and Recovery	4C	3B	3C	N/A	4C	4C	3B 3A 4C 3C 2C	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat									
Chemical Dispersion	4C	3C	3B	N/A	4C	4C	3B 3B 3C 3C 2B	N/A	N/A N/A 4C N/A
Summary Risk for Sub-habitat									
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat									
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat									

Bottom / Benthos – On the bottom; Includes the bottom and 1 to 2-meters of water column above the bottom

RESPONSE ACTIONS	Vegetation	Crustose Coraline Algae	Sponges	Coral and Live Rock	Meiofauna / Infauna	Non-T/E Fish	Non-T/E Shellfish & Other Invertebrates	T/E Species or Rare - ANIMALS	T/E Species or Rare - PLANTS	Critical Habitat
Natural Attenuation and Monitoring	4D	4D	4D	4D	4D	4D	4D	N/A 4D 4D 4D 4D	4D	N/A N/A 4D N/A
Summary Risk for Sub-habitat										
Mechanical Containment and Recovery	4D	4D	4D	4D	4D	4D	4D	N/A 4D 4D 4D 4D	4D	N/A N/A 4D N/A
Summary Risk for Sub-habitat										
Chemical Dispersion	4D	4D	4C	4C	4C	4C	4C	N/A 4D 4D 4C	4D	N/A N/A 4D N/A
Summary Risk for Sub-habitat										
Resource Protection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat										
Shoreline Clean Up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summary Risk for Sub-habitat										

Appendix G: Final Environmental Risk Ranking Scores

T/E species – ANIMALS
Reporting order:

- Birds
- Marine Mammal – HI Monk Seal
- Marine Mammal – cetaceans
- Reptiles – Sea Turtles
- Fish - Manta Ray

Critical Habitat
Reporting order:

- Insects CH
- Plants CH
- HI Monk Seal CH

Insular False Killer Whale

		RECOVERY			
		VERY SHORT	SHORT	INTERMEDIATE	LONG
		< 1 year (4)	1 to 3 years (3)	3 to 7 years (2)	> 7 YEARS (1)
SEVERITY	Unlikely to Adversely Affect (D)	4D	3D	2D	1D
	Impaired (C)	4C	3C	2C	1C
	Significantly Impaired (B)	4B	3B	2B	1B
	Dysfunctional (A)	4A	3A	2A	1A

Green	No Adverse Effect
Yellow	Limited Level of Concern
Orange	Moderate Level of Concern
Red	High Level of Concern
Light blue	Ranking Not Applicable in the Matrix

Appendix H:
Notes from Group Risk Ranking

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Appendix H: Notes from Group Risk Ranking – May 8-10, 2018

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
On Land Environment (above the high, high tide line) – with use of Dispersants			
TERRESTRIAL	On shore, above mean high, high tide line	**Vegetation**	Ranking 4D. Group agreed **Final Rankings: NAM:** 4D **ChemDisp:** 4D
		Non T/E Birds	Proposed that ranking for adult birds should be 4D, 3C for nests, eggs and chicks with the use of dispersants. Less oil will get on the shore and therefore dispersant will mitigate impacts onshore. Browning wants 3B for chicks, nests and eggs and 4C for adults with wetlands the driver for this decision. Marhoffer says what are the chances of oil impacting a non-tidally influenced terrestrial wetland? The wetlands are above the high-high tide land so that is then not a big concern. Marhoffer says that marshes, estuaries will be considered part of the intertidal zone. Browning says 4D for both then. **Final Rankings: NAM:** 4C **ChemDisp:** 4D **ShoreClean:** 4D
		Non-T/E Mammals	The oil budget is reduced, and the ranking then becomes 4D. McIntosh says that critical habitat for the HI Monk Seal is above high-high tide and wants the ranking to remain at 4C due to the possibility of adverse impact on seals. McIntosh has recanted because it will be dealt with under T/E and agrees with 4D ranking. **Final Rankings: NAM:** 4C **ChemDisp:** 4D
		Non-T/E Reptiles	Reptiles – like geckos. Gulko brings up that T/E plants are N/A but there are state listed plants that are T/E and should be considered. Geckos are not indigenous and should not be considered for protection. He says there are State listed plants that should be considered in the coastal zone. Ranking is 4D. **Final Rankings: NAM:** 4B **ChemDisp:** 4D
		Non-T/E Insects	Ranking is 4D, no dissent. **Final Rankings: NAM:** 4C **ChemDisp:** 4D
		T/E Species – ANIMALS ***Reporting order:*** • Birds • Marine Mammal – HI Monk Seal • Marine Mammal – Cetaceans • Reptiles – Sea Turtles • Fish – Manta Ray	Ranking of 4D for adult mammals, turtles is proposed. Ranking of 4C for birds, nest, chicks, eggs is proposed. Gulko brought up the point that using the dispersant reduces the shoreline oil budget by 50%, but now adds the toxicity of the dispersant to the shoreline/terrestrial receptors. Barron says that the conceptual models says that dispersant molecules are in the water, and toxicity should be kept in that water zone. Gulko says that we should be more conservative given that 60ft is close to shore. Marhoffer states that they may or may not spray dispersant at 60 ft. deep is its close to shore and depends on the weather. Scholz has said with 25 mph winds, drift has been 1,200 feet when dispersant was applied far offshore. Marhoffer says you can still do surface vessel application. Gewecke says that dispersant is not diminishing impact below 10%. Browning says green turtles will bask on land. Highly dependent on location and individual turtles. Hawksbill won't haul out. Critical habitat for Seal, assuming HI Monk Seal moves through the water to get there, but temporary impacts. McIntosh says seals will go through oil and then come upland. Question is does reducing oil reduce impacts. Final Ranking 4C for all animals. **Final Rankings: NAM:** 3A 4C N/A 4C N/A **ChemDisp:** 4C 4C 4C 4C N/A **ShoreClean:** 4D
		T/E (or Rare) Species - PLANTS	State T/E species are unlikely to be impacted. Marhoffer, Fry and Gulko agreed to 4D ranking. **Final Rankings: NAM:** 4D **ChemDisp:** 4D
		Critical Habitat ***Reporting order:*** • Insects CH • Plants CH • HI Monk Seal CH • Insular False Killer Whale CH	Gulko and Robberson brought up that turtle nests should be considered here. Insects should remain 4D. McIntosh said that any impact to even one HI Monk Seal is hugely adverse. Therefore, ranking should be 4B. Tomita said that as someone who is in response, when he looks at that chart, and if they are the same color, he would think that there is no preference for one over the other (e.g. no action and use of dispersant is equally preferred). Gewecke said that as a tool, no biologist is likely to say that the actions are unlikely to have an adverse impact, so overall the ranking is leaning toward too conservative. Scholz clarified that the use of dispersant does not change the ranking for T/E species. But for the overall species does it make a difference? Minimal impact for the generic population for the terrestrial; Bejarano believes that the risk would be reduced. **Final Rankings: NAM:** 4D 4D 4B N/A **ChemDisp:** 4D TBD 4B N/A **ShoreClean:** 4D

