Ocean Thermal Energy Conversion:

Information Needs Assessment

Coastal Response Research Center
University of New Hampshire

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FOREWORD

The Coastal Response Research Center, a partnership between the National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration (ORR) and the Environmental Research Group at the University of New Hampshire (UNH), develops new approaches to marine environmental response and restoration through research and synthesis of information. The center partnered with NOAA's Office of Ocean and Coastal Resource Management (OCRM) to conduct a series of conversations with members of the OTEC community, including federal regulators, industry, and academia, to better understand the information needs associated with development of OTEC in U.S. waters. As the primary licensing agency for OTEC projects, NOAA OCRM sponsored this effort, participated in conversations, and was integral in the synthesis of information obtained.

I hope you find the report interesting. If you have any comments, please contact me. I look forward to hearing from you.

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I. Overview of OTEC

In the waters of tropical and subtropical locales, including Hawaii, long days of intense sunlight result in significant heating of the upper 35 to 100 meters of the ocean, yielding comparatively warm (27 - 29°C) ocean surface waters. Below this warm surface layer the temperature decreases to an average of about 4.4°C (Avery, 1994). This temperature differential represents a significant amount of potential energy, which, if harnessed, is a renewable source of energy. One potential method of extracting this energy is ocean thermal energy conversion (OTEC). In a closed-cycle OTEC facility, both the warm and cold seawater pass through heat exchangers which transfer heat to and from seawater to a working fluid with a low boiling point (e.g., ammonia). After the seawater has passed through the heat exchanger it is discharged back into the ocean whereas the working fluid goes through cycles of vaporization and condensation which drives a turbine generator to produce electricity. In an open-cycle OTEC facility, warm surface seawater is placed in a low-pressure environment driving it to steam. The expanding steam then drives a low-pressure turbine generator to produce electricity. The steam can then be condensed into desalinized fresh water by exposure to the cold temperatures from deep-seawater. [N.B., for an in-depth review of the technical aspects of an OTEC facility see the 2009 Coastal Response Research Center (CRRC) Report titled, "Technical Readiness of Ocean Thermal Energy Conversion (OTEC)"].

Regardless of whether the OTEC facility is an open- or closed-cycle system, there are concerns about the potential environmental impacts of OTEC operation. OTEC is unique in that very large flows of warm surface and deep cold water are required to efficiently operate an OTEC facility. It is estimated that 3-5 m^3/sec of warm surface water and a roughly equivalent amount of cold deep ocean water are required for each megawatt (MW) of power generated (Myers *et al*., 1986). For a commercial-size facility (i.e., 100 MW) the total required flows for the warm and cold seawater would likely be between 600 – 1000 m^3/sec, roughly 14 to 22 billion gallons per day, and would vary with facility design considerations.

The ownership, location, construction, and operation of an OTEC facility in U.S. waters will need to comply with many federal, state and local regulations. With respect to environmental impacts, regulatory drivers include both direct and indirect impacts to biota and water quality, as well as food chain and ecosystem impacts.

II. Needs Assessment Background

In June 2010, CRRC and the National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean and Coastal Resource Management (OCRM) hosted the workshop, "OTEC: Assessing Potential Physical, Chemical and Biological Impacts and Risks," which aimed to identify potential environmental impacts of construction, installation, operation, and maintenance of an OTEC facility. The discussions at the workshop made it clear that the scale and extent of impacts, as well as the extent to which any regulatory thresholds may be exceeded, are likely to be proportional to the size and type of facility.

Water quality is most likely to be impacted through the discharge of seawater from the warm and cold water pipes to different depths from which they originated and the displacement of water removed via the intake pipes. The discharge, particularly in the immediate vicinity of the OTEC facility, is predicted to be cooler than the ambient receiving water with higher concentrations of nutrients and dissolved gasses from the seawater transported from the bathypelagic zone. Water quality may also be impacted from any chemical additions or erosion of the plant constituents (e.g., heat exchanger, cold and warm water pipes, turbines) from OTEC operations or accidental release of biocides or other potential pollutants. Any impacts to biota are likely to result from impingement, entrainment, secondary entrainment, attraction, avoidance, behavioral changes, shifts in predator/prey relationships, trauma, and broader ecological impacts. Impingement and entrainment are likely to be a function of intake velocity and screen size, while attraction, repulsion, and behavioral changes are most likely the result of the presence of the OTEC facility, and the light, noise, and EMF the facility would create.

Many of these impacts are interdependent and inter- and intra-species related (i.e., impingement of zooplankton results in change to prey available for fish, thus leading to ecological impacts). Once the type, scale, and scope of the impacts are known, it is possible to determine if the impacts exceed any thresholds established by various regulations. If thresholds are not established for a particular regulation then qualitative evaluation of the significance of impacts must instead be made. Determination of impacts requires knowledge of pre-disturbance (i.e., baseline) water quality and biological information, as well as an understanding of the major stressors involved with OTEC and how they are likely to impact the previously mentioned parameters. A partial list of information, modeling, and baseline needs was developed in the previous workshop (See Appendix A); however, this should be viewed as a starting point and not a complete or final list.

The discussions during the workshop made it clear that the size and extent of potential OTEC impacts are unknown or difficult to predict, and additional information will be required prior to beginning the OTEC licensing process in order to ensure the risk to the environment is minimized. As a follow up to this workshop, CRRC held a series of conversations with members of the OTEC community, including representatives from federal regulatory agencies, industry, and academia, to gain a better understanding of the information needs associated with licensing and permitting an OTEC facility, and research that can be conducted to advance our knowledge of potential OTEC impacts to the environment. To begin with, CRRC, over a period of nine months, oversaw a series of conversations with regulators from several federal agencies, including NOAA National Marine Fisheries Service (NMFS), NOAA National Ocean Service (NOS), U.S. Fish and Wildlife Service (USFWS), Environmental Protection Agency (EPA), and U.S. Army Corps of Engineers (USACE) to obtain a better understanding of OTEC’s information needs. In order to better determine what data currently exists, and how some of the information needs could be fulfilled, CRRC held additional conversations with scientists from the University of Hawaii, TetraTech, Oak Ridge National Labs, Alden Research Labs, Tenera Environmental, Makai Ocean Engineering, NOAA Office of Coast Survey, NOAA Office of Oceanic and Atmospheric Research, and the Pacific Northwest National Laboratory.

This document is an analytical summary of the conversations that is meant to act as an information resource to NOAA OCRM and is focused on the federal permitting process. While state regulations and information needs are just as important as federal regulations and information needs, it was not possible to consider them due to the time and economic constraints of this effort. <u>The aim of this effort was to try to target those aspects of OTEC that are unique to OTEC.</u>

To focus the conversations this needs assessment aimed to address the following general questions:

1. What environmental information is needed in order to permit and license an OTEC facility? (i.e., What information is needed to satisfy existing environmental regulations, such as the Clean Water Act, the Endangered Species Act, and the Marine Mammal Protection Act?)
   - What environmental baseline information is required?
   - What models are needed to simulate predicted impacts, such as the spatial and temporal extent of plumes?
   - What environmental monitoring plans are needed to evaluate impacts from OTEC operations and to validate models?
2. How can the necessary information be obtained?
   - Does the information already exist (i.e., literature review, existing databases)?
   - Is new research required?
3. For regulations that were developed for industries other than OTEC, but will or may be applicable to OTEC, can it be shown that the impacts from OTEC in an offshore, deep-water environment are environmentally acceptable? In what ways can this be shown if this is the case?

While there could be many impacts and risks associated with OTEC construction, installation, operation, and removal, this needs assessment is more focused on aspects of OTEC that are unlike other marine development or energy systems. For example, the impacts from noise generated during construction and operation; and impacts from the electromagnetic field (EMF) from the power cable are not discussed in detail in this assessment because the information needs associated with those parameters are relatively well understood. The impacts of an OTEC facility that seem to be of most concern are 1) water quality impairment and 2) impacts to biota. While these are interdependent on each other, most impacts of concern from an OTEC facility can be placed into one of these two broad categories.

For the purposes of this report and the conversations that were held it was assumed that the representative OTEC facility was a 100 MW closed-cycle facility and was floating, offshore, and moored (Table 1). Electricity was going to be generated on the facility less than 20 miles from shore and then transmitted via a submarine electric transmission cable to shore. These assumptions were made to be consistent with previous workshops and because a large commercial-scale facility would most likely have these characteristics. At the time this document was prepared, NOAA was not aware of any imminent OTEC Act license applications or solidified commercial or utility-scale OTEC development plans, and the characteristics and location of the facility discussed in this document were purely hypothetical and for discussion purposes only.

While this OTEC Information Needs Assessment does not specifically address onshore OTEC facilities, many of the information needs would be the same, just examined from the perspective of shore-based development. The choice of not specifically examining onshore OTEC facilities was due to time and economic constraints and is in no way ignoring their place in OTEC development. Indeed, NOAA and CRRC understand that the first functioning OTEC facilities my actually be smaller onshore facilities.

Table 1 gives generic parameters for a hypothetical 100 MW closed-cycle OTEC facility in Hawaiian waters.

Table 1: Generic 100 MW Closed-Cycle OTEC Facility Characteristics

	Range of Parameters
Location	3 – 4 miles offshore Hawaii
Warm Water Intake Depth	20 m
Warm Water Intake Temperature	25°C
Warm Water Intake Flow	460 m^3/s
Warm Water Intake Velocity	0.15 m/s
Warm Water Intake Antifouling	Intermittent Chlorination (50 – 70 µg/L for 1 hr)
Cold Water Intake Depth	1000 m
Cold Water Intake Temperature	5°C
Cold Water Pipe Diameter	10 m
Cold Water Intake Flow	370 m^3/s
Cold Water Intake Velocity	2.5 m/s
Cold Water Intake Antifouling	None
Discharge	Combined or Separate Depth TBD

III. General Knowledge Gaps

Throughout the course of the conversations, it became clear that there are general knowledge gaps that are applicable to multiple agencies and regulations. These knowledge gaps represent significant information needs and meaningful efforts should be made to address them. Filling these knowledge gaps will aid regulators and members of the OTEC community in better understanding the impact of an OTEC facility. These knowledge gaps are presented in no particular order, and it should be noted that the majority of them have the potential to impact both water quality and biota through direct or indirect means.

- The degree or level of impact of an OTEC facility will be heavily influenced by the location and final design parameters of the OTEC facility. Design specifications such as depth of the cold and warm water intakes and discharges, approach velocity at the intakes, discharge velocity, screen size, and even simpler parameters such as color of the pipes and facility may impact the magnitude and extent of any potential impact. Before an accurate estimate of any impacts can be developed, design specifications need to be completed and furnished to the various regulatory authorities as early in the project development process as possible. Minor engineering changes to the facility have the potential to dramatically alter the environmental impact and economic feasibility, and if detailed design specifications are furnished early on, design alterations may be possible that reduce or eliminate environmental impact without significantly impacting the feasibility of the OTEC facility.

- In the conversations with the federal regulators, it became clear that an accurate determination of the spatial and temporal extent of the discharge plume and intake zones forms the foundation for determination of potential impacts. Without this information, it is difficult to determine the magnitude of the impact, and impossible to determine the overall effect on the environment. While the spatial and temporal extent of the discharge plume can be estimated using modeling techniques, these must include ground-truthed site-specific, regional, and global models, and accurate and representative data must be used as model inputs. Model inputs will vary with the type of model, but are likely to include physical, chemical and biological parameters and must be location-specific in order to obtain useful results. While it is likely that region-specific data exists in the form of data from the Hawaiian Ocean Time series (HOT), site-specific information would likely need to be collected over a requisite period of time to account for inter-annual variability, as well as the influence that weather, climactic shifts, and changes to global, regional, and local circulation patterns have on the spatial and temporal extent of discharge plumes and intake zones.

- Little is known about the bathypelagic (1,000 – 4,000 m ocean depth) and abyssopelagic (4,000 – 6,000 m ocean depth) zones in the region surrounding Hawaii. The intake for the cold water pipe is anticipated to be at 1000 m and the zone of influence of the cold water intake may extend into these regions. Redistribution of water from deep in the ocean to the surface was a recurring concern for many participants in the conversations, and many of them noted that the water in the bathypelagic zone is fundamentally different than at the surface, and contains many trace elements and heavy metals that may impact local water chemistry when discharged near the surface. Due to the uniqueness of OTEC and the transfer of large volumes of water from the deep ocean to the surface, very little is known about the potential loading of contaminants and nutrients on the receiving waters. Site-specific data from a range of depths is needed in order to ascertain the potential impacts of redistribution of deep water to the surface. Of critical importance are chemical constituents, including nutrients (NH_4, NO_3, NO_2, PO_4, Si), trace elements (Fe, Mb, Co, Mn, Zn, Si, Ni), dissolved gases (O_2, CO_2), and heavy metals (Hg, Cd, As). In addition, pH, alkalinity, carbonate ion, and dissolved inorganic carbon (DIC) should be measured. The discharge of water originating from approximately 1000 m may increase the concentration of key limiting nutrients in the upper water column where it is released (i.e., it will create artificial upwelling). An increase in limiting nutrients can result in algal blooms, including harmful algal blooms (HAB), which may impact water quality. Detailed information on the daily and annual loading of limiting nutrients, along with research into the presence and abundance of algal species, and their expected response to increased nutrient availability (throughout all thermal, salinity, and light ranges) should be obtained.

- The transport of water from the deep ocean to the surface will also likely result in the release of dissolved gases due to the change in partial pressure. Of most concern is the release of carbon dioxide, resulting in localized ocean acidification and consumption of buffering agents. Very little is known about the long-term impacts of transport of water from the deep ocean to the surface and resultant changes to the chemical properties of the water. Thorough analysis and modeling may be required to gain a better understanding of the volume of carbon dioxide released to the atmosphere as a greenhouse gas, the extent of ocean acidification, and consumption of buffering agents.

- While there have been efforts to understand the migratory patterns of fishes, birds, mammals, and sea turtles in the region, in general very little is known and additional research is needed to better characterize the behavioral and migratory patterns of these species. Multi-year, species-specific, and sometimes group-specific (e.g., marine mammal pod) information is needed to be able to assess whether migratory and behavioral patterns are being impacted. Shifts in behavior or migratory patterns of any species may result in a cascading ecological effect in the Hawaii region, and it is crucial to understand not only how the construction, installation, operation and maintenance of an OTEC facility may impact a single species, but if it can impact the ecosystem as a whole. In order to accomplish this, detailed, site-specific, multi-year information on the presence and frequency of biota, as well as its susceptibility to impact is needed. While larger organisms are often the focus, it is important to consider impacts to plankton, bacteria, protozoa and viruses, as they are key members of the ecosystem and changes to their distribution, abundance, or relative health may have negative consequences. While it is unlikely that a single OTEC facility will completely depopulate a region of plankton, it is important to understand how OTEC operations may impact the distribution and abundance of plankton, more in ecosystem terms, in a specific water parcel, and in the region, rather than focusing on specific planktonic species.

- The scale of the impact to biota will depend, in part, on the mortality of species that are entrained or impinged. Most of the discussions thus far have assumed 100% mortality as a worst-case scenario; however, some entrained organisms may survive, while others may ultimately die due to the stresses of the new environment. The percent mortality is an important input for predictive models, and efforts should be made to get a realistic, statistically valid estimate of percent mortality for entrained organisms. Due to the uniqueness of design and depth of intake and discharge structures, information obtained from intakes in other industries may not be relevant and additional research may be needed.

