ENVIRONMENTAL SENSITIVITY INDEX—COOK INLET/KENAI PENINSULA, ALASKA

SHORELINE TYPES

The list below, presented in order of increasing sensitivity to spilled oil, provides a summary of all shoreline types common to the Cook Inlet/Kenai Peninsula region. All shoreline types are found within the study area.

1. Exposed rocky shores
2. Exposed wave-cut platforms
3. Fine-grained sand beaches
4. Coarse-grained sand beaches
5. Exposed tidal flats
6. Mixed sand and gravel beaches
7. Gravel beaches
8. Sheltered rocky shores
9. Sheltered tidal flats
10. Marshes

BIOLOGICAL RESOURCES

The biological resources of the study area were determined during a field survey conducted in 1985, from published literature, from unpublished biological resource maps provided by the Alaska Department of Fish and Game (ADFG), and from personal communications with ADFG staff biologists.

The biological resources of Cook Inlet are highly diverse and abundant. The fish and wildlife resources represented on the ESI maps were selected on the basis of commercial or recreational importance, special status under various state or federal wildlife protection laws, or inherent sensitivity to the toxic or sublethal effects of oil pollution. Sensitivity to oil was determined from documented effects on fish and wildlife species at previous oil spill incidents, the spatial and temporal distribution of the organisms, and intrinsic physiological sensitivity to petroleum hydrocarbons.

The information presented is based on documented use by fish and wildlife of the nearshore areas shown on the maps. Known concentration areas such as bird rookeries, marine mammal nurseries, and haulout areas, anadromous fish streams, and shellfish beds are shown as site-specific features. In addition, the general distribution of fish and wildlife is indicated and is based on documented observations and known ecological associations with specific habitats.

The symbols used to indicate these resources are presented below.

MARINE MAMMALS
- Seals, sea lions, and otters
- Whales and dolphins

MARINE BIRDS
- Birds of prey
- Diving birds
- Seabirds
- Shorebirds
- Wading birds
- Waterfowl

SHELLFISH
- Bivalve molluscs
- Crabs
- Shrimp

FISHES
- Anadromous fishes
- Nonanadromous fishes

The seasonality of the fish and wildlife of Cook Inlet is as follows:

Spring:	Early-to-late April through mid-to-late June
Summer:	Mid-to-late June through mid-to-late August
Fall:	Mid-to-late August through early-to-mid November
Winter:	Early-to-mid November through early-to-late April

where early means the 1st to the 10th of the month, mid means the 11th to the 20th of the month, and late means the 21st to the 31st of the month.