Appendix H: Notes from Group Risk Ranking – May 8-10, 2018

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Nearshore Environments (within the Fringing Reef / Photic Zone) – with use of Dispersants			
NEARSHORE, INTERTIDAL	May include: Reef flats; rocky platforms; tidal flats; sand beaches; man-made structures e.g., fish ponds, bulkheads; Anchialine ponds	**Vegetation**	Barron suggested that we look at Bejarano's summary and see if we agree with it. Bejarano suggested that the no action be a higher risk and ranked at 3B. The oil, whether chemically dispersed or not, impacted the shoreline. Gulko suggested that exposure concentration would be increased with the use of dispersant in the first five days, when there is a higher concentration, so ranking stays at 3B for dispersant use. **Final Rankings: NAM:** 3B **ChemDisp:** 3B **ResProtect:** 3C
		Crustose Coralline Algae	Bejarano suggests that the ranking for no action be changed to 3B. Gulko said for use of dispersant with the increased concentration would keep the ranking at 3B. Marhoffer and Walker said that the longevity of the oil would be decreased and that the quantity of whole oil coming into the environment would be less. Fry pointed out that the whole shoreline was black without the use of the dispersant. Conmy reiterated that Barron's suggestion for use of SCAT would be critical to better understand the shoreline impacts in a way that the model can't. Gulko says that you are not getting mixing in the shallow tidal habitat. Unless there is wave action and energy, oil won't move into the colony. With dispersants, still in the water column. Barron stated that free product will stick to coral, whereas the use of dispersant may mitigate the degree to which the oil sticks. Barron's argument supports Bejarano's suggestion of 3B. Barron and Walker emphasized that whole oil effects are really bad and very persistent, and that the use of dispersant can mitigate this aspect. Yender commented that oil type can be categorized, but hard to do in the model. Ranking for use of dispersant will be 3C. **Final Rankings: NAM:** 3B **ChemDisp:** 3C **ResProtect:** 3C
		Sponges	Gulko stated that sponges by their nature cannot be exposed to air. They would not be exposed to the oil on the surface. In HI there is little chance of the sponges being in an area that will be impacted by an oil spill. However, the use of dispersant will make the oil more likely to be in the water column in an area that will be in contact with the sponges. Gulko suggests that ranking for no action be 4C. Use of dispersant will make the ranking 4B. Grange says that the sponges are incidental in this area and therefore should not be driving the ranking in this area. Final ranking 4C for no action, 4B for dispersant. **Final Rankings: NAM:** 4C **ChemDisp:** 4B **ResProtect:** 4B
		Corals & Live Rock	Gulko again stated that the use of dispersant creates a greater threat than not using dispersants. The vast majority of coral and live rock in HI is below the water surface. Proposes ranking no action as 2B, ranking of dispersant use as 2A. **Final Rankings: NAM:**2B **ChemDisp:** 2A **ResProtect:** 2B
		Non-T/E Birds	Barron said that reducing sticky oil for birds would reduce the risk ranking. Fry agreed changing it from a 3B to a 3C for use of dispersants, keep at 3B for no action. Rudolph noted that one of the birds should be under T/E. **Final Rankings: NAM:** 3B **ChemDisp:** 3C **ResProtect:** 3B
		Non-T/E Mammals	The group decided that the non-protected mammals in this area are sporadic and non-native. Ranking remains 4D. **Final Rankings: NAM:** 4D **ChemDisp:** 4D
		Non-T/E Reptiles	N/A
		Non-T/E Fish	Ranking of 3C for no action and would not change with the use of dispersants from last workgroup. Bejarano thinks it should be changed to 4C for dispersant use because natural mixing would minimize risk and less concentrated oil would come in with use of dispersants. Barron thinks that the use of dispersants would make it worse. Gulko clarified reef fish and tidal fish. Conmy says recovery would take longer; EC50 might be reached. Proposes ranking to 3B. Fry and Lundgren agree. Gulko points out that the ranking should be higher for anchialine ponds because they are not connected tidally and will only be affected by dispersant. **Final Rankings: NAM:** 3C **ChemDisp:** 3B **ResProtect:** 4C

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Nearshore Environments (within the Fringing Reef / Photic Zone) – with use of Dispersants, *Continued*			
NEARSHORE, INTERTIDAL, *Continued*	May include: Reef flats; rocky platforms; tidal flats; sand beaches; man-made structures e.g., fish ponds, bulkheads; Anchialine ponds	**Vegetation**	No action ranking is 3C. Gulko thinks that ranking for anchialine ponds for dispersant use should be 3B with similar logic to above. Group agrees. **Final Rankings: NAM:** 3C **ChemDisp:** 3B **ResProtect:** 3C
		T/E Species – ANIMALS ***Reporting order:*** • Birds • Marine Mammal – HI Monk Seal • Marine Mammal – Cetaceans • Reptiles – Sea Turtles • Fish – Manta Ray	<u>Birds</u>: No action is 3B. Fry thinks that the amount of oil will be reduced with dispersant, Marhoffer says the stickiness will be reduced, the oiling will be reduced. Barron supports Marhoffer. Ranking with dispersant use will be 3C. <u>HI Monk Seal</u>: No action is 2A. Bejarano suggests that with dispersant use it should be 2B. McIntosh and Conmy think that it should stay 2A. Conmy talked about nanoparticles in water that are created by breaking waves and dispersed oils and causes volatilization. Walker thinks that if you use dispersant on non-weathered oil this won't happen. Conmy says that there is a current study to look at the inhalation of the nanoparticles on the surface of the oil by use of dispersant. Conmy thinks it should be a 2B. <u>Turtles</u>: With no action it is a 2B. Conmy again stated that the inhalation threat exists for the nanoparticles caused by using dispersants. Gulko says that the green sea turtles come into the inner tidal area to feed on the algae and that they would have an ingestion pathway. He wants to know the effect of oil droplets on the algae that the turtles ingest. Barron and Walker agreed that there would be more oil on the algae without dispersant use, and sea turtles would ingest more oil if dispersant were not used. Gewecke thinks that the time needed for recovery should be factored in and that the dispersant would speed up period of recovery as opposed to no action. Fry thinks that there is an increased risk of ingestion of oil from the water column and a decreased exposure for inhalation. The final ranking is dispersant use 2B for green sea turtles and for hawksbill. **Final Rankings: NAM:** 3B 2A N/A 2B N/A **ChemDisp:** 3C 2B N/A 2B N/A **ResProtect:** 3B 4C N/A 2B N/A
		T/E (or Rare) Species – PLANTS	N/A
		Critical Habitat ***Reporting order:*** • Insects CH • Plants CH • HI Monk Seal CH • Insular False Killer Whale CH	No action ranking is 4B. Changed from 4C after McIntosh and Barron discussion about whole oil impairment of HI Monk Seal habitat. The intertidal zone is mostly a transit zone and sometimes used for basking. Dispersant use ranking would likely be better so ranking would be better. Critical habitat consists of water column and basking components. McIntosh and Barron agree with ranking of 4C for use of dispersants. **Final Rankings: NAM:** N/A N/A 4B N/A **ChemDisp:** N/A N/A 4C N/A **ResProtect:** N/A N/A 4B N/A