- Optimized site selection is a valuable tool to mitigate or avoid impacts. A better understanding of the characteristics that make a potential site unsuitable from a biological perspective (e.g., areas of high biological activity) would be beneficial, and likewise, a site survey which identifies areas that are preferable for OTEC development would be useful (e.g., areas that are more biologically barren or unproductive). Other parameters, including local currents, presence of sensitive biota, or poor flushing rates may also make the difference between a favorable location and an unfavorable one. Due to the presence of reefs, geologic formations, and hydrodynamic interactions, many regions in Hawaii have localized, small-scale currents and waves which may play a role in the potential impact of an OTEC facility, and these currents and waves should be thoroughly characterized prior to site selection. It is possible that geospatial tools can be used or developed to aid in site selection. It should be noted that several participants made the argument that areas of high productivity may be preferable from a site selection standpoint, as the loss of a single individual is less important in areas of high diversity and productivity than it would be in a region with low productivity and low species diversity.

- One potential method of reducing the impact of the discharge plume is to discharge below the photic zone in order to limit exposure of nutrients to biota. In order to accomplish this, the depth of the photic zone, as well as the pycnocline and thermocline, needs to be determined over a requisite period of time to better understand the influence of weather events, shifts in circulation patterns and currents, inter-annual variability, and global climate change.

- Although it is not unique to OTEC, the addition of continuous noise and EMF will be a new addition to the Hawaiian offshore environment which is devoid of large platforms (i.e., hydrocarbon production platforms) often associated with offshore oil and gas development. Constant noise and production of EMF from the facility and submarine electric transmission cable has the potential to negatively impact the behavior of numerous species, most notably marine mammals and sharks. It is crucial that the types, magnitudes, characteristics, and anticipated extent of noise and EMF associated with the construction, installation, operation, maintenance, decommissioning, and removal of the facility be fully characterized, and the potential impact this will have on sensitive species be investigated.

IV. Applicable Regulations and Information Needs

Ultimately, any change to the environment from an OTEC facility must be compliant with applicable regulations and authorities. This will most likely be determined through careful analysis of data and modeling to determine if the activities associated with constructing, installing, operating, maintaining, and decommissioning, and removing an OTEC facility impacts the environment beyond what is allowed by regulation. In order to accomplish this, information needs associated with applicable regulations must be fulfilled to ensure a defensible assessment can be conducted. While there are numerous federal, state, and local regulations that apply to the construction, installation, operation, maintenance, decommissioning, and removal of an OTEC facility, this section focuses on those primary federal regulations that have been identified as having significant information needs. The absence of a specific regulation or authority in this section does not imply that it is not applicable, relevant, or important.

A. National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to incorporate environmental values and ethics into the decision making processes by considering potential environmental impacts (both positive and negative) of their proposed federal actions and reasonable alternatives to those actions.

In order to satisfy NEPA requirements, federal agencies must thoroughly consider potential negative and positive direct and indirect impacts of any proposed federal action and prepare a detailed Environmental Assessment (EA) or Environmental Impact Statement (EIS) which attempts to determine the degree of impacts, including cumulative impacts, of any proposed federal action. EPA reviews and comments on EISs prepared by other federal agencies, maintains a national filing system for all EISs, and assures that its own actions comply with NEPA.

As the lead licensing authority for OTEC, NOAA would be responsible for development and submittal of an EIS for an OTEC Act license application. Section 9117e of the OTEC Act of 1980 states:

> The issuance of any license for ownership, construction, and operation of an ocean thermal energy conversion facility or plantship shall be deemed to be a major Federal action significantly affecting the quality of the human environment for purposes of section 4332 (2)(C) of this title. For all timely applications covering proposed facilities in a single application area, and for each application relating to a proposed plantship, the Administrator [of NOAA] shall, pursuant to such section 4332 (2)(C) of this title and in cooperation with other involved Federal agencies and departments, prepare a single environmental impact statement, which shall fulfill the requirement of all Federal agencies in carrying out their responsibilities pursuant to this chapter to prepare an environmental impact statement.

Due to the unique nature of OTEC, it is probable that a significant amount of new research and analysis and distillation of existing research would be required in order to develop the EIS. While NEPA was not separately addressed in the information gathering stage of this needs assessment, the information needs mentioned in this assessment will likely apply to the EIS. However, this does not preclude the possibility that information beyond what is addressed in this assessment would be required to develop a satisfactory EIS.

B. Clean Water Act

Water quality impairment and cooling water intake generally fall under the jurisdiction of the EPA and the Clean Water Act (CWA) sections 316(b), 402, and 403. Section 316(b) requires that the location, design, construction, and capacity of cooling water intake structures for facilities, including screening technology, reflect the best technology available for minimizing adverse environmental impact. While OTEC is not specifically mentioned under CWA 316(b) rules, these regulations require that water intake structures (e.g., cold and warm water intakes) for new facilities that are not explicitly mentioned in the regulations must be developed using best professional judgment. Section 402 requires any discharge into a waterway to hold a valid National Pollutant Discharge Elimination System (NPDES) permit, and Section 403 establishes ocean discharge criteria guidelines for issuing NPDES permits. In addition, depending on the specific location selected for an OTEC facility, CWA section 401 (water quality standards for wetlands) may be pertinent for coastal environments.

As stated above, best professional judgment will be used in lieu of specific regulation standards. For example, intake regulations that govern approach velocity were crafted primarily to protect the near-shore environment, but intake structures for an OTEC facility will be suspended far from the benthos. Should best professional judgment deem the impact acceptable, a higher approach velocity may be viable. In all cases, the goal is to not have unreasonable degradation of the water.

Below is a principal, but not definitive, list of information needs to ensure compliance with various sections of the CWA to prevent water quality impairment:

- What is the spatial and temporal extent and physical and chemical composition of the OTEC facility's discharge plume?
- What are the spatial extent and characteristics of the OTEC facility's intake zones?
- What is the extent of the intake zone of influence, and how does it impact the aqueous chemistry of the region?
- What are the concentrations and loading of potential contaminants, including nutrients, from the OTEC facility's discharge plume?
- What is the thermal impact of the OTEC facility's intake and discharge to the surrounding environment?
- Will the OTEC facility's discharge or intake (including induced thermal and artificial currents) significantly impact local, regional, or global currents or circulation patterns?
- What is the fate of entrained or impinged organisms and will their presence or decomposition result in impaired water quality?
- How much and what kind of data (e.g. duration, spatial extent, scale, etc.) are needed to adequately ensure compliance with various water quality regulations?

- Does the water in the region of the proposed OTEC facility contain elevated concentrations of heavy metals like mercury (Hg) or trace elements like iron (Fe), and how would their transport to the surface impact water quality? Water in the bathypelagic and abyssopelagic zones in certain regions of the world have been shown to contain higher concentrations of heavy metals such as mercury (Hg) and trace elements such as Iron (Fe) and Molybdenum (Mo).
- What is the variability of the organic carbon concentrations in the OTEC facility's intake zones, and will changing oceanic circulation patterns result in the need for higher chlorine dosing to limit biofouling? The chlorine dose required to maintain negligible biofouling of heat exchangers is a function of total organic carbon (TOC) in the water column. Higher TOC will require increased doses, and potentially result in the formation of trihalomethanes.
- What is the site- and region-specific speciation of carbonates and what impact, if any, will it have on the local pH. The transport of dissolved gases from the deep ocean to the surface has the potential to result in the release of CO_2 and result in formation of carbonates, both of which can potentially impact the pH of the receiving waters.

C. General Biota Information Needs

Impact to biota is a broad category that is applicable to numerous federal regulations, most notably the Endangered Species Act, the Marine Mammal Protection Act, the Magnuson-Stevens Fishery Conservation and Management Act, and the Migratory Bird Treaty Act. While these Acts are discussed separately later in this report, there are a number of general information needs that apply across many regions and organisms.

The construction, installation, and operation of an OTEC facility has the potential to impact biota through several pathways, however, the stressors of most concern are the intakes and discharge. The cold and warm water intakes both have the potential to entrain or impinge a wide variety of organisms, potentially reducing their abundance, fecundity, and changing their behavior, thus disrupting the local ecosystem. Organisms may become entrained within the intake, or become subject to secondary entrainment in the discharge plume. The fate of organisms entrained or impinged is generally poorly understood, and depends on a variety of factors, including physical and chemical characteristics of the receiving waters, tolerance to temperature, pressure, and salinity disturbances, and the ability to maintain normal biological functions while impinged. The discharge will create a plume with physicochemical characteristics different from the ambient water, potentially disturbing normal ecological and behavioral patterns in the region.

While the extent of impact is not known, the physical presence, lighting, noise and EMF generated by the facility could disrupt sensitive species in the region. The presence of the OTEC facility will likely act as a fish aggregating device (FAD), resulting in greater than normal abundance of species in the vicinity of the facility. Appendix B gives FAD location information throughout Hawaii. In addition, the presence of the cold water pipe will add a significant amount of surface area for colonization by filter feeders, potentially reducing the amount of suspended particulate matter, including eggs and larvae, in the vicinity of the facility. Despite being shielded, high energy power cables have previously been shown to disrupt behavioral patterns of EMF-sensitive species, most notably members of the chondrichthyes class of fishes (i.e., sharks and rays).

Prior to licensing, significant efforts need to be made to accurately characterize the presence, abundance, composition, and distribution of biota, including eggs and larvae, in the region, most notably at the depth of the warm and cold water intakes. While numerous organisms reside in the bathypelagic and abyssopelagic zones, they are typically widely distributed with a very low population density and fecundity. As a result, removal of any of these individuals will likely impact the species and ecosystem to a greater extent, and additional information is needed on the likelihood of impact to bathypelagic and abyssopelagic organisms, and the effect it would have on the species and ecosystem. It also is important to understand the behavioral and biological differences between juveniles and adults in larger biota.

Due, in part, to predator-prey interactions, inter-annual shifts in resource availability, and behavioral and physiological responses, a sufficient baseline is necessary to better characterize the biological community. Ideally, this should include a variety of climactic (e.g., *El Niño*, *La Nina*) conditions, and take into account natural inter-annual variability in populations. Some of this information is already available from the Hawaiian Ocean Time-series (HOT); however, little is known about species at depth. Once an accurate baseline is obtained, population modeling will help to predict the impact of varying configurations and placements of OTEC facility intake and discharge structures.

D. Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) places a moratorium on the "taking" of marine mammals, which is defined as harassing, hunting, capturing, killing or collecting, or attempting to harass, hunt, capture, kill or collect marine mammals. However, the MMPA allows for the authorization of the incidental taking of marine mammals that occurs during otherwise lawful activities with prior approval. Marine mammals are likely to be present in all areas where OTEC is considered (i.e., locations with warm surface water and cold deep water), and some proposed locations (i.e., Hawaii) are located in migratory pathways of larger marine mammals such as whales. While it is unlikely that healthy marine mammals will become entrained or impinged, juvenile, sick, or injured individuals may become impinged, and alteration of the abundance or distribution of marine mammal prey species such as plankton may result in behavioral changes in marine mammals. In addition, most marine mammals are sensitive to noise. The noise generated by the facility has the potential to result in significant behavioral changes in marine mammals, including disruption or alteration of migratory patterns and their presence in the region. Further, because sound is conducted very efficiently through water, the potential spatial impact will likely be significantly larger than other impacts. Appendix C states general acoustic thresholds (for non-explosive sounds) for use with the MMPA.

Below is a principal, but not definitive, list of information needs associated with the MMPA:

- What is the abundance and distribution of marine mammals in the vicinity of the OTEC facility, including intake and discharge zones, and how are they using the area (e.g., migration, feeding, and breeding)?
- Are juvenile, sick, or injured marine mammals more likely to be impacted by the OTEC facility than healthy adults?
- What is the ambient noise level in the vicinity of the OTEC facility's site location and operating area?
- What noise will be added to the existing environment during the OTEC facility's construction, installation, operation, and decommissioning and how will it impact marine mammals?

- What are the magnitude, location, and characteristics of EMF produced during the OTEC facility's construction, installation, operation, and decommissioning, and how will it impact marine mammals?
- Will the OTEC facility's discharge plume or intake zone impact key prey availability, abundance, or distribution?
- Does the presence of the OTEC facility, and its mooring or submarine electric transmission cable, represent an entanglement or entrapment risk?
- What are the expected levels of marine mammal "take," and how will the "take" impact the species as a whole?
- What are the potential stressors that may result in "take?" How can those stressors be reduced or limited?
- How will the presence of an OTEC facility disrupt migratory patterns or the presence of marine mammals in the region?
- What oceanic currents or geographic locations should be avoided to minimize impact to marine mammal presence and migration?

E. Endangered Species Act

The Endangered Species Act (ESA) requires federal agencies to ensure that any action that may affect threatened or endangered species that is authorized, funded, or carried out by them is not likely to jeopardize the continued existence of that species or destroy or adversely modify its critical habitat. If an action is determined, through consultation with the USFWS or NMFS, to jeopardize a species or adversely modify its critical habitat, reasonable and prudent alternatives will be suggested that would not violate the ESA. The full list of threatened and endangered species is kept up to date by the USFWS. Table 2 shows a partial list of the threatened endangered species identified in the waters surrounding Hawaii.

Table 2: Protected Species in Hawaiian Waters[1]

Marine Mammals	Marine Reptiles	Marine Birds
Hawaiian Monk Seals *(Monachus schauinslandi)*	Hawksbill Sea Turtles *(Eretmochelys imbricata)*	Hawaiian Petrel *(Pterodroma sandwichesis)*
Humpback Whales *(Megaptera novaeangliae)*	Green Sea Turtles (*Chelonia mydas)*	Short-Tailed Albatross *(Pheobastria albatrus)*
Sperm Whales *(Physeter macrocephalus)*	Leatherback Sea Turtles *(Dermochelys coriacea)*	Newell's Shearwater *(Puffinus newelli)*
Blue whales *(Balaenoptera musculus)*	Loggerhead Sea Turtles *(Caretta caretta*	Hawaiian Hawk *(Buteo solitarius)*
Fin Whales *(Balaenoptera physalus)*	Olive Ridley Sea Turtles *(Lepidochelys olivacea)*	
Sei Whales *(Balaenoptera borealis)*		

[1] Protected Species information obtained from the Western Pacific Regional Fishery Management Council at http://www.wpcouncil.org/hawaii-protectedspecies.html

It should be noted that many vulnerable species, most notably corals, were not listed as threatened or endangered at the time this document was prepared, but could be listed as threatened or endangered in the near future, and a common sense approach should be used to avoid impact to vulnerable species.

Below is a principal, but not definitive, list of information needs associated with the ESA:

- What is the range, behavior, and abundance of ESA listed species in the area to be impacted by the OTEC facility?
- What is the function of the area used by ESA listed species or how do ESA listed species use the area?
- Do any ESA listed species have a higher risk of impingement or entrainment by the OTEC facility's intakes?
- What geographic locations, currents, or geological formations represent critical habitat for ESA listed species, and should therefore be avoided?
- What are the expected levels of "take," and how will the "take" impact the ESA listed species? The term "take" as it relates to the ESA means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.
- What are the potential stressors that may result in "take?" How can these stressors be reduced or eliminated?
- Will the OTEC facility be a FAD for ESA listed species or their food source?
- How will critical habitat (e.g., grass beds for sea turtles) be impacted by the construction, installation, operation, or decommissioning of the OTEC facility?
- What is the ambient noise level in the vicinity of the OTEC facility's site location and operating area?
- What noise or EMF will the OTEC facility emit and how will it impact ESA listed species?
- What are the parameters that need to be monitored in order to determine impact? (e.g., abundance, frequency of visits to the site, use as a feeding ground, use as a breeding ground)?
- How long does a potential OTEC site need to be monitored in order to show that the facility does not interfere with ESA listed species beyond what is authorized?
- While not currently listed, corals, including mesophotic corals at deeper depths, could be listed in the near future. How will the construction, installation, operation, decommissioning, and removal of the OTEC facility (most notably the installation and removal of the mooring, anchoring, and submarine electric transmission cables) impact corals and coral reefs? What impact will this have on other species that rely on coral reefs for nursery, feeding, or shelter habitat?

F. Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires federal agencies to consult with NMFS if any actions authorized, funded, or undertaken by them could adversely affect essential fish habitat (EFH). An adverse effect means any impact that reduces the quality and/or the quantity of EFH. This includes direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Areas that are deemed to be EFH Habitat Areas of Particular Concern (HAPC) are distinctly important due to the rarity of habitat, ecological function, susceptibility to human impacts, or the likelihood of development impacts. Designation as a HAPC results in greater scrutiny by NMFS and indicates that greater efforts should be made to protect the habitat. As Table 3 illustrates, the large extent of EFH and HAPC designations in the Hawaiian region make it likely any OTEC facility placed in the Hawaiian region has the potential to impact EFH or HAPC.

Table 3: Summary of EFH and HAPC designations for Hawaiian pelagic MUS[2]

Management Unit Species (MUS)	Essential Fish Habitat: Juveniles and Adults	Essential Fish Habitat: Eggs and Larvae	Habitat Areas of Particular Concern
Pelagic	Water column down to 1,000 m	Water column down to 200m	Water column down to 1,000 m that lies above seamounts and banks
Bottomfish	Water column and bottom habitat down to 400 m	Water column down to 400m	All escarpments and slopes between 40- 280 m and three known areas of juvenile opakapaka habitat
Seamount Groundfish	Water column and bottom from 80 to 600 m, bounded by 29° - 35 ° N and 171° E - 179°W (adults only)	Epipelagic zone (0 – 200 nm) bounded by 29° - 35°N and 171° E - 179°W (includes juveniles)	Not Identified
Precious Corals	Keahole, Makapuu, Kaena, Wespac, Brooks, and Milolii, S. Kauai, and Auau Channel Black Coral beds	Not Applicable	Makapuu, Wespac, and Brooks Bank beds, and the Auau channel
Crustaceans	Bottom Habitat from Shoreline to depth of 100m	Water column down to 150m	All banks within the northwestern Hawaiian Islands with summits less than 30 m
Coral Reef Ecosystem	Water column and benthic substrate to a depth of 100 m	Water column and benthic substrate to a depth of 100m	All MPAs identified in FMP, all PRIA, many specific areas of coral reef habitat

Adverse effects to EFH and HAPC may result from actions occurring within EFH or outside of EFH. The federal action agency must provide NMFS with an assessment of the action's impacts to EFH and HAPC (see Appendix D for help assessing impacts to EFH in the Hawaiian region), and NMFS provides the federal action agency with EFH conservation recommendations to avoid, minimize, mitigate, or otherwise offset those adverse effects. Federal agencies must provide a detailed written explanation to NMFS describing which recommendations, if any, it has not adopted. Impacts to EFH and HAPC could be direct (e.g., destruction of benthic or pelagic habitat

[2] Table adapted from the Western Pacific Regional Fishery Management Council managed Fishery Management Plans at http://www.wpcouncil.org/hot/index.html

through physical disruption, presence, or impact to water quality), or indirect (e.g., modification of prey species that managed species rely upon). For the conditions and locations assumed for the purposes of this needs assessment, migratory species such as tuna and mahi mahi are likely to be a focus of conservation efforts, as they are both culturally and commercially important species. For detailed information on EFH and HAPC in the Hawaiian region, see Appendix E. It should be noted that at the time of publication of this document, EFH and HAPC designations were in the process of being revised, and may current designations may be different than what is listed.

Below is a principal, but not definitive, list of information needs associated with EFH and HAPC:

- Is there EFH or HAPC designated in the vicinity of the proposed OTEC facility?
- How will the presence of the OTEC facility impact the behavior of fishes in the region (i.e., will it act as a FAD or will it act as a deterrent)
- How will the zone of influence of the OTEC facility's intakes or discharge impact EFH or HAPC functions?
- What impact will the quality of the OTEC facility's discharge water have on EFH or HAPC functions?
- How will the OTEC facility's discharge and intakes directly or indirectly impact EFH or HAPC through change in abundance or behavior of predator and or prey species?
- How will noise generated from construction and operation of the OTEC facility impact the behavior of fishes and their habitat?
- How will the anchors and submarine electric transmission cable installation for the OTEC facility impact the behavior of fishes and their habitat?
- How will EMF from the OTEC facility's submarine electric transmission cable impact the behavior of fishes and their habitat?
- How will the presence of the OTEC facility impact plankton and nekton migration, and will that result in a shift in feeding behavior or prey availability in protected regions (e.g., EFH or HAPC)?
- Will the OTEC facility result in artificial upwelling or downwelling, and if so, how will that impact the primary productivity in the region?
- What oceanic currents and geographic locations should be avoided to minimize or eliminate potential impacts to EFH and HAPC?

G. Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) states that, unless permitted by regulation, it is unlawful to, or attempt to, pursue, hunt, shoot, kill, wound, capture, trap, collect, transport, or cause to be transported at any time, or in any manner, any migratory bird, nest, or egg of any such migratory bird. Note that a harassment condition is not associated with the MBTA as it is with the MMPA and ESA. OTEC facilities are likely to be used as a resting point or shelter during storm events by migratory birds. However, due to its offshore location, only birds capable of open ocean travel are likely to be impacted by its presence. Of particular concern is the ability of the facility to act as a FAD, which will concentrate prey species and may result in a larger than normal abundance of birds as they feed. In addition, any lighting or sound produced by the facility will attract or deter birds, resulting in alteration of normal behaviors and potentially making them more vulnerable to further impact. Birds that are capable of diving may be vulnerable to impingement by the warm surface-water intake, especially if the FAD phenomenon encompasses the warm surface-water intake zone.

Below is a principal, but not definitive, list of information needs associated with the MBTA:

- What birds are likely to be present in the vicinity of the proposed OTEC facility?
- Will the presence of the OTEC facility alter the behavior, presence, abundance, or distribution of migratory birds?
- Will the presence or operation, including operational noise and lighting, of the OTEC facility result in direct or incidental capturing, trapping, wounding, or killing of any migratory birds, and if so, in what quantity and of what species?
- Will diving birds, including healthy, sick or injured individuals, be present in the OTEC facility's warm surface-water intake zone, and if so, are they likely to become impinged by the warm surface-water intake or impacted by secondary entrainment?

H. Fish and Wildlife Coordination Act:

The Fish and Wildlife Coordination Act (FWCA) provides authority for the USFWS's involvement in evaluating impacts to fish and wildlife from proposed water resource development projects. The FWCA requires that fish and wildlife resources receive equal consideration to other project features. It also requires federal agencies that construct, license, or permit water resource development projects to first consult with the USFWS (and NMFS in some instances) and state fish and wildlife agencies regarding the impacts on fish and wildlife resources and measures to mitigate any impacts.

Below is a principal, but not definitive, list of information needs associated with the FWCA:

- How will the OTEC facility impact aquatic resources, including corals, coral reefs, seagrass beds, and estuaries?
- What species, particularly benthic species, are likely to be present in the vicinity of the proposed OTEC facility, especially around its anchors and submarine electric transmission cable?
- How will the presence of the OTEC facility alter the behavior of fishes or wildlife?
- How will the OTEC facility impact the abundance or diversity of fishes and wildlife around the OTEC facility's location and in the region?
- How will the OTEC facility change ecosystem function in both the near and far field regions?

I. Rivers and Harbors Act

Any dredging or placement of structures in navigable waters of the United States that is associated with the construction and installation of an OTEC facility will have to comply with Section 10 of the Rivers and Harbors Act of 1899 as administered by the USACE. The USACE has a standard approval process in place with specific information needs for specific work in navigable waters of the United States. Appendix F contains the USACE's standard application (ENG Form 4345) and a questionnaire developed to supplement the information required in ENG Form 4345.

Below is a principal, but not definitive, list of information needs associated with obtaining a U.S. Army Corps permit to be able to construct and install an OTEC facility in navigable waters of the United States:

- What are the exact activities that need to be accomplished to construct and install the OTEC facility? Descriptions of activities need to be as detailed as possible.
- What are the exact locations, including any alternative locations, of the proposed OTEC facility, submarine electric transmission cable(s), intake and discharge pipes, and anchoring or moorings?
- What are the specifications for the all the OTEC facility's structures and components, such as size, dimension, composition, depth, and other specifications?
- What are the maintenance considerations for the OTEC facility for work that is required after construction and installation?
- What is the environmental baseline (a detailed description of the existing environment) at the OTEC facility's site location and operating areas? Environmental baselines should include, at a minimum, a benthic survey, information on marine mammals, threatened and endangered species, essential fish habitat, migratory birds, and water quality.
- What are the environmental impacts which may be expected as a result of constructing and installing the OTEC facility?
- What are acceptable mitigation proposals to account for unavoidable permanent impacts by the OTEC facility?
- What are the associated monitoring plans for the OTEC facility considering the developmental nature of OTEC?
- What are acceptable alternatives to current construction and installation methods or project designs that will minimize the impacts by the OTEC facility?

V. Obtaining Required Information

Existing sources of data

Several of the experts suggested that some of the required information needs may be partially or completely filled by exploring data sources from other industries, most notably the oil and LNG industries. However, the relevance of this information is likely to be limited to information needs associated with physical or chemical parameters because oil and LNG operations are rare in the region surrounding Hawaii, making any biological data potentially not useful. Several locations within Hawaii use marine intakes, including the Kahe Power Plant and the Natural Energy Laboratory of Hawaii Authority (NELHA). These pipes are monitored for entrainment and impingement and long-term datasets exist which could be a useful source of historical data. However, the availability and usefulness of this, and other potential datasets, will depend on many factors, including the parameters of sampling and analysis (e.g., frequency of sampling, intake location and depth, and degree to which species are identified), as well as if the data is publically available. Private organizations may not wish to make their data publically available to avoid revealing proprietary or unfavorable information, and therefore available data may be limited to publically-funded institutions. Region-specific information may be available through the University of Hawaii and the Hawaii Ocean Time-series (HOT). Data for the HOT project has been collected since 1988, and therefore represents a significant amount of baseline information and should be explored prior to funding additional research. However, many participants noted that much of the data required for licensing an OTEC facility is location specific, so unless the OTEC facility is located within the immediate vicinity of a HOT data collection station or intake pipe, the available data may not be specific enough for some regulatory authorities. It is also important that the data collected be representative and complete; all species, size-classes and life stages should be included, and sampling and analysis should not favor one type over another (e.g., plankton vs bacteria), however, priority should be given to vulnerable species. Because of these limitations, existing sources of data may need to be supplemented with additional analyses to include organisms or parameters previously excluded.

Water Quality

If new data needs to be collected, the current state of the art technology for measurement of water quality parameters is the use of an autonomous underwater vehicle (AUV) or glider equipped with appropriate sensors to perform automated grid analysis of the area of interest. Currently, sensors are only available for a small range of parameters including temperature, conductivity, pressure, fluorescence, chlorophyll, and some nutrients. For other required parameters, an autosampler would need to be used and the samples analyzed at the surface using traditional methods. Gliders and AUVs are expensive, and cost on average $100,000 to purchase, however, they are much more versatile than boats and allow greater freedom when sampling. Several educational institutions and private companies own gliders and AUVs, and it may be possible to contract with them to collect samples rather than purchasing and operating one outright. Ship costs are generally $10,000 per day and higher depending on ship size and the sampling regime. Remote imaging (e.g., aerial photographs and satellite imagery) may be useful tools to look at changes to chlorophyll as a surrogate for photosynthesis.

Impingement and Entrainment

Extensive data exists for entrainment and impingement from power plants and other marine intakes, however, very little of this data may be applicable to OTEC due to the depth and location of an OTEC facility's intakes. Power plant intakes tend to be in water less than 100 m deep, close to the benthos, and in the nearshore. In contrast, intakes associated with an offshore OTEC facility are likely to be in deeper water (especially for the cold water intake), farther from shore, and suspended above the benthos. It is possible that an OTEC intake will actually result in less impingement or entrainment due to lower species abundance offshore, however, little data exists for this environment in the Hawaiian region. Although the species abundance may be lower, they may be more sensitive to impact and removal of individuals may result in a greater net impact (e.g., as species density and abundance decreases, each individual becomes more important with respect to reproduction). Impingement and entrainment data needs to be as site-specific as possible, as regional data may not capture potential impacts. This information can be obtained by pelagic surveying methods such as Bongo nets, trawls, and simulated intakes, and should include analysis of a wide range of species, including plankton, larvae, eggs, juveniles, adults, and microplankton. In order to adequately assess the potential impact, data should be collected for a period sufficient to account for seasonal, annual, and inter-annual variability, as well as local, regional, and global current shifts. The data also should try to meet statistical standards for validity. It is probable that data will need to be collected over multiple years, however, this will vary greatly with location, target constituents, and other variables. Operators of the first generation of facilities should be encouraged to collect data for the life of the facility to capture any long-term impacts that may not be immediately observed. Finally, additional information is needed on the sensitivity of species to impacts from entrainment and impingement in order to gain a better understanding of the percent mortality rate, as this is a key input into models evaluating environmental impact.

Benthic Biota

The survey method employed for benthic biota will depend on the depth and type of substrate. In soft-bottom or sandy substrates, coring devices such as box cores, Van Veen grabs, Eckman samplers and multicoring devices are typically used, while with hard-bottom substrates (e.g., rocks, lava, hard sediment) visual inspection is preferred. Often, a combination of remote operated vehicles (ROVs), human occupied vehicles (HOVs), and divers are used, however this may vary with substrate type, depth, location, and safety concerns. In shallow waters, divers can perform a grid analysis of the benthos and manually count species present. For deeper locations, a ROV or AUV equipped with video monitoring is used and a transect analysis is performed to count species present on the benthos. The cost and accuracy of this will vary widely with the number of transects or grids analyzed, resolution, expertise, and duration, and generally starts at $40,000 per dive day. A typical ROV or AUV dive day is able to cover a 1 – 3 km transect of the benthos, depending on the complexity and biological distribution. Image analysis of the video collected during these dives will typically cost an additional $5,000 – $10,000. Due to resolution limitations, only larger organisms usually are able to be detected and identified, typically to the order or family level.

Pelagic Biota

Pelagic biota are typically enumerated using trawls, plankton tows, and Bongo sampling devices. The frequency and duration of sampling is a function of expected and observed species composition, distribution, and abundance (i.e., high diversity or patchy distribution may require more frequent sampling to obtain a representative sample). Surveys in the Hawaiian region typically sample 6 – 12 times annually for 2 – 24 hours at a time. The cost of pelagic surveys will vary with methods used and resolution of identification. The major contributors to cost for pelagic surveys are the cost of sampling (including boat time, personnel and equipment) and analysis. Sampling costs can exceed $10,000 per day, while analysis costs will vary with level of identification required. At the time this document was prepared, the majority of identification efforts used taxonomical methods and visual identification. While these methods are relatively inexpensive, specificity of identification for smaller organisms (i.e., plankton and larvae) is often limited only to the family or genus level. Emerging techniques such as metagenetics and metagenomics have the potential to greatly increase the specificity of identification, however, their application is currently limited by availability and cost.

