ENVIRONMENTAL SENSITIVITY INDEX: Guam and the Commonwealth of the Northern Mariana Islands (CNMI)

INTRODUCTION

Environmental Sensitivity Index (ESI) maps have been developed for the marine and coastal areas of Guam and the Commonwealth of the Northern Mariana Islands (CNMI). The ESI maps are a compilation of information from three main categories: shoreline habitats, sensitive biological resources, and human-use resources.

The individual map pages in this atlas are divided according to the index (see title page). Black and white scanned images of U.S. Geological Survey (USGS) topographic quadrangles are used as a backdrop for each map page in the atlas. The name on the bottom right of each map page refers to the island featured.

SHORELINE HABITAT MAPPING

The intertidal shoreline habitats were mapped during overflights and ground surveys conducted by an experienced coastal geologist in August 2004. The overflights were conducted at elevations of 400-600 feet and slow air speed. During this work, the ESI ranking of observed intertidal shoreline habitats was denoted directly onto the shoreline depicted on 1:24,000-scale USGS topographic maps. Where appropriate, revisions to the existing shoreline were made and, where necessary, multiple habitats were described for each shoreline segment.

To determine the sensitivity of a particular intertidal shoreline habitat, the following factors are integrated:

1) Shoreline type (substrate, grain size, tidal elevation, origin)
2) Exposure to wave and tidal energy
3) Biological productivity and sensitivity
4) Ease of cleanup

Prediction of the behavior and persistence of oil in intertidal habitats is based on an understanding of the dynamics of the coastal environments, not just the substrate type and grain size. The intensity of energy expended upon a shoreline by wave action, tidal currents, and river currents directly affects the persistence of stranded oil. The need for shoreline cleanup activities is determined, in part, by the slowness of natural processes in removal of oil stranded on the shoreline. The potential for biological injury and ease of cleanup of spilled oil are also important factors in the ESI ranking. Generally speaking, areas exposed to high levels of physical energy, such as wave action and tidal currents, and low biological activity rank low on the scale, whereas sheltered areas with associated high biological activity have the highest ranking. The list below includes the shoreline habitats delineated for Guam and CNMI, presented in order of increasing sensitivity to spilled oil.

1A) Exposed Rocky Shores
1B) Exposed, Solid Man-made Structures
2A) Exposed Wave-cut Platforms
3A) Fine- to Medium-grained Sand Beaches
5) Mixed Sand and Gravel Beaches
6A) Gravel Beaches
6B) Riprap
8A) Sheltered Rocky Shores
8B) Sheltered, Solid Man-made Structures
8C) Sheltered Riprap
9B) Vegetated Low Banks
10A) Salt- and Brackish-water Marshes
10B) Freshwater Marshes
10C) Swamp
10D) Scrub-Shrub Wetlands
10D) Mangroves

Each of the shoreline habitats are described on pages 10-15 in terms of their physical description, predicted oil behavior, and response considerations.

In addition to the field mapped ESI shoreline habitats, the wetland habitat types derived from the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory and CNMI Coastal Resource Management (CRM) Office Planning Division's 2004 wetlands coverages were plotted on the maps. These polygonal wetland types were not checked or edited extensively as a part of this project. Salt-and brackish-water marshes, swamps, scrub-shrub wetlands, and freshwater marshes did not occur in the mapped intertidal zone and, therefore, were not validated as part of the ESI shoreline classification.

Major Data Sources Used: Wetlands

CNMI Coastal Resource Management (CRM) Office Planning Division. 2004. Digitized 2004 updated Saipan and Tinian wetland and Saipan constructed wetland inventories. CNMI CRM Office, San Jose, Saipan, MP, digital vector data.

Stinson, D.W. 1993. Commonwealth of the Northern Mariana Islands. *In* Scott, D. A. (ed.), A Directory of Wetlands in Oceania. IWRB, Slimbridge, U.K. and AWB, Kuala Lumpur, Malaysia.

U.S. Fish and Wildlife Service (USFWS). 2005. National Wetlands Inventory Wetlands Digital Data: Guam. USFWS, Portland, OR, digital vector data.

Wiles, G.J. and M.W. Ritter. 1993. Guam. *In* Scott, D. A. (ed.), A Directory of Wetlands in Oceania. IWRB, Slimbridge, U.K. and AWB, Kuala Lumpur, Malaysia.

SENSITIVE BIOLOGICAL RESOURCES

Biological and human-use information presented in this atlas was collected, compiled, and reviewed with the assistance of biologists and resource managers from the following agencies:

- National Oceanic and Atmospheric Administration (NOAA), Honolulu, HI and Silver Spring, MD offices
- U.S. Fish and Wildlife Service (USFWS)
- National Park Service (NPS)
- U.S. Geological Survey (USGS)
- Guam Department of Agriculture Division of Aquatic and Wildlife Resources (DAWR)
- Gov. Guam Bureau of Statistics and Plans Coastal Management Program (CMP)
- Gov. Guam Department of Public Works
- Gov. Guam Department of Parks and Recreation
- Guam Historic Resources Division
- Guam Environmental Protection Agency (GEPA)
- The Nature Conservancy (TNC)
- University of Guam
- Western Pacific Fisheries Management Council (WPFMC)
- Guam Fishermen's Co-op
- CNMI Department of Natural Resources Division of Fish and Wildlife (DFW)
- CNMI Department of Environmental Quality (DEQ)
- CNMI Coastal Resources Management (CRM) Office
- CNMI Division of Historic Preservation
- CNMI Commonwealth Development Authority (CDA)
- University of Hawaii

The above agencies provided the majority of information included in the atlas. Other participating individuals and agencies will be cited throughout the atlas and in the metadata accompanying the digital product.

KEY FEATURES ON ESI MAPS

1) Animal and plant species that are at risk during oil spills and/or spill response are represented on the maps by polygons and points.

2) Species have been divided into groups and subgroups based on their behavior, morphology, taxonomic classification, and spill vulnerability and sensitivity. The icons below reflect this grouping scheme.

BIRDS
- Gulls and Terns
- Passerine Birds
- Pelagic Birds
- Shorebirds
- Wading Birds
- Waterfowl

MARINE MAMMALS
- Dolphins

REPTILES
- Turtles

FISH
- Fish

INVERTEBRATES
- Bivalves
- Cephalopods
- Crabs / Invertebrates
- Echinoderms
- Gastropods
- Lobsters

HABITATS
- Plants

3) Polygons and points are color-coded based on the species composition of each feature, as shown below:

ELEMENT	COLOR AND HATCH PATTERN

Birds	Green diagonal hatch
Fish	Blue diagonal hatch
Invertebrates	Orange diagonal hatch
Marine mammals	Brown horizontal hatch
Reptiles	Red diagonal hatch
Benthic habitats	Multiple colors and patterns (see legend)
Plants	Purple horizontal hatch
Multi-element group	Black diagonal hatch

4) There is a Resources at Risk number (RAR#) located under each icon or group of icons. The RAR# references a table on the reverse side of the map with a complete list of species associated with the feature. No icons are associated with benthic marine habitats plotted on the maps. Please consult the legend for the colors and patterns associated with these features.

5) Also associated with each species in the table is the territorial (listed under 'state status') and federal protected status as threatened (T), endangered (E), or species of special concern (C), as well as concentration, seasonality, and life-history information.

6) For species that are found throughout general geographical areas or habitat types on certain maps, displaying the polygons for these species would cover large areas or would obscure the shoreline and biological features, making the maps very difficult to read. In these cases, a small box will be shown on the maps which states that they are "Present in ..." (e.g., "Present in Apra Harbor" or "Present nearshore"). The geographical extent of these polygons are depicted in the digital data available on the CD-ROM.

KEY RESOURCE EXPERTS

As stated above, a large number of local agencies and resource experts provided the information on which the data in this atlas is based. Because of the nature of their work in diverse ecological communities on islands, many of the researchers and resource managers have a breadth of knowledge on a variety species groups, habitat types, and use of these resources by island residents. In the event of an oil or hazardous material spill, please contact the local agencies and resource experts listed in Tables 1 and 2 for the most current information on resources of concern. There are additional experts that are not listed below, so it is important to inquire about other individuals within or outside of the agencies contacted that may have local knowledge and other critical information during a spill event.

