Coral, Great Barrier Reef, Australia

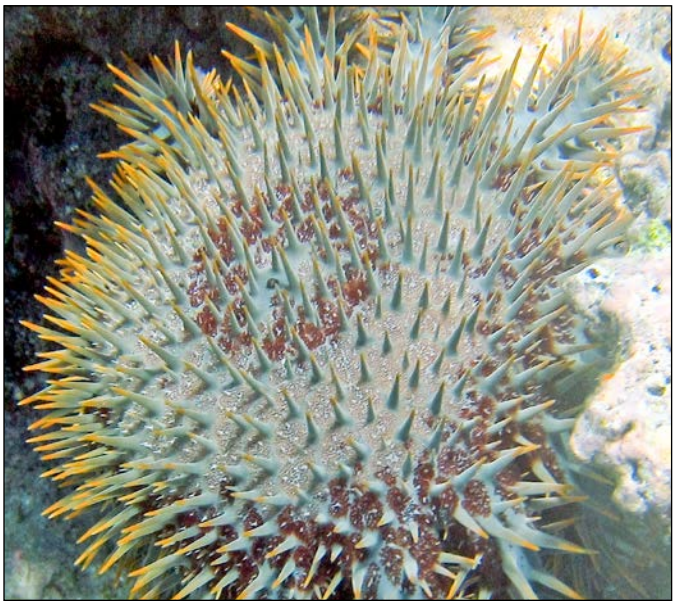
Introduction

The Great Barrier Reef along northeastern Australia supports more than 300 species of reef-building or hard corals. Light, water clarity (how clear the water is), and temperature all help determine where reef-building coral grows. The corals occupy a band between 30°N and 30°S latitude and grow in shallow regions of the tropical and subtropical western Atlantic and Indo-Pacific oceans. Coral reefs form highly diverse habitats that provide sanctuary to hundreds of species of fish and invertebrates. Sixty-five percent of marine fish live in or near coral reefs because this habitat provides shelter and food. A few organisms, including various marine snails, fish, and sea stars, prey on coral. The most aggressive predator on hard corals is the crown-of-thorns sea star.

Changes in water clarity, sea surface temperatures, and water quality resulting from the runoff of nitrates have led to declines in the amount of hard coral in the Great Barrier Reef.

Key Species

The crown-of-thorns sea star belongs to the phylum Echinodermata, which also includes sea urchins and sea cucumbers. Temperature and coral (a food resource) limit the distribution of this sea star. The crown-of-thorns sea star has a planktonic (microscopic, free-living) larval stage in which its larvae move along with the currents. Many larvae die off in this stage, especially when their food source of phytoplankton (plant-like plankton) is low. The amount of phytoplankton available depends on the level of nutrients in the water. An increase in nutrients leads to an increase in phytoplankton (referred to as a “bloom”) and thus an increase in the survival rate of the crown-of-thorns sea star larvae. More larvae mean more adult sea stars on the Great Barrier Reef.

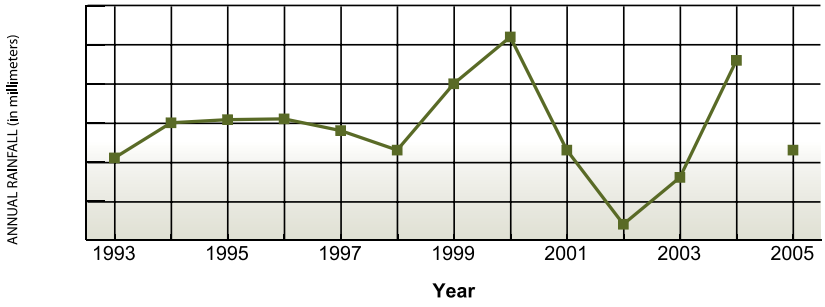


Crown-of-thorns sea star

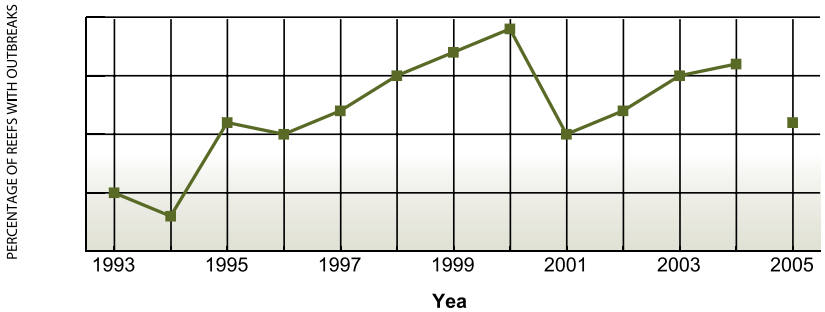
Habitat Data

- Phytoplankton concentrations have increased along coastal regions.
- Nutrient levels along the eastern coast of Australia have increased in areas adjacent to where major rivers drain into the ocean.
- Nutrient levels along the coast are higher during rainy seasons, when more water from rivers runs into the ocean.
- The survival of crown-of-thorn larvae increases during the wet season.
- Ocean currents along the eastern coast of Australia run from north to south.
- In eastern Australia, agriculture has increased over the past several decades:
  - In the past 10 years, native vegetation has been replaced with crops planted for agriculture.
  - The use of fertilizers is unregulated in the Australian agricultural industry.
  - Fertilizers contain nutrients (nitrates and phosphates) that flow into rivers as runoff from farms.
  - The banks of the major rivers along agricultural regions have been altered for irrigation, increasing the amount of runoff that flows into rivers.
- The size of the region where outbreaks of crown-of-thorns sea stars occur has increased over the past 10 years.
- Coral bleaching, or die-off, along the Great Barrier Reef has increased over the past 25 years.