Marine Mammals and Endangered Species

Many of the key information needs related to the MMPA and the ESA require an accurate account of the presence, abundance, migratory patterns, and distribution of marine mammals and threatened and endangered species (e.g., sea turtles). While it is not necessary to know where every individual is at any given time, the data should provide regulators with enough information to better understand how these species use the area in the location that the OTEC facility would be constructed and operated, and if the OTEC facility's presence would adversely impact their behaviors, abundance, distribution, or presence on a regional or site-specific scale. Additional monitoring and surveillance is likely required over a period of several years to better understand how any given area is used by these species, and can be accomplished through a combination of remote sensing (i.e., autonomous video monitoring) and tracking of tagged individuals, data collected from private and non-profit organizations (e.g., Pacific Whale Foundation), and regular visual surveys.

Models

Accurate models will be crucial to understanding the magnitude and extent of any impact. In turn, accurate physical, chemical, and biological inputs are required to produce high-quality model outputs and will influence the validity and usefulness of the models. Models should include both spatial and temporal components with an annual temporal scale. Conversations with modelers indicate that two discrete, linked models may be necessary. One model would be required to determine global impacts with lower resolution, while the other would model regional impacts with a higher resolution. While both models would require similar inputs, the primary difference is resolution, with a typical global model resolution of approximately 10 km, and a regional model resolution of 10 – 200 m. Global and regional models currently exist, and could likely be adapted to model OTEC intakes and discharges if necessary. The US Department of Energy and State of Hawaii are sponsoring a project on OTEC-specific ocean circulation and biological modeling for the ocean near Oahu. The project is entitled, "Modeling the Physical and Biochemical Influence of Ocean Thermal Energy Conversion Plant Discharges into their Adjacent Waters." NOAA's Geophysical Fluid Dynamics Laboratory maintains a global model to examine climate change which could be adapted to model global impacts due to OTEC. Likewise, an open-source regional model named ROMS (Regional Ocean Modeling System) exists which could be used to model potential impacts on a regional level with higher resolution. The only significant barriers to using these models are adapting them to OTEC, obtaining input data with a high degree of accuracy and selectivity, and devoting manpower to develop, run, and interpret the models. However, it should be noted that discharge analysis using OTEC-specific models has been conducted by several organizations, including a report titled "Preliminary Modeling of OTEC Discharge Plumes" produced by Planning Solutions for Lockheed Martin Maritime Systems and Sensors. Much of the information needs associated with modeling relate to obtaining high quality, location-specific information for parameters that might not be readily available (e.g., plankton, larvae, heavy metal, and nutrient data).

VI. Working With Regulations That Are Not Written With OTEC In Mind

There may be some regulations written for specific industry activities (e.g., cooling water intake structures for onshore power plants) that will be applied to OTEC and its related activities despite significantly different local environments (e.g., offshore OTEC intake structures versus near-shore power plant intake structures). In some cases, these regulations may be unnecessarily conservative because they were intended for a different environment. A good example of this is the approach velocities of intake pipes in the near shore versus deep water. Because the majority of intake pipes are located in the nearshore, appropriate approach velocities are based upon the sensitivity of nearshore species and their ability to escape impingement and entrainment. In open water environments such as where an offshore OTEC facility intake would be situated, these values may be unnecessarily conservative, and higher approach velocities may be possible without a significant increase in impacts. In situations like this, best professional judgment may be allowed, especially if data is available to show that exceeding the regulation's threshold tolerance will not result in significantly higher impacts.

In order to show this, species and location-specific data collected over a sufficient period of time would likely be required with a statistically valid sampling frequency to clearly show that the proposed activity would not result in additional or more detrimental impacts. The frequency, duration, and spatial distribution of data collection will vary widely with location, target species, distribution and abundance, and presence of behavioral or ecological patterns, and as such, a detailed sampling plan is beyond the scope of this document. A collaboration between regulators and biologists familiar with the species and environment in question would be required to develop an appropriate sampling plan.

VII. Conclusion

Throughout the course of conversations with regulators, industry, and academia, it became clear that while there is much data available that may be useful in the analysis of impacts from an OTEC facility, in many cases it is not specific enough or was collected with another purpose in mind and may not hold up to the scrutiny required for certain regulatory authorities.

Fortunately, many of the information needs are relevant to multiple regulations and agencies, and if an organized, coordinated effort is made it may be possible to obtain the necessary information without duplication of efforts and with a reduced cost. The overlying theme that emerged from these conversations was that the location of the facility will be a major driver of the magnitude and extent of any impacts and much of the information needs are associated with site-specific characterization of the presence, abundance, composition, diversity, distribution, and behavior of biota, as well as the impact to water quality from water column disturbances. All data should be collected as close to the designated OTEC facility location as reasonably possible, as small variations may result in significantly different results. The duration and frequency of sampling should vary with the parameter and the expected confidence in the results. However, most experts seemed to agree that a minimum baseline of one year for chemical, physical, biological data is required to answer the questions posed by proposing to construct and operate an OTEC facility. However, how much time constitutes minimum baseline information will greatly vary based on target species, location, and variability in the system. Early discussions with those agencies that have that have a role in permitting an OTEC facility will help determine if the information one plans to collect and analyze is sufficient to meet those agencies' needs in determining impacts and if any established regulatory thresholds are exceeded.

Finally, during the many conversations and discussions that were held, the participants frequently mentioned or provided references to help clarify points they were making. Appendix G gives the citations for most of these references in the hope that they may be of some help in understanding potential environmental impacts, developing research or monitoring protocols, or understanding some information need associated with licensing and permitting an OTEC facility. Be aware that some of these citations have not been independently reviewed for accuracy and are not necessarily peer reviewed.

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Appendix A

Information Needs and Baseline Data Requirements from June, 2010 Workshop

Table 1: Baseline Assessment

Category	Impact	Baseline Data Needed	Minimum duration for Baseline Data	Justification of duration
Fisheries and Corals	**Entrainment**	Larval community surveys to cover all management unit species (MUS); biota density at intake and discharge depth; specific catch and effort information for site (i.e., grids, interviews)	Varies with spawning season. 4-5 locations for more data over 1 year	Inter-year variation can be significant and would require long sampling duration to capture; multiple sampling locations required
	Impingement			
	Physical Damage to Shallow Corals	Community structure of corals, including size and frequency of species. Spatial and temporal survey of species within region.	1 year and after hurricane	
	Physical Damage to Deepwater Corals	Survey of sub-bottom profiling; bathy structure and composition data; optical imagery	1 survey/map is sufficient	
Oceanography	**Oxygen, Temperature, Salinity, and Nutrients**	Climatological data with spatial and temporal coverage of the region where the model anticipates the plume will be located. Sampling over a range of frequencies to capture variability. Intensive sampling at one location	1 – 3 years	Duration will depend upon variability in data; if little variation, shorter duration required
	Trace elements and EPA regulated substances	Need background concentrations of baseline EPA regulated trace elements/regulated substances, OTEC facility construction materials (e.g. Ti, Al), antifouling agents and plasticizers	Quarterly for 1 year	Unlikely to have significant temporal or spatial variability
Marine Mammals and Turtles	**Entrainment/Impingement**	Distribution, abundance and diving depth	1 year assuming normal conditions	
	Migratory pattern shift	Distribution, abundance and movement patterns, satellite tracking data	1 year assuming normal conditions and control sites are adequate	
	Entanglement	Some data from the Hawaii marine debris program, however not the same as entanglement with mooring or transmission lines		
	Behavioral changes	Species diving depths, basic distribution and abundance, "habitat use maps"	1 year adequate as long as sample size is sufficient for statistical analyses	
	Attractant/Repellant	Distribution, abundance and diving depth		
Plankton	**Bacteria**	Spatial and temporal abundance and distribution; fate after entrainment	2 years at multiple locations. If data is variable, increase duration	Need to ensure temporal, seasonal, and spatial variations are captured
	Phytoplankton and Zooplankton		Several samplings in one location	
	Eggs/Larvae			
	Micronekton			

Table 2: Monitoring Strategies

Category	Impact	What should be monitored?	How should this be monitored?	How often?
Fisheries and Corals	**Entrainment**	Water at intakes, fishery catch and effort, status of fishery stocks, control sites, density and type of all MUS, eggs/larvae density and type; effect of light on biota	Net collection and plankton tows; intake flow rate; multiple control sites, fishery catch data and interviews with fishermen; stock assessment; experimental fishing	Increase according to expectation of density of eggs and larvae for different periods of the year; diel 24 hr assessments; life history: monthly; interview fishermen: as needed
	Impingement	Biota on screens, fishery catch and effort, status of fishery stocks, control sites, all MUS. eggs/larvae density and type	Bongo nets; plankton tows; intake flow rate; use of multiple control sites, fishery catch data and interviews with fishermen; stock assessment	
	Physical Damage to Shallow Corals	Community structure and baseline parameters of corals, including size and frequency of species	Diver surveys to evaluate community abundance and composition	Once during baseline and once after construction is complete
	Physical Damage to Deepwater Corals		Submersible, ROV or towed camera surveys along route	
Oceanography	**Oxygen, Temperature, Salinity and Nutrients**	Spatial and temporal monitoring of dissolved oxygen, temperature, salinity and nutrients within the plume and in the vicinity	Appropriate use of combinations of CTD casts; gliders; fixed moorings; monitoring needed at the discharge	Sampling over a range of frequencies to capture variability.
	Trace Elements and EPA regulated substances	Spatial and temporal monitoring of trace metals, EPA regulated substances, and OTEC facility fluids and components (e.g. Ti and Al).	Measurement of concentrations in discharge plume and surrounding area; in accordance with EPA methods	Once a month at discharge; quarterly for receiving waters
Marine Mammals and Turtles	**Entrainment/Impingement**	Distribution, abundance, CWP flow	Acoustic sensors, flow monitoring	Continuous, automatic
	Migratory pattern shift	Migratory pathways (abundance and distribution)	Autonomous acoustic recorder, aerial/visual surveys	Continuous, automatic
	Entanglement	Marine debris in region	Visual survey	Daily at surface, quarterly at depth
	Behavioral changes (i.e., Attractant/Repellant)	Presence, diversity and behavior	acoustics and visual	Acoustics: continuous; visual: 1/season for 4 years
Plankton	**Bacteria**	Fate after entrainment (i.e., live/deceased abundance), community composition, population density	Acoustics to measure density; advanced molecular techniques for composition; three sampling stations surrounding OTEC facility plus control	Dependent on baseline information
	Phytoplankton and Zooplankton			
	Eggs/Larvae			
	Micronekton			

Table 6: Modeling Methods

Category	Impact	What existing models can be used?	Improvements to existing models	New models
Fisheries and Corals	**Entrainment**	Empirical Transport Model (ETM), Adult Equivalent Loss Model (AELM), Fecundity Hindecast (FH)	Addition of life history for species of concern	Include current patterns and intake draw field; comprehensive ecosystem-based model of the area near site
	Impingement	Estimated catch blocks, Fisheries models		
	Physical Damage to Shallow Corals	Use existing cable laying software to optimize route		
Oceanography	**Oxygen, nutrients, temperature, salinity**	EFDC model; HIROMS model input; Ocean observing models; Discharge plume model	Further developed and peer reviewed. Modify to be an assimilative model; incorporate bio-geochemical components; validate by field experiments, including near field current measurements	
	Trace elements	Not necessary/applicable in this situation.	Not applicable/necessary	Not applicable/necessary
Marine Mammals and Turtles	**Behavioral changes**	Acoustic propagation/animal movement models (acoustical integration model (AIM); marine mammal movement and behavior model (3MB); NMFS TurtleWatch	Integrate animal behavior; modification for different species; validation	
Plankton	**Bacteria**	Chlorophyll models from 20yrs hindcast; data set diurnal and seasonality for 4 years off Kahe (1, 5, 15 yrs offshore); use HiROM and existing current models	Fate of organic carbon	
	Micronekton	Models available in University of Hawaii reports		

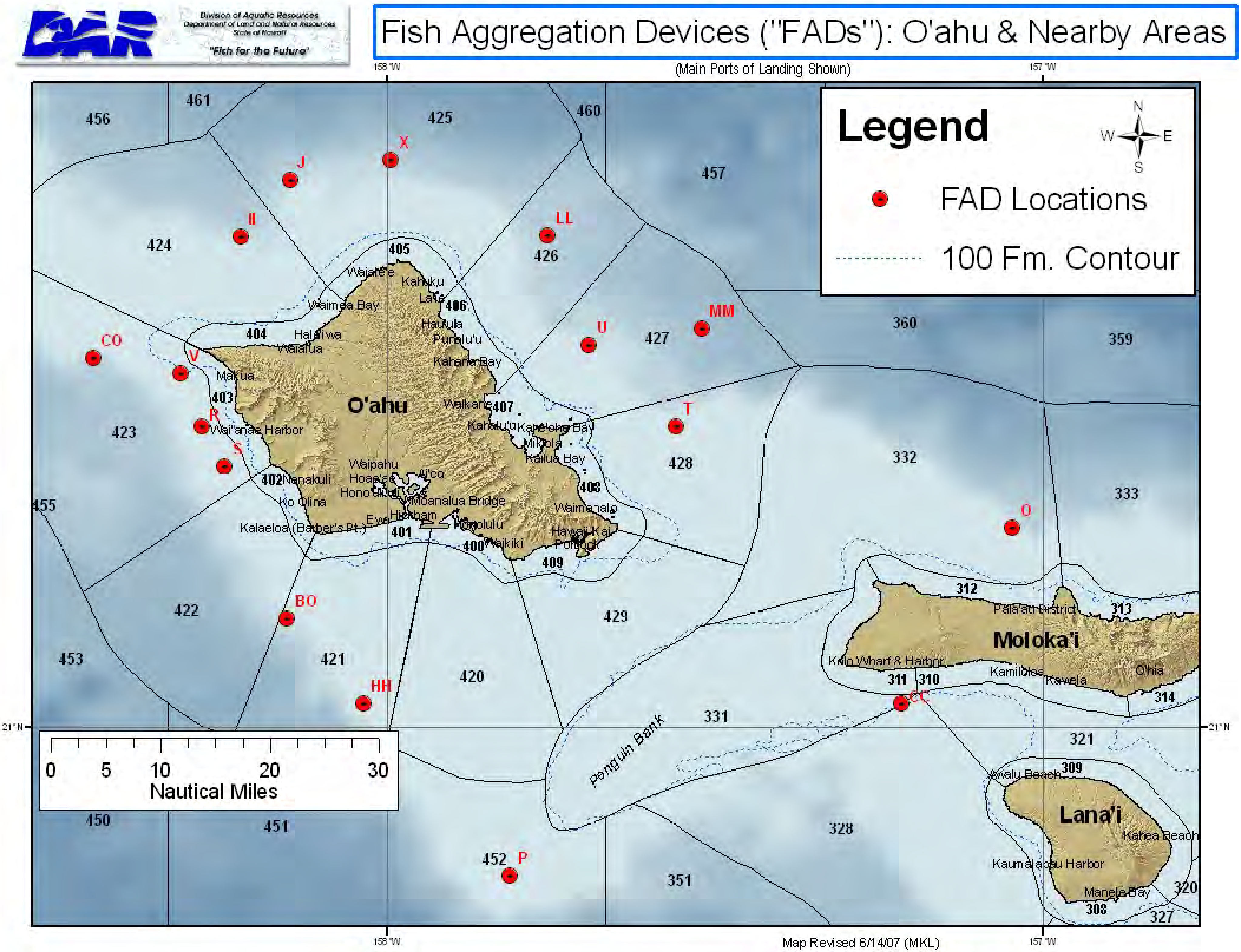
Appendix B

FAD Locations

OAHU FISH AGGREGATING DEVICE SITES
DLNR-Division of Aquatic Resources (6/14/07)