TABLE 1. Biological and Human-Use Resource Experts: Guam

Name	Agency	Location	Phone	Resources
Gerry Davis	NOAA	Honolulu, HI	808/973-2935x283	Fish, birds, sea turtles, marine mammals, habitats, human-use
Dave Burdick	NOAA	Guam	671/472-4201/2/3	Benthic habitats, GIS
Tim Battista	NOAA	Silver Spring, MD	301/713-3028x121	Digital benthic habitat data: Guam and CNMI
Main Admin.	DAWR	Guam	671-735-3955	General information
Jay Gutierrez	DAWR	Guam	671/735-4036	Fisheries supervisor
Brent Tibbatts	DAWR	Guam	671/735-3987	Fish, inverts, sea turtles, birds, habitats
Tom Flores	DAWR	Guam	671/735-4033	Pelagic and bottomfish
Valerie Porter	DAWR	Guam	671/735-4032	Coral reefs, fish, birds, turtles, GIS
Tino Aguon	DAWR	Guam	671/735-3955/79	Marine birds
Nathaniel Martin	DAWR	Guam	671-735-3986	Local fisheries, FADs, SWMs
Trina Leberer	TNC	Guam	671/320-4267	Fish, coral reefs, sea turtles, habitats, human-use
Vangie Lujan	CMP	Guam	671/472-4201/2/3	General knowledge, GIS
Vic Torres	CMP	Guam	671/472-4201/2/3	GIS
Vic April	HPO	Guam	671/475-6294/5	Archaeological and historic sites
Bill Hernandez	HPO	Guam	671/475-6294/5	Archaeological and historic sites
Lynda Aguon	HPO	Guam	671/475-6294/5	Archaeological and historic sites
Jose Uloa Garrido	HPO	Guam	671/475-6294/5	Archaeological and historic sites
Mike Gawel	GEPA	Guam	671/475-1662/3	Fish, inverts, habitats, human-use
Danzel Narcis	GEPA	Guam	671/475-1658/9	Fish, birds, habitats, human-use
Jesse Cruz	GEPA	Guam	671/475-1653	General knowledge
Dwayne Minton	NPS	Guam	671/472-7240	War in the Pacific NHP resources (marine and terrestrial Guam/CNMI)
Gerry Deutscher	USFWS	Guam	671/355-5096/7	Guam NWR
Dana Lujan	USAF	Guam	671/366-3049	Andersen AFB
Barry Smith	U. of Guam	Guam	671/735-2190	Benthic/ intertidal invertebrates, reef fish
Susanne de Wilkins	U. of Guam	Guam	671/735-2181	Seagrass, algae
Bob Richmond	U. of Hawaii	Honolulu, HI	808/531-7331	Fish, benthic habitats, human-use
Chuck Birkeland	U. of Hawaii	Honolulu, HI	808/956-4238	Fish, benthic habitats
John Calvo	WPFMC	Guam	671/649-3150	Fish, inverts, human-use
Manny Duenas	Guam Fisher-men's Co-op	Guam	671/472-6323	Fish, inverts, human-use

TABLE 2. Biological and Human-Use Resource Experts: CNMI

Name	Agency	Location	Phone	Resources
Peter Houk	DEQ	Saipan	670/664-8504/0	Benthic habitats, reef fish and inverts, marine mammals, human-use
Mike Trianni	DFW	Saipan	670/664-6018	Fish, inverts, marine mammals
Mike Tenorio	DFW	Saipan	670/664-6019	Fisheries, sea turtles
Shelly Kremer	DFW	Saipan	670/664-6013	Marine birds
Tina de Cruz	Former DFW	New Britain, CT	tinadecruz@comcast.net	Marine birds, general knowledge
Laura Williams	DFW	Saipan	670/664-6005	Marine birds
Stan Tissican	Former DFW	Rota	671/532-0206	Birds, marine mammals, sea turtles, human-use
Henry Cabrera	DFW	Tinian	670/433-9298/3	General knowledge
Edwin Hofschneider	CDA	Tinian	670/433-0494	General knowledge
Steve Tilley	CRM	Saipan	670/664-8307	Deputy Director of CRM
Erica Cochrane	CRM	Saipan	670/664-8303	Benthic habitats, reef fish, human-use
Ken Cochrane	CRM	Saipan	670/674-8303	GIS data manager
Kathy Yuknavage	CRM	Saipan	670/664-8300/11	Wetlands/GIS
Richard Brooks	CRM	Saipan	670/664-8316	Coastal coordinator
Genevieve Cabrera	DHP	Saipan	670/664-2120/1	Archaeological and historic

				sites
John Mark Joseph	DHP	Saipan	670/64-2120	Archaeological and historic sites
Curt Kessler	USFWS	Honolulu	808/792-7465	Pelagic birds
Nathan Johnson	USGS	Formerly of CNMI	njohnson@usgs.gov	Pelagic birds

MARINE MAMMALS

Marine mammals depicted in the Guam and CNMI atlas include selected species of dolphins. Marine mammal concentration areas were mapped based on interviews with local resource experts from NOAA, CNMI DFW, NPS, and CNMI DEQ. We did not attempt to map all species potentially present in coastal and marine waters around Guam and CNMI, but rather we focused on known concentration areas and records of frequent, recent sightings. Most whales occur at least 3 miles offshore and are migratory, therefore mapping specific nearshore concentration areas was not possible. See Table 3 for a comprehensive list of marine mammal species potentially present in coastal and marine waters.

TABLE 3. Marine mammals sighted in coastal and marine waters around Guam and CNMI.

Common Name	Federal T/E Status*	Sightings
Spinner dolphin		Frequent year-round
Pantropical spotted dolphin		Frequent year-round
Bottlenose dolphin		Frequent year-round
Short-beaked common dolphin		Rare, year-round
Risso's dolphin		Rare, year-round
Rough-toothed dolphin		Confirmed sightings
Short-finned pilot whale		Common during winter migration (Oct.-Jan.)
Melon-headed whale		Groups observed off of Rota; individuals sighted infrequently in winter around Guam
Killer whale		Extremely rare
Pygmy sperm whale		More seen in late summer, mostly individuals
Dwarf sperm whale		Individuals seen in summer
Long-finned pilot whale		Common in winter
Sperm whale	Endangered	Small groups common June-Aug.
Blue whale	Endangered	Confirmed sightings in summer
Humpback whale	Endangered	Confirmed sightings Jan.-Apr. around Saipan and Tinian
Pygmy killer whale		Common in summer
Cuvier's beaked whale		Extremely rare
False killer whale		Extremely rare
Bryde's whale		Confirmed sightings
Sei whale	Endangered	Unconfirmed

* All marine mammals in territory waters are protected under the Marine Mammal Protection Act and are considered to be CNMI "Species of Special Concern".

Major Data Sources Used: Marine Mammals

NOAA. 2005. Cetacean sightings database: Guam and CNMI. NOAA, Honolulu, HI, digital table.

BIRDS

Birds mapped in this atlas include pelagic birds, shorebirds, wading birds, waterfowl, gulls, terns, and select passerine birds. Species that are federally and territorially listed and coastal nesting and roosting locations were specifically emphasized. In addition, pelagic birds (e.g. shearwaters, terns, noddies) may be feeding and/or rafting nearshore and offshore seasonally. Birds using on-water habitats were typically not mapped because of broad use of the area. Please contact the appropriate resource experts (Tables 1 and 2) for current information on potential on-water concentration areas during a spill event.

While a few bird species are federally/territorially listed threatened or endangered, a larger group is protected under the Migratory Bird Species Act, and are considered to be CNMI "Species of Special Concern". Protected species include: marine birds (albatrosses, shearwaters, boobies, frigatebirds, tropicbirds, terns, noddies), wetland birds (egrets, herons, bitterns, pintails, scaup, ducks, mallards, teals), and shorebirds (plovers, tattlers, godwits, sandpipers, snipe, stilts, turnstones).

Bird concentration areas were based primarily on information gathered at interviews with local resource experts from NOAA, Guam DAWR, CNMI DFW, GEPA, and USGS. Additional sources are listed below and are included in the metadata accompanying the CD-ROM.

Major Data Sources Used: Birds

CNMI Coastal Resource Management (CRM) Office. 1999. Environmental Sensitivity Index – Mariana Islands – Vol. 2 – Saipan, Tinian, Rota, Aguijan. CNMI CRM, digital vector data.

Guam Division of Aquatic and Wildlife Resources (DAWR). 2005. Natural resources at risk – monthly seasonality for marine species on Guam. Guam DAWR, Mangilao, Guam, 3 pp.

Takano, L.L. 2003. Seasonal movement, home range, and abundance of the Mariana common moorhen (*Gallinula chloropus guami*) on Guam and the Northern Mariana Islands. Oregon State University, Masters Thesis, 38 pp.

REPTILES

Sea turtle nesting beaches and documented in-water foraging and juvenile concentration areas are included in this atlas. Nesting, foraging, and concentration areas were based primarily on expert knowledge and information provided by NOAA, Guam DAWR, The Nature Conservancy, CNMI DFW, and GEPA staff. Please note that turtles may be foraging and present around the islands in areas not mapped as consistent concentration areas. Also, the nesting seasonality displayed on the tables represents peak nesting periods for green and hawksbill sea turtles. Agency staff have observed signs of nesting at other times of year.

Major Data Sources Used: Reptiles

CNMI Division of Fish and Wildlife (DFW). 2005. Sea turtle nesting sites on Saipan, Tinian, and Rota. CNMI DFW, digital map.

Guam Division of Aquatic and Wildlife Resources (DAWR). 2005. Natural resources at risk – monthly seasonality for marine species on Guam. Guam DAWR, Mangilao, Guam, 3 pp.

Guam DAWR. 2005. Turtle nesting beaches on Guam. Guam DAWR, Mangilao, Guam, digital vector data.

FISH

Finfish depicted in this atlas include selected reef, pelagic, benthic, and estuarine species. Species of subsistence, recreational, local commercial, ecological, and/or conservation interest are emphasized. Fish distributions are based on information gathered at interviews with resource experts from NOAA, Guam DAWR, GEPA, TNC, University of Guam, Western Pacific Fisheries Management Council (WPFMC), CNMI DEQ, CNMI DFW, and CNMI CRM and unpublished harvest data provided by Guam DAWR and CNMI DFW. Please note that while the Marine Protected Areas, some estuaries, and other nearshore locations were emphasized as having high/sensitive fish concentrations, diverse populations of reef and pelagic species are present throughout the inshore and offshore waters surrounding the islands.

