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SIXTH EDITION

Invitation to Oceanography

Chapter 15

The Human Presence in the Ocean

Petroleum is a complex mixture of hydrocarbons with various amounts of nitrogen and metals.

- Oil as it comes from the ground is called crude oil or petroleum.
- It must be transported and refined in order to make usable hydrocarbon compouds that drive the global economy

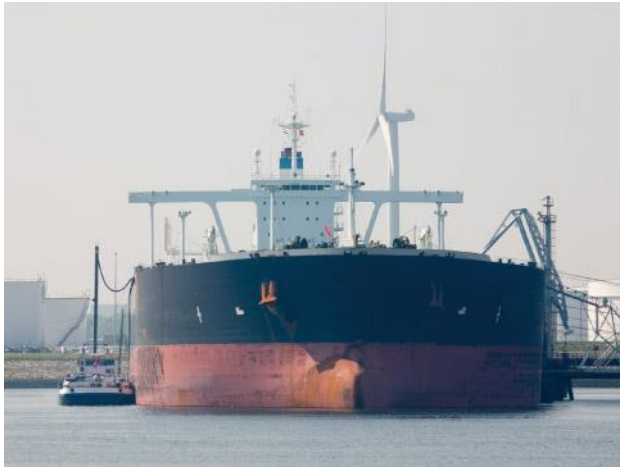

Figure 15.01a: Tanker delivering oil to a refinery.

Figure 15.01b: Oil refinery.

Crude Oil Transportation Routes (Tankers)

