ENVIRONMENTAL SENSITIVITY INDEX—U.S. VIRGIN ISLANDS

SHORELINE TYPES

The island shorelines of the study area were classified during overflights undertaken in November 1985. These flights were made at a low altitude from a small, fixed-wing aircraft. Based on previous investigations of numerous spills, shoreline types are ranked in order of increasing sensitivity (as shown below).

1. Exposed rocky shores and vertical seawalls.
2. Exposed rocky/carbonate platforms.
3. Fine-grained sand beaches.
4. Medium- to coarse-grained sand beaches.
5. Mixed sand and gravel beaches.
6. Gravel beaches and exposed riprap.
7. Exposed tidal flats (not present).
8. Sheltered coastal structures and rocky shores.
9. Sheltered tidal flats.

10a. Exposed mangroves.

10b. Sheltered mangroves.

BIOLOGICAL RESOURCES

The distribution and seasonality of oil-sensitive wildlife of the U.S. Virgin Islands were determined from review of literature and from personal interviews with local experts. The presence of fish and wildlife resources is indicated using color-coded markers with symbols and numbers.

The symbols present on each marker indicate the ecological type of the animals present. The symbols used are as follows:

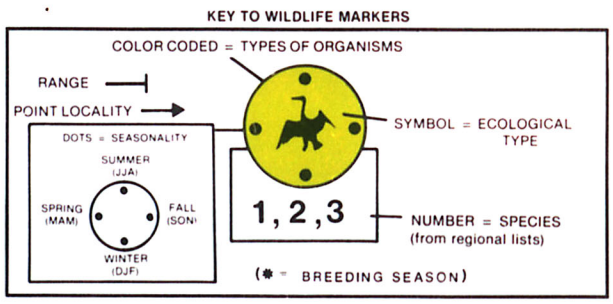
MARINE BIRDS
- Diving birds
- Seabirds
- Shorebirds
- Wading birds
- Waterfowl
- Raptors

MARINE MAMMALS
- Whales and dolphins

REPTILES
- Sea turtles

FISHES
- Marine fish

INVERTEBRATES
- Shellfish
- Coral reefs



The seasonality of the U.S. Virgin Islands is as follows:

Summer:	June through August
Fall:	September through November
Winter:	December through February
Spring:	March through May

The dot for summer is located at 12:00 (as in the face of a clock); fall at 3:00; winter at 6:00; and spring at 9:00. The seasonality may appear as a simple dot indicating the seasonal presence of the organism, or as an asterisk indicating the reproductive season.

The location of the wildlife depicted is shown using arrows or range bars. An arrow indicates a specific, localized area where a particular activity, usually reproduction, occurs. The range bars indicate broader distributional patterns for activities such as wintering areas, turtle nesting beaches, or concentration areas.

KEY TO SPECIES

BIRDS

1.	Brown pelican	*Pelecanus occidentalis*
2.	Brown booby	*Sula leucogaster*
3.	Royal tern	*Sterna maxima*
5.	Roseate tern	*Sterna dougalli*
6.	Least tern	*Sterna antillarum*
10.	Sandwich tern	*Sterna sandvicensis*
12.	Bridled tern	*Sterna anaethetus*
13.	Sooty tern	*Sterna fuscata*
14.	Brown noddy	*Anous stolidus*
15.	White-tailed tropicbird	*Phaethon lepturus*
16.	Red-billed tropicbird	*Phaethon aethereus*
17.	Masked booby	*Sula dactylatra*
18.	Red-footed booby	*Sula Sula*
19.	Magnificent frigatebird	*Fregata magnificens*
20.	Laughing gull	*Larus atricilla*
24.	Great blue heron	*Ardea herodias*
25.	Green-backed heron	*Butorides striatus*
26.	Little blue heron	*Florida caerulea*
27.	Cattle egret	*Bubulcus ibis*
28.	Great egret	*Casmerodius albus*
29.	Snowy egret	*Egretta thula*
30.	Louisiana heron	*Hydranassa tricolor*
31.	Yellow-crowned night heron	*Nyctanassa violacea*
34.	Wilson's plover	*Charadrius wilsonia*
35.	Black-bellied plover	*Pluvialis squatarola*
37.	Semipalmated sandpiper	*Calidris pusilla*
39.	Ruddy turnstone	*Arenaria interpres*
40.	Spotted sandpiper	*Actitis macularia*
42.	Lesser yellowlegs	*Tringa flavipes*
43.	Willet	*Catoptrophorus semipalmatus*
47.	Stilt sandpiper	*Micropalama himantopus*
48.	Black-necked stilt	*Himantopus mexicanus*
49.	Semipalmated plover	*Charadrius semipalmatus*
50.	American oystercatcher	*Haematopus ostralegus*
53.	Bahama duck	*Anas bahamensis*
61.	Blue-winged teal	*Anas discors*
63.	Northern pintail	*Anas acuta*
66.	American wigeon	*Anas americana*
68.	Osprey	*Pandion haliaetus*
69.	Peregrine falcon	*Falco peregrinus*
70.	Audubons shearwater	*Puffinus lherminieri*