KEY TO SPECIES

BIRDS			
	1.	Common loon	*Gavia immer*
	2.	Arctic loon	*Gavia arctica*
	4.	Red-necked grebe	*Podiceps grisegena*
	5.	Horned grebe	*Podiceps auritus*
	8.	Double-crested cormorant	*Phalacrocorax auritus*
	10.	Pelagic cormorant	*Phalacrocorax pelagicus*
	12.	Canada goose	*Branta canadensis*
	14.	White-fronted goose	*Anser albifrons*
	15.	Snow goose	*Chen caerulescens*
	16.	Mallard	*Anas platyrhynchos*
	17.	Pintail	*Anas acuta*
	18.	Green-winged teal	*Anas crecca*
	20.	Northern shoveler	*Anas clypeata*
	21.	Canvasback	*Aythya valisineria*
	22.	Greater scaup	*Aythya marila*
	23.	Lesser scaup	*Aythya affinis*
	24.	Common goldeneye	*Bucephala clangula*
	25.	Barrow's goldeneye	*Bucephala islandica*
	26.	Bufflehead	*Bucephala albeola*
	27.	Oldsquaw	*Clangula hyemalis*
	28.	Harlequin duck	*Histrionicus histrionicus*
	29.	White-winged scoter	*Melanitta deglandi*
	30.	Surf scoter	*Melanitta perspicillata*
	32.	Common merganser	*Mergus merganser*
	33.	Red-breasted merganser	*Mergus serrator*
	35.	Parasitic jaeger	*Stercorarius parasiticus*
	36.	Glaucous-winged gull	*Larus glaucescens*
	38.	Herring gull	*Larus argentatus*
	41.	Mew gull	*Larus canus*
	46.	Common murre	*Uria aalge*
	47.	Pigeon guillemot	*Cepphus columba*
	48.	Marbled murrelet	*Brachyramphus marmoratus*
	49.	Cassin's auklet	*Ptychoramphus aleuticus*
	51.	Tufted puffin	*Lunda cirrhata*
	53.	Northern phalarope	*Phalaropus lobatus*
	62.	Least sandpiper	*Calidris minutilla*
	69.	Semipalmated plover	*Charadrius semipalmatus*
E	76.	Bald eagle	*Haliaeetus leucocephalus*
	77.	Osprey	*Pandion haliaetus*
	80.	Arctic tern	*Sterna paradisaea*
	81.	Horned puffin	*Fratercula corniculata*
	82.	Glaucous gull	*Larus hyperboreus*
	84.	Parakeet auklet	*Cyclorrhynchus psittacula*
	99.	Red-faced cormorant	*Phalacrocorax urile*
	100.	Black-legged kittiwake	*Rissa tridactyla*
	101.	Aleutian tern	*Sterna aleutica*
	102.	Fork-tailed storm-petrel	*Oceanodroma furcata*
	103.	Common eider	*Somateria mollissima*
	105.	Thick-billed murre	*Uria lomvia*
	106.	Ancient murrelet	*Synthliboramphus antiquus*
E	107.	Peregrine falcon	*Falco peregrinus*
	124.	Redhead	*Aythya americana*
	129.	Northern fulmar	*Fulmarus glacialis*
	152.	American oystercatcher	*Haematopus palliatus*
	158.	King eider	*Somateria spectabilis*
	160.	Red phalarope	*Phalaropus fulicarius*
	161.	Rock sandpiper	*Calidris ptilocnemis*
	162.	Gadwall	*Anas strepera*
	169.	American wigeon	*Anas americana*
	170.	Trumpeter swan	*Olor buccinator*
	172.	Sandhill crane	*Grus canadensis*
	181.	Marsh hawk	*Circus cyaneus*
	197.	Black scoter	*Melanitta nigra*
	199.	Pomarine jaegar	*Stercorarius pomarinus*
	200.	Sooty shearwater	*Puffinus griseus*
	201.	Short-tailed shearwater	*Puffinus tenuirostris*
SHELLFISH			
	6.	Pink shrimp	*Pandalus borealis*
	7.	Sidestripe shrimp	*Pandalopsis dispar*
	10.	Humpy shrimp	*Pandalus goniurus*
	11.	Coon-stripe shrimp	*Pandalus danae*
	14.	Dungeness crab	*Cancer magister*
	16.	King crab	*Paralithodes* sp.
	25.	Soft-shell clam	*Mya arenaria*
	28.	Razor clam	*Siliqua patula*
	40.	Tanner crab	*Chionoecetes bairde*
FISH			
	7.	Pacific halibut	*Hippoglossus stenolepis*
	66.	Pacific herring	*Clupea harengus pallasi*
	68.	Chinook salmon	*Oncorhynchus tshawytscha*
	69.	Coho salmon	*Oncorhynchus kisutch*
	70.	Pink salmon	*Oncorhynchus gorbuscha*
	71.	Sockeye salmon	*Oncorhynchus nerka*
	72.	Chum salmon	*Oncorhynchus keta*
	74.	Rainbow trout steelhead	*Salmo gairdneri*
	135.	Dolly varden	*Salvelinus malma*
	156.	American sand lance	*Ammodytes americanus*
	189.	Arctic char	*Salvelinus alpinus*
MAMMALS			
T	1.	Northern (Steller) sea lion	*Eumetopias jubatus*
	2.	Harbor seal	*Phoca vitulina*
	4.	Killer whale	*Orcinus orca*
	6.	Harbor porpoise	*Phocoena phocoena*
T	7.	Sea otter	*Enhydra lutris*
	9.	Beluga whale	*Delphinapterus leucas*
	28.	Dall porpoise	*Phocoenoides dallii*

T–THREATENED **E**–ENDANGERED

SOCIOECONOMIC FEATURES

Socioeconomic features that may be adversely affected by oil spills are indicated on the maps where that information is available. Much of the Cook Inlet area is sparsely inhabited, so these features tend to be associated with the larger towns and cities. State management areas are indicated in writing on the appropriate maps.