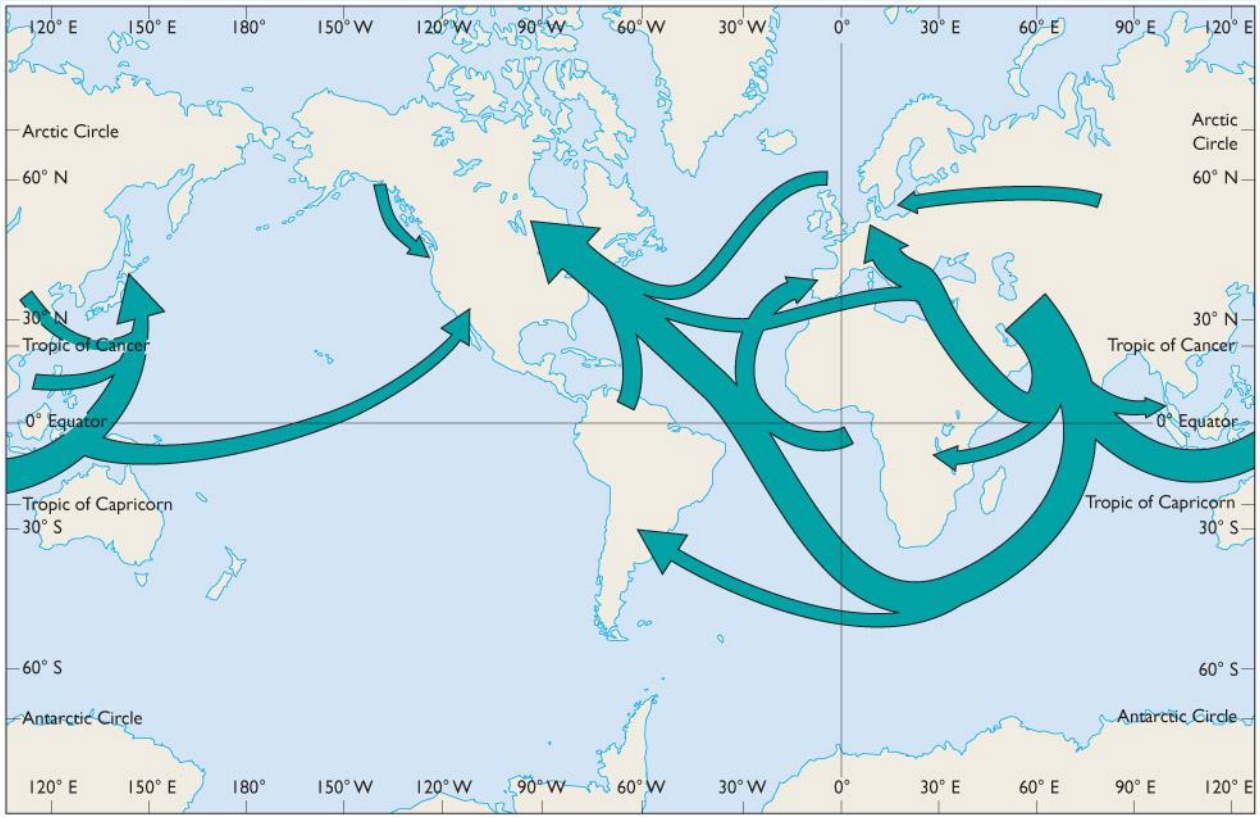

Figure 15.02: The thickness of the arrows indicates the relative volume of petroleum transported across the oceans.

Oil in the Sea

- Only a small fraction of the oil in the sea comes from major oil tanker accidents.

- Most oil in the sea is the result of river runoff and normal tanker operations.

- Once in the environment, an oil spill begins to be altered in a complex variety of ways.

Pathways and Movement of Oil Through the Ocean and Its Bio-Geo-Chemical Systems

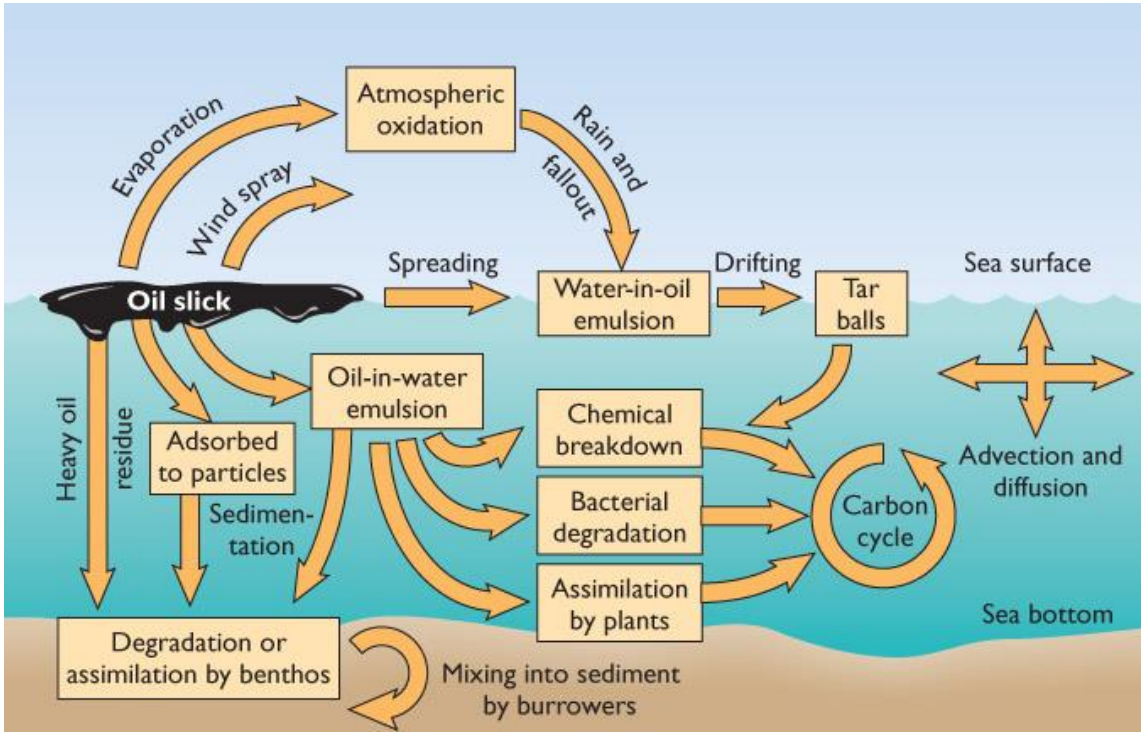

Figure 15.03: An oil slick in the sea is affected by complex interactions (physical, chemical, and biological processes) that cause weathering of the slick with time.