Location	ID	Buoy Coordinates	Landmark	Magnetic Heading to Buoy (Degrees)	nMiles to Buoy (approx)	Approx Depth (fathoms)
Barbers Point	BO	21-09.9N	Pōka'ī Bay Lt.	161.0	16.7	850
		158-09.1W	Honolulu Hbr. Buoy Lt.	233.0	16.4	
			Barbers Pt. Lt.	185.0	8.5	
Ka'ena Point	CO	21-33.7N	Ka'ena Pt. Lt.	259.0	10.0	1010
		158-26.8W	Pōka'ī Bay Lt.	286.1	15.7	
Pearl Harbor	HH	21-02.1N	Diamond Head Lt.	213.0	17.0	647
		158-02.1W	Honolulu Hbr. Buoy Lt.	199.0	16.6	
			Barbers Pt. Lt.	154.0	16.2	
Hale'iwa	II	21-44.8N	Ka'ena Pt. Lt.	5.0	11.1	985
		158-13.3W	Hale'iwa Channel Buoy Lt.	314.0	10.7	
			Kahuku Pt.	267.5	13.4	
Waiale'e	J	21-50.0N	Ka'ena Pt. Lt.	11.0	16.9	960
		158-08.8W	Hale'iwa Channel Buoy Lt.	341.5	13.5	
			Kahuku Pt.	296.5	11.5	
Hau'ula	LL	21-44.9N	Kahuku Pt.	67.7	12.7	1140
		157-45.3W	Lā'ie Pt.	44.0	10.5	
			Pyramid Rock	350.0	17.2	
Mōkapu Point	MM	21-36.4N	Pyramid Rock	45.0	15.0	1355
		157-31.2W	Makapu'u Pt. Lt.	7.5	18.0	
Penguin Bank	P	20-46.4N	Diamond Head Lt.	168.0	28.2	286
		157-48.7W	Honolulu Hbr. Buoy Lt.	160.0	31.0	
			Lā'au Pt. Lt. (Moloka'i)	223.5	34.5	
Mākaha	R	21-27.5N	Lahilahi Pt.	253.5	3.5	460
		158-16.9W	Pōka'ī Bay Lt.	268.0	4.9	
			Ka'ena Pt. Lt.	168.8	7.2	
Pōka'ī Bay	S	21-23.8N	Ka'ena Pt. Lt.	158.8	10.8	460
		158-14.8W	Pōka'ī Bay Lt.	214.0	4.2	
			Barbers Pt.	295.0	9.8	
Makapu'u	T	21-27.5N	Mōkapu Pt.	80.0	9.3	365
		157-33.6W	Makapu'u Pt. Lt.	18.9	10.1	
Kāne'ohe	U	21-34.9N	Mokoli'i Island	47.0	9.5	554
		157-41.5W	Mōkapu Pt. Lt.	0.5	7.7	
Mākua	V	21-32.3N	Ka'ena Pt. Lt.	207.5	3.1	309
		158-18.8W	Lahilahi Pt.	298.0	7.2	
Kahuku	X	21-51.8N	Ka'ena Pt. Lt.	33.0	23.6	945
		157-59.6W	Hale'iwa Channel Buoy Lt.	14.0	18.2	
			Lā'ie Pt.	330.5	13.3	

For current information or to report a missing FAD contact Warren Cortez, Hawaii Institute of Marine Biology, 808-848-2939 or visit website www.hawaii.edu/HIMB/FADS. You can also call the Division of Aquatic Resources at 808-587-0100 (Honolulu).



Division of Aquatic Resources
Department of Land and Natural Resources
State of Hawaii
"Fish for the Future"
Fish Aggregation Devices ("FADs"): O'ahu & Nearby Areas
(Main Ports of Landing Shown)
Legend
FAD Locations
100 Fm. Contour
N
S
E
W
O'ahu
Moloka'i
Lana'i
Penguin Bank
Waimea Bay
Hale'iwa
Waialua
Kahuku
La'ie
Hau'ula
Punalu'u
Kahana Bay
Makua
Wai'anae Harbor
Waipahu
Nanakuli
Ko Olina
Kalaeloa (Barber's Pt.)
Waikane
Kane'ohe Bay
Kailua Bay
Waimanalo
Honolulu
Waikiki
Moanalua Bridge
Ai'ea
Pala'au District
Kolo Wharf & Harbor
Kamiloloa
Kawela
O'hia
Kaumalapau Harbor
Manele Bay
Kahea Beach
CO
V
R
S
II
J
X
LL
U
MM
T
O
BO
HH
CC
P
0
5
10
20
30
Nautical Miles
Map Revised 6/14/07 (MKL)
158°W
157°W
21°N

HAWAII ISLAND FISH AGGREGATING DEVICE SITES

DLNR-Division of Aquatic Resources (6/14/07)

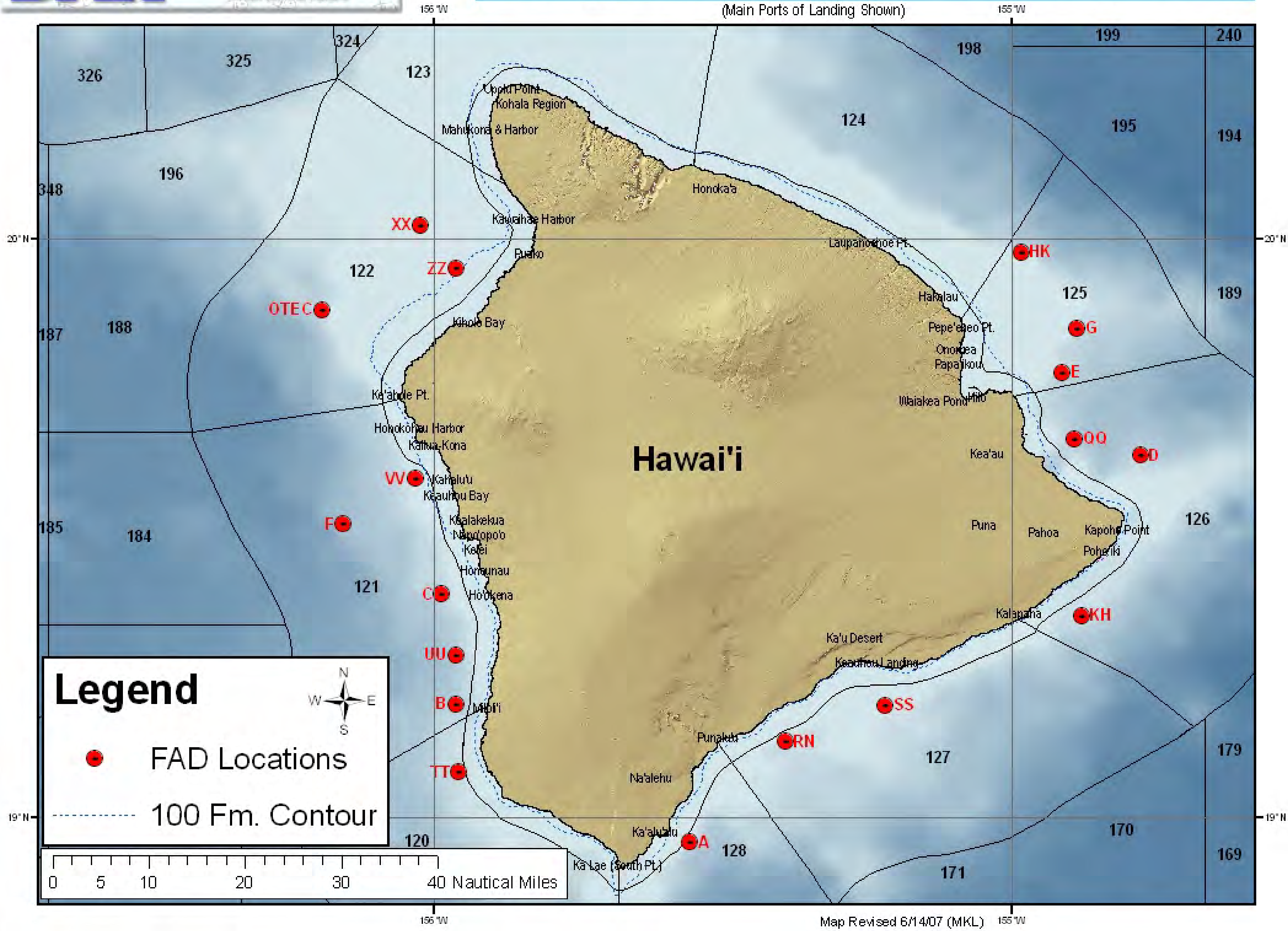
Location	ID	Buoy Coordinates	Landmark	Magnetic Heading to Buoy (Degrees)	nMiles to Buoy (approx)	Approx Depth (fathoms)
Ka Lae (South Pt.)	A	18.57.35N	Ka Lae (South Pt.)	60.0	7.9	700
		155-33.4W	Lae o Kamilo (Kamilo Pt.)	95.0	3.0	
Miloli'i	B	19-11.9N	Miloli'i Lt.	266.9	2.3	850
		155-56.9W	'Au'au Pt.	197.0	7.2	
			Kānewa'a Pt.	331.5	5.1	
Lae Loa (Loa Pt.)	C	19-23.1N	Kealakekua Bay Lt.	202.0	6.0	969
		155-59.2W	Lae Loa (Loa Pt.)	257.0	4.6	
			Miloli'i	330.0	13.2	
Kumukahi	D	19-37.5N	Cape Kumukahi Lighthouse	41.5	11.4	950
		154-46.7W	Kaloli Pt.	79.0	16.7	
			Leleiwi Pt.	96.0	20.7	
Lele'iwi	E	19-46.1N	Cape Kumukahi Lighthouse	324.0	16.5	920
		154-54.8W	Hilo Bay Breakwall Lt.	71.0	8.7	
			Leleiwi Pt.	53.0	4.7	
			Pepe'ekeo Pt. Lt.	110.0	10.3	
Kailua-Kona	F	19-30.4N	Kailua Bay Lt.	230.0	10.1	1592
		156-09.4W	Keauhou Bay Lt.	258.0	11.5	
			Captain Cook	281.0	14.0	
Pepe'ekeo	G	19-50.7N	Cape Kumukahi Lighthouse	338.0	22.5	578
		154-53.3W	Pepe'ekeo Pt. Lt.	68.0	11.5	
			Hilo Bay Breakwall Lt.	41.0	14.1	
			Leleiwi Pt.	26.0	11.5	
Hakalau	HK	19-58.64N	Hilo Bay Breakwall Lt.	4.0	15.0	890
		154-59.0W	Leleiwi Pt.	253.0	14.7	
			Pepe'ekeo Pt. Lt.	25.0	10.0	
Kehena	KH	19-20.9N	Poho'iki Lt.	187.0	7.4	940
		154-52.8W	Hakuma Pt.	90.0	5.4	
Waikoloa	OTEC	19-52.6N	Kawaihae Lt.	234.0	23.0	714
		156-11.6W	Māhukona	212.0	25.0	
			Ke'āhole Pt. Lt.	312.0	11.8	
Maku'u	QQ	19-39.2N	Leleiwi Pt.	127.0	8.3	950
		154-53.5W	Cape Kumukahi Lighthouse	314.0	8.5	
Pālima Pt.	RN	19-07.8N	'Āpua Pt.	225.0	13.7	733
		155-23.5W	Nīnole Cove	77.3	7.0	
'Āpua Pt.	SS	19-11.6N	'Āpua Pt.	188.0	4.1	515
		155-13.1W	Keauhou Bay Lt.	159.1	4.4	
Kānewa'a Pt.	TT	19-04.6N	Miloli'i Lt.	202.1	4.6	700
		155-57.4W	Kaunā Pt.	312.0	6.3	
'Au'au Pt.	UU	19-16.8N	Kealakekua Bay Lt.	164.0	12.2	650
		155-57.1W	Miloli'i Lt.	341.9	5.5	
Kahalu'u	V V	19-35.1N	Kailua Bay Lt.	193.5	3.8	600
		156-01.9W	Keauhou Bay Lt.	274.5	4.0	
Puakō	XX	20-01.4N	Māhukona Lt.	203.5	11.7	345
		156-01.3W	Kawaihae Lt.	255.0	10.8	
			Ke'āhole Pt. Lt.	356.7	17.7	
Waimā Pt.	ZZ	19-56.9N	Hou Pt.	324.0	5.0	214
		155-57.7W	Waimā Pt.	250.0	6.2	
			Kawaihae Lt.	224.0	9.2	

For current information or to report a missing FAD contact Warren Cortez, at the Hawaii Institute of Marine Biology, 808-848-2939 or visit website www.hawaii.edu/HIMB/FADS. You can also call the Division of Aquatic Resources at 808-587-0100 (Honolulu), 808-327-6226 (Kona) or 808-974-6201 (Hilo).