Major Data Sources Used: Fish

CNMI DFW. 2005. Coral reef fish. CNMI DFW, Lower Base, Saipan, MP, digital table.

Guam DAWR. 2003. Estimated harvest of top 20 families for inshore/offshore fisheries: 2000-2003. Guam DAWR, Mangilao, Guam, digital table.

Hoover, J.P. 1993. Hawaii's Fishes: A Guide for Snorkelers, Divers, and Aquarists. Mutual Publishing, Honolulu, HI, 183 pp.

INVERTEBRATES

Invertebrates depicted in this atlas include selected intertidal, reef, and mangrove associated species. Species of subsistence,

recreational, local commercial, ecological, and/or conservation interest are emphasized. Invertebrate distributions are based on information gathered at interviews with Guam DAWR, GEPA, University of Guam, WPFMC, CNMI DFW, and CNMI DEQ staff and unpublished harvest data provided by Guam DAWR and CNMI DFW. Please note that while the Marine Protected Areas, reserves, and other nearshore locations were emphasized as having high invertebrate concentrations, diverse populations of reef associated species as well as terrestrial invertebrates (e.g. coconut crabs) are present throughout the islands.

Major Data Sources Used: Invertebrates

CNMI DFW. 2005. Coral reef fish. CNMI DFW, Lower Base, Saipan, MP, digital table.

Guam DAWR. 2003. Estimated harvest of top 20 families for inshore/offshore fisheries: 2000-2003. Guam DAWR, Mangilao, Guam, digital table.

HABITATS

Benthic marine habitats and plants were included in this atlas.

BENTHIC MARINE HABITATS

Five types of benthic marine habitats are mapped for Guam and CNMI: 1) coral reef and colonized hardbottom, 2) seagrass, 3) coralline algae, 4) macroalgae, and 5) turf algae. The NOAA, National Ocean Service (NOS), National Centers for Coastal Ocean Science (NCCOS), Center for Coastal Monitoring and Assessment (CCMA), Biogeography Team provided digital maps of benthic habitats for use in this atlas. The benthic habitat classification scheme was developed by the Biogeography Team for the U.S. Pacific territories of American Samoa, Guam, and CNMI (contact Tim Battista (see list of resource experts) for more information). In addition to the data provided by NOAA, CNMI DEQ provided a benthic habitat coverage for Saipan Lagoon (contact Peter Houk for more information), and Dave Burdick, the NOAA Pacific Islands Technical Assistant for Guam, provided an updated benthic coverage for Guam during the review phase of the project. Additional benthic habitat information, including edits to the digital data sets, was provided during interviews with CNMI DEQ, NOAA, Guam DAWR, GEPA, NPS, and TNC staff. The benthic data provided on the maps and CD-ROM should only be used as a guide for spill response and spill response planning. Please contact the data providers listed above for access to the most updated and detailed benthic habitat information.

The NOAA NOS data were delivered as shapefiles and contained a hierarchical classification scheme, therefore making it possible for the user to display the benthic habitat types as general or as detailed as deemed appropriate. In order to keep the hardcopy ESI maps readable and to maintain a level of detail commensurate with oil spill response and planning, we chose to display the following geomorphological structure types and biological cover types :

Coral Reef and Colonized Hardbottom (broken into 2 density categories on the ESI maps)

Lower Density Live Coral Cover (Sparse cover: 10%<50%)

Higher Density Live Coral Cover (Patchy: 50%<90% and Continuous: 90%-100% cover)

Coralline Algae (1 category on ESI maps)

Sparse (10%<50%), patchy (50%<90%), and continuous (90%-100%) cover combined.

Macroalgae (1 category on ESI maps)

Macroalgae algae: all coverage percentages (sparse, patchy, and continuous) combined.

Turf algae (1 category on ESI maps)

Turf algae: all coverage percentages (sparse, patchy, and continuous) combined.

Seagrass (1 category on ESI maps)

All coverage percentages (sparse, patchy, and continuous) combined.

"Coral Areas of Special Significance", shown on the maps using yellow stars, and "Seagrass Areas of Special Significance", shown on the maps using purple stars, were designated by resource experts as those areas that should be highly prioritized for protection following spills due to various reasons (e.g. species diversity, abundance of soft coral species, high percent cover, sensitive habitat for fish/invertebrates, having structure-building potential that may lead to high diversity/high cover in the future, etc.).

PLANTS

Occurrences of Nipa palm (*Nypa fruticans*), a mangrove species located in certain river mouths and estuarine environments, was deemed as rare and potentially sensitive to coastal oil spills, and were included in this atlas. Location information was provided by Guam EPA, Guam DAWR, and NOAA staff.

Major Data Sources Used: Habitats

CNMI Department of Environmental Quality (DEQ). 2004. Saipan Lagoon benthic data. CNMI, DEQ, Saipan, MP, digital vector data.

NOAA. 2005. Guam Benthic Habitat Data: Draft 06_09_05. NOAA and Gov. Guam Bureau of Statistics and Plans, Hagatna, Guam, digital vector data.

NOAA NOS NCCOS CCMA Biogeography Team. 2004. Benthic habitats of the Southern Mariana Archipelago prepared by visual interpretation. NOAA NOS NCCOS, Silver Spring, MD, digital vector data.

HUMAN-USE RESOURCES

Management areas such as Marine Protected Areas (MPAs), wildlife refuges, national parks, etc. are mapped as polygons, with the boundaries indicated as a black dot-dash line with the corresponding icon placed near the center of the polygon. Where the feature is a known point location (e.g., water intake, marina), the location is shown as a small black dot and a leader line is drawn from it to the icon. In cases of sensitive resources (e.g., archaeological sites) or features in more general locations (e.g. dive sites), an icon without a leader line may be placed in the vicinity of the feature.

A human use number (HU#) can be found below the icon for some human-use resources, such as management areas, recreational beaches, and aquaculture sites. The HU# references a table on the reverse side of the map and may provide more information (i.e., name, contact) for that particular resource. The types of human use resources mapped in this atlas are depicted below.

Airport: Locations of airports, airfields, landing strips, helipads etc., whether they are manned or unmanned.

Aquaculture: Locations of aquaculture sites.

Archaeological/Historical Site: Locations of known archaeological and historic sites. Please note that additional sites are likely to occur. Specific information on individual sites was provided by the resource agencies, but was not included on the maps due to sensitivity. Please contact the appropriate agencies in the event of an oil or hazardous material incident (see list of resource experts).

Boat Ramp: Locations of public boat ramps.

Coast Guard: Locations of U.S. Coast Guard stations.

Dive Site: Locations of popular dive sites.

Management Area: Locations of Marine Protected Areas (MPAs), marine sanctuaries, wildlife conservation areas, reserves, marine conservation areas, environmental restricted areas, and ecological reserve areas. Management Areas are managed by multiple agencies, including: CNMI DFW, Guam DAWR, and U.S. Navy.

Marina: Locations of marinas.

National Historic Park/Landmark: Locations of National Historic Parks and National Historic Landmarks managed by the NPS.

Recreational Beach: Locations of recreational beach parks and other high-use beach access points.

Subsistence Fishing/Collecting: General areas where subsistence fishing and collecting take place near villages, on reefs, in estuaries, lagoons, etc. Please note that harvesting of subsistence resources are not limited to these areas.

Surfing: Locations of popular surfing spots.

Water Intake/Outfall: Locations of seawater intakes and outfalls (sewage, power plants).

Wildlife Refuge: Locations of wildlife refuges and seabird sanctuaries managed by USFWS and CNMI DFW.

Major Data Sources Used: Human-Use Resources

CNMI Coastal Resource Management (CRM) Office. 1997. Saipan dive site information. CNMI CRMO, Saipan, MP, digital vector data.

CNMI Division of Fish and Wildlife (DFW). 2005. Marine Protected Areas in Saipan and Rota. CNMI DFW, Saipan, MP, digital maps.

Dive Pacific Wholesale. 1998. Dive! Snorkel! Kayak! Hike! A guide to Guam's wonderful water adventures. Dive Pacific Wholesale, 67 pp.

Gov. Guam Bureau of Statistics and Plans. 2005. Marinas on Guam. Gov. Guam, Hagatna, Guam, digital vector data.

Gov. Guam Bureau of Statistics and Plans. 2002. Marine Protected Areas (MPAs), Ecological Reserve Area, and Environmental Restricted Area. Gov. Guam, Hagatna, Guam, digital vector data.

Gov. Guam Dept. of Parks and Recreation. 2000. Historical sites located on Guam. Gov. Guam, Hagatna, Guam, digital vector data.

Gov. Guam Dept. of Public Works. 2003. Recreation areas. Gov. Guam, Hagatna, Guam, digital vector data.

Gov. Guam Dept. of Public Works. 1993. Landmarks and government facilities on Guam. Gov. Guam, Hagatna, Guam, digital vector data.

Marianas Visitors Authority. 2005. Rota Map. Marianas Visitors Authority, 1 map.

National Park Service (NPS). 2005. "Dissolve Asan" (War in the Pacific National Historic Park Boundary). NPS, Asan, Guam, digital vector data.

National Register Information System. 2005. Historical and archaeological sites in CNMI. http://www.nr.nps.gov

U.S. Fish and Wildlife Service (USFWS). 2005. Guam National Wildlife Refuge Boundary. USFWS, Portland, OR, vector digital data.