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Nearshore Environments (within the Fringing Reef / Photic Zone) – with use of Dispersants, *Continued*			
NEARSHORE	**WATER SURFACE:** Based on mixing zones and where the life is 0 to 2-meter water depths	**Vegetation, Floating Algae**	No action for seaweeds and seagrasses was set at 3C. Gulko says very limited vegetation because there is so little area for grasses to root into. Debate whether there is a vegetation on the surface area. Take out to 60 ft. Floating algae in subtidal? Sargassum? Consensus: Agree to keep this category but call it floating vegetation. Ranking with dispersants remains at 3C. **Final Rankings: NAM:** 3C **MechCont:** 3C **ChemDisp:** 3C
		Crustose Coralline Algae	No action is 3C. Crustose coralline algae will only be found in the benthos at this shallow zone, and would be crustose algae. Would not be in the water column, it needs to be attached. They won't be in the surface waters. Conmy suggested breaking subtidal into 0-2m with water column and benthic sub-categories, and then 2-20m with water column and benthos categories; participants agreed. Crustose coralline algae is a benthic growing coral. Dispersants will increase exposure to oil from zero exposure for no action, to some amount for dispersant smaller droplets. Recovery time is the same, but severity of exposure is increased with the use of dispersants. Dispersants will make ranking 3B. **Final Rankings: NAM:** 3C **ChemDisp:** 3B
		Sponges	Sponges are not that important except for Hawksbill foraging. They are super small and found in the inner reef area. Untreated oil has minimal effect on natural sponges. When dispersant drive oil droplets into the water column then the sponges will become exposed and ranking 3B. No action is 4C. **Final Rankings: NAM:** 4C **ChemDisp:** 3B
		Coral and Live Rock	No action was 2C. Dispersants will increase recovery rate. Gulko says growth is more than 7 years so recovery is longer. Severity will increase because coral will be exposed much more severely than to floating oil and ranking increases to 1B. **Final Rankings: NAM:** 2C **ChemDisp:** 1B
		Non-T/E Birds	Boobies, non-endangered Shearwaters, white terns. No action was 3B. If dispersant was used off shore, Fry thinks that recovery time would be the same, but the severity/impact would be less making the ranking 3C. **Final Rankings: NAM:** 3B **MechCont:** 4D **ChemDisp:** 3C
		Non-T/E Mammals	Only mammal is the spinner dolphins that would come into this area. Exposure to whole oil was a 2B, based on dermal contact, inhalation, kidney and reproductive failure. McIntosh does not think risk would significantly drop so ranking remains a 2B. **Final Rankings: NAM:** 2B **MechCont:** 4D **ChemDisp:** 2B
		Non-T/E Reptiles	N/A
		Non-T/E Fish	Gulko mentioned that oil slicks may act as a surrogate FAD (fish aggregate device) and attract fish to "shelter" underneath the darkened overhead slick. It may serve to bring fish into the area. Fry thinks that behavior may be tempered by the fact that this zone is an active zone that will create droplets. Rudolph brought up the fact that we need to look at a population effect, not a localized effect on the species. Barron brought up issue of surface layer eggs. Gulko thinks that fish that normally stick to the bottom may be lured into shallower depths thinking that the slick provides shelter and draw more animals into the area than would normally be there. Gulko concludes that this would be more of an issue in the subsurface than surface area. No action ranking remains at 4C to reef fish. For use of dispersant, Fry stated it would be worse than oil itself due to gill injury. This zone has the highest amount of dispersed oil droplets and would have more impact. Scholz mention inhalation, ingestion, dermal contact. Ranking with dispersant will be 4B. **Final Rankings: NAM:** 4C **MechCont:** 4D **ChemDisp:** 4B

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Nearshore Environments (within the Fringing Reef / Photic Zone) – with use of Dispersants, *Continued*			
NEARSHORE - *Continued*	**WATER SURFACE - *Continued*** Based on mixing zones and where the life is 0 to 2-meter water depths	**Non-T/E Shellfish and Other Invertebrates**	Whole oil (NAM) was ranked 4C. For use of dispersant, Conmy suggested that the same logic applied to the fish can be applied to this category. Gulko says all these fish are at the bottom, and only squid, larvae and jelly fish would be found in the upper reaches here. Gewecke asked whether we are assuming that recruits or advection of new members would repopulate the species within a year. Conmy confirmed. Ranking for dispersant use is 4B. **Final Rankings: NAM:** 4C **MechCont:** 4D **ChemDisp:** 4B
		T/E Species – ANIMALS ***Reporting order:*** • Birds • Marine Mammal – HI Monk Seal • Marine Mammal – Cetaceans • Reptiles – Sea Turtles • Fish – Manta Ray	Birds: Hawaiian Petrel, Newell Shearwater: Whole oil would expose the birds at a level that was dysfunctional for a 3-7 year period, with a ranking of 2A. With use of dispersants, Fry says there are two aspects. Dispersant will reduce the overall amount of oil and reduce exposure. But dispersants will act as a surfactant to allow birds feathers to be wetted more so that water can get to the skin and there is now a dermal contact exposure. Inhalation is reduced, ingestion would remain the same. Dermal effects will be acute, preening effects more chronic. Stressors will eliminate reproduction. Use of dispersant ranking would depend on the concentration of oil. Either 2A or 2B. Fry does not "trust the judgement of seabirds" to stay away from dispersed oil. Browning mentioned that the dark mass of oil represents a school of fish and attracts birds, and Scholz says the calm of the waters from the oil also attracts the birds. Fry states that Shearwaters are particularly sensitive to the effects of oil. HI Monk Seal: NAM (whole oil) ranking was 2B originally. McIntosh and Fry agree that it should be 2A because of the severity of impacts at the surface when the seal breathes. McIntosh and Rudolph guess that dispersant will decrease inhalation hazard but will increase ingestion exposure. Conmy and Scholz said that research from Gulf were focused on long term chronic effects on seals. McIntosh emphasized that this category must look at effects on an individual animal and therefore the dysfunctional impact should be chosen. Ranking with dispersant remains at 2A Sea Turtles: Ranked with NAM at 1B due to length of recovery time. Rudolph mentioned that Hawksbill population levels are so low that any loss would be much more devastating to the species than a loss of a green sea turtle where the total number is much larger. Browning mentioned that the chances of turtles making it to adult hood are 1/10,000. Rudolph thinks that the impacts qualify for dysfunctional with a ranking of 1A. Browning would support the ranking of 1A. Ranking for NAM is now 1A. With the use of dispersant, McIntosh says that the inhalation impacts will be improved and ranking will now become 1B. Manta Rays: Ranking of NAM was 3C. Gulko thinks that because mantas pump a large amount of water through they are likely to be exposed to oil compared to an animal of a similar size. Gewecke and Conmy say that mantas like to play and come to the surface a lot. Rudolph said impacts are potentially lethal for respiration. Marhoffer mentioned that with wave height there could be significant mixing of whole oil and Walker said that patchiness had not been taken into account (Workshop 4??). Ranking for NAM is being changed to 2C. Use of dispersant also results in ranking of 2C. Browning mentioned that time at surface is comparable to turtle. She thinks that the manta should be in the red zone of ranking because turtle is. Scholz clarified that inhalation for manta is in the water and so different from turtle. Group concurs with 2C ranking. **Final Rankings: NAM:** 2A 2A N/A 1A 2C **MechCont:** 4D 4D N/A 4C 4D **ChemDisp:** 2A 2A N/A 1B 2C
		T/E (or Rare) species - PLANTS	N/A
		Critical Habitat ***Reporting order:*** • Insects CH • Plants CH • HI Monk Seal CH • Insular False Killer Whale CH	NAM ranking originally is 4C. The surface water is an essential feature that would be affected and remains at 4C. This zone is critical habitat for the HI Monk Seal and not for the Insular False Killer Whale whose habitat is further out. With dispersant, the ranking remains 4C. **Final Rankings: NAM:** N/A N/A 4C N/A **MechCont:** N/A N/A 4D N/A **ChemDisp:** N/A N/A 4C N/A

