




## Toxic Effects of Oil

- ▶ Oil = Complex mixture of toxic components
- ▶ Routes of Exposure
  - External
    - ▶ Physical impairment
    - ▶ Dermal/ocular irritation and ulceration
  - Internal
    - ▶ Inhalation of volatiles
    - ▶ Ingestion of oil
      - Organ damage
      - Reproductive disorders

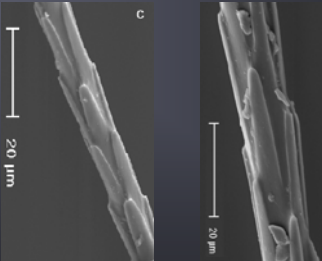


## Sea Otters/Fur Seals

- ▶ Specialized fur: Keeps cold water away from skin
- ▶ Oil interferes with ability to trap & hold air
- ▶ Leads to loss of:
  - Insulation
  - Buoyancy
  - Swimming
- ▶ Causes:
  - Hypothermia
  - Dehydration
  - Starvation



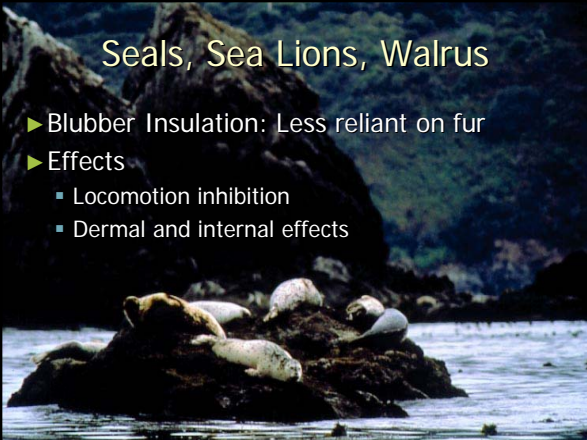
## Oil physically disrupts the normal architecture of fur



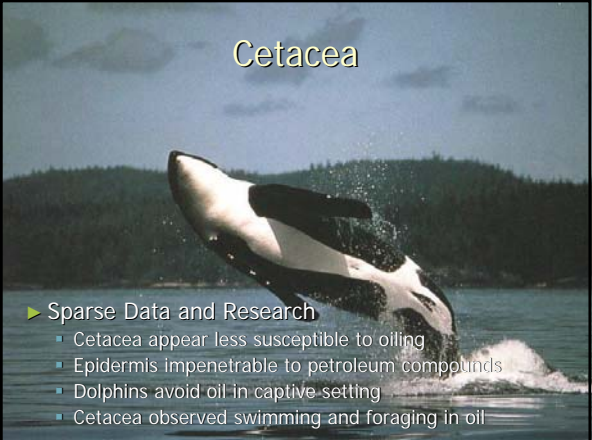
Clean fur                      Oiled fur

## Seals, Sea Lions, Walrus

- ▶ Blubber Insulation: Less reliant on fur
- ▶ Effects
  - Locomotion inhibition
  - Dermal and internal effects



## Cetacea

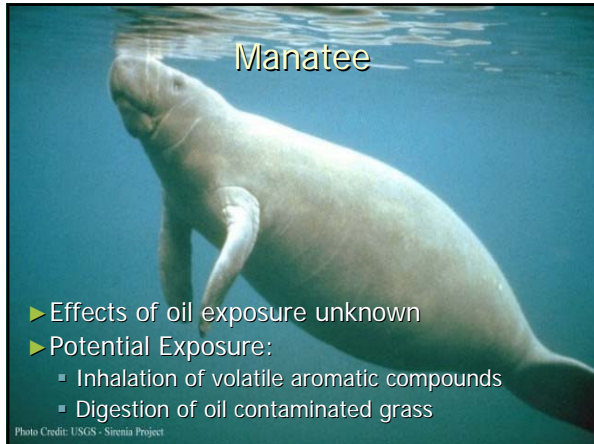


- ▶ Sparse Data and Research
  - Cetacea appear less susceptible to oiling
  - Epidermis impenetrable to petroleum compounds
  - Dolphins avoid oil in captive setting
  - Cetacea observed swimming and foraging in oil

## Manatee


- ▶ Effects of oil exposure unknown
- ▶ Potential Exposure:
  - Inhalation of volatile aromatic compounds
  - Digestion of oil contaminated grass

Photo Credit: USGS - Sirenia Project



## Dermal Effects

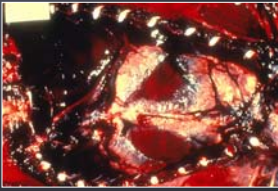
- ▶ Mucosal irritation
- ▶ Skin irritation
- ▶ Ocular ulceration
- ▶ Predisposed to bacterial infections



## Respiratory Effects

- ▶ Volatile components
  - Aromatics
- ▶ Fume inhalation pneumonia
- ▶ Interstitial pulmonary emphysema
- ▶ Bullous emphysema
- ▶ Pneumothorax

Pulmonary edema & hemorrhage



## Sources of Ingested Oil

- ▶ Grooming and nursing
- ▶ Water contamination
- ▶ Prey contamination



Grooming




Prey Contamination



Baleen whale skim feeding

## Gastrointestinal Effects


- ▶ Mucosal damage
- ▶ GI ulcers
- ▶ GI bleeding
- ▶ Maldigestion
- ▶ Malabsorption
- ▶ Diarrhea
- ▶ Organ damage
  - CNS, kidney, liver



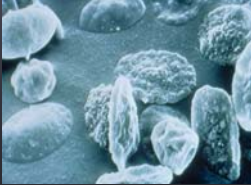
## Hematological Effects

- ▶ Anemia
  - Destruction (hemolysis)
  - Decreased production (chronic disease)
  - Loss (hemorrhage)
- ▶ Immunotoxicosis
  - Leukopenia
  - ↑ interleukin-6

Healthy avian red blood cells



Oil exposed avian red blood cells



## Reproductive Effects

- ▶ Altered reproductive behavior
- ▶ Early embryonic death
- ▶ Decreased pup survival
- ▶ Increased pup abandonment



## Population Level Effects

- ▶ Massive declines in abundance
- ▶ Population distributions may change
- ▶ Age-class shifts
- ▶ Potential loss of genetic diversity
- ▶ Extinction of threatened & endangered species
- ▶ None



## Effects of Oil on Harbor Seals

Evidence from *EVOS* (Loughlin 1994)



- ▶ Behavioral changes
  - No oil avoidance, "tameness", lethargy, dullness, - visual acuity
- ▶ Physical exam findings
  - Corneal ulcers, conjunctivitis, diarrhea, + AST, ALT, LDH, anemia
- ▶ Histopathological findings
  - Conjunctivitis, epidermal/hepatic/renal lesions, neuronal damage
- ▶ Reproductive
  - 26% decrease in pup production
- ▶ Chemical analyses
  - Elevated petroleum hydrocarbons in tissues
  - Metabolites in bile present one year after the *EVOS*

## Effects of Oil on Cetaceans

Evidence from *EVOS*



- ▶ Killer Whale Losses
  - 14 members of AB pod missing (presumed dead)
  - 11 members of AT pod missing (presumed dead)
  - Only 5 carcasses found (1990-1992)
    - ▶ Cause of death could not be determined
- ▶ Other Cetaceans
  - Record number of carcasses found (n=37)
    - ▶ Potentially due to increased survey effort
  - Tissues from 7 carcasses were tested for hydrocarbons
    - ▶ One gray whale had hydrocarbons in blubber
  - Cause of death could not be determined