Weathering and Breakdown of Spilled Oil

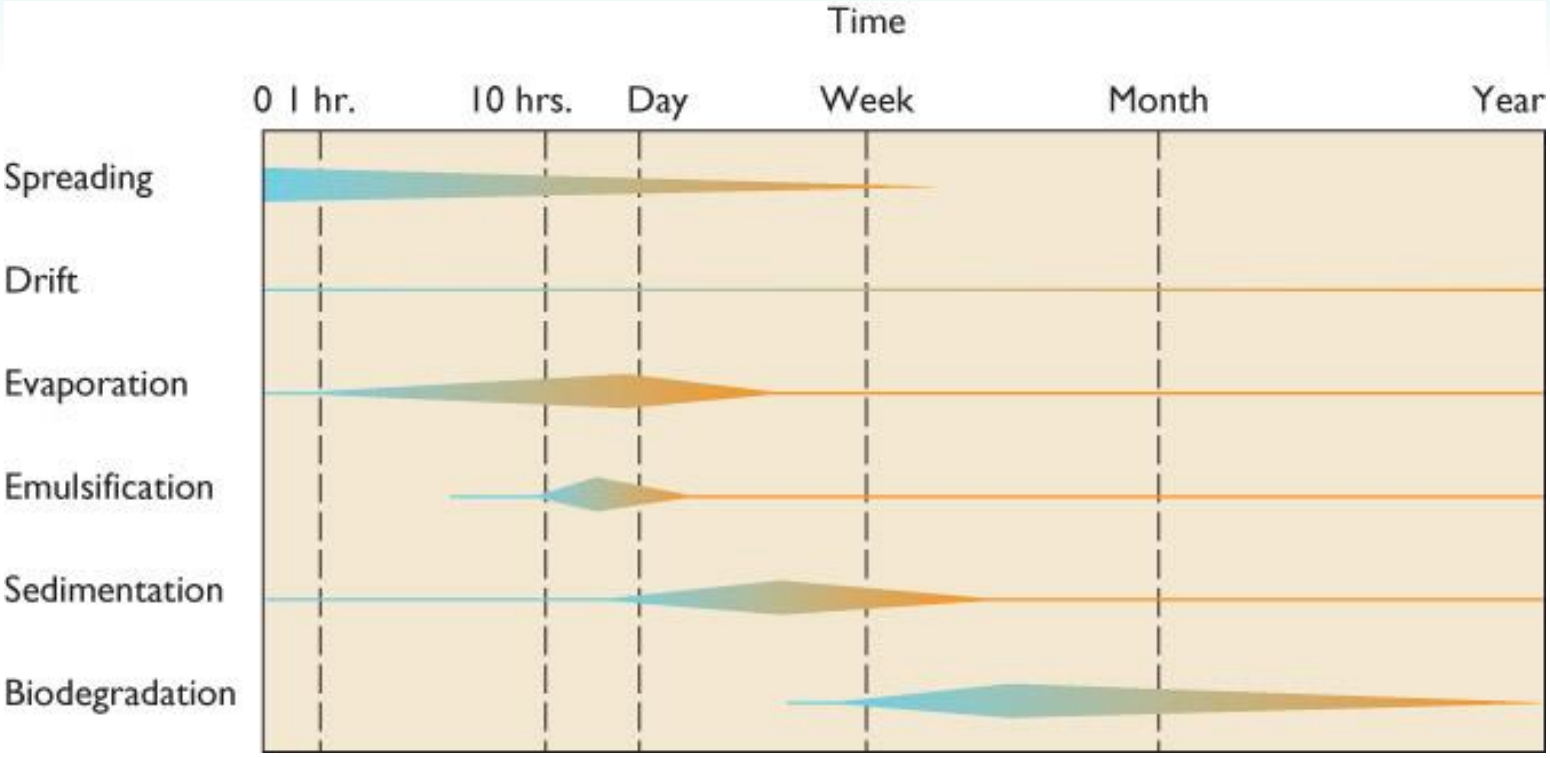

Figure 15.04: Different processes dominate at different times during the various stages in the natural weathering of an oil slick.