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Nearshore Environments (within the Fringing Reef / Photic Zone) – with use of Dispersants, *Continued*			
NEARSHORE, SUBTIDAL: *Continued*	**WATER COLUMN** >2-meters water depth but 1 to 2-meters above the bottom (depends upon mixing depth)	**Non-T/E Birds**	NAM original ranking of 3B remains. Use of dispersant will wet the birds causing dermal exposure. Fry does not think the ingestion pathway will change significantly between the two scenarios. Ranking for use of dispersant remains at 3B. **Final Rankings: NAM:** 3B **ChemDisp:** 3B
		Non-T/E Mammals	Spinner dolphin and other non-T/E species. Original NAM ranking is 3B and changes to 3C. Conmy says that the major contact occurs at the surface. With use of dispersant, McIntosh said that he does not know that much about this situation, Conmy said that wave height will determine mixing and then after its dissolved and away from the waves it will move throughout the water column. The toxicity becomes a chronic effect. Gewecke put forward a ranking of 2B for impacting distinct species of cetaceans which are not covered under T/E. Group agreed that the ranking with use of dispersant should be 3B, with slightly increased impacts over whole oil. **Final Rankings: NAM:** 3C **ChemDisp:** 3B
		Non-T/E Reptiles	N/A
		Non-T/E Fish	Original Ranking with NAM is 4C. Rudolph said that population effect of dispersed oil would have an effect but not at the population level. Consensus is for ranking to be 4C. **Final Rankings: NAM:** 4C **ChemDisp:** 4C
		Non-T/E Shellfish and other Invertebrates	Original ranking of NAM 4C remains. Use of dispersants keeps ranking at 4C. **Final Rankings: NAM:** 4C **ChemDisp:** 4C
		T/E Species – ANIMALS ***Reporting order:*** • Birds • Marine Mammal – HI Monk Seal • Marine Mammal – Cetaceans • Reptiles – Sea Turtles • Fish – Manta Ray	Birds (diving birds: HI Petrels and Newell Shearwaters): Ranking of 3C to whole oil. No discussion. Fry thinks that risk to birds with use of dispersant is long term physiological problems, so ranking is 2C. HI Monk Seal: NAM original ranking is 3B. Gewecke was questioning whether the dispersed oil would be more concentrated than in the offshore. Rudolph said that the seals would just be transiting through the area so would not have a high exposure. Use of dispersant remains at 3B. Same logic as offshore. Cetaceans: Insular False Killer Whales: Exposure could be oiling of mouth and eyes and ranking of 3C for whole oil (NAM). If animal swims through dispersed oil, Rudolph and McIntosh recommend leaving ranking at 3C. Turtles: Whole oil and dispersant are both 3C Manta Ray: Ranking with whole oil remains 2C, and with the use of dispersant becomes 2B with similar logic to the offshore **Final Rankings: NAM:** 3C 3B 3C 3C 2C **ChemDisp:** 2C 3B 3C 3C 2B
		T/E (or Rare) Species - PLANTS	N/A
		Critical Habitat ***Reporting order:*** • Insects CH • Plants CH • HI Monk Seal CH • Insular False Killer Whale CH	Ranking for exposure to whole oil remains at 4C, use of dispersant will keep the ranking at 4C. **Final Rankings: NAM:** N/A N/A 4C N/A **ChemDisp:** N/A N/A 4C N/A