GROUNDED, ABANDONED, AND DERELICT VESSELS

Grounded and abandoned vessels are a problem in many coastal areas, and they pose a significant threat to coral reef habitats. In 1999, the U.S. Coral Reef Task Force published a National Action Plan that identified groundings as a significant factor in the loss of reef habitat. In response to this plan, NOAA implemented the Abandoned Vessels Program (AVP) through which field surveys were conducted in 2003 to investigate issues related to abandoned and derelict vessels in Guam and CNMI.

Location information for grounded, abandoned, and derelict vessels in Guam and CNMI is provided on the ESI maps and in the accompanying digital database. Yellow triangles with numeric values are depicted on the maps and refer to the ESI Group/Vessel ID code in Table 4. The triangles may depict an individual vessel or a cluster of vessels in a defined area. Vessels were grouped on the hardcopy maps in some instances to ensure readability of the other resource information displayed. The numeric ESI Group codes were assigned for display purposes for this atlas only, and do not relate back to the Abandoned Vessel Inventory (AVI) database, from which the majority of information in Table 4 was adapted. The AVI database is a compilation of existing data from sources such as NOAA, U.S. Coast Guard, U.S. Navy, States, Territories and the maritime industry, as well as original data from charts and interviews with local sources. In some cases, the position information in the database and on the ESI maps may be approximate or inaccurate. Furthermore, new vessels continue to become abandoned while older vessels degrade, shift in position, or are occasionally removed. Only a subset of vessels depicted on the maps were surveyed and verified in 2003, and changes in their status may have occurred since that time. Please refer to the AVP website **http://response.restoration.noaa.gov/dac/vessels/** for contact information and links to published documents.

Major Data Sources Used: Abandoned Vessels

Lord, C., C. Plank, I. Zelo, and D. Helton. 2003. Surveys of Abandoned Vessels: Guam and the Commonwealth of the Northern Mariana Islands. NOAA Damage Assessment Center (DAC) Northwest, Seattle, WA, 52 pp. + appendices.

NOAA Abandoned Vessels Program. 2005. Abandoned Vessels Inventory, tabular digital data.

GEOGRAPHIC INFORMATION SYSTEM

The entire atlas product is stored in digital form in a Geographic Information System (GIS) as spatial data layers and associated databases. The format for the data varies depending on the type of information or features for which the data are being stored.

Under separate cover is a metadata document that details the data dictionary, processing techniques, data lineage, and other descriptive information for the digital data sets and maps that were used to create this atlas. Below is a brief synopsis of the information contained in the digital version. Refer to the metadata file for a full explanation of the data and its structure.

SHORELINE CLASSIFICATIONS

The ESI shoreline habitat classification is stored as lines and polygons with associated attributes. In many cases, a shoreline may have two or three different classifications or colored lines. These multiple classifications are represented on the maps by double and triple line patterns and in the database by ESI#1/ESI#2, where ESI#1 is the landward-most classification and ESI#2 is the seaward-most classification. In addition to the line features, tidal flats (ESI = 7, ESI = 9A) and mangroves (ESI = 10D) are also stored as polygons. Therefore, the legend on each map may contain two patterns depicted on a map, a linear feature as well as a polygonal feature. Salt-and brackish-water marshes (ESI = 10A), freshwater marshes (ESI = 10B), swamps (ESI = 10C), and scrub-shrub wetlands (ESI = 10D) were only mapped as polygonal features.

SENSITIVE BIOLOGICAL RESOURCES

Biological resources are stored as polygons or points. Associated with each feature is a unique identification number that is linked to a series of data tables that further identify the resources. The main biological resource table consists of a list of species identification numbers for each site, the concentration of each species at each site, and identification codes for seasonality and source information. This data table is linked to other tables that describe the seasonality and life-history time-periods for each species (at month resolution) for the specified map feature. Other data tables linked to the first table include: the species identification table, which includes common and scientific names; the species status table, which gives information for state and/or federal threatened or endangered listings; and the source database, which provides source metadata at the feature-species level (specific sources are listed for each species occurring at each mapped feature in the biology coverages).

HUMAN-USE FEATURES

Human-use features are represented as points or polygons. The resource name, a contact, and phone number are included in the database for management areas, water intakes, recreational beaches, and aquaculture sites when available. All metadata sources are documented at the feature level.

ACKNOWLEDGMENTS

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The biological and human-use data included on the maps were provided by numerous individuals and agencies. Staff at NOAA, National Park Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, University of Hawaii, University of Guam, Guam Division of Aquatic and Wildlife Resources, The Nature Conservancy, Guam EPA, Western Pacific Fisheries Management Council, Guam Fishermen's Co-op, Gov. Guam Bureau of Statistics and Plans Coastal Management Program, Gov. Guam Department of Public Works, Gov. Guam Department of Parks and Recreation, Guam Historic Resources Division, CNMI Coastal Resource Management Office, CNMI Department of Environmental Quality, CNMI Division of Fish and Wildlife, and CNMI Division of Historic Preservation contributed a vast amount of information to this effort, including first-hand expertise, unpublished data, maps, and digital data. The hospitality provided by the people associated with the agencies listed above while NOAA and RPI staff were on-island was greatly appreciated.

At Research Planning, Inc. (RPI) of Columbia, South Carolina, numerous scientific, GIS, and graphic staff were involved with different phases of the project. Christine Lord Boring, biologist, was Project Manager. Shoreline habitat mapping was conducted by Thomas Freeman. The biological and human-use data were collected and compiled onto base maps by Christine Lord Boring. Lee Diveley, Chris Locke, and Mark White entered, processed, and produced the GIS data and hardcopy atlas. Graphic art production was conducted by Joe Holmes. Christine Lord Boring, Chris Locke, Mark White, and Joe Holmes prepared the final text documents and metadata.

APPROPRIATE USE OF ATLAS AND DATA

This atlas and the associated database were developed to provide summary information on sensitive natural and human-use resources for the purposes of oil and chemical spill planning and response. Although the atlas and database should be very useful for other environmental and natural resource planning purposes, it should not be used in place of data held by participating agencies. Likewise, information contained in the atlas and database cannot be used in place of consultations with natural and cultural resource agencies or in place of field surveys. Also, this atlas should not be used for navigation.

TABLE 4. Location information for grounded, abandoned, and derelict vessels in Guam and CNMI.

ESI Group/ Vessel ID	Island	ESI Location/Group Name	Incident ID	2003 NOAA Survey	Vessel Name	Vessel Type
1	Guam	Apra Harbor Group	1916	No	Breakwater Barge	barge
1	Guam	Apra Harbor Group	1091	No	Chin Jaan Horn	fishing boat
1	Guam	Apra Harbor Group	1188	No	Chloe	fishing boat
1	Guam	Apra Harbor Group	1096	No	Chun Hsing #2	fishing boat
1	Guam	Apra Harbor Group	1185	No	Daiki Maru #7	fishing boat
1	Guam	Apra Harbor Group	1200	No	Daikichi Maru No. 62	fishing boat
1	Guam	Apra Harbor Group	1098	No	Donna Cristina	fishing boat
1	Guam	Apra Harbor Group	1182 and/or 1120	No	Endeavour	passenger
1	Guam	Apra Harbor Group	1173	No	Fu Maan Chuen No. 13	fishing boat
1	Guam	Apra Harbor Group	1133	No	GU2310PU (Unknown)	recreational
1	Guam	Apra Harbor Group	1216	No	GU4077PU (Unnamed)	commercial
1	Guam	Apra Harbor Group	1093	No	Hsing Te Chi	fishing boat
1	Guam	Apra Harbor Group	1119	No	JQC One	fishing boat
1	Guam	Apra Harbor Group	1097	No	Kasuga Maru	fishing boat
1	Guam	Apra Harbor Group	1219	No	Katsuei Maru #31	fishing boat
1	Guam	Apra Harbor Group	1094	No	Kim Yi Shen #29	fishing boat
1	Guam	Apra Harbor Group	1159	No	Kisyu Maru	fishing boat
1	Guam	Apra Harbor Group	1095	No	Lien Hong Tsai #7	fishing boat
1	Guam	Apra Harbor Group	1172	No	Micronesian Dream	passenger
1	Guam	Apra Harbor Group	1153	No	Neptune Shuttle	passenger
1	Guam	Apra Harbor Group	1166	No	New Utopia	passenger
1	Guam	Apra Harbor Group	1160 and/or 1260	No	Oryo Maru	fishing boat
1	Guam	Apra Harbor Group	1204	No	Patriot	passenger
1	Guam	Apra Harbor Group	1912	No	Polaris Sailboat	sailboat
1	Guam	Apra Harbor Group	1148	No	Pura Vida	passenger
1	Guam	Apra Harbor Group	1128	No	S-2011	barge
1	Guam	Apra Harbor Group	2537	Yes	Seagull	sailboat
1	Guam	Apra Harbor Group	1092	No	Shin Feng #3	fishing boat
1	Guam	Apra Harbor Group	1090	No	Shou Long Shin #3	fishing boat
1	Guam	Apra Harbor Group	1152	No	SS Neptune	passenger
1	Guam	Apra Harbor Group	1184	No	Stars & Stripes	passenger
1	Guam	Apra Harbor Group	1127	No	Stingray	tug
1	Guam	Apra Harbor Group	1086	No	Tayo Maru No. 1	fishing boat
1	Guam	Apra Harbor Group	1143	No	Umidori II	passenger
1	Guam	Apra Harbor Group	1165	No	Unknown	
1	Guam	Apra Harbor Group	2532	Yes	Unknown2532 - concrete barge	barge
1	Guam	Apra Harbor Group	2533	Yes	Unknown2533 - concrete barge	barge
1	Guam	Apra Harbor Group	2534	Yes	Unknown2534 - concrete barge	barge
1	Guam	Apra Harbor Group	2535	Yes	Unknown2535 - concrete barge	barge
1	Guam	Apra Harbor Group	1139	No	Yu Fai Tsai No. 3	fishing boat
2	Guam	Agat	1193	No	Guams Amio (2)	
3	Guam	Agat	1151	No	GU1287CP (Unknown)	
4	Guam	Cocos Lagoon	2542	Yes	Unknown2542 - Sailboat	sailboat
5	Guam	Cocos Lagoon	1198	No	Oz	passenger
6	Guam	Cocos Lagoon	1099	No	Jui Chun Tsai NO. 16	fishing boat
7	Guam	Tumon Bay	1084	No	Jean Carcot	research vessel
8	Guam	Agana Bay	1208	No	Haggan Tsi	passenger
9	Guam	Agana Boat Basin Group	2541 or 1911	Yes	Ciao	sailboat
9	Guam	Agana Boat Basin Group	1137	No	I Kan Du	recreational
9	Guam	Agana Boat Basin Group	1901	Yes	Lion's Den	sailboat
9	Guam	Agana Boat Basin Group	1900	Yes	Unk1900 - ferro-cement sailboat	sailboat
9	Guam	Agana Boat Basin Group	2539	Yes	Unknown2539 - steel sailboat	sailboat
9	Guam	Agana Boat Basin Group	2540	Yes	Unknown2540 - sailboat	sailboat
9	Guam	Agana Boat Basin Group	1089	No	Virgo IV	recreational
9	Guam	Agana Boat Basin Group	2538	Yes	Windsong	sailboat
10	Guam	Offshore of Agana	1157	No	Sgt. William Button	freight ship
11	Guam	Piti Channel Group	292	Yes	Chamorro I	fishing
11	Guam	Piti Channel Group	2525	Yes	Crystal Be???	sailboat