REPTILES

1.	Hawksbill turtle	*Eretmochelys imbricata*
2.	Green turtle	*Chelonia midas*
3.	Leatherback turtle	*Dermochelys coriacea*

MAMMALS

1.	Humpback whale	*Megaptera movaeangliae*
2.	Pilot whale	*Globicephalus melaena*
3.	Spinner dolphin	*Stenella longirostris*
4.	Bottlenose dolphin	*Tursiops truncatus*

FISH

1.	Snapper	*Lutjanidae*
2.	Grouper	*Serranidae*
3.	Grunt	*Haemulonidae*

SHELLFISH

1.	Spiny lobster	*Panulirus argus*
2.	Queen conch	*Strombus gigas*
3.	West Indian top shell	*Cittarium pica*
4.	Coral reefs	

SOCIOECONOMIC FEATURES

The following features are indicated on the map to aid spill-response efforts:

- Marinas
- Boat Ramp
- Parks

SPILL-RESPONSE INFORMATION

Booms are the primary spill-response tools indicated on the maps. The positions of each are meant to be only approximate depending on the particular spill and weather conditions. They are placed to prevent oil from entering highly sensitive areas.

Skimmer locations

Boom Locations

PRIMARY REFERENCES

Much of the information presented in this atlas was obtained from personal interviews with biologists at Division of Fish and Wildlife, Department of Conservation and Cultural Affairs, and the National Park Service. In addition, the following references were used:

Raffaele, H.A., 1983, A guide to the birds of Puerto Rico and the Virgin Islands: Fondo Educatiro Interamericano, 255 pp.

Smalls, V., 1982, Sea turtle nesting at Virgin Islands National Park and Buck Island Reef National Monument, 1980 and 1981: U.S. Dept. Int., Natl. Park Serv., Research/Resources Mgmt. Rept. SER-61, 54 pp.

van Halewyn, R., and R. Norton, 1984, The status and conservation of seabirds in the Caribbean: ICBP Tech. Publ. No. 2, pp. 169-222.

Please reference as follows: Research Planning Institute, Inc.; 1986; Sensitivity of coastal environments and wildlife to spilled oil, U.S. Virgin Islands: an atlas of coastal resources: T. Ballou and W. J. Sexton; RPI/ESI/ 86-1; Columbia, S.C.; 8 maps.

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Description of Shoreline Types

EXPOSED ROCKY SHORES AND VERTICAL SEAWALLS — ESI = 1

- Exposed rocky shores are very common
- They are found most commonly on the western, northern, and eastern shorelines but are also present on the southern shores
- They are composed of steeply-dipping to vertical rock
- Exposed vertical seawalls are not common
- Fringing reefs commonly occur nearshore to exposed rocky shores

Predicted Oil Impact

- On more exposed shores:
  - Most commonly, oil will be held offshore by waves reflecting off the steep cliffs
  - Deposited light oils would be removed rapidly by wave action; heavier sticky oils are likely to remain longer
- On less exposed shores:
  - Oil removal would depend upon storm frequency
  - Oil would tend to adhere more readily to the rough, porous limestone rock surfaces

Recommended Response Activity

- On very exposed shores, no cleanup is necessary (and may be dangerous)
- On less exposed shores:
  - Low-pressure spraying may be effective while oil is still liquid
  - Manual scraping of seawalls may be necessary for removal of tarry deposits
- Cleanup of recreational areas may be necessary for aesthetic rather than environmental reasons

EXPOSED ROCKY/ CARBONATE PLATFORMS — ESI = 2

- This shoreline type is very common along the eastern beaches of St. Croix
- They consist of wave-cut or low-lying rock platforms
- Fringing reefs commonly occur nearshore to exposed platforms
- Platforms are often covered by a thin veneer of sand or gravel
- Tide/wave pools and associated organisms are common in the lower-to-middle intertidal zone
- Access to shore is highly variable; in unpopulated areas, it is very difficult