There are several methods employed in attempting to clean a spill:

- floating booms
- chemical dispersants
- burning the oil at the surface
- skimming
- bioremediation

Figure 15.06b: Burning an oil slick is difficult and, in effect, transfers the pollution to the atmosphere.

Figure 15.06a: Large, floating booms are used to contain oil slicks, the oil then being transferred to ships or barges.

Wastes

- Each year humans produce over 20 billion tons of **wastes**
  - Much of it is disposed of in the ocean.
  - Even waste that is disposed of on land has a very high chance to reach the ocean over longer time scales.

- Most of the wastes come from farmland, cities and industrial areas.
  - They enter the sea through rivers.

- Wastes tend to be concentrated in harbors, bays, and estuaries.

Direct Discharge of Industrial/Municipal Waste at Sea:

- Strong spatial and temporal correlations between waste discharge and major changes in ecosystem balance

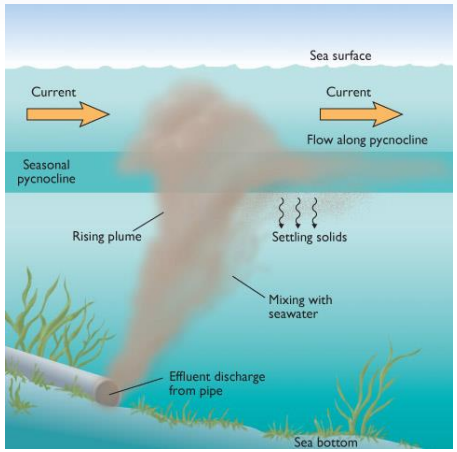

Figure 15.07a: (a) Effluents discharged from a pipe tend to rise as a plume and spread out along pycnoclines.

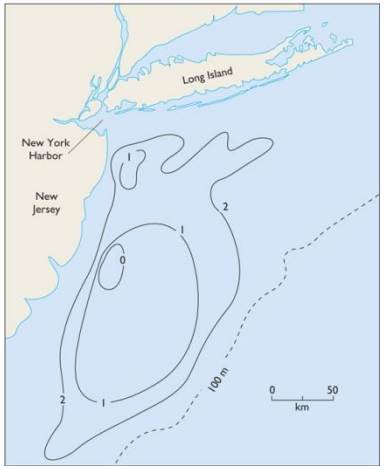

Figure 15.08a: The New York Bight has been a long-standing dumping site, creating bottom water that has little dissolved oxygen.

Figure 15.08b: Bottom water along the continental shelf of Louisiana is hypoxic due to the high BOD of the organic discharge from the Mississippi River.

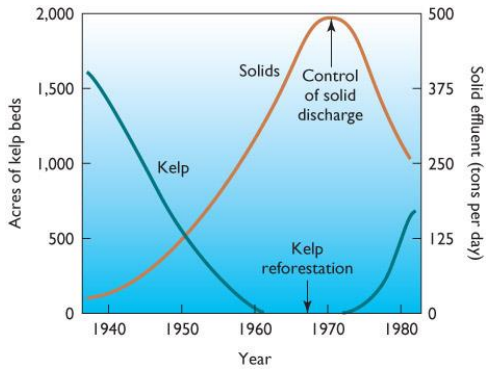

Figure 15.10a: Kelp beds near Palos Verdes, CA, have been destroyed by discharge of solid wastes. They are rebounding, though, because of restoration efforts.

Pollution and Cleaning

- All bodies of water have a natural capacity to clean themselves of a certain amount of pollution.

- Dense human populations can produce so much pollution that the self-cleaning capacity of the marine habitat is exceeded.

- As pollution enters the sea, it can be greatly diluted by waves, tides, and currents.

Types of Waste

- Sewage consists of mostly human waste sludge or organic and inorganic chemicals.

- Heavy metal is a term loosely applied to a collection of elements such as:
  - Lead
  - Mercury
  - Cadmium
  - Arsenic
  - Copper
  - Nickel
  - They normally occur in trace amounts in the ocean, but are toxic in larger dosages.

