Threats

Human activities in the coastal zone are known to have a number of negative impacts, both direct and indirect, on the natural environment, including on coral reef ecosystems. The health of coral reefs is also influenced by natural factors such as disease and tropical storms. The ability of coral ecosystems to cope with and recover from these natural factors may be curtailed, however, by the effects of human activities. The following list of coral reef ecosystem threats and descriptions are excerpts and summarized material from the threats chapter in the report, *State of the Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005* (47). This report is online at http://ccma.nos.noaa.gov/ecosystems/coralreef/coral_report_2005/.

Coastal Population Growth and Development

For decades people have been moving to coastal areas, and more than 50% of the U.S. population now live in coastal counties. This has increased coastal development including housing, road, and other infrastructure construction. The associated increased runoff from streets and buildings has led to greater volumes of polluted water entering near-shore coastal ecosystems. Additionally, increases have occurred in recreational and commercial use of coastal resources, particularly affecting fisheries. Increased dredging for marina facilities, ship access and navigation, beach nourishment, and building materials has also increased the amount of pollution impacting coral habitats.

Threats to Coral Reef Ecosystems

Coastal Population Growth and Development

Tourism and Recreation

Coastal Pollution

Effects of Fishing and Overfishing

Ships, Boats, and Groundings

Marine Debris

Oil and Gas Exploration

Cable-laying Operations

Security Training Activities

Aquatic Invasive Species

Climate Change and Coral Bleaching

Diseases

Tropical Storms

Trade in Coral and Live Reef Species

Tourism and Recreation

Tourism and recreation are by far the fastest-growing sector of coastal economies. Coral reefs, in particular, have a major economic value. In the Florida Keys alone, over three million tourists visit the area and purchase about $1.2 billion in services annually. Recreational activities on U.S. coral reefs include snorkeling, scuba diving, boating, and fishing. The intensity of each activity varies widely from region to region, but can be considerable in some areas. In southeast Florida, residents and visitors spent 28 million person-days fishing and nearly 5 million person-days snorkeling and scuba diving during June 2000 through May 2001. Divers and snorkelers can have a significant negative impact on coral reefs in terms of physical damage and a reduction in their aesthetic appeal. Increasing tourism will also have an overall effect on coastal development and population.

Coastal Pollution

Sediment, fertilizers and other nutrients, herbicides, pesticides, and sewage are the most significant forms of pollution threatening U.S. coral ecosystems. For example, sediment that settles out of the water can smother corals and cover up habitat needed for coral recruitment. Also, turbidity in the water column reduces light availability for coral growth. Nutrient pollution may promote increased algal and bacterial growth, cause sea grasses and corals to die, and may effect fish reproduction and growth. Other pollutants, such as heavy metals and oil, are also harmful. The impacts of coastal pollution may make coral ecosystems more susceptible to other stressors, such as climate change and disease.

Effects of Fishing and Overfishing

Coral habitats are highly diverse and support important commercial and recreational fisheries. In many areas, they also support essential subsistence fisheries, a valuable marine aquarium industry, and provide specimens for the biotechnology and pharmaceutical industries. Impacts of fishing include: (1) excessive harvesting of fish, invertebrates, and algae for food and the aquarium trade; (2) near total loss of single species or groups of species (3) by-catch of non-target species; and (4) damage to habitat caused by fishing techniques, fishing gear, and anchoring of fishing vessels. For example, in Biscayne Bay, Florida, a long-term reef fish monitoring program found that 77% of 35 individual species are overfished. In Hawaii, long-term catch rates suggest that stocks of near-shore fishes declined by nearly 80% between 1900 and the mid-1980s. In Puerto Rico and the U.S. Virgin Islands, the Nassau grouper fishery collapsed in the 1980s due to overexploitation.