Predicted Oil Impact

- Oil will tend to accumulate along upper intertidal zones
- Tide/wave-pool organisms may be killed
- Light oils would tend to be removed rapidly by waves and evaporation
- Heavy oils and tar balls would tend to melt into crevices and depressions and may persist for long periods, especially on porous, irregular limestone

Recommended Response Activity

- In most wave-exposed areas, cleanup is not necessary
- Within high-use recreational areas:
  - Low-pressure spraying of rocks may be effective with recovery of released oil
  - Scraping of rocks impossible because of irregular surface
- Removal of organisms and attached plants should be avoided

FINE-GRAINED SAND BEACHES — ESI = 3

- They are commonly found as pocket beaches bordered by rocky headlands
- These beaches are narrow and dunes are not common
- Upper beach fauna are scarce
- They are usually high-use recreational areas with good access

Predicted Oil Impact

- Large accumulations would cover entire active beach face
- Light oil accumulations will be deposited as oily swashes along the upper intertidal zone
- Oil would accumulate in any wrack if present
- Penetration of oil into the beach will be up to 10 cm; burial will be minimal
- Shorebirds resting/feeding on these beaches may be oiled

Recommended Response Activity

- Fine-grained sand beaches are among the easiest beach types to clean
- Removal of sand from the beach should be avoided if at all possible with cleanup commencing after all oil has come ashore
- Activity through oiled areas should be limited
- Manual cleanup rather than use of road graders and front-end loaders is advised

MEDIUM- TO COARSE-GRAINED SAND BEACHES — ESI = 4

- These beaches are not common within the study area
- They may be present as small pocket beaches or as sand spits and tombolos
- They usually have a moderate slope and are mixed carbonate, clastic sediments
- Species density and diversity are low

Predicted Oil Impact

- Large accumulations would cover entire beach face
- Small accumulations would be deposited primarily as swash lines and in wrack deposits
- Oil penetration would be up to 10 to 15 cm, with light oils penetrating deeper than heavy oils
- Oil may become deeply buried (30-50 cm) into the beach sands

Recommended Response Activity

- Cleanup should commence only after the majority of oil has come ashore
- Cleanup may be difficult because of relatively soft sediments
- Access to the shoreline may be difficult
- Cleanup should concentrate on oil and oily debris removal from the upper beach face
- Sand removal should be minimal to avoid erosion problems
- No attempt should be made to remove buried oil

MIXED SAND AND GRAVEL BEACHES ESI = 5

- These beaches are very common throughout the study site
- They are composed of a mixture of coarse-grained, carbonate-rich sand, gravels of varying sizes, and shell fragments
- In active beaches, organisms are scarce because of the mobility of the sediment
- In more stable beaches, moderate faunal species and diversity are present
- The large rocks may also provide habitat for chitons, snails, and crabs

Predicted Oil Impact

- Oil penetration may be high with greatest penetration in coarse, well-sorted sediments (gravel)
- Under very heavy accumulations, oil may spread across the entire beach face with greatest concentrations along the high-tide swash zone
- Biota present may be killed by the oil, either by smothering or by lethal concentrations in the water

Recommended Response Activity

- Cleanup should commence only after the majority of oil has impacted beach
- Oiled wrack and debris deposits should be removed
- Low-pressure spraying may be used effectively on gravel-rich beaches
- Removal of sediment should be limited
- Mechanical scraping and/or reworking of sediment is not recommended or effective

GRAVEL BEACHES AND EXPOSED RIPRAP ESI = 6

- Gravel beaches are common throughout the study area and frequently occur in areas with rocky shores
- Riprap structures generally are found in harbors and industrial sites
- Exposed concrete armor units (dolos, tetrapods, etc.) are most common on St. Thomas
- Biomass is generally very low in high-wave areas; at calmer sites, faunal densities and species are high

Predicted Oil Impact

- Oil on gravel beaches would coat individual rocks and penetrate to several tens of centimeters into substrate
- Cavities in riprap structures may be completely filled
- Penetration would be greatest in areas of largest grain size and poorest sorting
- If oil is left to harden, an asphalt/gravel pavement may result
- Resident fauna and flora may be killed by the oil