ESI Group/ Vessel ID	Island	ESI Location/Group Name	Incident ID	2003 NOAA Survey	Vessel Name	Vessel Type
11	Guam	Piti Channel Group	2524	Yes	Dolphin Dancer	sailboat
11	Guam	Piti Channel Group	1206	No	Flipper II	passenger
11	Guam	Piti Channel Group	293	Yes	Guahan One	landing craft
11	Guam	Piti Channel Group	294	Yes	Guahan Two	landing craft
11	Guam	Piti Channel Group	1104	No	Kimi Maru	fishing boat
11	Guam	Piti Channel Group	2522	Yes	Lady Catherine	fishing
11	Guam	Piti Channel Group	1903	Yes	Merlin	sailboat
11	Guam	Piti Channel Group	1106	No	Miwa Maru No. 18	fishing boat
11	Guam	Piti Channel Group	1910	Yes	Piti Crane Barge	barge
11	Guam	Piti Channel Group	1902	Yes	Piti Dive Barge	barge
11	Guam	Piti Channel Group	1914	No	Piti Marina	
11	Guam	Piti Channel Group	1907	No	Piti Overturned	
11	Guam	Piti Channel Group	1905	No	Piti Sailboat Bow	
11	Guam	Piti Channel Group	1908	No	Piti Unknown	
11	Guam	Piti Channel Group	1105	No	Seiwa No. 8	fishing boat
11	Guam	Piti Channel Group	1906	Yes	Unk1906 - small LC	landing craft
11	Guam	Piti Channel Group	1909	Yes	Unk1909 - frieghter	cargo/supply
11	Guam	Piti Channel Group	2523	Yes	Unknown2523 - sailboat	sailboat
11	Guam	Piti Channel Group	2526	No	Unknown2526 - wood barge	barge
11	Guam	Piti Channel Group	2527	Yes	Unknown2527 - sailboat	sailboat
11	Guam	Piti Channel Group	2528	Yes	Unknown2528 - ketch	sailboat
11	Guam	Piti Channel Group	2529	No	Unknown2529 - landing craft	landing craft
11	Guam	Piti Channel Group	2530	Yes	Unknown2530 - barge	barge
11	Guam	Piti Channel Group	2531	Yes	Unknown2531 - barge	barge
11	Guam	Piti Channel Group	2536	Yes	Unknown2536 - trimeran	sailboat - trimaran
11	Guam	Piti Channel Group	295	No	Unknown295	other
11	Guam	Piti Channel Group	296	No	Unknown296	other
11	Guam	Piti Channel Group	1904	No	Unnamed Piti Sailboat	sailboat
12	Rota	Offshore of Rota	2327	No	M/T Artemis	towboat/tugboat
13	Rota	Offshore of Rota	1841	No	Tse Yuen Yui No. 102	river cargo
14	Rota	Offshore of Rota	1839	No	Shoun Maru	
15	Rota	Offshore of Rota	1840	No	Chinese Trawler	
16	Rota	Rota	1829	Yes	Rota Queen	tug
17	Rota	Sasan Lago, Rota Group	1830	Yes	T. T. Gov't (LCU) 1	landing craft
17	Rota	Sasan Lago, Rota Group	1831	Yes	T. T. Gov't (LCU) 2	barge
17	Rota	Sasan Lago, Rota Group	2581	Yes	Unknown2581 - LCU skeleton	landing craft
18	Rota	Tatqua Reef	1832	Yes	#62 Nam Sung	fishing
19	Tinian	Tinian Harbor Group	2577	No	Lian Gi	cargo/supply
19	Tinian	Tinian Harbor Group	1828	Yes	Sun Long No. 8	fishing
19	Tinian	Tinian Harbor Group	1930	No	Unknown1930	
19	Tinian	Tinian Harbor Group	2578	No	Unknown2578 - cement fishing boat	fishing boat
19	Tinian	Tinian Harbor Group	2579	No	Unknown2579 - steel yacht	yacht
20	Saipan	Offshore of Saipan	2300	No	Shin Kang 705	freight barge
21	Saipan	West Saipan	2299	No	Shin Kang 801	freight barge
22	Saipan	Offshore of Saipan	1998	No	Pluto	passenger
23	Tinian	Offshore of Tinian	2296	No	Chloe Z	fishing boat
24	Saipan	Saipan	2297	No	Shin Kang 502	towboat/tugboat
25	Saipan	Saipan	2298	No	Shin Kang 703	freight barge
26	Saipan	Saipan Lagoon Group	2036	No	Lambada	fishing boat
26	Saipan	Saipan Lagoon Group	2026	No	Puti'on Saipan	passenger
26	Saipan	Saipan Lagoon Group	2012	No	Shin Kang 501	towboat/tugboat
26	Saipan	Saipan Lagoon Group	1837	No	Unknown1837	
26	Saipan	Saipan Lagoon Group	1838	No	Unknown1838	
26	Saipan	Saipan Lagoon Group	2545	Yes	Unknown2545 - cargo vessel	cargo/supply
26	Saipan	Saipan Lagoon Group	2547	Yes	Unknown2547 - steel barge	barge
26	Saipan	Saipan Lagoon Group	2548	Yes	Unknown2548 - cement freighter	cargo/supply
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2017	No	Flyer III	passenger
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2044	No	Jade Lady II	passenger

ESI Group/ Vessel ID	Island	ESI Location/Group Name	Incident ID	2003 NOAA Survey	Vessel Name	Vessel Type
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2546	Yes	Mwaalil Saat	fishing
27	Saipan	Outer Cove/ Smiling Cove Marina Group	1251	Yes	Samala	recreational
27	Saipan	Outer Cove/ Smiling Cove Marina Group	1915	No	Shogun	
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2550	Yes	Unknown2550 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2551	Yes	Unknown2551 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2553	Yes	Unknown2553 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2554	Yes	Unknown2554 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2555	Yes	Unknown2555 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2556	Yes	Unknown2556 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2557	Yes	Unknown2557 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2558	Yes	Unknown2558 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2559	Yes	Unknown2559 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2560	Yes	Unknown2560 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2562	Yes	Unknown2562 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2564	Yes	Unknown2564 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2565	Yes	Unknown2565 - barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2566	Yes	Unknown2566 - barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2567	Yes	Unknown2567 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2568	Yes	Unknown2568 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2569	Yes	Unknown2569 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2570	Yes	Unknown2570 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2571	Yes	Unknown2571 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2572	Yes	Unknown2572 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2573	Yes	Unknown2573 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2574	Yes	Unknown2574 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2575	No	Unknown2575 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	2576	Yes	Unknown2576 - steel barge	barge
27	Saipan	Outer Cove/ Smiling Cove Marina Group	1913	No	WWII Barges (>3)	barge
28	Saipan	Garapan Group	1252	Yes	Charito	fishing boat
28	Saipan	Garapan Group	1253	Yes	Nago No. 15	fishing
28	Saipan	Garapan Group	2543	Yes	Unknown2543 - steel barge	barge
28	Saipan	Garapan Group	2544	Yes	Unknown2544 - steel barge	barge