Ships, Boats, and Groundings

Boats that run aground, sink, or carelessly drag anchors in coral habitats can be very destructive, and the impact often continues well beyond the initial injury. Over 2,100 grounding accidents in near-shore waters are reported to the U.S. Coast Guard annually, with about 440 vessels sinking each year. Reefs may stay in a damaged condition for long periods of time due to the slow recovery rate and fragmentation of coral organisms that are essential to reef structure and function. When fuel, chemical or cargo spills occur, additional damage ensues.

Marine debris (net) removal in Kaneohe Bay on Oahu. Credit: NOAA Pacific Islands Fisheries Science Center Coral Reef Ecosystem Division's Marine Debris Team

Coastal development, old and new, in Puerto Rico. Credit: NOAA Office of Ocean and Coastal Resource Management

Marine Debris

Marine debris adversely impacts marine life through the destruction of essential habitat, entanglement, and ingestion by marine organisms and sea birds. The most notable impacts of marine debris on coral reef ecosystems come from derelict fishing gear, including nets, fishing line, and traps. Synthetic nets and fishing line, in use since the 1950s, can persist in the ocean for decades and can be transported for thousands of kilometers by ocean currents and wind. Lost fishing gear comprised of conglomerates of netting and fishing line rolls across reef habitats, crushing corals, dislodging sessile organisms, snagging on corals and trapping fish, marine mammals, and sea turtles.

Oil and Gas Exploration

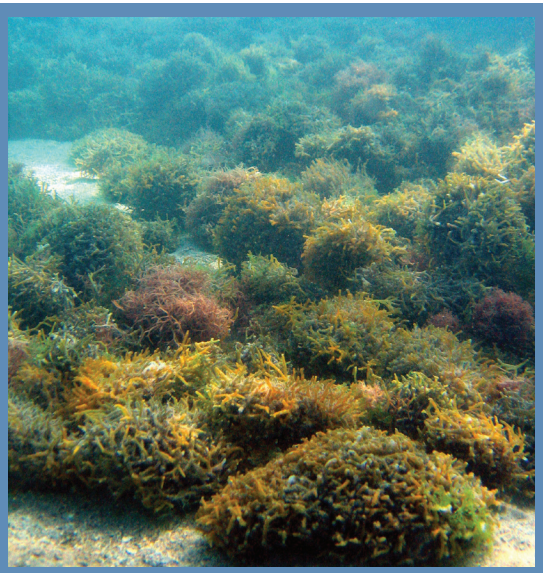
Whether from chronic or episodic oil spills or from activities related to the exploration, production, or transport of energy resources, oil can impact reefs through physical breakage, sedimentation and smothering, toxic contamination by heavy metals, and by inhibition of growth and recruitment. Once introduced, oil tends to persist in sheltered tropical coastal environments and clean-up following a spill is often extremely difficult. The use of dispersants is often discouraged in shallow-water areas because they cause the oil to sink to the bottom, where it comes into contact with sensitive reef habitats. Oil spill recovery in shallow-water reef ecosystems can take decades.

Cable-laying Operations

There has been a rapid increase in the need for submarine cables, particularly fiber-optic cables, to support the telecommunications industry. Cable-laying operations and the movement of unsecured cables have been found to disrupt and destabilize benthic structures. The impact of laying a cable on benthic habitats depends on the location of landing points, the route chosen, and the installation process.

Security Training Activities

U.S. military installations near coral reefs include operations in Hawaii, Johnston Atoll, Wake Atoll, Kwajelein Atoll, Guam, the Commonwealth of the Northern Mariana Islands, Florida, Puerto Rico, and the U.S. Virgin Islands. Military bases and associated activities include simulated war exercises, training, and operational procedures (e.g., construction, dredging, sewage discharge). These activities have the potential for adverse ecological impacts on coral reefs, such as excessive noise, explosives and munitions disposal, oil and fuel spillage, wreckage and debris, breakage of reef structure, and non-native species introductions from ship bilge water or aircraft cargo. U.S. military services, with some exceptions, generally avoid coral reef areas in their normal operations.