Recommended Response Activity

- On gravel beaches, heavily oiled wrack and debris should be removed
- There should be no removal of sediments or riprap
- High-pressure spraying of oiled riprap and gravel may help in cleaning exposed surfaces but would have little effect on oil penetrated deeply into structures or gravel without extensive reworking
- For small areas of impact, riprap units can be manually wiped or scraped to remove oil

EXPOSED TIDAL FLATS — ESI = 7

Not Present

SHELTERED COASTAL STRUCTURES AND ROCKY SHORES — ESI = 8

- Such structures are commonly found in harbors and industrial sites
- They occur as short segments of various man-made structures (seawalls, docks, bulkheads, riprap revetments) in developed areas
- Sheltered rocky shores are common in small coves and bays

Predicted Oil Impact

- Oil will penetrate into the joints and voids of the structure
- Oil will coat the intertidal surfaces of solid structures and rocky shores
- Biota living on the structures and bedrock (barnacles, coral, snails) would be impacted
- Oil may persist for weeks to months

Recommended Response Activity

- Low-pressure spraying of the structures and rocky shores may be required:
  - To remove oil
  - To prepare structures for recolonization of barnacles, coral, etc.
  - For aesthetic reasons, in high-use recreational areas
  - To prevent the chronic leaching of oil from the structure

SHELTERED TIDAL FLATS — ESI = 9

- Sheltered tidal flats are not common in the study site
- They are composed of mud and very fine-grained sand
- Tidal flats are small because of the low tidal range
- They are often associated with mangrove swamps
- High densities and species richness of both epifauna and infauna are common

Predicted Oil Impact

- Oil deposition commonly will occur along the upper fringes of the flat
- Very heavy accumulations will cover much of the flat surface
- Oil may persist for many years; natural removal is very slow
- Long-term contamination of muddy tidal-flat sediments is common
- Organisms living in the sediments will be impacted

Recommended Response Activity

- These environments are high-priority areas necessitating the use of spill-protection devices such as booms to prevent or minimize oil impact
- No cleanup is recommended since such operations are likely to be more harmful than oil impact
- Sorbent booms can be deployed along the low-tide line to absorb oil as it is slowly released, but they must be changed frequently to be effective

EXPOSED MANGROVES — ESI = 10a

- Mangroves are most common on eastern ends of the islands
- They are exposed to relatively high wave activity and currents
- Occurrence of heavy wrack deposits in storm swash lines is common
- Sediment types range from thin layers of sand and mud to muddy peat on bedrock
- The topographic profile is generally flat
- Mangrove forests are rendered inaccessible by density, width, elevation, and sediment type

Predicted Oil Impact

- As oil moves into forests, roots and associated epiphytic communities would be coated with a band of oil
- Oiling of sediment would occur if large quantities of oil were washed ashore
- Persistence would be long-term with heavy accumulations
- Presence of a beach berm, fronting the mangroves, would limit the extent of oil impact to seaward side of berm, thus preventing oiling of forest interiors

Recommended Response Activity

- Under most conditions, the best practice is to allow natural recovery, especially where natural cleaning can occur
- Placement of sorbent boom along the mangrove forest fringe may reduce the quantity of oil significantly
- With heavy accumulations when cleanup is deemed necessary, low-pressure flushing (used in conjunction with sorbent boom) may be effective in cleaning oil from prop roots of fringing mangroves (only during low wave activity and ebbing tides)
- All cleanup activities should be carefully supervised to avoid excessive traffic and disturbance in the mangroves

SHELTERED MANGROVES — ESI = 10b

- These wetlands are located in bays and estuaries well-sheltered from waves and tidal currents
- Sediments are composed of thin-to-thick deposits of mud or irregular rock
- Topographic profiles are very flat

Predicted Oil Impact

- As oil enters mangrove forests, their roots and associated epiphytic communities would be covered with a band of oil
- Oiling of sediments would occur if large quantities of oil were washed ashore
- Oil in heavy accumulations may persist for decades
- Even small quantities of oil will persist for years; physical removal will be very slow

Recommended Response Activity

- No cleanup is recommended under light-to-moderate accumulations
- Under heavy accumulations, to prevent chronic oil pollution of surrounding areas, placement of sorbent booms along fringing mangrove forest (to absorb oil as it is slowly released) may be effective under close scientific supervision
- No attempt should be made to clean the interior mangroves
- Proper strategic boom placement in sheltered lagoonal areas may be effective in trapping large quantities of oil and reducing impact to interior mangrove forests