SPECIES LIST

Common Name*	Scientific Name*
BIRDS	
GULL/TERN	
Black noddy	*Anous minutus*
Brown noddy	*Anous stolidus*
Common tern	*Sterna hirundo*
Little tern	*Sterna albifrons*
Terns	-
Whiskered tern	*Chlidonias hybridus*
White tern	*Gygis alba*
White-winged black tern	*Chlidonias leucopterus*
PASSERINE BIRD	
Micronesian starling	*Aplonis opaca*
Nightingale reed-warbler	*Acrocephalus luscinia*
PELAGIC BIRD	
Boobies	*Sula spp.*
Brown booby	*Sula leucogaster*
Frigatebirds	*Fregata spp.*
Great frigatebird	*Fregata minor*
Red-footed booby	*Sula sula*
Red-tailed tropicbird	*Phaethon rubricauda*
Wedge-tailed shearwater	*Puffinus pacificus*
White-tailed tropicbird	*Phaethon lepturus*
SHOREBIRD	
Black-bellied plover	*Pluvialis squatarola*
Common sandpiper	*Actitis hypoleucos*
Curlews	*Numenius spp.*
Gray-tailed tattler	*Heteroscelus brevipes*
Greater yellowlegs	*Tringa melanoleuca*
Lesser yellowlegs	*Tringa flavipes*
Mongolian plover	*Charadrius mongolus*
Pacific golden-plover	*Pluvialis fulva*
Ruddy turnstone	*Arenaria interpres*
Shorebirds	-
Stints	*Calidris spp.*
Wandering tattler	*Heteroscelus incanus*
Whimbrel	*Numenius phaeopus*
WADING BIRD	
Black-crowned night-heron	*Nycticorax nycticorax*
Cattle egret	*Bubulcus ibis*
Great egret	*Ardea alba*
Intermediate egret	*Egretta intermedia*
Little egret	*Egretta garzetta*
Pacific reef-heron	*Egretta sacra*
Yellow bittern	*Ixobrychus sinensis*
WATERFOWL	
Common teal	*Anas crecca*
Greater scaup	*Aythya marila*
Mariana common moorhen	*Gallinula chloropus guami*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Tufted duck	*Aythya fuligula*
FISH	
FISH	
Barracudas	*Sphyraena spp.*
Bigeye scad	*Selar crumenopthalmus*
Bigeyes	*Priacanthidae*
Bumphead parrotfish	*Scarus perrico*
Butterflyfishes	*Chaetodontidae*
Damselfishes	*Pomacentridae*
Emperors	*Lethrinidae*
Fusiliers	*Caesionidae*
Giant manta	*Manta birostris*
Goatfishes	*Mullidae*
Groupers	*Serranidae*
Grunts	*Haemulidae*
Jacks	*Hemicaranx sp.*
Mackerels	*Scomberomorus spp.*
Milkfish	*Chanos chanos*
Mojarras	*Diapterus spp.*
Mullets	*Mugilidae*
Napolean wrasse	*Cheilinus undulatus*
Needlefishes	*Belonidae*
Parrotfishes	*Scaridae*
Porcupinefishes	*Diodontidae*
Puffers	*Tetraodontidae*
Rabbitfishes	*Siganus spp.*
Requiem sharks	*Carcharhinidae*
Rudderfishes	*Kyphosus spp.*
Scalloped hammerhead	*Sphyrna lewini*
Sharks	-
Skipjack tuna	*Katsuwonus pelamis*
Small-toothed whiptail	*Pentapodus caninus*

Common Name*	Scientific Name*
FISH, cont.	
FISH, cont.	
Snappers	*Lutjanidae*
Soldierfishes	*Myripristinae*
Squirrelfishes	*Holocentridae*
Surgeonfishes	*Acanthuridae*
Sweetlips	*Haemulon spp.*
Triggerfishes	*Balistidae*
Unicornfishes	*Naso spp.*
Wrasses	*Labridae*
HABITATS	
ALGAE	
Coralline algae	-
Turf algae	-
CORAL	
Coral reef habitat	-
PLANT	
Nipa palm	*Nypa fruticans*
SAV	
Macroalgae	-
Seagrass	-
INVERTEBRATES	
BIVALVE	
Bivalves	-
Giant clams	*Tridacna spp.*
CEPHALOPOD	
Octopus	*Octopodidae*
CRAB	
Mangrove crab	*Ucides occidentalis*
Swimming crabs	*Portunidae*
ECHINODERM	
Sea cucumbers	*Stichopodidae*
GASTROPOD	
Gastropods	-
Topshell	*Trochus spp.*
Turbo shell	*Turbo sp.*
INVERTEBRATE	
Intertidal invertebrates	-
Reef invertebrates	-
Sponges	-
LOBSTER	
Slipper lobsters	*Parribacus spp.*
Spiny lobsters	*Panulirus spp.*
MARINE MAMMALS	
DOLPHIN	
Bottlenose dolphin	*Tursiops truncatus*
Spinner dolphin	*Stenella longirostris*
Spotted dolphin	*Stenella attenuata*
REPTILE	
TURTLE	
Green sea turtle	*Chelonia mydas*
Hawksbill sea turtle	*Eretmochelys imbricata*

* Threatened and endangered species and species of special concern are designated by underlining

SHORELINE DESCRIPTIONS

EXPOSED ROCKY SHORES **ESI = 1A**

DESCRIPTION

- Steep intertidal zone (usually greater than 30 degree slope) with very little width; they are often uncut
- Regularly exposed to high wave energy, with strong wave reflection patterns
- Sediment accumulations are uncommon and usually ephemeral, because waves quickly remove debris slumped from eroding cliffs
- Attached organisms are hardy and accustomed to strong hydraulic impacts and pressures
- Impermeable substrate with no potential for subsurface penetration
- Found in some areas in combination with another shoreline type such as wave-cut platforms and gravel beaches
- Very common throughout the mapped area, representing nearly 52 percent of the shoreline

PREDICTED OIL BEHAVIOR

- Oil would be held offshore by waves reflecting off the steep cliffs
- Any oil that was deposited would be rapidly removed from exposed faces by wave action
- Most resistant oil would remain as a patchy band at or above the high-tide line

- Impacts to intertidal communities are often short term, an exception being where heavy concentrations of a light refined product comes ashore very quickly

RESPONSE CONSIDERATIONS

- Cleanup usually not required
- Access can be difficult and dangerous

EXPOSED, SOLID MAN-MADE STRUCTURES **ESI = 1B**

DESCRIPTION

- Typically composed of concrete or metal bulkheads
- Organisms, such as barnacles and algae, may be common on the lower levels, whereas biota along the upper intertidal zone are sparse
- Attached organisms are hardy and accustomed to strong hydraulic impacts and pressures
- Very uncommon, representing < 1 percent of the shoreline

PREDICTED OIL BEHAVIOR

- Much of the oil would be held offshore by wave reflection
- Oil could percolate between the joints of the structures
- Under heavy accumulations, oil may coat the intertidal area and biota present would be impacted

RESPONSE CONSIDERATIONS

- High-pressure spraying may be required in order to:
  - remove oil
  - clean substrate for re-colonization by attached biota

- minimize aesthetic damage

EXPOSED WAVE-CUT PLATFORMS **ESI = 2A**

DESCRIPTION

- Intertidal zone is a flat rock bench of variable width
- Rock can consist of both bedrock and calcareous beach rock
- They are exposed to high wave energy with strong wave reflection patterns
- Attached organisms are hardy and used to strong hydraulic impacts and pressures
- May be backed by a steep scarp or low bluff
- Perched beach of sand- to boulder-sized sediments may be present at base of the scarp
- Substrate is impermeable with no potential for subsurface penetration over much of intertidal zone, except in the ephemeral beach sediments
- Surface is highly irregular and tidal pools are common
- Small accumulations of gravel, shells, or coral rubble can be found in the tidal pools and crevices in the platform
- May support large populations of encrusting animals and plants, with rich tidal pool communities
- Common throughout, representing over 27 percent of the shoreline; they are typically interspersed along the shore with rocky cliffs and gravel beaches

PREDICTED OIL BEHAVIOR

- Oil will not adhere to the wet rock platform, but rather be transported across the platform and accumulate along the high-tide line, where it can penetrate in beach sediments, if present
- Persistence of oiled sediments is usually short-term, except in wave shadows or larger sediment accumulations at the

landward edge of the platform, where oil could persist for up to several weeks to months

- Biological impacts can be immediate and severe, particularly if fresh oil slicks cover tidal pool communities

RESPONSE CONSIDERATIONS

- Cleanup is usually not required because oil is quickly removed by wave action
- Access may be difficult and dangerous
- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and oiled debris in areas of high recreational use or in order to protect a nearshore marine resource, such as marine birds

FINE- TO MEDIUM-GRAINED SAND BEACHES ESI = 3A

DESCRIPTION

- These beaches are generally narrow and composed of hard-packed fine- to medium-grained sand
- Rate of sediment mobility is high, thus rapid changes in the beach profile are common
- Surface sediments subject to regular reworking by waves
- Beach fauna can vary in type and density; mobile surface, burrowing, and interstitial forms are typical
- Sea turtle nesting, eggs, and hatchlings may occur on outer coast sand beaches
- They are common, representing over 20 percent of the shoreline types on the islands