Division of Aquatic Resources
Department of Land and Natural Resources
State of Hawaii
"Fish for the Future"

Fish Aggregation Devices ("FADs"): Hawaii County

(Main Ports of Landing Shown)



Map Revised 6/14/07 (MKL)

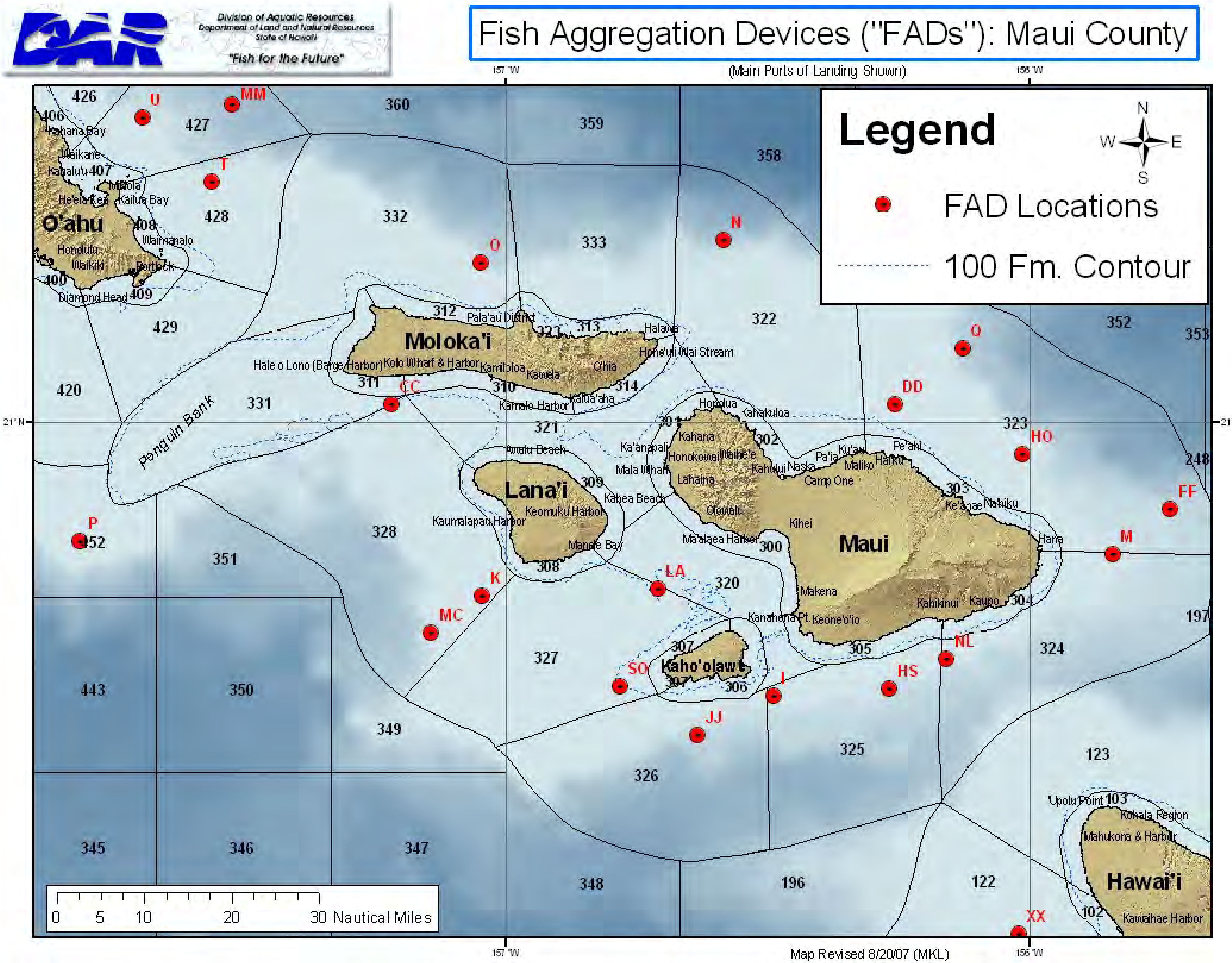
MAUI COUNTY FISH AGGREGATING DEVICE SITES
DLNR-Division of Aquatic Resources (8/20/07)

Location	ID	Buoy Coordinates	Landmark	Magnetic Heading to Buoy (Degrees)	nMiles to Buoy (approx)	Approx Depth (fathoms)
KAHO'OLAWE						
Hālona	I	20-28.7N	Kākā Pt.	110.0	4.0	500
		156-29.3W	Waikahalulu Bay Lt.	88.0	10.5	
			Molokini	164.4	9.3	
Kamōhio	JJ	20-24.2N	Kākā Pt.	203.9	8.0	900
		156-38.0W	Waikahalulu Bay Lt.	149.6	6.6	
Keolaikahiki	SO	20-29.8N	Kealaikahiki Pt.	255.0	5.0	110
		156-46.9W				
LĀNA'I						
Palaoa	K	20-40.1N	Palaoa Pt. Lt.	233.0	5.5	31
		157-02.6W	Ke'anapapa Pt.	165.0	12.6	
Palaoa	MC	20-35.9N	Ke'anapapa Pt.	182.0	18.3	575
		157-08.5W	Palaoa Pt. Lt.	217.0	12.8	
			Mānele Bay Lt.	226.0	16.7	
MAUI						
'Ōpana Pt.	DD	21-02.1N	Nākālele Pt. Lt.	78.0	19.1	203
		156-15.4W	Kahului Bay Lt.	45.5	14.8	
			Pa'uwela Pt. Lt.	25.0	6.5	
			'Ōpiko'ula Pt.	313.0	15.6	
Pukaulua Pt.	FF	20-50.12N	'Ōpiko'ula Pt.	73.0	13.5	828
		155-43.9W	Hāna Bay Lt.	43.0	9.3	
Ho'olawa Pt.	HO	20-56.4N	Pa'uwela Pt. Lt.	71.0	15.2	550
		156-00.8W	Ke'anae Pt.	26.0	9.0	
			Pukaulua Pt.	335.0	11.8	
Hālona	HS	20-29.5N	Apole Pt.	204.0	9.7	650
		156-16.04W	Naka'ohu Pt.	174.0	6.4	
			La Pérouse Lt.	112.5	10.0	
Lahaina	LA	20-41.0N	Lahaina Lt.	178.0	11.5	110
		156-42.5W	McGregor Pt. Lt.	230.0	12.0	
			Molokini	273.8	12.3	
			Mānele Bay Lt. (Lanai)	99.0	10.8	
Hāna Bay	M	20-44.9N	Hāna Bay Lt.	85.0	8.0	700
		155-50.5W				
Nu'u Landing	NL	20-32.9N	Apole Pt.	152.0	4.4	664
		156-09.5W	Naka'ohu Pt.	104.0	7.0	
			Puhilele Pt.	212.0	8.4	
Pa'uwela Pt.	Q	21-08.5N	Nākālele Pt. Lt.	69.0	23.0	907
		156-07.7W	Kahului Bay Lt.	47.0	19.5	
			Pa'uwela Pt. Lt.	30.0	12.0	
			Nānu'alele Pt. Lt.	320.0	23.1	
MOLOKA'I						
Kolo Harbor	CC	21-02.1N	La'au Pt.	120.0	6.7	110
		157-13.0W	Kaunakakai	246.0	10.5	
Cape Hālawa (Lamaloa Head)	N	21-20.9N	Cape Hālawa	21.0	14.3	940
		156-35.0W	Kalaupapa Penn. Lt.	59.0	25.0	
			Nākālele Pt. Lt.	35.1	20.5	
Kalaupapa	O	21-18.2N	Kalaupapa Penn. Lt.	309.0	8.0	600
		157-02.8W	'Īlio Pt.	57.5	11.7	

For current information or to report a missing FAD contact Warren Cortez, Hawaii Institute of Marine Biology, 808-848-2939 or visit website www.hawaii.edu/HIMB/FADS. You can also call the Division of Aquatic Resources at 808-587-0100 (Honolulu), 808-243-5295 (Maui) or 808-553-3778 (Moloka'i).

Fish Aggregation Devices ("FADs"): Maui County

(Main Ports of Landing Shown)



Map Revised 8/20/07 (MKL)

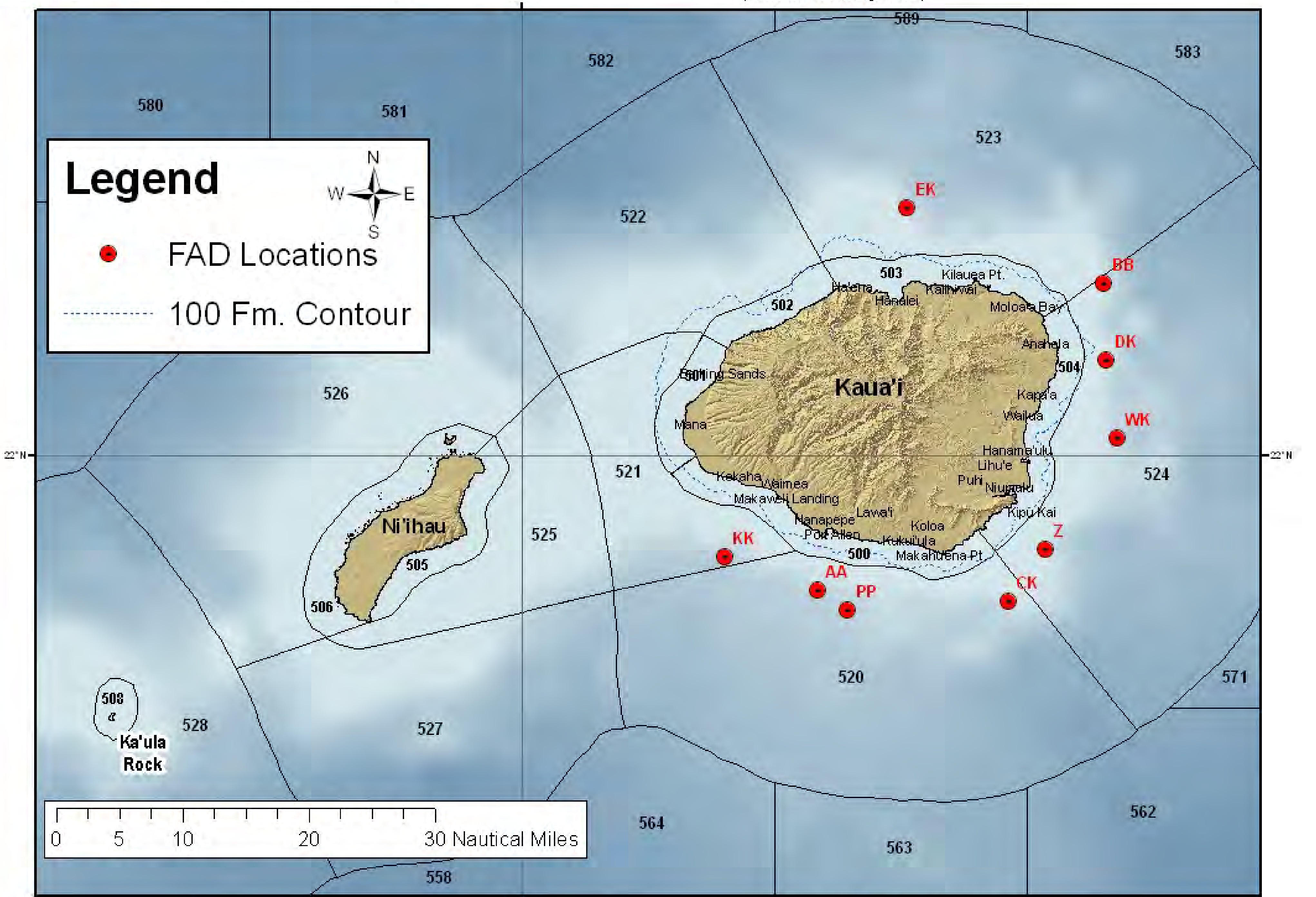
KAUAI FISH AGGREGATING DEVICE SITES
DLNR-Division of Aquatic Resources (6/14/2007)

Location	ID	Buoy Coordinates	Landmark	Magnetic Heading to Buoy (Degrees)	nMiles to Buoy (approx)	Approx Depth (fathoms)
Port Allen	AA	21-49.3N	Kokole Pt.	125.0	13.4	960
		159-36.6W	Hanapēpē Buoy Lt.	170.5	4.7	
			Makahū'ena Pt. Lt.	238.0	9.6	
Moloa'a	BB	22-13.6N	Kīlauea Pt. Lt.	82.0	8.1	1000
		159-13.9W	Kahala Pt. Lt.	15.0	5.1	
Makahū'ena Pt.	CK	21-48.4N	Makahū'ena Pt.	130.0	5.8	825
		159-21.5W	Ninini Pt.	182.0	10.2	
Anahola	DK	22-07.5N	Kepuhi Pt.	119.0	9.0	700
		159-13.7W	Kahala Pt. Lt.	105.0	4.3	
			Kamilo Pt.	19.5	10.8	
Hanalei	EK	22-19.6N	Kīlauea Pt. Lt.	306.0	8.5	1000
		159-29.5W	Kailiu Pt.	27.0	8.5	
			Hanalei Bay	358.0	8.5	
Waimea	KK	21-51.9N	Kokole Pt.	162.0	7.0	960
		159-43.9W	Waimea Channel Marker	207.0	6.0	
			Pū'olo Pt.	245.0	8.0	
Kōloa	PP	21-47.7N	Makahū'ena Pt.	215.0	8.4	950
		159-34.2W	Port Allen Lt.	146.8	7.8	
Waialua	WK	22-01.3N	Kahala Pt. Lt.	142.5	9.0	915
		159-12.9W	Ninini Pt.	50.0	7.5	
Kīpū Kai	Z	21-52.5N	Makahū'ena Pt.	77.0	8.5	892
		159-18.5W	Kawelikoa Pt.	101.0	5.2	
			Ninini Pt.	149.9	5.6	

For current information or to report a missing FAD contact Warren Cortez, Hawaii Institute of Marine Biology, 808-848-2939 or visit website www.hawaii.edu/HIMB/FADS. You can also call the Division of Aquatic Resources at 808-587-0100 (Honolulu) or 808-274-3344 (Kauai).

Fish Aggregation Devices ("FADs"): Kauai County

(Main Ports of Landing Shown)



Map Revised 6/14/07 (MKL)

Division of Aquatic Resources
Department of Land and Natural Resources
State of Hawaii
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Appendix C

NOAA National Marine Fisheries Service current general acoustic thresholds (for non-explosive sounds) for use with the Marine Mammal Protection Act

NOAA National Marine Fisheries Service (NMFS) current (as of 2012) general acoustic thresholds for use with the Marine Mammal Protection Act (MMPA)

For Non-Explosive Sounds		
Criterion	**Criterion Definition**	**Sound Pressure Level (SPL) Threshold**
Level A Harassment (Injury)	Permanent Threshold Shift (PTS) [Any level above that which is known to cause Temporary Threshold Shift (TTS)]	180 dB re 1 microPa-m root mean square (rms) (For Cetaceans) 190 dB re 1 microPa-m (rms) (For Pinnipeds)
Level B Harassment	Behavioral disruption for impulse noises	160 dB re 1 microPa-m (rms)
Level B Harassment	Behavioral disruption for non-impulse or continuous noises	120 dB re 1 microPa-m (rms)

Level A harassment: any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.

Level B harassment: any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

Appendix D

EFH Assessment Worksheet

NOAA FISHERIES
PACIFIC ISLANDS REGION OFFICE (PIRO)
EFH ASSESSMENT WORKSHEET FOR
FEDERAL AGENCIES

(11/2010)

Introduction:

The Magnuson-Stevens Fishery Conservation and Management Act mandates that federal agencies conduct an EFH consultation with NOAA Fisheries regarding any of their actions authorized, funded, or undertaken that may adversely effect essential fish habitat (EFH). An adverse effect means any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts including individual, cumulative, or synergistic consequences of actions.

This worksheet has been designed to assist Federal agencies in determining whether an EFH consultation is necessary, and developing the needed information should a consultation be required. This worksheet will lead you through a series of questions that will provide an initial screening to determine if an EFH consultation is necessary, and help you assemble the needed information for determining the extent of the consultation required. The information provided in this worksheet may also be used to develop the required EFH Assessment.

Consultation through NOAA Fisheries regarding other NOAA-trust resources may also be necessary if a proposed action results in adverse impacts. Part 6 of the worksheet is designed to help assess the effects of the action on other NOAA-trust resources. This helps maintain efficiency in our interagency coordination process. In addition, consultation with PIRO, Protected Resources Division (PRD) may be required if a proposed action impacts marine mammals or threatened and endangered. Staff from the PRD should be contacted regarding potential impacts to marine mammals or threatened and endangered species.

Instructions for Use:

An EFH Assessment must be submitted by a Federal agency to the Habitat Conservation Division (HCD) as part of the EFH consultation. An EFH Assessment must include the following information:
1) A description of the proposed action.
2) An analysis of the potential adverse effects of the action on EFH, and the MUS.
3) The Federal agency conclusions regarding the effects of the action on EFH.
4) Proposed mitigation if applicable.