The invasive Gorilla ogo seaweed grows on reefs in Hawaii where it forms thick intertwining mats that can overgrow and kill coral. Credit: Christy Martin, Hawaii Coordinating Group on Alien Pest Species

Coastal landfill in Culebra, Puerto Rico. Credit: NOAA Office of Ocean and Coastal Resource Management

Aquatic Invasive Species

Aquatic invasive species are organisms that are introduced into new ecosystems and result in harmful ecological, economic, and human health impacts. Invasive species are generally second only to habitat destruction in causing declines in biodiversity, and are thought to impact nearly half of the species currently listed as threatened or endangered under the Federal Endangered Species Act. Shallow-water coral reef habitat are particularly vulnerable to the introduction of invasive species from ships, aquaculture, releases by aquarium hobbyists, and marine debris.

Climate Change and Coral Bleaching

Climate change refers to any change in climate over time, whether due to natural variability or human activity. Between 1900 and 1999, both the mean near-surface air temperature over land and the mean sea surface temperature increased. Most of the observed warming over the last 50 years can be linked to increased concentrations of greenhouse gases, such as carbon dioxide and methane, in the atmosphere. Higher carbon dioxide concentrations have been linked to decreased growth rates of corals. Reduced growth rates may impede a reef's ability to keep pace with rising sea levels or recover from natural disruptions such as hurricanes and volcanoes. Additionally, elevated sea surface water temperatures cause corals to bleach due to the loss of helpful alga from coral tissues. Although corals can recover from brief bleaching episodes, if water temperatures get too warm and remain high for extended periods, corals will bleach and then die.

Diseases

Since the mid-1980s, there has been an increase in the occurrence of diseases affecting marine plants and animals. For example, an unknown waterborne pathogen killed 90-95% of spiny sea urchins throughout the Caribbean in 1982-1983. That same decade, a fungus infected sea grasses in southern Florida, causing severe declines, and white-band disease virtually wiped out two species of coral on shallow western Atlantic reefs. The ability of corals and other organisms to ward off infection may be compromised by climate change, nutrient pollution, sedimentation, and other impacts. Their vulnerability is increased because many warm-water corals grow slowly and live within a narrow range of light, temperature, dissolved oxygen, and salinity conditions.

Tropical Storms

The extent of coral ecosystem damage from tropical storms is influenced by reef physical structure and biologic composition, and the path, strength, and duration of a storm. Storms can generate high storm surges, heavy rainfall, and very strong winds, causing physical and water quality-related damage to coral reefs. Coral habitats that are less affected by changes in salinity due to heavy rain or sediment from terrestrial runoff generally weather storms better. Although direct wave damage from storms occurs in the shallow (0-20 meter) depth range, corals in deeper water can be damaged by pieces of coral and other objects that tumble down from shallower waters. Further, broken or crushed corals reduce the suitable habitat for fish and other organisms that live on the reef. The damage also reduces their food supply and increases their exposure to predators.

The 2005 Caribbean bleaching event affected St. Croix, USVI as well as most of the Caribbean. Bleaching is caused by periods of higher than normal sea temperatures which cause coral to expel symbiotic algae, giving them a striking white coloration.
Credit: NOAA CCMA Biogeography Team

Illegally caught conch shown with can for size reference, Caja Muertos, Puerto Rico, 2007.
Credit: Eileen Alicea, NOAA National Ocean Service, International Programs Office

Trade in Coral and Live Reef Species

Many coral reef species are harvested domestically and internationally to supply a growing demand for seafood, aquarium pets, live fish food, construction materials, jewelry, pharmaceuticals, traditional medicines, and other products. Harvesting at unsustainable levels may lead to reductions in the abundance and size of important species, shifts in species composition, and, in some cases, population explosions of other organisms. Some of the techniques used to collect reef organisms, such as cyanide poisoning of fishes and breakage of coral colonies, are also very destructive.