PREDICTED OIL BEHAVIOR

- Light oil accumulations would be deposited as oily swashes or bands along the upper intertidal zone
- Heavy oil accumulations would cover the entire beach surface; the oil would be lifted off the lower beach with a rising tide
- Maximum penetration of oil is about 10 cm into fine-grained sand and 15 cm into medium-grained sand
- Burial of oiled layers by clean sand can occur within hours on these microtidal beaches, but the maximum burial will typically occur along the upper beach face to depths less than 30 cm
- Organisms living in the beach may be killed by smothering or lethal oil concentrations in interstitial water
- Direct and indirect impacts to sea turtle nests, eggs, and hatchlings can be severe

RESPONSE CONSIDERATIONS

- This is the easiest beach type to clean because hard substrate can support vehicular and foot traffic and depths of oil burial and penetration are minimal

- After all oil has come ashore, cleanup activities should concentrate at first on the removal of oil from the upper swash zone
- Vehicular traffic and walking through oiled areas and dunes should be limited to prevent contamination of clean areas and disturbance of dune vegetation
- Vehicular and foot traffic, and mechanical or manual beach cleanup, should be carefully planned and monitored in sea turtle nesting areas to avoid disturbance and destruction of nesting turtles, eggs, and young
- Manual cleanup, rather than road graders and front-end loaders, is advised where feasible to minimize the volume of sand removed from the shore
- It is important to prevent the mixture of oil deeper into the sediments by vehicular and foot traffic

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MIXED SAND AND GRAVEL BEACHES ESI = 5

DESCRIPTION

- Moderately sloping beach composed of a mixture of sand and at least 20 percent gravel
- Soft sediments with low trafficability
- Sediment mobility is very high during storms, but considerably less than sand beaches during normal conditions
- Spatial variations in the distribution of grain sizes may be significant, with separate zones of pure sand, pebbles, or cobbles, in addition to the mixed sediment zones
- Gravel can be composed of a variety of materials, including volcanic bedrock, beach-rock rubble, coral rubble, shells, and other calcium carbonate materials
- Substrate has medium-to-high permeability
- Beach fauna can vary in type and density; mobile surface, burrowing, and interstitial forms are typical
- Sea turtle nesting, eggs, and hatchlings can be expected on outer coast mixed sand and gravel beaches, particularly those dominated by sand and smaller-sized gravel
- Common, occurring along nearly 9 percent of the shoreline

PREDICTED OIL BEHAVIOR

- During small spills, oil would be deposited along the high-tide swash line
- During large spills, oil would be spread across the entire intertidal area
- Oil penetration into the beach sediments may be up to 50 cm; however, the sand fraction can be quite mobile, and if the sand fraction exceeds about 40 percent, oil behavior is similar to that described for sand beaches
- Significant amounts of oil can be eroded away during storms
- Burial of oil may be deep (up to 1 m) if oil comes ashore while the beach is recovering from storm conditions
- In sheltered pockets on the beach, such as in the lee of large boulders, pavements of asphalted sediments can form if there is no removal of heavy oil accumulations; once formed, these pavements can persist for many years
- Organisms living in the beach may be killed by smothering or lethal oil concentrations in interstitial water
- Direct and indirect impacts to sea turtle nests, eggs, and hatchlings can be severe

RESPONSE CONSIDERATIONS

- Remove heavy accumulations of pooled oil as quickly as possible
- All oiled debris should be removed
- Vehicular traffic and walking through oiled areas should be limited to prevent contamination of clean areas
- Vehicular and foot traffic, and mechanical or manual beach cleanup, should be carefully planned and monitored in sea turtle nesting areas to avoid disturbance and destruction of nesting turtles, eggs, and young
- Sediment removal should be limited as much as possible because of potential beach erosion problems
- Low-pressure flushing can be used to remove heavy oil where collection of the flushed oil is feasible, but high-pressure flushing should be avoided, because of the potential for transporting contaminated finer sediments (sand) to the lower intertidal or subtidal zones
- Mechanical reworking of oiled sediments from the high-tide zone to the upper intertidal zone for wave reworking (berm relocation) can be effective in areas subject to significant wave action
- In-place tilling may be used to expose deeply buried oil layers to wave reworking in areas subject to significant wave action

GRAVEL BEACHES — ESI = 6A

DESCRIPTION

- Composed of sediments larger than 2 mm (granules, pebbles, cobbles and boulders) that may be made up of bedrock and beachrock fragments and coral rubble
- Most permeable of all beach sediments
- Slope is intermediate to steep; multiple, wave-built berms may be present on the upper beach
- Sediment replenishment rates are lowest of all beach types
- Attached animals and plants are usually restricted to lowest parts of the beach where the sediments are less mobile
- Uncommon, representing about 1 percent of the shoreline

PREDICTED OIL BEHAVIOR

- Deep penetration and rapid burial of stranded oil is likely; penetration of 10's of cm (over 1 m possible) can extend oil to depths below where it cannot be reworked by any natural process except extreme storms
- Therefore, long-term persistence will be controlled by the depth of penetration versus the depth of routine reworking by storm waves
- Oil may be carried over the normal high-tide line and storm berms during high-water events where it can pool and persist above the normal zone of wave wash
- In more sheltered areas, formation of asphalt pavements is likely if oil accumulations are heavy
- Oil can penetrate and stain the permeable coral rubble

RESPONSE CONSIDERATIONS

- Because of low trafficability and rapid rates of burial and deep penetration of the oil, this is the most difficult of all the beach types to clean

- Where removal of significant amounts of oiled material is required, it may be necessary to replace the sediments with clean material, to prevent erosion
- In-place tilling may be used to expose deeply buried oil layers to wave reworking in areas subject to significant wave action
- Mechanical reworking of oiled sediments from the high-tide line to the upper intertidal zone (berm relocation) can be effective in areas regularly exposed to wave activity (as evidenced by storm berms)

RIPRAP — ESI = 6B

DESCRIPTION

- Composed of cobble- to boulder-sized rock fragments
- Used for shoreline protection and inlet stabilization
- Attached mid- and low-intertidal zone biota may be plentiful and varied
- Uncommon, representing <1 percent of the shoreline

PREDICTED OIL BEHAVIOR

- Deep penetration of oil because of the high permeability of the riprap
- Oil would adhere readily to the rough rock surfaces
- If left uncleaned, oil may cause chronic leaching (weeks to months) until it hardens
- Resident fauna and flora may be killed by the oil

RESPONSE CONSIDERATIONS

- Flushing can be effective for removing mobile oil, but large amounts of residue can remain after flushing, particularly for heavy oil
- Heavy accumulations of pooled oil should be removed quickly
- All oiled debris should be removed

- Flushing with ambient water can be used to remove liquid oil from inside the rocks, provided adequate oil recovery is possible
- Scraping and/or hot-water spraying of heavy or weathered oil may be required in areas of high recreational value

SHELTERED ROCKY SHORES — ESI = 8A

DESCRIPTION

- Bedrock shores of variable slope (though vertical cliffs are most common) that are inside bays and lagoons, thus sheltered from exposure to high wave and tidal energy
- Attached biota may be plentiful and varied, especially in lower and mid-intertidal zones
- They represent about 5.5 percent of the shoreline

PREDICTED OIL BEHAVIOR

- Oil will adhere readily to the rough rocky surface, particularly along the high-tide line, forming a distinct oil band
- Oil can remain for a long time (months to years) because of the low energy setting
- Where surface sediments are abundant, oil will penetrate into the crevices formed by the surface rubble and pool at the contact of the sediments and the rock surface
- Where the rubble is loosely packed, oil will penetrate deeply, causing long-term contamination of the subsurface
- Impacts to attached organisms can be severe
- Asphalt pavements can form in the cracks and cervices

RESPONSE CONSIDERATIONS

- Cleanup is often required; natural removal rates are slow

- Water flushing at ambient water temperatures is most effective when the oil is fresh
- All pooled oil and oiled debris should be removed as soon as possible
- Weathered asphalt pavements can be removed manually

SHELTERED, SOLID MAN-MADE STRUCTURES ESI = 8B

DESCRIPTION

- Include revetments, seawalls, piers, and docks typically constructed of impermeable materials such as concrete and steel
- Commonly found inside harbors and lagoons in highly developed areas sheltered from direct exposure to waves
- Attached biota may be plentiful and varied, especially in lower and mid-intertidal zones
- They represent over 4 percent of the shoreline

PREDICTED OIL BEHAVIOR

- On impermeable surfaces the oil will form a band at the high-tide line
- If the oil is not removed, it may cause chronic leaching until the oil hardens
- Impacts to attached organisms can be severe

RESPONSE CONSIDERATIONS

- Cleanup is frequently required, because natural removal rates are slow and these features are located in populated areas
- High-pressure spraying may be required to remove oil for aesthetic reasons and to prevent leaching of oil from the structure

- Cleanup crews should make sure to recover all released oil
- All pooled oil and oiled debris should be removed as soon as possible

SHELTERED RIPRAP ESI = 8C

DESCRIPTION

- Composed of cobble- to boulder-sized volcanic and carbonate rock fragments, similar to exposed riprap but sheltered from wave energy
- Commonly found inside harbors and lagoons in highly developed areas sheltered from direct exposure to waves
- Attached biota may be plentiful and varied, especially in lower and mid-intertidal zones
- Represents nearly 4 percent of the shoreline

PREDICTED OIL BEHAVIOR

- On impermeable surfaces, the oil would form a band at the high-tide line, oil will adhere readily to the rough rock surfaces
- Deep penetration of oil possible because of the high permeability of the riprap
- If the oil is not removed, it may cause chronic leaching (weeks to months) until the oil hardens
- Impacts to attached organisms can be severe