The symbols used to indicate socioeconomic features are as follows:

- Parks
- Marinas
- Boat ramps

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Description of Shoreline Types

EXPOSED ROCKY SHORES — ESI=1

- Exposed rocky shores are most common along the outer Kenai Peninsula
- They are composed of steeply dipping to vertical bedrock, with little to no beach
- Normal wave climate is of high energy
- Many of the more remote cliffs are heavily used by marine birds and mammals, which are indicated by wildlife symbols

Predicted Oil Impact

- Oil will be held offshore by waves reflecting off the steep cliffs
- Oil persistence will be short and will be a function of the wave energy during the spill; during high wave energy, oil will be removed in days
- Impacts to intertidal organisms are expected to be of short duration
- Marine birds and mammals using these rocky shores may be affected

Recommended Response Activity

- On most shores, no cleanup is necessary or recommended
- Access is usually very difficult
- Monitoring for impacts to marine birds and mammals is advised

EXPOSED WAVE-CUT PLATFORMS — ESI=2

- Exposed wave-cut platforms are most common along the western shore of lower Cook Inlet
- They are composed of a wave-cut rock terrace which can be up to several kilometers wide and exposed to high wave energy
- The shoreline is backed by a steep rock scarp
- There may be a narrow, perched beach of gravel and boulders at the base of the scarp
- The surface is irregular, with numerous tidal pools
- They may be used by marine birds and mammals, as indicated by wildlife symbols

Predicted Oil Impact

- Oil may be transported across the platform and accumulate along the high-tide line
- There may be a short-term oiling of the beach sediments, if present
- Persistence is limited to days or weeks, as a function of the wave energy
- Tidal pool organisms may be killed, but recovery of populations can be rapid

Recommended Response Activity

- Cleanup is not necessary in most areas
- Monitoring for impacts to marine birds and mammals is advised

FINE-GRAINED SAND BEACHES — ESI=3

- Fine-grained sand beaches are the least common shoreline type in the study area
- These wide, flat beaches are composed of fine-grained sand

Predicted Oil Impact

- During small spills, oil tends to be deposited at the high-tide line
- Large spills will cover the entire beach face
- Oil penetration into the sediments will be only a few centimeters
- Oil penetration into the surface sediments and burial by clean sand will be minimal

Recommended Response Activity

- Cleanup may not be necessary if located in a remote area
- Oiled wrack and debris can be removed readily at any time

COARSE-GRAINED SAND BEACHES ESI=4

- Coarse-grained sand beaches are not very common throughout the study area
- These wide, steep beaches are composed of coarse-grained sand

Predicted Oil Impact

- During small spills, oil tends to be deposited at the high-tide line
- Large spills will cover the entire beach face
- Oil penetration into the sediments can be up to 25 cm
- Oil can be buried rapidly by clean sand to depths of up to 50 cm

Recommended Response Activity

- Cleanup may not be necessary if located in a remote or exposed area
- Oiled wrack and debris can be removed readily

EXPOSED TIDAL FLATS ESI=5

- Exposed tidal flats are common throughout the study area because of the high tidal range; particularly common and wide in upper Cook Inlet
- They are exposed to moderate wave energy, tidal currents, and/or river flow
- They are composed of sand and/or sand and gravel and are frequently covered by sand bars
- Areas of shellfish harvest or heavy bird use are denoted by wildlife symbols

Predicted Oil Impact

- Heaviest concentrations will be along the high-tide line
- Most oil will be transported across the flat with the rising tide
- Heavy accumulations will cover the flat during low tide
- Biological impacts to shellfish and birds may be severe

Recommended Response Activity

- Cleanup is generally not recommended
- When deemed necessary, cleanup should be done manually to prevent mixing of oil into the sediments by heavy machinery
- Cleanup should concentrate on accumulations at the high-tide line
- Potential contamination of commercial shellfish should be monitored
- Hazing of birds from the oiled areas may be necessary

MIXED SAND AND GRAVEL BEACHES ESI=6

- Mixed sand and gravel beaches are the most common shoreline type in Cook Inlet, occurring as:
  - -Pocket beaches along rocky shores
  - -Extensive beaches in front of till cliffs
  - -Perched beaches on bedrock platforms
- They are present in both sheltered and exposed areas
- Coarse-grained sand and gravels of various sizes compose these beaches
- There may be heavy accumulations of wrack and debris at the high-tide line

Predicted Oil Impact

- Oil will be deposited primarily along the high-tide swash line
- During large spills, oil will spread across the entire beach face
- Oil penetration into the beach sediments may be up to 60 cm
- Burial of oil may be very deep at the high-tide berm
- Along exposed shorelines, oil will be removed rapidly by wave action