In some cases, this worksheet can be used as an EFH Assessment. If the Federal agency determines that the action will not cause substantial impacts to EFH, then this worksheet may suffice. If the action may cause substantial adverse effects on EFH, then a more thorough discussion of the action and its impacts in a separate EFH Assessment will be necessary. The completed worksheet should be forwarded to HCD for review.

The information contained on the HCD website will assist you in completing this worksheet. The HCD website contains information regarding: EFH consultation process; EFH Maps; MUS Species Descriptions which provide important ecological information for each species and life stage; and other EFH reference documents.

EFH ASSESSMENT WORKSHEET FOR FEDERAL AGENCIES (11/2010)

PROJECT NAME:____ **DATE:**_____________________

PROJECT NO.:______________________ **LOCATION:**____

PREPARER:____

Step 1. Use the Habitat Conservation Division EFH websites resources and other existing information to generate the list of designated EFH for MUS species for proposed project area. Use the species list as part of the initial screening process to determine if EFH for those species occurs in the vicinity of the proposed action. Attach that list to the worksheet because it will be used in later steps. Make a preliminary determination on the need to conduct an EFH Consultation.

1. INITIAL CONSIDERATIONS

EFH Designations	Yes	No
Is the action located in or adjacent to EFH designated for eggs?		
Is the action located in or adjacent to EFH designated for larvae?		
Is the action located in or adjacent to EFH designated for juveniles?		
Is the action located in or adjacent to EFH designated for adults?		
Is the action located in or adjacent to EFH designated for spawning adults?		
If you answered no to all questions above, then EFH consultation is not required -go to Section 5. If you answered yes to any of the above questions proceed to Section 2 and complete remainder of the worksheet.		

Step 2. In order to assess impacts, it is critical to know the habitat characteristics of the site before the activity is undertaken. Use existing information, to the extent possible, in answering these questions. Please note that, there may be circumstances in which new information must be collected to appropriately characterize the site and assess impacts.

2. SITE CHARACTERISTICS	
Site Characteristics	**Description**
Is the site intertidal, sub-tidal, or water column?	
What are the sediment characteristics?	
Is Habitat Area of Particular Concern (HAPC) designated at or near the site? If so what type, size, characteristics?	
Are there coral reef colonies at or adjacent to project site? If so describe the spatial extent.	
What is typical salinity and temperature regime/range?	
What is the normal frequency of site disturbance, both natural and man-made?	
What is the area of proposed impact (work footprint & far afield)?	

Step 3. This section is used to describe the anticipated impacts from the proposed action on the physical/chemical/biological environment at the project site and areas adjacent to the site that may be affected.

3. DESCRIPTION OF IMPACTS			
Impacts	**Y**	**N**	**Description**
Nature and duration of activity(s)			
Will benthic community be disturbed?			
Will coral reef colonies be impacted?			
Will sediments be altered and/or sedimentation rates change?			
Will turbidity increase?			
Will water depth change?			
Will contaminants be released into sediments or water column?			
Will tidal flow, currents or wave patterns be altered?			
Will ambient salinity or temperature regime change?			
Will water quality be altered?			

Step 4. This section is used to evaluate the consequences of the proposed action on the functions and values of EFH as well as the vulnerability of MUS and their life stages. Identify which species from the EFH species list (generated in Step 1) will be adversely impacted from the action. Assessment of EFH impacts should be based upon the site characteristics identified in Step 2 and the nature of the impacts described within Step 3. Determine the ecological parameters/preferences associated with each species listed and the potential impact to those parameters.

4. EFH ASSESSMENT

Functions and Values	Y	N	Describe habitat type, species and life stages to be adversely impacted
Will functions and values of EFH be impacted for:			
Spawning			
Nursery			
Forage			
Shelter			
Will impacts be temporary or permanent?			
Will compensatory mitigation be used?			

Step 5. This section provides the Federal agency determination on the degree of impact to EFH from the proposed action. The EFH determination also dictates the type of EFH consultation that will be required with NOAA Fisheries.

5. DETERMINATION OF IMPACT

	/	Federal Agency EFH Determination
Overall degree of adverse effects on EFH (not including compensatory mitigation) will be: **(check the appropriate statement)**		**There is no adverse effect on EFH** **EFH Consultation is not required**
		The adverse effect on EFH is not substantial. **This is a request for an abbreviated EFH consultation. This worksheet is being submitted to NMFS to satisfy the EFH Assessment requirement.**
		The adverse effect on EFH is substantial. **This is a request for an expanded EFH consultation. A detailed written EFH assessment will be submitted to NMFS expanding upon the impacts revealed in this worksheet.**

Step 6. Consultation with NOAA Fisheries may also be required if the proposed action results in adverse impacts to other NOAA-trust resources or their habitats. Inquiries regarding potential impacts to marine mammals or threatened/endangered species should be directed to PIRO Protected Resources Division.

6. OTHER NOAA-TRUST RESOURCES IMPACT ASSESSMENT

Species known to occur at site (list others that may apply)	Describe habitat impact type (i.e., physical, chemical, or biological disruption of spawning and/or egg development habitat, juvenile nursery and/or adult feeding or migration habitat).
Bottlenose Dolphin *Tursiops truncatus*	
Green Turtle *Chelonia mydas*	
Hawaiian Monk Seal *Monachus schauinslandi*	
Hawksbill Turtle *Eretmochelys imbricata*	
Humpback Whale *Megaptera novaeangliae*	
Spinner Dolphin *Stenella longirostris*	
Other species:	

Appendix E

Summary of EFH and HAPC for the Hawaiian Archipelago

Summary of EFH and HAPC for the Hawaiian Archipelago and surrounding Pelagic MUS

The charts below are taken from the Pelagic Fishery Ecosystem Plan (Pelagic FEP) and the Hawaii Archipelago Fishery Ecosystem Plan (Hawaii FEP). The charts provide a summary of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) designations for Management Unit Species (MUS). Digital copies of the Pelagic FEP and Hawaii FEP can be found on the Western Pacific Regional Fishery Management Council managed Fishery Management Plans page.

Link: http://www.wpcouncil.org/hot/index.html

Pelagic FEP (pages 189-199)

Table 14. Summary of EFH and HAPC Designations for PMUS

<table>
<tr><th>Species Complex</th><th>EFH</th><th>HAPC</th></tr>
<tr><td>Temperate species
Striped Marlin (Tetrapurus audax), Bluefin Tuna (Thunnus thynnus), Swordfish (Xiphias gladius), Albacore (Thunnus alalunga), Mackerel (Scomber spp.), Bigeye (Thunnus obesus), Pomfret (family Bramidae)</td><td rowspan="4">Eggs and larvae: the (epipelagic zone) water column down to a depth of 200 m (100 fm) from the shoreline to the outer limit of the EEZ

Juvenile/adults: the water column down to a depth of 1,000 m (500 fm) from the shoreline to the outer limit of the EEZ</td><td rowspan="4">The water column from the surface down to a depth of 1,000 m (500 fm) above all seamounts and banks with summits shallower than 2,000 m (1,000 fm) within the EEZ</td></tr>
<tr><td>Tropical species
Yellowfin (Thunnus albacares), Kawakawa (Euthynnus affinis), Skipjack (Katsuwonus pelamis), Frigate and bullet tunas (Auxis thazard, A. rochei), Blue marlin (Makaira nigricans), Slender tunas (Allothunnus fallai), Black marlin (Makaira indica), Dogtooth tuna (Gymnosarda unicolor), Spearfish (Tetrapturus spp.), Sailfish (Istiophorus platypterus), Mahimahi (Coryphaena hippurus, C. equiselas), Ono (Acanthocybium solandri), Opah (Lampris spp.)</td></tr>
<tr><td>Sharks
Pelagic thresher shark (Alapias pelagicus), Bigeye thresher shark (Alopias), Common thresher shark (Alopias vulpinus), Silky shark (Carcharhinus falciformis), Oceanic whitetip shark (Carcharhinus longimanus), Blue shark (Prionace glauca), Shortfin mako shark (Isurus oxyrinchus), Longfin mako shark (Isurus paucus), Salmon shark (Lamna ditropis)</td></tr>
<tr><td>Squid
Neon flying squid (Ommastrephes bartamii), Diamondback squid (Thysanoteuthis rhombus), Purple flying squid (Sthenoteuthis oualaniensis)</td></tr>
</table>

Pelagic FEP **(page 175)**

Table 17. EFH and HAPC for Management Unit Species of the Western Pacific Region
All areas are bounded by the shoreline, and the seaward boundary of the EEZ, unless otherwise indicated.

MUS	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Pelagic	Water column down to 1,000 m	Water column down to 200 m	Water column down to 1,000 m that lies above seamounts and banks
Bottomfish	Water column and bottom habitat down to 400 m	Water column down to 400 m	All escarpments and slopes between 40–280 m and three known areas of juvenile opakapaka habitat
Seamount Groundfish	Water column and bottom from 80 to 600 m, bounded by 29° °–35° ° N and 171 ° E –179° ° W (adults only)	Epipelagic zone (0–200 nm) bounded by 29° °–35° ° N and 171° ° E -179° ° W (includes juveniles)	Not identified
Precious Corals	Keahole, Makapuu, Kaena, Wespac, Brooks, and 180 Fathom gold/red coral beds, and Milolii, S. Kauai, and Auau Channel black coral beds	Not applicable	Makapuu, Wespac, and Brooks Bank beds, and the Auau Channel
Crustaceans	**Lobsters** Bottom habitat from shoreline to a depth of 100 m	Water column down to 150 m	All banks with summits less than 30 m
	Deepwater shrimp The outer reef slopes at depths between 300-700 m	Water column and associated outer reef slopes between 550 and 700 m	No HAPC designated for deepwater shrimp.

Hawaii FEP (pages 189-199)

Table 28: EFH and HAPC for Management Unit Species of the Western Pacific Region
All areas are bounded by the shoreline, and the seaward boundary of the EEZ, unless otherwise indicated.

MUS	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Pelagic	Water column down to 1,000 m	Water column down to 200 m	Water column down to 1,000 m that lies above seamounts and banks
Bottomfish	Water column and bottom habitat down to 400 m	Water column down to 400 m	All escarpments and slopes between 40–280 m and three known areas of juvenile opakapaka habitat
Seamount Groundfish	Water column and bottom from 80 to 600 m, bounded by 29° °–35° ° N and 171 ° E –179° ° W (adults only)	Epipelagic zone (0–200 nm) bounded by 29° °–35° ° N and 171° ° E -179° ° W (includes juveniles)	Not identified
Precious Corals	Keahole, Makapuu, Kaena, Wespac, Brooks, and 180 Fathom gold/red coral beds, and Milolii, S. Kauai, and Auau Channel black coral beds	Not applicable	Makapuu, Wespac, and Brooks Bank beds, and the Auau Channel
Crustaceans	Bottom habitat from shoreline to a depth of 100 m	Water column down to 150 m	All banks within the Northwestern Hawaiian Islands with summits less than 30 m
Coral reef ecosystem	Water column and benthic substrate to a depth of 100 m	Water column and benthic substrate to a depth of 100 m	All MPAs identified in the FMP, all PRIA, many specific areas of coral reef habitat (see Chapter 6)

Hawaii FEP (Pages 164-168)

Table 24: EFH and HAPC Designations for All Western Pacific Archipelagic FEP MUS (Including the Hawaii Archipelago)

	Species Complex	EFH	HAPC
Bottomfish and Seamount Groundfish	**Shallow-water species (0–50 fm):** uku (*Aprion virescens*), thicklip trevally (*Pseudocaranx dentex*), lunartail grouper (*Variola louti*), blacktip grouper (*Epinephelus fasciatus*), ambon emperor (*Lethrinus amboinensis*), redgill emperor (*Lethrinus rubrioperculatus*), giant trevally (*Caranx ignoblis*), black trevally (*Caranx lugubris*), amberjack (*Seriola dumerili*), taape (*Lutjanus kasmira*)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fm). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fm)	All slopes and escarpments between 40–280 m (20 and 140 fm) Three known areas of juvenile opakapaka habitat: two off Oahu and one off Molokai
Bottomfish and Seamount Groundfish	**Deep-water species (50–200 fm):** ehu (*Etelis carbunculus*), onaga (*Etelis coruscans*), opakapaka (*Pristipomoides filamentosus*), yellowtail kalekale (*P. auricilla*), yelloweye opakapaka (*P. flavipinnis*), kalekale (*P. sieboldii*), gindai (*P. zonatus*), hapuupuu (*Epinephelus quernus*), lehi (*Aphareus rutilans*)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fathoms) **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 meters (200 fm)	All slopes and escarpments between 40–280 m (20 and 140 fm) Three known areas of juvenile opakapaka habitat: two off Oahu and one off Molokai
Bottomfish and Seamount Groundfish	**Seamount groundfish species (50–200 fm):** armorhead (*Pseudopentaceros richardsoni*), ratfish/butterfish (*Hyperoglyphe japonica*), alfonsin (*Beryx splendens*)	**Eggs and larvae:** the (epipelagic zone) water column down to a depth of 200 m (100 fm) of all EEZ waters bounded by lattitude 29°–35° **Juvenile/adults:** all EEZ waters and bottom habitat bounded by latitude 29°–35° N and longitude 171° E–179° W between 200 and 600 m (100 and 300 fm)	No HAPC designated for seamount groundfish
Crustaceans	**Spiny and slipper lobster complex:** Hawaiian spiny lobster (*Panulirus marginatus*), spiny lobster (*P. penicillatus, P.* sp.), ridgeback slipper lobster (*Scyllarides haanii*), Chinese slipper lobster (*Parribacus antarticus*) **Kona crab :** Kona crab (*Ranina ranina*)	**Eggs and larvae:** the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m (75 fm) **Juvenile/adults:** all of the bottom habitat from the shoreline to a depth of 100 m (50 fm)	All banks in the NWHI with summits less than or equal to 30 m (15 fathoms) from the surface

	Species Complex	EFH	HAPC
Precious Corals	**Deep-water precious corals (150–750 fm):** Pink coral (*Corallium secundum*), red coral (*C. regale*), pink coral (*C. laauense*), midway deepsea coral (*C.* sp nov.), gold coral (*Gerardia* sp.), gold coral (*Callogorgia gilberti*), gold coral (*Narella* spp.), gold coral (*Calyptrophora* spp.), bamboo coral (*Lepidisis olapa*), bamboo coral (*Acanella* spp.) **Shallow-water precious corals (10-50 fm):** black coral (*Antipathes dichotoma*), black coral (*Antipathis grandis*), black coral (*Antipathes ulex*)	EFH for Precious Corals is confined to six known precious coral beds located off Keahole Point, Makapuu, Kaena Point, Wespac bed, Brooks Bank, and 180 Fathom Bank EFH has also been designated for three beds known for black corals in the Main Hawaiian Islands between Milolii and South Point on the Big Island, the Auau Channel, and the southern border of Kauai	Includes the Makapuu bed, Wespac bed, Brooks Banks bed For Black Corals, the Auau Channel has been identified as a HAPC
Coral Reef Ecosystems	**All Currently Harvested Coral Reef Taxa** **All Potentially Harvested Coral Reef Taxa**	EFH for the Coral Reef Ecosystem MUS includes the water column and all benthic substrate to a depth of 50 fm from the shoreline to the outer limit of the EEZ	Includes all no-take MPAs identified in the CRE-FMP, all Pacific remote islands, as well as numerous existing MPAs, research sites, and coral reef habitats throughout the western Pacific