Annual Rainfall for Cairns Australia

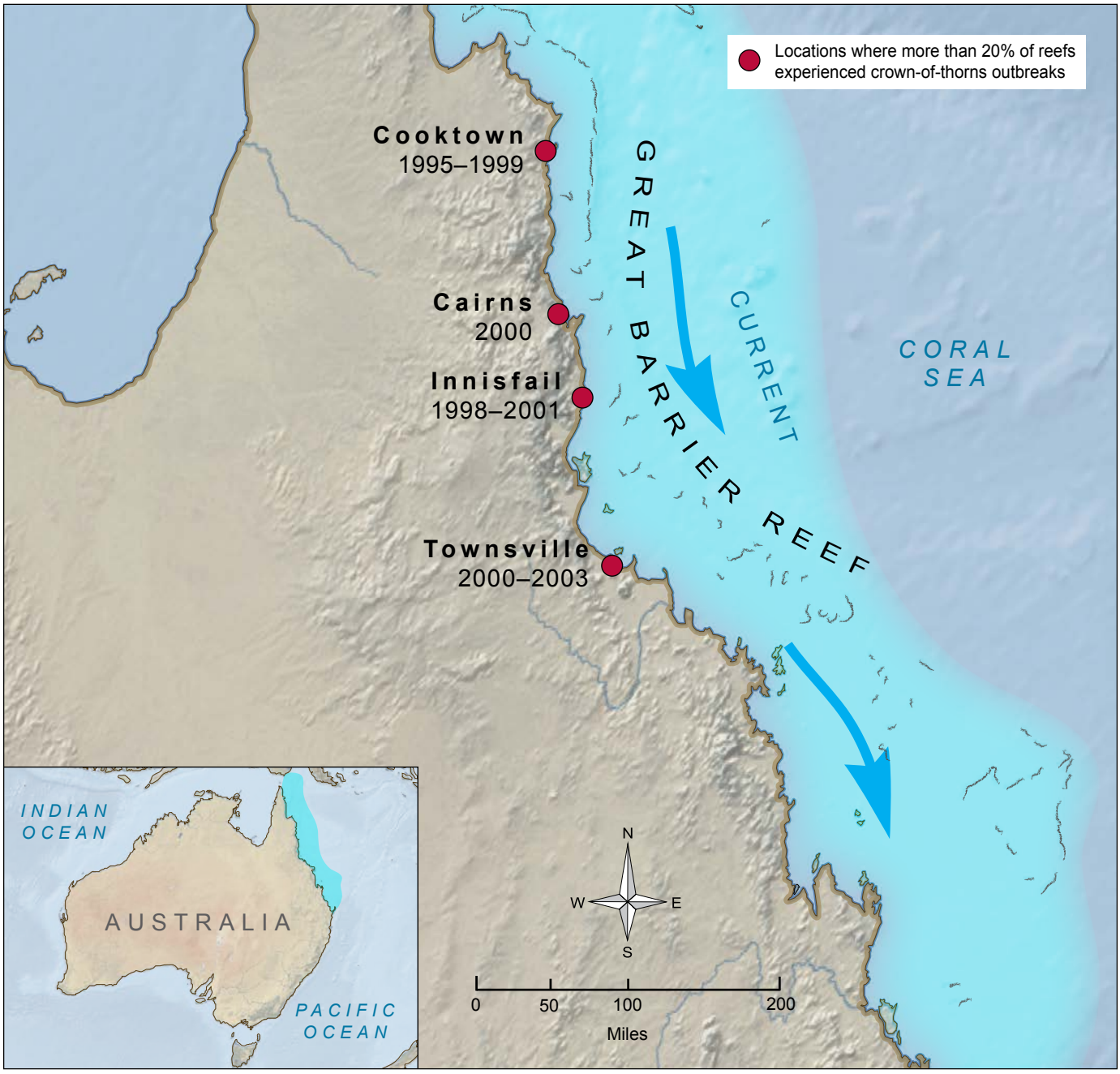


Percentage of Reefs with Outbreaks of Crown-of-Thorns Sea Stars



Source: Australian Institute of Marine Science, www.aims.gov.au

Years When More Than 20% of Reefs Experienced Outbreaks (Between 1993–2003)



SCIENTIFIC OBSERVATIONS

Scientist's Observations: Great Barrier Reef, Australia

Most of the time few crown-of-thorns sea stars populate healthy coral reefs because most of this organism's larvae die off instead of growing into adult sea stars. Outbreaks of crown-of-thorns sea stars have increased on Australian reefs due to a recent increase in larval survival. Larvae usually die because the phytoplankton, their favorite food, is often scarce. The recent increases in crown-of-thorn larval survival probably result from an increase in phytoplankton (microscopic plants). Scientists often use measurements of chlorophyll levels to calculate phytoplankton density. Some researchers have reported increased chlorophyll levels near crown-of-thorns sea star outbreaks. The researchers attribute the increase in phytoplankton to an increase in nutrient concentrations; for example, more phytoplankton grow when more nutrients are available in the water.

Researchers have also recorded a recent increase in nitrates in certain areas around the reefs. Agriculture, which often uses nitrate-containing fertilizers, is a common contributor of nitrates to water supplies. Surveys of land use along the main river near the reef areas containing increased phytoplankton indicate that brush has been cleared there for agriculture. Clearing and conversion of the land to agricultural production has resulted in the increased use of nitrates in the form of fertilizers. Without the roots of brush plants to hold the soil in place and protect it from rainfall, increased runoff from agriculture has resulted in higher levels of nutrients in the water. Consequently, phytoplankton continue to bloom, leading to an increase in crown-of-thorn sea stars.