Nickel Concentrations in Narragansett Bay, Rhode Island - part of a larger system with many expressions of human impact.

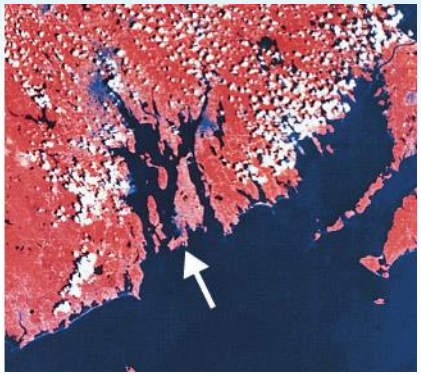

Figure 15.11a: A satellite image of Narragansett Bay.

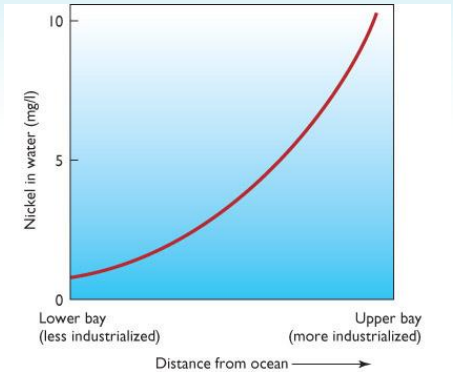

Figure 15.11b: The dramatic increase in the nickel concentrations of the waters of Narrangansett Bay indicates the source of the metal is at the head of the bay.

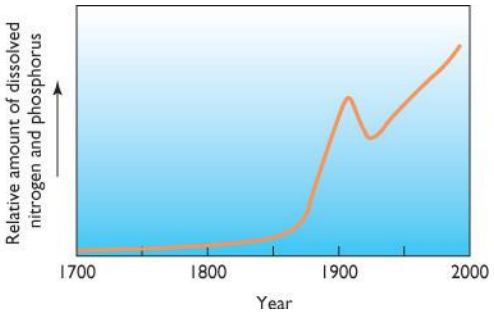

Figure 15.11c: The upper reaches of Narragansett Bay have received an ever-increasing load of nutrients from the surrounding land.

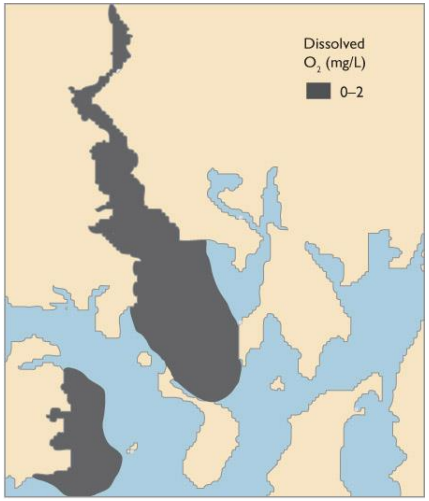

Figure 15.11d: Hypoxic and near-anoxic water occupies large expanses of the upper half of Narragansett Bay.

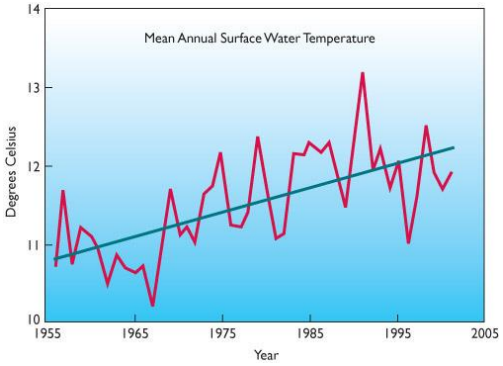

Figure 15.11e: The temperature of the bay's surface water has been rising on average for the past 50 year, whichis affecting the local ecosystems.

- Artificial biocides are chemically-manufactured toxic compounds that do not occur naturally.

- **Bioaccumulation** is the process whereby organisms retain and concentrate a toxic material within their body.