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Nearshore Environments (within the Fringing Reef / Photic Zone) – with use of Dispersants, *Continued*			
NEARSHORE, SUBTIDAL: *Continued*	**BOTTOM / BENTHOS** Includes the bottom and 1 to 2-meters of water column above the bottom (depths of mixing to be considered)	**Vegetation**	Seaweed and seagrasses, original ranking for whole oil is 4C. Fry said where the break is (in the closest, shallower areas) may encounter the oil. With use of dispersed oil, Conmy said that there are very little studies done on the effects on vegetation. Limited research on mangroves which are not that similar to grasses and seagrasses. It's mostly a smothering and coating effect. Conmy says that for whole oil sunlight would be shut out. Use of dispersant brings ranking to 4B. **Final Rankings: NAM:** 4C **ChemDisp:** 4B
		Crustose Coralline Algae	In shallower areas whole oil may be able to make it down to this algae. Okano says growth is slow and Gulko said that recovery would be very long. Okano and Gulko recommend ranking to be 3B. With use of dispersant, Gulko said oil will make it down and recovery rate would be very slow. Rudolph thinks there will only be a localized effect. Conmy asked about rates Gulko and Okano said it depends where the impact occurs on the crustose coralline algae. Gulko mentioned that the [Sept. 2013] molasses spill had really hurt the algae in Honolulu Harbor. Okano says that contact dermal smothering would be the greatest exposure route for dispersant use. Algae do not take in nutrients like coral does, their whole body takes things in and sends them out. Greater population effect than coral, recovery would take longer than coral, lots of uncertainty due to lack of studies. Ranking for dispersant use is 2A. **Final Rankings: NAM:** 3B **ChemDisp:** 2A
		Sponges	Original ranking was 4B for exposure to whole oil. Consensus. For dispersed oil, Conmy and Gulko said that the sponges are not as slow growing and come back really fast (at least in HI). Ranking for dispersant stays at 4B. **Final Rankings: NAM:** 4B **ChemDisp:** 4B
		Coral and Live Rock	Original ranking was 3B for whole oil, with the concern again being the exposure in the shallower areas with large wave action. Gulko mentioned that the recovery rate for corals is on the order of that for turtles. Hawaii coral growth is significantly slower than in other parts of the world. Okano says that corals are already under so much stress that any other stressor might wipe them out. If it's a rare species and the State has designated coral as native as rare or if it's really large colonies (over 50cm), Gulko wants to say ranking is 1A. If it's a really small colony (newer) or not as rare then 1B. **Final Rankings: NAM:** 3B **ChemDisp:** 1A
		Non-T/E Birds	For NAM ranking is 4C. In shallower you would be able to see a little whole oil, but at depth there would be no oil. Fry thinks the ranking would not significantly change for dispersed oil as the birds would swim through the water column. Ranking for dispersed remains 4C. **Final Rankings: NAM:** 4C **ChemDisp:** 4C
		Non-T/E Mammals	Not inhaling, contact is minimal with whole oil on the bottom. McIntosh thinks that 3C is more realistic and group agrees. With the use of dispersant, McIntosh thinks that in this zone the ranking would not change and stays at 3C. **Final Rankings: NAM:** 3C **ChemDisp:** 3C
		Non-T/E Fish	Secondary ingestion of whole oil results in ranking of 4C which remains. Marhoffer said very low amount of oil would make it to the bottom. Fry stated that the toxic effects of dispersants of gills would make exposure effects worse in this lower water column. Smaller droplets and mixing would also make exposure greater. Ranking for dispersants is 4B. **Final Rankings: NAM:** 4C **ChemDisp:** 4B
		Non-T/E Shellfish and other Invertebrates	Same logic as fish. NAM ranking is 4C. Gulko was wondering about pearl oysters but agreed that the dispersant use ranking would be 4B. **Final Rankings: NAM:** 4C **ChemDisp:** 4B

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Nearshore Environments (within the Fringing Reef / Photic Zone) – with use of Dispersants, *Continued*			
NEARSHORE, SUBTIDAL: *Continued*	**BOTTOM / BENTHOS, *Continued*** Includes the bottom and 1 to 2-meters of water column above the bottom (depths of mixing to be considered)	**T/E Species – ANIMALS** ***Reporting order:*** • Birds • Marine Mammal – HI Monk Seal • Marine Mammal – Cetaceans • Reptiles – Sea Turtles • Fish – Manta Ray	Birds: NAM ranking is 4C, and Fry recommends that ranking with dispersant would be 3C. Fry said that the toxicity of ingestion of droplets and dermal exposure effects from droplets impacting wetting drive ranking. HI Monk Seal: Original ranking with NAM was 2B. Marhoffer pointed out that HI Monk Seal tend to forage on the bottom right in this zone. McIntosh stated that the seals move through the area and are not confined to one spot. With use of dispersant, McIntosh was not sure except perhaps for a chronic effect. Marhoffer and McIntosh emphasized that the seals are highly mobile. Scholz brought up secondary ingestion exposure. Ranking for dispersants is 2B. Cetaceans: (False Killer Whale): NAM ranking is 4B. For use of dispersant, McIntosh says there is no data for benthos for this animal. Conmy said the cetaceans sleep at the bottom. Gewecke thinks the exposure in the water column is higher than when they swim along the bottom. McIntosh recommends moving it to 3B for dispersants, acknowledging the scarcity of data. Reptiles (turtles): Browning mentioned that within the 5-day period of this exercise how much oil would be down at the bottom. Marhoffer and Conmy brought up depth variations and wave action/mixing and think it's likely it will get to the bottom in the shallower areas. McIntosh thinks that because they feed in this area, there could be significant impact on an individual Group decided that NAM ranking should be 3B. McIntosh reiterated that ingestion of dispersed oil constituents may be problematic and more accessible. Conmy pointed out that physical dispersion causes the same exposure as chemical dispersion, just the proportion of smaller droplets is higher with chemical dispersion and chances of exposure are therefore higher. Ranking is 3B. Manta Ray: NAM ranking is 3C. Discussion among group agreed that exposure on the bottom will not be likely to change so it will be 3C for dispersants. **Final Rankings: NAM:** 4C 2B 4B 3B 3C **ChemDisp:** 3C 2B 3B 3B 3C
		T/E (or Rare) species - PLANTS	N/A
		Critical Habitat ***Reporting order:*** • Insects CH • Plants CH • HI Monk Seal CH • Insular False Killer Whale CH	NAM ranking is 4C. Rudolph said that looking at water quality and prey affects critical habitat. He thinks that prey is not affected by dispersant use, it may be a short-term reduction in prey and the seals would go elsewhere. Rudolph says that the HI Monk Seal forages far offshore and would likely only be in the subtidal zone briefly. It's more of a transit zone with opportunistic feeding. Ranking remains 4C. **Final Rankings: NAM:** N/A N/A 4C N/A **ChemDisp:** N/A N/A 4C N/A

