



OCEANA®

PROTECTING THE WORLD'S OCEANS

DEEP SEA CORALS:

OUT OF SIGHT, BUT NO LONGER OUT OF MIND



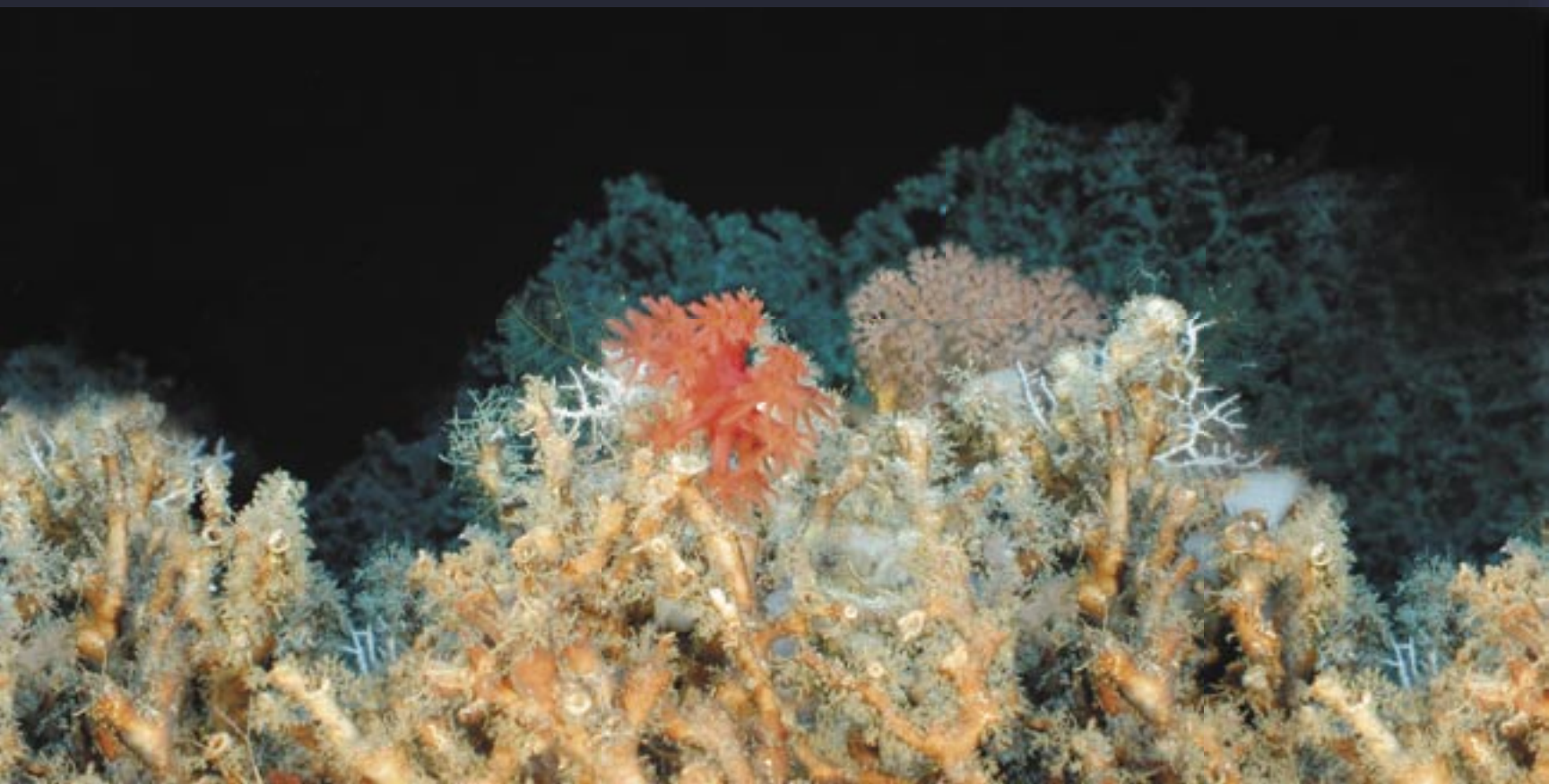
“At fifteen

fathoms depth...