- **Biomagnification** is the process whereby a toxic material increases in concentration at each trophic level of a food chain.
  - It results from bioaccumulation at each trophic level.
  - Top-level predators (large fish, marine mammals, birds) generally have the highest levels of these chemicals

Figure 15.12a: Sea lions are top predators on a long food chain. Many have high levels of DDT and contaminants in their fatty tissue, built up by biomagnification.

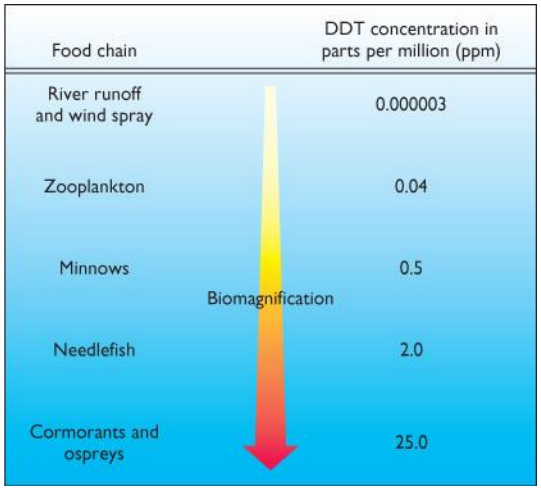

Figure 15.12b: DDT, which is a fat-soluble compound, gets magnified in successively higher trophic levels of the food web.

Dredging

- Contaminated dredge spoils represent both an initial and long-term source of pollution.

- Solid wastes dumped into the sea tend to spread out across the ocean bottom and along existing pycnoclines.

Figure 15.13: Keeping channels and waterways safe for boat and ship traffic, requires the continual dredging of sand.

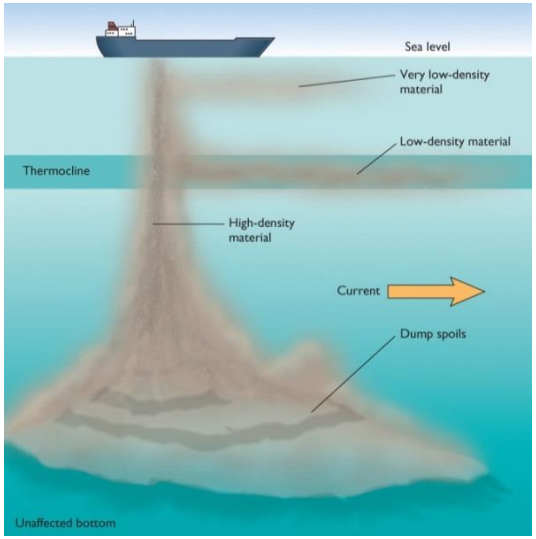

Figure 15.14: Solid wastes dumped into the bay spread out across the bottom and along pycnoclines.

Figure 15.15: If dredge spoils offshore consist of clean sand, a means of disposing the material is to pump it to the updrift end of a beach.

Mining

•Mining of deep ocean deposits can be accomplished with a hydraulic pumping system.

•It vacuum waters, sediment and organisms from the sea floor and brings them to the surface.

•The majority of the organisms drawn into the system will be killed.

•Large areas of the sea floor will be disrupted and stripped of life each day.

•Sediment released at the surface will create a massive plume as it sinks to the bottom.

Overfishing

- is removing fish from the population faster than they can be replaced.
  - If continued long enough, the population will collapse.

- Overfishing is possible today because:
  - Technology has made it easier to locate large schools of fish and direct fishing fleets to those locations.
  - Mismanagement of policies related to sustaining fish production.
  - Fishermen resist quotas and misreport catches.

Fish harvests around the world have leveled off

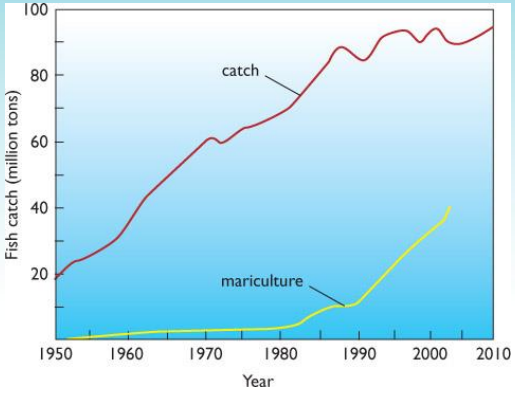

Figure 15.16: The global harvest of marine fish caught and raised by mariculture.