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Offshore Environments (on water, open coastal outside of the fringing reef) – with use of Dispersant			
OFFSHORE	**WATER SURFACE:** Based on mixing zones and where the life is at the air/water interface down to 2-meter water depths	**Plankton**	Population will be affected but will recover quickly with NAM no dispersant ranking is 4C. Use of dispersant increases impairment significantly and ranking increases to 4B. **Final Rankings: NAM:** 4C **MechCont:** 4D **ChemDisp:** 4B
		Non-T/E birds	Impact in this zone is significantly impaired, but population will recover. Nesting is not an issue. Oiling would be an issue. NAM ranking is 2B. Use of dispersant would bring the ranking to 2C with a decreased risk because the oil slick is being diminished with use of dispersants. **Final Rankings: NAM:** 2B **MechCont:** 4D **ChemDisp:** 2C
		Non-T/E Mammals	There is not much oil in this zone, mixing to 10 meters. NAM ranking is 2B due to effects of oil slick. Adding dispersant would keep the ranking to 2B. McIntosh says that he is concerned about the increased concentrations available with the use of dispersants. Conmy says we don't have research on aerosolizing of dispersants at the surface to prove or disprove exposure. She says improved outcome for less oiling, but other exposure pathways increased. Gewecke says that the mammals often swim around with their mouths open. Inhalation, ingestion and dermal contact with toxicants is increased with dispersant use. **Final Rankings: NAM:** 2B **MechCont:** 4D **ChemDisp:** 2B
		Non-T/E Reptiles	N/A
		Non-T/E Fish	NAM ranking is 4C. Impact and quick recovery. Fry thinks that the risk to fish will be increased with use of dispersant and will affect the gills to a greater extent in the top 2m. Ranking will increase to 4B. **Final Rankings: NAM:** 4C **MechCont:** 4D **ChemDisp:** 4B
		Non-T/E Shellfish and other Invertebrates	NAM ranking stays at 4C. Use of dispersant results in increased exposure but does not result in increased impairment and stays at 4C. **Final Rankings: NAM:** 4C **MechCont:** 4D **ChemDisp:** 4C
		T/E Species – ANIMALS ***Reporting order:*** • Birds • Marine Mammal – HI Monk Seal • Marine Mammal – Cetaceans • Reptiles – Sea Turtles • Fish – Manta Ray	Birds with NAM is 2B, and remains 2B. Fry says that the same logic should be used as for birds above that the dispersant will help with reducing impairment. Oil does such radical damage to birds that the risk of dispersant is less risk. Browning thinks that the risk is not mitigated by dispersant. Reducing surface slick was agreed by Fry, Browning and Marhoffer to be a better option. Ranking becomes 2C with dispersant. HI Monk Seal has NAM ranking of 2A. Gewecke said that false killer whales were about 150 and seals were at 1500, so impacts to whale were less allowable. Scholz said that even one impact is not acceptable to a T/E species. Walker said that the research on nanoparticle inhalation risks from dispersant has been done on fresh oil and may not be applicable, but we will work with the findings for now. Weathered oil may not be the same. Use of dispersant increases the adverse impacts of inhalation, ingestion. Robberson stated that the time factor is not being considered that if we don't use dispersant the chances of getting slicked remain higher. Fry stated that dispersants have a positive effect for birds in the pelagic but may not have be positive for mammals and fish. Ranking with dispersant use remains at 2A. Cetaceans The whales were ranked as a 1B with NAM. Using the same logic as seals, the use of dispersant will retain the same ranking, 1B Retiles (sea turtles) impacts from NAM is 2B. Adding dispersant minimizes the oil slick impacts, but increases inhalation risk so ranking remains at 2B. Manta Ray comes up to surface and NAM ranking is changed to 3C – based on impairment to oil slick with longer recovery time than originally estimated in previous workshop. Adding dispersant may decrease dermal contact but will increase ingestion and inhalation (on the gills) adverse effects according to Fry and McIntosh. Dispersant ranking will increase to 3B with a 1 to 3 year recovery time. **Final Rankings: NAM:** 2B 2A 1B 2B 3C **MechCont:** 4D 4D 4D 4C 4D **ChemDisp:** 2C 2A 1B 2B 3B
		T/E (or Rare) Species - PLANTS	N/A
		Critical Habitat ***Reporting order:*** • Insects CH • Plants CH • HI Monk Seal CH • Insular False Killer Whale CH	McIntosh stated that Manta Ray does not have critical habitat designated yet. Habitat for Insular False Killer Whale will be all waters in this area including surface water and designation is imminent. We will use the designation in this workshop. He thinks that recovery of the habitat may be significantly impaired with a short recovery period. With NAM it is a ranking of 4B. With use of dispersant, the impairment and recovery does not change, and ranking remains at 4B. **Final Rankings: NAM:** N/A N/A N/A 4B **MechCont:** N/A N/A N/A 4D **ChemDisp:** N/A N/A N/A 4B

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Offshore Environments (on water, open coastal outside of the fringing reef) – with use of dispersant			
OFFSHORE, SUBSURFACE: 2-meter water depth and greater, to within 1 meter above the bottom	**WATER COLUMN** Based on mixing zones and where life is from 2-meter water depth up to 10 fathoms (20 meters) Does not include 1 to meters of water column above the bottom	**Plankton**	NAM previously was 4C, Fry proposed 4D for planktons below 6 feet, group consents. Barron stated that with the use of dispersant would drive the oil further down into the water column. The turnover of the plankton community is so fast that it will not be overall affected – localized (discrete) and short recovery, so Fry, McIntosh and Gulko propose ranking of 4C with addition of dispersants. **Final Rankings: NAM:** 4D **MechCont:** 4C **ChemDisp:** 4C
		Non-T/E Birds	NAM was originally a 3B for birds exposed to whole oil in the water column with significant short-term impairment. Fry said that there was just not a lot of whole oil in the water column below 6 ft, so ranking should be less severe at 3C. Browning agreed that oil encountered in this zone would be negligible. Fry stated that the dispersant itself has the effect of wetting the birds' feathers which will allow the oil to penetrate the birds' feathers. The amount of dispersed oil will be very low that the birds are exposed to so minimal effect, so Fry suggests ranking stays at 3C. Browning thinks that the dispersant will move the oil and allow the oil to get lower than otherwise so that exposure would still be there. Marhoffer emphasized that the density of the oil was much less for the dispersant option. **Final Rankings: NAM:** 3C **MechCont:** 3B **ChemDisp:** 3C
		Non-T/E Mammals	Gewecke thinks that there is likely some effect on cetaceans swimming 6 feet under an oil slick. Conmy stated that if the wave height was such that it could mix the oil into the 6 feet below surface then there would still be exposure. Gulko and Rusty said wave heights are 6-8 feet so there would be mixing and the chance for the mammals to also get out of the oil quickly, so it works for and against. Group agreed to leave ranking for NAM at 3C. With the use of dispersant, McIntosh thought that the exposure lower in the water column would be increased. Bejarano had proposed increased exposure ranking too and ranking for dispersant was set at 3B. **Final Rankings: NAM:** 3C **MechCont:** 3C **ChemDisp:** 3B
		Non-T/E Reptiles	N/A
		Non-T/E Fish	NAM remains at 4C. Use of dispersant had no discussion to change original proposed ranking of 4C. **Final Rankings: NAM:** 4C **MechCont:** 4C **ChemDisp:** 4C
		Non-T/E Shellfish and other Invertebrates	NAM was given at 4C, and remains at 4C. Group agreed to retain dispersant use at 4C. **Final Rankings: NAM:** 4C **MechCont:** 4C **ChemDisp:** 4C
		T/E Species – ANIMALS ***Reporting order:*** • Birds • Marine Mammal – HI Monk Seal • Marine Mammal – Cetaceans • Reptiles – Sea Turtles • Fish – Manta Ray	Birds have a ranking for NAM as 3B. With dispersant the ranking remains unchanged at 3B. HI Monk Seal: Original ranking for NAM was 3B, with limited availability of whole oil at depths below 6ft. With use of dispersant, the oil will go lower in the water column but less dense and the ranking will stay at a 3B. Seals feed from benthos (McIntosh and Conmy) and will not have a big exposure. Cetaceans NAM is 3C. Addition of dispersants will make ingestion an issue because they feed in mid-column. The state of the science is still very sparse, and the experts decided to leave the ranking at 3C. Sea Turtles NAM ranking is 3C. With addition of dispersant ranking remains 3C. Manta Ray NAM ranking was 2C. With addition of dispersant ranking changes. Rudolph said that Rays spend the majority of their lifecycle in this portion of the water column, so feeding and respiratory pathway exposures are increased. Ranking goes to 2B. **Final Rankings: NAM:** 3B 3B 3C 3C 2C **MechCont:** 3B 3A 4C 3C 2C **ChemDisp:** 3B 3B 3C 3C 2B
		T/E (or Rare) Species - PLANTS	N/A
		Critical Habitat ***Reporting order:*** • Insects CH • Plants CH • HI Monk Seal CH • Insular False Killer Whale CH	HI Monk Seal: McIntosh/Group now thinks that with the wave energy the oil may be able to get to the bottom. Spawning events may cause flocculation of marine snow and bring oil to the bottom too. Ranking for NAM is 4C. Addition of dispersant may bring oil in droplets to the bottom which would primarily be determined by mixing depth. Ranking with dispersant is 4C. Insular False Killer Whale: Critical habitat will be from 45m– 3200m in depth. Oil is unlikely to be able to make it to this depth even with wave energy and therefore it is not applicable. **Final Rankings: NAM:** N/A N/A 4C N/A **MechCont:** N/A N/A 4C N/A **ChemDisp:** N/A N/A 4C N/A