... It was the coral kingdom.

The light produced a thousand charming varieties, playing in the midst of the branches that were so vividly coloured. I seemed to see the membraneous and cylindrical tubes tremble beneath the undulation of the waters. I was tempted to gather their fresh petals, ornamented with delicate tentacles, some just blown, the others budding, while a small fish, swimming swiftly, touched them slightly, like flights of birds.”

- Jules Verne, [20,000 Leagues Under the Sea](#) (1870)



OUT OF SIGHT, BUT NO LONGER OUT OF MIND

DISCOVERY: DEEP SEA CORALS

Fact, not fiction—corals really do exist, and flourish, hundreds and even thousands of feet below the ocean's surface. In the last few decades, cameras have recorded beautiful gardens of deep sea coral off the coasts of North America, Europe, Australia and New Zealand—even deeper than Jules Verne imagined, and every bit as breathtaking. Unlike shallow water coral communities, which are the subject of many nature films, deep sea corals are unfamiliar to the public and even to many marine scientists.

Remarkably, scientists have discovered that some of the largest coral structures in the world are found in waters too deep for sunlight to reach.^{1,2} Moreover, two-thirds of all known coral species live in deep, cold, and dark waters.³ These beautiful and valuable animals are among the oldest living organisms on Earth; some reefs have been found to be several thousand years old, and some individual corals several hundred.^{4,5,6}

REMARKABLE DEEP SEA COMMUNITIES

Deep sea coral reefs can have levels of biological diversity comparable to shallow water reefs—and hundreds of species of corals and associated sea life have yet to be discovered or described.^{5,7,8} Although our understanding of deep sea coral communities is still incomplete, it is clear that in many cases, they are important to the survival of other species, including commercially important fish populations.^{9,10}

OUT OF SIGHT, OUT OF MIND—HUMAN THREATS TO DEEP SEA CORALS

As our knowledge of these remarkable communities improves, along with our understanding of their important role in deep sea life, a clear picture has emerged. Human activities below the waves are causing massive—and largely unnoticed—destruction of corals found in the cold depths of the ocean. Even more troubling, dam-

aged deep sea corals are not likely to recover for hundreds of years, if at all.^{10,11}

While many activities can harm deep sea corals, including oil exploration and seabed mining, the biggest human threat is destructive fishing. Bottom trawling in particular has pulverized these communities and ripped many of them from the seabed.^{10,13,38} Some forty percent of the world's trawling grounds are now deeper than the edge of the continental shelf¹⁴—on the slopes and in the canyons of the continental margins, and on seamounts (undersea mountains)—where most of the world's known deep sea coral communities are found. Unfortunately, few policies specifically protect these communities from bottom trawling and other destructive fishing practices anywhere in the world.

“Towing a heavy trawl net through a cold water coral reef is a bit like driving a bulldozer through a nature reserve. The only practical way of protecting these reefs is therefore to find out where they are and then prevent boats from trawling over them.”

David Griffith, General Secretary of the scientific advisory body ICES, the International Council for the Exploration of the Sea¹⁵

WHAT NEEDS TO BE DONE?

This report contains specific recommendations to address the tragic loss of deep sea corals. In fact, they can be summarized in the two steps recommended by ICES—**locate deep sea corals and prohibit trawls from destroying them.** Although awareness of the threats to deep sea corals is growing, we must act soon to prevent these ‘coral kingdoms’ from becoming as imaginary as those in *20,000 Leagues Under the Sea*.

DEEP SEA CORALS:

WHAT ARE THEY AND WHERE DO THEY LIVE?

>> Although scientists first documented the existence of deep sea corals over 200 years ago, most of what we now know has been learned in the last few decades. Since the development of manned and unmanned submersible vehicles, scientists have finally been able to study deep sea corals in their natural environment. At the same time, these technologies have helped document their widespread destruction.