And in the oldest fisheries, have declined dramatically in less than a century…

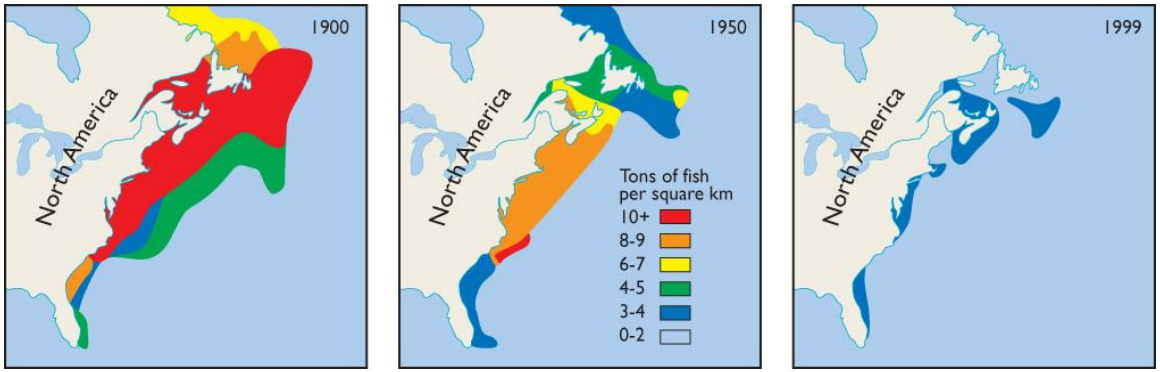

Figure 15.17: There is a clear sharp decline in the biomass of commercial fish in the western North Atlantic ocean during the 20th century.

Coastal habitats are being severely affected and destroyed at an increasing rate.

Figure 15.19a: Many beaches are littered with garbage and wastes that are brought in by the tide.

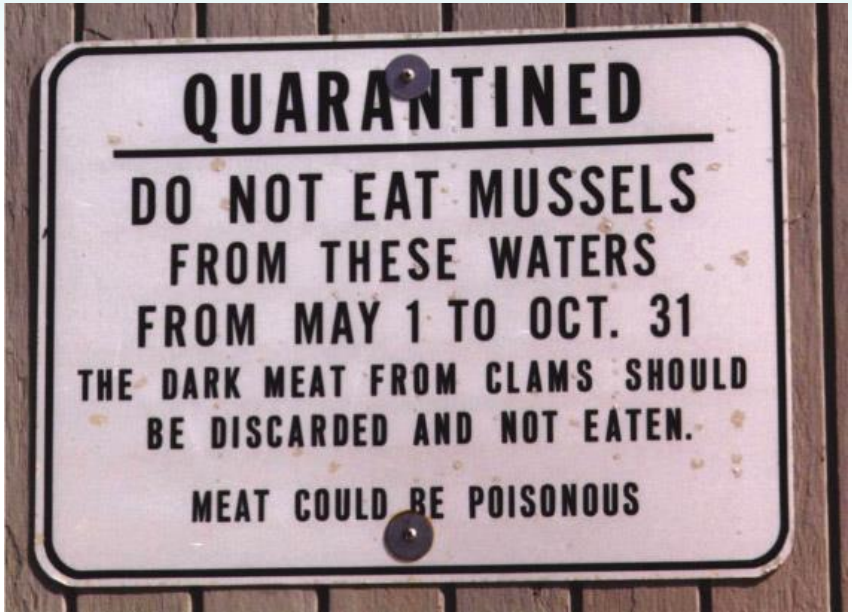

Figure 15.19b: Numerous clamming grounds have been closed because of contamination with toxins.