Appendix H: Notes from Group Risk Ranking – May 8-10, 2018

Habitat	Sub-Habitat	Resource Category	**Chemical Dispersion:** the targeted application of chemical dispersants for slicks heading towards shorelines and other protected resources; applied offshore when net environmental benefit analysis determines that allowing oil to remain would cause more harm than using dispersants to mix the oil into the water column; overspray, equipment effects, and mixing (dispersant/dispersed oil) may be transferred into the nearshore environment
Offshore Environments (on water, open coastal outside of the fringing reef) – with use of dispersant			
OFFSHORE, SUBSURFACE, *Continued*	**BOTTOM / BENTHOS** On the bottom; Includes the bottom and 1 to 2-meters of water column above the bottom	**Vegetation**	NAM ranking for vegetation on the bottom remains 4D. Dispersant ranking remains 4D **Final Rankings: NAM:** 4D **MechCont:** 4D **ChemDisp:** 4D
		Crustose Coralline Algae	NAM ranking for crustose coralline algae on the bottom remains 4D. Dispersant ranking remains 4D **Final Rankings: NAM:** 4D **MechCont:** 4D **ChemDisp:** 4D
		Sponges	NAM ranking remains 4D. Due to vertical migration of plankton and particulates (marine snow) dispersant ranking changes to 4C. **Final Rankings: NAM:** 4D **MechCont:** 4D **ChemDisp:** 4C
		Corals and Live Rock	NAM ranking remains 4D. Due to vertical migration of plankton and particulates (marine snow) dispersant ranking changes to 4C. (See Notes on Comments and Observations) **Final Rankings: NAM:** 4D **MechCont:** 4D **ChemDisp:** 4C
		Meiofauna and Infauna	NAM ranking remains 4D. Due to vertical migration of plankton and particulates (marine snow) dispersant ranking changes to 4C (See Notes on Comments and Observations) **Final Rankings: NAM:** 4D **MechCont:** 4D **ChemDisp:** 4C
		Non-T/E Fish	NAM ranking remains 4D. Due to vertical migration of plankton and particulates (marine snow) dispersant ranking changes to 4C (See Notes on Comments and Observations) **Final Rankings: NAM:** 4D **MechCont:** 4D **ChemDisp:** 4C
		Non-T/E Shellfish and other Invertebrates	NAM ranking remains 4D. Due to vertical migration of plankton and particulates (marine snow) dispersant ranking changes to 4C. (See Notes on Comments and Observations) **Final Rankings: NAM:** 4D **MechCont:** 4D **ChemDisp:** 4C
		T/E Species – ANIMALS **Reporting order:** • Birds • Marine Mammal – HI Monk Seal • Marine Mammal – Cetaceans • Reptiles – Sea Turtles • Fish – Manta Ray	<u>HI Monk Seal/mammals</u>: NAM ranking remains 4D. McIntosh thinks that with the addition of dispersant, ranking remains 4D <u>Reptiles</u>: NAM ranking remains 4D. McIntosh proposed ranking 4D* with dispersant use. * 4C may be appropriate for depths up to 100 feet because sea turtles can be found sleeping to these depths (McIntosh and Gulko) <u>Manta Ray</u>: NAM remains 4D. Rudolph says that manta ray primarily feed within 6 feet of the bottom and because prey has been exposed to the dispersed oil it would impact the manta so ranking becomes 4C. **Final Rankings: NAM:** N/A 4D 4D 4D 4D **MechCont:** N/A 4D 4D 4D 4D **ChemDisp:** N/A 4D 4D 4D 4C
		T/E (or Rare) Species - PLANTS	Endemic bed but not a T/E species and may not be in this area. It does not apply to this scenario. Ask Okano about this species.
		Critical Habitat **Reporting order:** • Insects CH • Plants CH • HI Monk Seal CH • Insular False Killer Whale CH	<u>HI Monk Seal:</u> Exposure to the whole oil (NAM) would be 4D. Because the seals feed in this narrow band from 60m to 200m McIntosh thinks that there is a potential for a small affect because of prey being affected by dispersant use. So 4D* The * means that with dispersant use the ranking might be 4C because the prey of the seals can be impacted by the dispersant use which would then impact the ingestion pathway of the HI Monk Seal. **Final Rankings: NAM:** N/A N/A 4D N/A **MechCont:** N/A N/A 4D N/A **ChemDisp:** N/A N/A 4D N/A

NOTES:

- **ChemDisp** - Chemical Dispersion
- **MechCont** - Mechanical Containment and Recovery
- **NAM** – Naturally Attenuate and Monitoring
- **ResProtect** – Resource Protection
- **ShoreClean** – Shoreline Clean Up
- **CH** – Critical Habitat
- **N/A** – Not Applicable
- **T/E** – Threatened or Endangered

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Appendix I:
Summary Oil Budgets for the Kona and Trade Winds

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Appendix I: Summary Oil Budgets for the Kona and Trade Winds from the NOAA GNOME Modeling

TABLE 1 – KONA WINDS MODELED "OIL BUDGET" – NO DISPERSANTS (NATURAL DISPERSION)