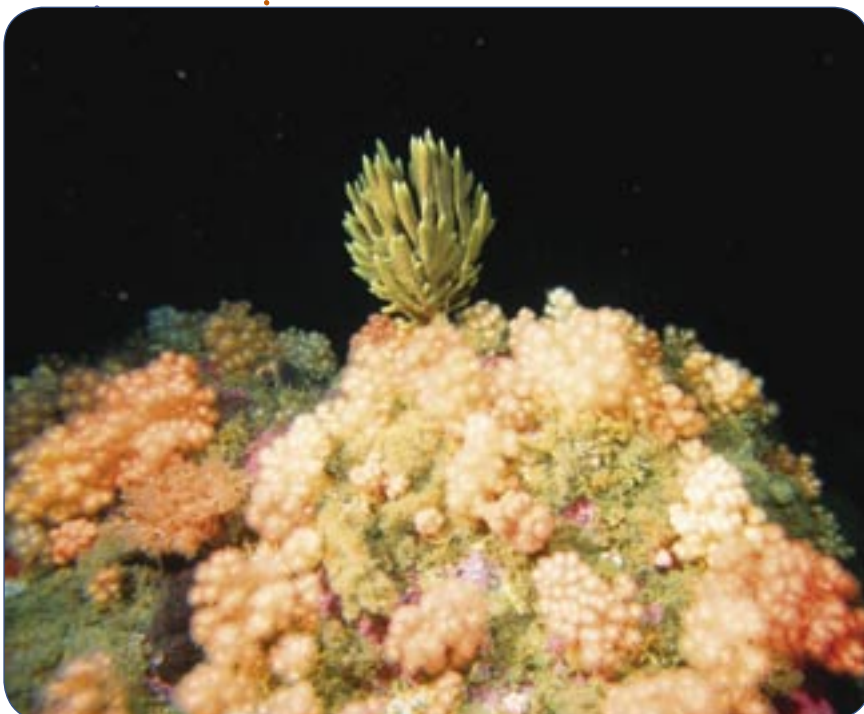
In many ways, deep sea corals are similar to their shallow water relatives. They vary greatly in size, shape, and color, from ivory cups the size of fingertips to crimson trees ten feet tall. Some are stony and hard, others are soft and sway with the current.¹⁶ A few build gigantic mounds reaching 500 feet⁶ from the seafloor, several build smaller colonies, and still others are solitary.¹⁷ About 20 of the 703 known species of deep sea stony corals build reef structures.⁸ Most are also part of larger communities of sponges, sea anemones, fish, shellfish, and a host of other species.

Unlike most tropical and subtropical corals, however, deep sea corals do not obtain any energy directly from sunlight. Instead, they capture microscopic animals from the surrounding water.

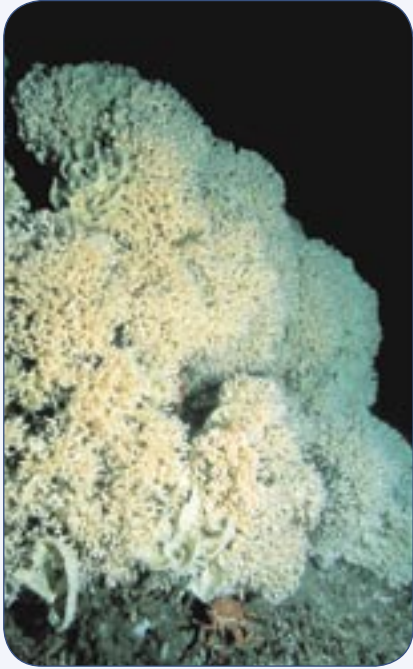
They can also survive much lower temperatures—as cold as 30°F. With these adaptations, they are capable of living far below the reach of the sun's rays, some over three miles below the ocean's surface.¹² There, like much of the deep sea floor, they have been largely hidden from our eyes.