RESPONSE CONSIDERATIONS

- Cleanup is frequently required, because natural removal rates are slow and these features are located in populated areas
- Flushing can be effective for removing mobile oil, but large amounts of residue can remain after flushing, particularly for heavy oil; clean up is often difficult and intrusive

- High-pressure spraying and/or scraping may be required to remove oil for aesthetic reasons and to prevent leaching of oil from the structure
- Cleanup crews should make sure to recover all released oil
- All pooled oil and oiled debris should be removed as soon as possible

VEGETATED LOW BANKS ESI = 9B

DESCRIPTION

- Sheltered banks along stream channels that have dense vegetation along the water's edge in fresh to brackish water
- Calm-water habitats that are typically muddy, soft, and highly vegetated
- Wave energy is very low, although there may be some tidal and/or riverine currents along the banks
- Represents nearly 2 percent of the shoreline

PREDICTED OIL BEHAVIOR

- Natural removal rates are very slow because of low energy and dense vegetation
- Oil adheres readily to the intertidal vegetation
- The band of oil coating on the vegetation will vary widely, depending upon the tidal stage at the time of oiling, there may be multiple bands
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe with penetration and lighter oiling to the limit of tidal influence

RESPONSE CONSIDERATIONS

- These are high-priority areas necessitating the use of spill protection devices to limit oil-spill impact; most are along channels that have an opening to the open ocean close by, therefore, deflection booming should be used to prevent the oil from entering the channel mouth

- Cleanup of the banks is very difficult because of the soft substrate
- Manual operations and deployment of sorbents from shallow-draft boats may be helpful
- Under light oiling, the best practice is to let the area recover naturally
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing
- Any cleanup activity must not mix the oil deeper into the sediments; trampling of the plant roots must be minimized
- Cutting of oiled vegetation should only be considered when other resources present (such as birds) are at great risk from leaving the oiled vegetation in place

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SALT- AND BRACKISH – WATER MARSHES **ESI = 10A**

DESCRIPTION

- Intertidal wetlands consisting of emergent, herbaceous vegetation
- Marshes in Guam are typically narrow fringes
- Sediments in the substrate range from fine sands to silts and organically rich muds
- Salt-and brackish-water marshes are uncommon in Guam and CNMI; small estuarine communities composed primarily of bulrushes (*Scirpus littoralis*) occur in a few locations along Apra Harbor

PREDICTED OIL BEHAVIOR

- Oil adheres readily to intertidal vegetation
- Oil coating typically takes the form of a band of varying width; multiple bands are possible
- Large slicks will persist through multiple tidal cycles and coat vegetation from high tide line to the base of the stem
- If the vegetation is thick, the heaviest oil coating will be restricted to the outer fringe of the marsh; however, the lighter the oil, the further into the marsh it may penetrate
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool in surface depressions or collect in burrows
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks

RESPONSE CONSIDERATIONS

- Extent of oiling, degree of use by sensitive resources, and natural removal rates should be evaluated prior to conducting cleanup
- Under light oiling, the best practice is to allow the area time to recover naturally
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing; during flushing care must be taken to prevent transporting oil to sensitive areas down slope or along shore
- Cleanup crews and activities must be carefully monitored to avoid unnecessary vegetation damage
- Any cleanup activity must not mix the oil deeper into the sediments; trampling of the roots must be minimized
- Cutting of oiled vegetation should only be considered when other resources present (such as birds) are at great risk from leaving the oiled vegetation in place

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FRESH WATER MARSHES **ESI = 10B**

DESCRIPTION

- Wetlands consisting of emergent, herbaceous freshwater vegetation
- Marshes vary in extent from extensive areas to narrow fringes
- Sediments in the substrate range from fine sands to silts and organically rich muds and potentially thick accumulations of peat
- Both natural and manmade freshwater wetlands occur in Guam and CNMI; typical species include *Phragmites karka, Panicum muticum, Eleocharis ochrostachys, Cyperus spp., Acrostichum aureum*, and *Hibiscus spp.*
- Several freshwater marshes provide crucial habitat for common moorhen (federally and territorially endangered), and support migratory waterfowl, wading birds, and terns

PREDICTED OIL BEHAVIOR

- Oil adheres readily to vegetation
- Oil coating typically takes the form of a band of varying width. Multiple bands are possible as the water level changes over time
- If the vegetation is thick, the heaviest oil coating will be restricted to the outer fringe of the marsh. However, the lighter the oil, the further into the marsh it may penetrate
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool in surface depressions or collect in burrows
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and cracks (up to one meter)
- Natural removal rates can be slow in areas sheltered from wave action or current energy

RESPONSE CONSIDERATIONS

- Extent of oiling, degree of use by sensitive resources, and natural removal processes and rates should be evaluated prior to conducting cleanup
- Under light oiling, the best practice is to allow the area time to recover naturally
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing; during flushing care must be taken to prevent transporting oil to sensitive areas down slope or along shore
- Cleanup crews and activities must be carefully monitored to avoid unnecessary vegetation damage
- Any cleanup activity must not mix the oil deeper into the sediments; trampling of the roots must be minimized
- Cutting of oiled vegetation should only be considered when other resources present (such as birds) are at great risk from leaving the oiled vegetation in place

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FRESHWATER SWAMPS **ESI = 10C**

DESCRIPTION

- Freshwater swamps consist of shrubs and forested wetlands
- The sediment tends to be silty clay with large amounts of organic debris
- They may be seasonally flooded, though there are many low, permanently flooded areas
- Resident flora and fauna are abundant with numerous species
- Swamps occur along freshwater drainage, often adjacent to freshwater marshes, and in wet depressions in forests; typical species include: *Hibiscus tiliaceus, Barringtonia racemosa, Pandanus tectorius, Cynometra ramiflora, and Areca catechu*

PREDICTED OIL BEHAVIOR

- Oiled woody vegetation is less sensitive than grassy vegetation to oil coating
- Oil can be trapped and pooled on the swamp flood plain as water levels drop
- Penetration into the floodplain soils is usually limited because they can be muddy and water-saturated, though oil can coat debris and low vegetation
- Large amounts of oily debris can be sources of chronic sheening
- During dry periods, terrestrial spills can flow downhill and accumulate in depressions or reach waterbodies

RESPONSE CONSIDERATIONS

- Under light oiling, the best practice is to let the area recover naturally
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore
- Under stagnant water conditions, herding of oil with water spray may be needed to push oil to collection areas
- Oily debris can be removed where there is access
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized
- Cutting of oiled grassy vegetation should only be considered when other resources present are at great risk from leaving the oiled vegetation in place; no woody vegetation should be cut

SCRUB-SHRUB WETLANDS — ESI = 10D

DESCRIPTION

- Scrub-shrub wetlands consist of woody vegetation less than 6 meters tall including true shrubs, small trees, and trees and shrubs that are stunted due to environmental conditions
- They occur as narrow bands of woody vegetation in very few areas on the shoreline

PREDICTED OIL BEHAVIOR

- They are at risk of oiling from major spills on the shoreline
- They could become oiled during very high water levels, from land-based spills, or during cleanup of adjacent areas
- Woody vegetation is less sensitive than grasses to oil

RESPONSE CONSIDERATIONS

- Under light oiling, the best practice is natural recovery
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing
- Oily debris can be removed where there is access
- Any cleanup activity must not mix the oil deeper into the sediments; trampling of the roots must be minimized
- Woody vegetation should not be cut

MANGROVES — ESI = 10D

DESCRIPTION

- Mangrove species in Guam and/or CNMI include: *Rhizophora mucronata*, *R. apiculata*, *Bruguiera gymnorrhiza*, *Avicennia marina*, *Lumnitzera littorea*, *Nypa fruticans*, *Xylocarpus moluccensis*, *Heritiera littoralis*, *Hibiscus tiliaceus* and *Acrostichum aureum*
- Roots and trunks are typically intertidal, with the lowest leaves inundated at high tide
- Relatively sheltered from waves and strong tidal currents
- The substrate types include mud, sand, peat and exposed volcanic rock
- Mangroves are important nursery habitats for fish and invertebrates, and feeding and nesting areas for wildlife (such as birds)
- Occur along sheltered shorelines and estuarine areas throughout the islands, representing about 2.5 percent of the shoreline

PREDICTED OIL BEHAVIOR

- Oil can wash through mangroves if it comes ashore at high tide
- Heavy and emulsified oil can be trapped in and adhere to thickets of mangrove prop roots or pneumatophores
- Re-oiling from resuspended or released oil residues may cause additional injury over time
- Oiled trees may start to show evidence of effects (leaf yellowing) days to weeks after oiling; tree mortality may take months, especially for heavy oils
- Oil that penetrates the substrate or gets mixed into the sediments can cause long-term contamination of sediments and severe mangrove injury and mortality

RESPONSE CONSIDERATIONS

- Wrack may protect the trees from oiling, so wait until the threat of oiling has passed before removing oiled wrack
- Sorbent boom can be placed in front of oiled forests to recover oil released naturally
- In most cases, no other cleanup activities are recommended
- Where thick oil accumulations are not being naturally removed, low-pressure flushing or vacuum may be attempted at the outer fringe
- No attempt should be made to clean interior mangroves, except where access to the oil is possible from terrestrial areas
- It is extremely important to prevent disturbance of soft substrates by foot traffic, which can mix oil into the sediments