Recommended Response Activity

- Heavy accumulations of oil and oil-soaked debris at the high-tide swash line may be removed
- Exposed beaches do not require cleanup unless heavily oiled
- Removal of sediment should be minimal to prevent erosion
- Mechanical reworking of the sediment into the surf zone and/or high-pressure water spraying can effectively remove fresh oil, especially in sheltered areas; sorbent boom should be used to contain released oil

GRAVEL BEACHES ESI=7

- Gravel beaches are an uncommon shoreline type, occurring as short sections along rocky coasts
- They are composed of a wide range of gravel- to boulder-sized material
- They are present in both exposed and sheltered areas
- The beach is generally narrow and steep

Predicted Oil Impact

- Oil will penetrate deeply into the beach
- Persistence can be long term, especially if oil penetrates into the more sheltered interior spaces between the rocks
- If the oil is not removed, it may harden into an asphalt-like pavement
- Natural removal will be a function of normal wave activity and storm frequency

Recommended Response Activity

- No cleanup is necessary in exposed areas with low-to-moderate accumulations
- Sediment should not be removed under any conditions
- During large spills in sheltered areas, mechanical furrowing of oiled sediment into the surf zone may be attempted

SHELTERED ROCKY SHORES ESI=8

- Sheltered rocky shores are common throughout the study area
- They occur as:
  - -Vertical rock walls fronted by muddy tidal flats along sheltered bays, such as along western Cook Inlet bays
  - -Vertical rock walls and boulder-strewn rocky ledges along the inside of bays and coves, such as along the Kenai Peninsula
  - -Wide rock platforms, such as at the head of Kamishak Bay

Predicted Oil Impact

- Oil tends to adhere readily to rocky surfaces
- Even light accumulations can persist for years, especially between rocks
- Heavy accumulations can coat the entire intertidal zone

Recommended Response Activity

- Cleanup is very difficult; therefore, these areas require priority protection
- High- and low-pressure water spraying is effective on fresh oil
- Weathered oil can be removed only by physical scraping
- Cutting of oiled algae is generally not recommended unless it is determined to be a significant source of contamination itself

SHELTERED TIDAL FLATS ESI=9

- Sheltered tidal flats are common throughout the area, particularly along western and upper Cook Inlet
- They occur at the head of most bays and behind exposed tidal flats along upper Cook Inlet
- They can be very wide, up to several kilometers across
- They are composed of very soft mud or muddy sand
- Although wave activity is low, these flats may be exposed to moderate tidal currents
- They may be heavily used by birds for feeding and as staging areas during migration

Predicted Oil Impact

- Oil is most likely to be transported across the tidal flat and deposited along the high-tide line
- Very heavy accumulations can cover much of the tidal flat surface, but penetration will not occur into the water-saturated sediments of the flat
- In areas of high suspended sediments, sorption of oil onto them can result in contaminated sediments that can be deposited on the flats
- When sediments are contaminated, oil may persist for many years

Recommended Response Activity

- These areas require high priority for protection against oil contamination
- Cleanup of tidal flats is nearly impossible because of the soft substrate
- Cleanup is usually not even considered because of the likelihood of mixing oil deeper into the sediments during the cleanup effort
- Passive cleanup efforts such as sorbent boom can be used to retain oil as it is naturally removed

MARSHES ESI=10

- Marshes are common throughout the study area, though widely variable in extent as:
  - -Small areas associated with streams entering bays
  - -Moderate-sized marshes along the inside and at the head of major embayments
  - -Extensive wetland areas along rivers
  - -Expansive wetlands bordering the shoreline of upper Cook Inlet
- The high tidal range results in the presence of numerous tidal channels
- They are always fronted by tidal flats
- Marshes are heavily utilized by birds for nesting and feeding

Predicted Oil Impact

- Small amounts of oil will contaminate the outer marsh fringe only; natural removal by wave and tidal energy can occur within months
- Large spills will cover more area and may persist for decades
- Spring tides can transport oil deep into the marsh, contaminating areas above normal tidal flushing
- Oil, particularly the heavy fuel oils, tends to adhere readily to marsh grasses

Recommended Response Activity

- Marshes require the highest priority for shoreline protection
- Natural recovery is recommended when:
  - -A small extent of marsh is affected
  - -A small amount of oil impacts the marsh fringe
  - -A small-to-moderate spill occurs during late fall or winter
  - -There are no large concentrations of birds or mammals using the marsh
- The preferred cleanup method is a combination of low-pressure flushing, sorption, and vacuum pumping performed from boats
- Any cleanup activities should be supervised closely to avoid excessive disturbance of the marsh surface or roots
- Oil wrack and other debris may be removed by hand