Nevertheless, scientists are constantly finding new and unique deep sea coral communities throughout the world's oceans. Yet we know little about the distribution of the vast majority of them. Some are found worldwide, some are found in several regions around the world, but most are found in only a few locations or even a single place.^{5, 8, 17} Scientists have discovered some coral communities around hydrothermal seeps,⁵ but most seem to be found on the edges of the continental shelf, or on underwater islands called seamounts.

Deep sea corals typically grow slowly and may live for hundreds of years.¹¹ Growing at less than an inch per year, large bubblegum and red tree colonies may be more than 500 years old.⁴ *Lophelia* reefs have also been estimated to grow at no more than an inch per year, and the larger ones are thought to be many thousands of years old.⁵ Deep sea ivory tree coral grows about one-half inch per year,⁷ and is likely to reach 1,500 years old.⁶



A boulder reef near Nova Scotia. A finger sponge sits on top of the boulder, and the remainder of it is thickly covered with the small soft coral *Gersemia rubiformis*.



>> LOPHELIA PERTUSA

Lophelia is a reef-forming coral that provides a highly complex habitat supporting as diverse an array of life as some shallow water reef communities.⁵

It is found in every ocean except in the Polar Regions. Most *Lophelia* reefs are found at depths of 650-3,300 feet, though the deepest so far discovered is nearly two miles beneath the surface of the Atlantic.¹⁰

One of the largest *Lophelia* reefs discovered to date is about 1,000 feet deep in the waters off Norway. It is more than eight miles long and about a quarter-mile wide, and some parts reach as high as 100 feet off the seafloor.¹ Researchers recently discovered extensive *Lophelia* reefs in deep waters in the Gulf of Mexico, and are currently studying reefs in the coastal waters off North Carolina.¹⁸ Living *Lophelia* was also discovered for the first time in waters off Nova Scotia late in 2002.¹⁹

Lophelia provides habitat for animals such as sponges, anemones, bryozoans, gorgonians, worms, fish, mollusks and crustaceans.²⁰ Scientists have recorded more than 850 species living on or in *Lophelia* reefs in the Northeast Atlantic.⁵ The variety of life on these reefs is about three times higher than on surrounding soft bottoms.²¹

>> OCOLINA VARICOSA

The ivory tree coral builds extensive reefs similar in size, shape and structure to *Lophelia*.⁶ In contrast to the broad geographic range of *Lophelia*, however, these reefs are found only off the southeastern US.

Oculina is unusual because it adapts to the long-term presence or absence of light. In shallow waters it possesses the algae needed to help it use energy from the sun, much like other tropical corals; in deep water it feeds from the surrounding water.⁷

The deep sea form is found from 160-500 feet deep on the edge of the continental shelf from North Carolina to Florida, although most deep sea *Oculina* do not create reefs. The only known *Oculina* reefs, known as the Oculina Banks, stretch 100 miles along the central eastern Florida shelf edge at a depth of 230-330 feet.⁷

The Oculina Banks have an exceedingly high diversity of fish, shellfish, starfish, sponges and other animals, similar to that on tropical coral reefs. This dense and diverse community supports large numbers of fish, forming breeding grounds for gag and scamp grouper, nursery grounds for young snowy grouper, and feeding grounds for many other economically valuable fish including bass, other groupers, jacks, snappers, porgies, and sharks.⁷



>> RED TREES AND BUBBLEGUM CORALS

The gorgonian corals *Primnoa* and *Paragorgia arboorea*, more commonly known as red trees and bubblegum coral, can form great branching trees that reach many feet from the seabed. Red tree corals seven feet tall and 25 feet wide have been observed by scientists in submersibles,⁹ and fishermen have reported bubblegum corals over ten feet tall and several inches thick.²² An 1859 account of ‘the great tree’ (bubblegum coral) described fishermen pulling “up fragments ... so large ... that the people ... believe it to grow to the size of forest-trees.”²³