Table 25: Coral Reef Ecosytem HAPC Designations in the Hawaii Archipelago

	Rarity of Habitat	Ecological Function	Suscep-tibility to Human Impact	Likelihood of Develop-mental Impacts	Existing Protect-ive Status
NWHI					
All substrate 0–10 fm	x	x	x		x
Laysan: All substrate 0–50 fm	x	x			
Midway: All substrate 0–50 fm	x	x	x		x
FFS: All substrate 0–50 fm	x	x	x	x	
Main Hawaiian Islands					
Kaula Rock (entire bank)		x	x		x
Niihau (Lehua Island)	x	x	x		
Kauai (Kaliu Point)		x	x		
Oahu					
Pupukea (MLCD)		x	x	x	x
Shark's Cove (MLCD)			x	x	x
Waikiki (MLCD)			x	x	x
Makapuu Head/Tide Pool Reef Area		x	x	x	
Kaneohe Bay	x	x	x	x	
Kaena Point		x	x		
Kahe Reef		x	x		
Maui					
Molokini	x	x	x	x	x
Olowalo Reef Area		x	x	x	
Honolua-Mokuleia Bay (MLCD)		x	x		x
Ahihiki Kinau Natural Area Reserve	x	x	x		x
Molokai (south shore reefs)		x	x		

	Rarity of Habitat	Ecological Function	Suscep-tibility to Human Impact	Likelihood of Develop-mental Impacts	Existing Protect-ive Status
Lanai					
Halope Bay		x	x		
Manele Bay		x	x	x	
Five Needles		x	x		
Hawaii					
Lapakahi Bay State Park (MLCD)		x	x		x
Pauko Bay and Reef (MLCD)		x	x		x
Kealakekua		x	x		x
Waialea Bay (MLCD)	x	x	x		x
Kawaihae Harbor-Old Kona Airport (MLCD)		x	x		x
Additional Areas					
All Long-term Research Sites		x	x		
All CRAMP sites		x	x		

Appendix F

U.S. Army Corp of Engineers Application Permit

U.S. ARMY CORPS OF ENGINEERS
APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT
(33 CFR 325)

OMB APPROVAL NO. 0710-0003
EXPIRES: 31 AUGUST 2012

Public reporting for this collection of information is estimated to average 11 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters, Executive Services and Communications Directorate, Information Management Division and to the Office of Management and Budget, Paperwork Reduction Project (0710-0003). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. Please DO NOT RETURN your form to either of those addresses. Completed applications must be submitted to the District Engineer having jurisdiction over the location of the proposed activity.

PRIVACY ACT STATEMENT

Authorities: Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Programs of the Corps of Engineers; Final Rule 33 CFR 320-332. Principal Purpose: Information provided on this form will be used in evaluating the application for a permit. Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public and may be made available as part of a public notice as required by Federal law. Submission of requested information is voluntary, however, if information is not provided the permit application cannot be evaluated nor can a permit be issued. One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and/or instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	2. FIELD OFFICE CODE	3. DATE RECEIVED	4. DATE APPLICATION COMPLETE

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME First - Middle - Last - Company - E-mail Address -	8. AUTHORIZED AGENT'S NAME AND TITLE (agent is not required) First - Middle - Last - Company - E-mail Address -
6. APPLICANT'S ADDRESS: Address- City - State - Zip - Country -	9. AGENT'S ADDRESS: Address- City - State - Zip - Country -
7. APPLICANT'S PHONE NOs. w/AREA CODE a. Residence b. Business c. Fax	10. AGENTS PHONE NOs. w/AREA CODE a. Residence b. Business c. Fax

STATEMENT OF AUTHORIZATION

11. I hereby authorize, ______________________ to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

SIGNATURE OF APPLICANT DATE

NAME, LOCATION, AND DESCRIPTION OF PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE (see instructions)

13. NAME OF WATERBODY, IF KNOWN (if applicable)	14. PROJECT STREET ADDRESS (if applicable) Address
15. LOCATION OF PROJECT Latitude: °N Longitude: °W	City - State- Zip-

16. OTHER LOCATION DESCRIPTIONS, IF KNOWN (see instructions)

State Tax Parcel ID Municipality

Section - Township - Range -

17. DIRECTIONS TO THE SITE

18. Nature of Activity (Description of project, include all features)

19. Project Purpose (Describe the reason or purpose of the project, see instructions)

USE BLOCKS 20-23 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards:

Type Amount in Cubic Yards	Type Amount in Cubic Yards	Type Amount in Cubic Yards

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

Acres
or
Linear Feet

23. Description of Avoidance, Minimization, and Compensation (see instructions)

24. Is Any Portion of the Work Already Complete? ☐ Yes ☐ No IF YES, DESCRIBE THE COMPLETED WORK

25. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (if more than can be entered here, please attach a supplemental list).

a. Address-

City - State - Zip -

b. Address-

City - State - Zip -

c. Address-

City - State - Zip -

d. Address-

City - State - Zip -

e. Address-

City - State - Zip -

26. List of Other Certificates or Approvals/Denials received from other Federal, State, or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED

* Would include but is not restricted to zoning, building, and flood plain permits

27. Application is hereby made for permit or permits to authorize the work described in this application. I certify that this information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

SIGNATURE OF APPLICANT DATE SIGNATURE OF AGENT DATE

The Application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than $10,000 or imprisoned not more than five years or both.

Department of the Army Permit Application
SUPPLEMENTAL QUESTIONNAIRE

A complete Department of the Army Permit Application consists of the application form (ENG Form 4345, *http://usace.army.mil/CECW/Documents/cecwo/reg/eng4345a.pdf*), drawings and environmental information necessary to determine a project's probable impact on the public interest (33 CFR Part 325.1 (d)(1) and Part 325.3(a)). Based on our experience, the environmental information necessary to make the public interest determination is often inadequate when only the ENG Form 4345 form is submitted by applicants. Project managers must then request additional information from applicants, resulting in delays in project evaluation. In order to provide more efficient processing of your application, this questionnaire has been developed to supplement the information required in ENG Form 4345 and to simplify your submittal of environmental assessment information.

A. LOCATION (supplement to Blocks 15-16 of ENG Form 4345):

1. Please provide the Tax Map Key number(s) for the project site:_________________
2. Please provide the Latitude _____________ and Longitude___________________.
3. Please provide the watershed in which work is proposed:______________________

B. PROPOSED ACTION (supplement to Block 18 of ENG Form 4345)

1. Please provide a detailed description of the scope of work, especially those activities that may adversely impact the aquatic environment, including the following pertinent information:
   a. Construction method(s) highlighting those methods requiring in-water work
   b. Machinery/equipment necessary to complete construction
   c. Staging/Access requirements
   d. Construction sequence
   e. Construction scheduling (begin & end dates)
   f. Location of stockpiling of material. (Be advised, stockpiling of materials in waters of the U.S. is discouraged. If unavoidable, stockpiling of materials in waters of the U.S. will require prior authorization from this office as it constitutes a temporary discharge of fill material.)
2. Please provide the location of borrow and upland disposal sites for construction materials and any excess materials not utilized to complete the project
3. Please provide a description of Best Management Practices i.e., silt fence/curtain, sheet pile, sandbags, etc., proposed for implementation throughout the project site as a measure to prevent degradation of the aquatic environment. Include a diagram showing placement of BMPs relative to the project site with the

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C. DISCHARGE OF DREDGED AND/OR FILL MATERIAL (supplement to Blocks 20-22 of ENG Form 4345).

1. State the source of the dredged or fill material.*
2. State the method of discharge. Provide type of equipment/machinery required.
3. Indicate the location of the discharge within the project site. This is best accomplished through a plan view drawing of the site that shows the footprint of the filled area (discharge). A cross-sectional view with existing and proposed contours (elevations) also provides necessary information on the scope of proposed work.** The cross-sectional view should clearly demarcate either the Mean High Water Mark or the Mean Higher High Water Mark/High Tide Line for tidal waters or the Ordinary High Water Mark for non-tidal waters. Definitions of these limits of jurisdiction are available at, *http://gpo.gov/fdsys/pkg/CFR-2011-title33-vol3/pdf/CFR-2011-title33-vol3-part328.pdf*. Be advised, the Corps has sole authority to assert jurisdiction over a water body.
4. What types of structures or facilities would be constructed on the fill area? (Show on drawings their dimensions, layout, etc.)

*Note that Blocks 21 and 22 of ENG Form 4345 require both the volume (usually given in cubic yards) *and* surface area (square feet, acres, etc.) of fill.
**Please submit any drawings on 8 ½" x 11" paper.

D. DREDGING PROJECTS

1. Please provide plans showing the dredging footprint within the project site. Include cross-sectional views depicting the existing and proposed contours. Also include a location/vicinity map and plan view (if appropriate) of the area(s) where dredge spoil will be stockpiled, processed, and disposed.
2. What is the type and composition of the material to be dredged?
3. How much time will be required to complete the dredging (construction window)? Will the dredging project be accomplished in phases? If so, please describe. Is maintenance dredging proposed, and, if so, what is the timeframe of the dredging cycle?
4. How much material will be dredged?
   a. Volume:
   b. Surface area:
5. State what dredging method(s) will be used, and indicate why that method(s) is proposed.
6. Where will the dredged material be de-watered?
7. Do you plan to transport dredged material for the purpose of disposing it in the ocean?
   a. Where do you plan to dispose of the dredged material?
   b. How much material (volume) will be disposed?
   c. What is the type and composition of the material?
   d. How long do you plan to dispose of the material?
   e. How will you transport the material to the ocean dump site?

E. STRUCTURES IN NAVIGABLE WATERS

Be advised that the Corps considers and as such, regulates, some BMPs as structures.

1. What specific structures will be constructed (type and size) and with what machinery and/or equipment?
2. Is in-water work required? If yes, describe.
3. What will the structures be used for?
4. Describe support and/or anchoring systems, where applicable.

F. EXISTING ENVIRONMENT

Please submit photos when possible!

1. PHYSICAL ENVIRONMENT

   a. How would you generally describe the project area and surrounding area?
      (1) Level of development:
      (2) Existing land and water use:
      (3) Other general features:
   b. What kind of substrate (i.e., rock, rubble, soil, etc.) is found at the project site?
   c. What is the range of water levels which occur (during normal tides and during storm of flood periods)?
   d. Describe the water currents and water circulation patterns at the project site.
   e. What is the salinity (salt, brackish, or fresh) of the water at the project site?
   f. What is the quality of the water at the project site? For instance, in Hawaii a stream may be listed as a 303(d) Impaired Water by the State Department of Health (DOH).
   g. Is this area a groundwater recharge area?
   h. What is the history or possibility of contaminants/pollutants in the substrate (soil) at the source of fill material?
   i. Have there been problems with erosion at or near the project site?
   j. Is the project site located in or near a drainage way or flood plain? If yes, describe.
   k. What is the quality of the air at the project site? Will the proposed project have an adverse, or insignificant, effect on air quality at the site? Will the impacts to air quality be temporary or permanent?
   l. What are the existing noise levels at the project site? Will the proposed project have an adverse, or insignificant, effect on noise levels at the site? Will the impacts to noise levels be temporary or permanent?

2. BIOLOGICAL ENVIRONMENT (attach biological survey reports if available)

   a. Biological survey reports from a qualified environmental professional can provide much of the necessary information for evaluating a project's potential to impact aquatic resources. If not available, a general characterization of the plants and animals at the site should be provided.

b. Please list any plants and animals found within or near the project area that are listed as threatened or endangered under the Endangered Species Act of 1973. *http://fws.gov/pacificislands/teslist.html*.

3. SPECIAL AQUATIC SITES

Is the project site located at or adjacent to any of the following areas? (Show on vicinity drawings the extent of the special sites, if they are present, clearly labeling each type.) Are any of these sites proposed for impact as a result of this project?

Special Aquatic Site:	Dredge Site	Discharge Site	Construction Site
Wetlands (swamps, marshes, bogs)			
Mudflats			
Vegetated Shallows/Seagrass beds			
Coral Reefs			
Riffle & Pool Complexes (streams)			

4. PUBLIC INTEREST REVIEW

a. What is the existing land use zoning for the site and its vicinity?
b. What is on the land (including dwellings, facilities, etc.) at or near the site?
c. Do any of the following occur at or near the site?

Characteristic	Dredge Site	Discharge Site	Construction Site
Local fresh water supply			
Fishing (recreational, commercial)			
Scenic areas			
Agriculture (type)			
Aquaculture (type)			
Historic sites (type)			
Other cultural resources (type)			
Parks, monuments, preserves, etc.			
Other (type)			

G. ENVIRONMENTAL EFFECTS OF PROPOSED PROJECT

Briefly describe the environmental effects which may be expected as a result of your proposal, referring to the items listed in Section F above. Please don't answer "none"..all projects have some effects.

1. Physical environment (effects on land, water, air, soil, etc.)
2. Biological environment (effects on plants, animals, and habitats)
3. Special aquatic sites (effects on wetlands, coral reefs, etc.)
4. Human use (how existing human activities would be affected)
5. Historical/Cultural resources. The Corps must evaluate permit applications pursuant to Section 106 of the National Historic Preservation Act. In many cases, the Corps must coordinate its determination of a project's potential to adversely affect historic sites with the

local Historic Preservation Officer. The Corps encourages applicants to contact their local Historic Preservation Officer as soon as possible in the project planning process to address any issues relevant to Section 106.

   a. The State of Hawaii's Historic Preservation Office can be found at, *http://hawaii.gov/dlnr/hpd/hpgreeting.htm*.
   b. The Guam Historic Preservation Office can be found at, *http://historicguam.org/index.htm*

6. Indirect impacts (will the project eventually encourage or discourage residential, agricultural, urban, industrial or resort activities?)
7. Cumulative impacts (Is this project similar in purpose, characteristics, and location compared to previous projects? Will this project lead to or be followed by similar projects? Are there other activities in the area similar to your proposed activity?)
8. Other impacts

ALTERNATIVES to Activities Conducted in Aquatic Areas

1. List other sites which may be suitable for this proposal and indicate whether these are or could become available to you. If none, explain why.
2. If your project involves the discharge of fill material to convert wetlands or submerged areas to upland (dry land), list any existing upland sites which are or could become available to you. If none, clearly explain why.
3. List other methods or project designs which would fulfill the basic purpose of your proposal. Which ones are reasonable for you? If none, explain why.
4. If your permit application were denied, what other alternatives would you have?
5. What can you do to avoid or minimize adverse effects of your proposal on the environment? For instance, a project might be relocated to a non-aquatic site, the footprint of fill or dredging can be minimized to only that which is necessary to achieve project purpose, a project footprint might be moved within a site to avoid aquatic resources, and/or different construction methods that do not require in-water work could be used.

Please see the Honolulu District's Compensatory Mitigation and Monitoring Guidelines on-line on our web site (*http://poh.usace.army.mil/regulatory.asp*), or contact the Corps office listed below to request a hard copy. Thank you for your cooperation in this manner. If you have any questions, please contact the Corps of Engineers, Regulatory Branch at (808) 438-9258 in Honolulu or at (671) 339-2108 in Guam.

Appendix G

Further Reading

Additional Reading:

In the course of the discussions several documents were mentioned or reviewed that may be helpful in developing monitoring protocols, understanding potential impacts, and evaluating similar projects. The majority of these citations were provided by conversation participants and have not been independently reviewed for accuracy, and are not necessarily peer reviewed.

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