Global Marine Pollution

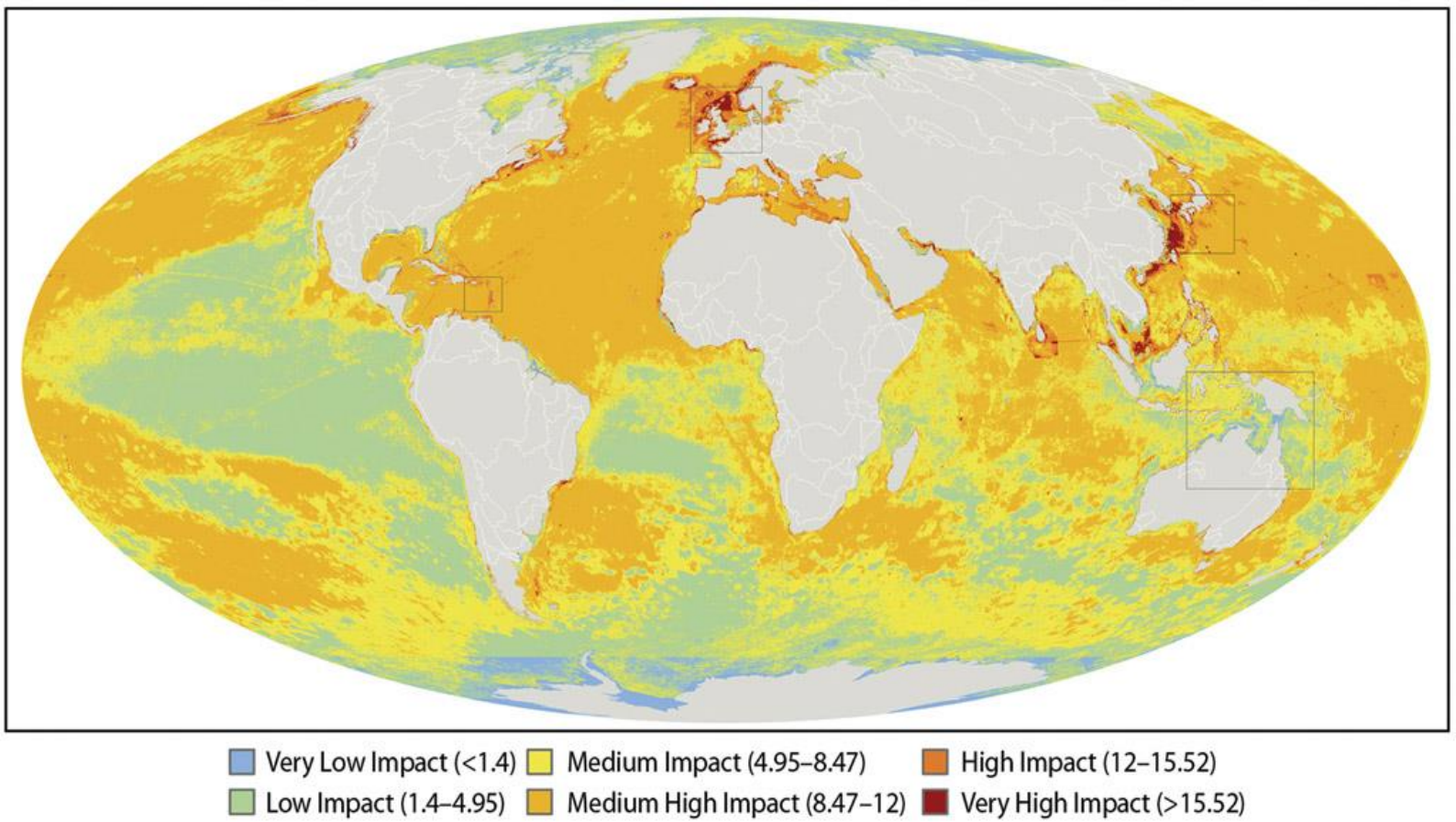

Figure 15.20: Coastal areas bordering industrial sites are heavily polluted. Even the waters of the open oceans show signs of human-caused contamination.