Hour	Volume Released (barrels)	Volume Evaporated	Natural Dispersion				Volume Beached	Volume Off map	Volume Floating	Totals
			Volume Dispersed	Av. Water Column (0-10 meters) Concentration (mg/L)[a]	Area affected (km2)	Max. Water Column (0-10 meters) Concentration (mg/L)[a, b]				
0	0	0	0	0.0	0.0	0.0	0	0	0	0
3	5000	1009	21	0.01-0.5	5.58	0.13	0	0	3970	5000
6	5000	1265	54	0.01-0.5	13.29	0.13	2	0	3679	5000
12	5000	1469	103	0.01-0.5	30.22	0.14	2	0	3426	5000
24	5000	1640	101	0.01-0.5	29.55	0.13	1961	2	1296	5000
48	5000	1725	95	0.01-0.5	21.49	0.13	2196	7	977	5000
72	5000	1728	89	0.01-0.5	24.32	0.13	3169	12	2	5000
96	5000	1730	85	0.01-0.5	20.12	0.14	3167	15	3	5000
120	5000	1738	79	0.01-0.5	19.44	0.14	3156	21	6	5000

[a] 1.0 mg/L = average conservative toxicity threshold for sensitive life stages of species entrained in the water column containing the dispersed oil. These values are provided with colorations to reflect the average water column concentration ranges defined on the trajectory snapshots in **Figures 5** through **12** in the main document.

[b] These values reflect a single point in time for the model. Oil concentration values are cyclical yet decreasing with the tidal cycle.

Appendix I: Summary Oil Budgets for the Kona and Trade Winds from the NOAA GNOME Modeling

TABLE 2 – KONA WINDS MODELED "OIL BUDGET" – 50% DISPERSED AT 3.5 HR (8:30 AM)

Hour	Volume Released (barrels)	Volume Evaporated	Chemical Dispersion					Volume Beached	Volume Off map	Volume Floating	Totals
			Volume Chemically Dispersed	Av. Water Column (0-10 meters) Concentration (mg/L)	Area with Oil (km2)	Percent Area with Oil (km2)	Max. Water Column (0-10 meters) Concentration (mg/L)[a, c]				
0	0	0	0	0	0	0	0	0	0	0	0
3	5000	1009	21	0.01-0.5	5.58	100%	1.25	0	0	3970	5000
6		1166	2010	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	23.69 2.77 10.92 0.34	62.8% 7.3% 29.0% 0.9%	2.2	2	13	1809	5000
12	5000	1263	2026	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	37.68 7.27 4.94 0.00	75.5% 14.6% 9.9% 0.0%	0.50	4	14	1693	5000
24	5000	1348	1989	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	48.85 11.03 4.49 0.00	75.9% 17.1% 7.0% 0.0%	0.48	947	45	671	5000
48	5000	1398	1854	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	93.29 10.17 1.17 0.00	89.2% 9.7% 1.1% 0.0%	0.35	1080	156	512	5000
72	5000	1399	1724	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	109.83 6.82 0.00 0.00	94.2% 6.8% 0.0% 0.0%	0.28	1614	262	1	5000
96	5000	1401	1627	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	131.25 6.84 0.11 0.00	95.0% 4.9% 0.1% 0.0%	0.25	1620	349	3	5000
120	5000	1403	1546	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0 10.0-50.0	150.29 0.62 0.34 0.00 0.03	99.3% 0.4% 0.2% 0.0% 0.0%	0.25	1631	418	2	5000

[a] 1.0 mg/L = average conservative toxicity threshold (at 50% dispersant effectiveness) for sensitive life stages of species entrained in the water column containing the dispersed oil.
[c] These values reflect a single point in time for the model. Oil concentration values are cyclical yet decreasing with the tidal cycle. These values are provided with colorations to reflect the average water column concentration ranges defined on the trajectory snapshots in **Figures 5** through **12** in the main document.

Appendix I: Summary Oil Budgets for the Kona and Trade Winds from the NOAA GNOME Modeling

NOTES: for **Table 3 - Trade Winds Modeled "Oil Budget" – 50% Dispersed** on next page:

- NOAA did not provide the ***Trade Winds - No Dispersant Added*** model run.
- The NOAA ***Trade Winds - 50% Dispersed*** model applied the dispersant at hour 7.0, instead of 3.5 hours as was done for the Kona winds scenario.
- Water depth of mixing within the model for the ***Trade Winds – 50% Dispersed*** scenario is only 0 to 5 meters; not 0 to10 meters as was provided for the ***Kona Winds – 50% Dispersed*** model run.

Appendix I: Summary Oil Budgets for the Kona and Trade Winds from the NOAA GNOME Modeling

TABLE 3 - TRADE WINDS MODELED "OIL BUDGET" – 50% DISPERSED AT 7.0 HR (12:30 PM)

Hour	Volume Released (barrels)	Volume Evaporated	Chemical Dispersion					Volume Beached	Volume Off map	Volume Floating	Totals
			Volume Chemically Dispersed	Av. Water Column (0-5 meters) Concentration (mg/L)	Area with Oil (km2)	Percent Area with Oil (km2)	Max. Water Column (0-5 meters) Concentration (mg/L)[a, c]				
0	0	0	0	0	0	0	0	0	0	0	0
3	5000	210	0	0	0	0	0	0	0	4790	5000
6	5000	663	0	0	0	0	0	0	0	4337	5000
12	5000	850	2187	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	28.04 6.09 4.94 0.00	71.8% 15.6% 12.6% 0.0%	2.2	0	0	1963	5000
24	5000	905	2187	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	30.07 6.41 10.88 0.00	63.5% 13.5% 23.0% 0.0%	1.6	0	0	1908	5000
48	5000	935	2187	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	58.33 10.02 5.84 0.00	78.6% 13.5% 7.9% 0.0%	1.6	0	0	1878	5000
72	5000	955	2187	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	68.73 12.16 6.63 0.00	78.5% 13.9% 7.6% 0.0%	1.2	0	2	1857	5000
96	5000	990	2187	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0	85.40 12.58 0.00 0.00	87.2% 12.8% 0.0% 0.0%	1.1	0	1808	15	5000
120	5000	990	2187	0.01-0.5 0.5-1.0 1.0-5.0 5.0-10.0 10.0-50.0	118.17 6.88 0.00 0.00 0.00	94.5% 5.5% 0.0% 0.0% 0.0%	1.0	0	1823	0	5000

[a] 1.0 mg/L = average conservative toxicity threshold (at 50% dispersant effectiveness) for sensitive life stages of species entrained in the water column containing the dispersed oil.
[c] These values reflect a single point in time for the model. Oil concentration values are cyclical yet decreasing with the tidal cycle. These values are provided with colorations to reflect the average water column concentration ranges defined on the trajectory snapshots in **Figures 5** through **12** in the main document.