Both species are found in the depths of the North Atlantic and North Pacific oceans, from 100 to over 2,500 feet deep.⁴ The bubblegum coral has been found in waters deeper than 4,300 feet.²⁴

Numerous animal species are known to use red tree corals as both food and habitat. Economically important rockfish, halibut, Pacific cod, shrimp and crabs hide among the branches, seeking protection. Crinoids, basket stars, anemones and sponges attach themselves to dead branches so they may better filter food from nutritious currents. Other animals, such as sea stars and snails, feed directly on the corals themselves.⁹



Monterey Bay Aquarium Research Institute/NOAA



Robert Stone, NMFS

The myriad shapes and sizes of corals and sponges may reflect different strategies for capturing food. Adak, Alaska.

Deep sea coral communities can be highly diverse. Furthermore, although thousands of different types of deep sea coral have been described—including hydrocorals, sea fans, bamboo corals and black corals—scientists estimate that roughly 800 species of stony corals alone have yet to be discovered,²⁵ in addition to many of the animals associated with them. For example, recent research on Tasmanian seamounts has found that between a quarter and one half of all the animal species associated with deep sea corals were new to science.²⁶

OTHER ‘LIVING HABITATS’

In addition to corals, other deep sea animals, such as sponges, sea anemones, sea squirts, and bryozoans, are also important in providing shelter, food and protection for many fish and shellfish. In general, even less is known about these other important ‘living habitats’ than about deep sea corals. However, preliminary research in Alaska suggests they may cover a larger area of habitat than corals, and so may be equally important to a large number of commercially important fish and shellfish species.²⁷

Massive sponge reefs, a mile wide and 50 feet high, have been recently photographed off British Columbia, and are every bit as spectacular as deep sea corals. The largest of these mounds are over 9,000 years old,²⁸ almost twice the age of the ancient Great Pyramid of Cheops in Egypt. A wide variety of fish, shrimp, crabs and other underwater life shelter and feed among these sponges. Scientists believe sponge reefs of this kind are found nowhere else in the world.²⁸

DEEP SEA CORALS ARE IMPORTANT FOR FISHERIES

➤➤ Fish aggregate on deep sea reefs²¹—that is precisely why, as one scientist puts it, “fishermen trawl them.”²⁹ Deep sea corals, sponges and other habitat-forming animals provide protection from currents and predators, nurseries for young fish, and feeding, breeding and spawning areas for numerous fish and shellfish species. Rockfish, Atka mackerel, walleye pollock, Pacific cod, Pacific halibut, sablefish, flatfish, crabs, and other economically important species in the North Pacific inhabit these areas.⁹ Eighty-three percent of the rockfish found in one study were associated with red tree coral.⁹ Flatfish, walleye pollock and Pacific cod appear to be more commonly caught around soft corals.³⁰ Dense schools of female redfish heavy with young have been observed on *Lophelia* reefs off Norway,¹⁰ suggesting the reefs are breeding or nursery areas for some species.²⁰ *Oculina* reefs are important spawning habitat for several grouper species, as well as other fishes.⁷

Fishermen believe that areas with deep sea corals are good fishing grounds.^{10,22} When fishing around deep water coral habitat, longline fishermen set their gear for different species of fish depending on the types of coral in that area. For example, when fishing around *Gersemia rubiformis*, a soft coral known as ‘strawberries,’ longline fishermen from Nova Scotia set their lines for haddock; when around bubblegum tree coral they target cod and halibut.³¹ Studies support fishermen’s assertions that the disappearance of corals influences the fish distribution in the area. For example, scientists in Norway have found that longline catches of rockfish may be six times higher, and for ling and tusk two to three times higher, on reefs compared to non-reef areas.¹⁰ Research in Alaska has concluded that red tree coral is a vital component of the deepwater ecosystem, and that removal of these slow-growing corals could affect associated animal communities, including economically important fish and shellfish species.⁹



Andy Shepard, NURC

School of anthiid reef fish over *Oculina* colony in the *Oculina* marine protected area in Atlantic Florida.



Victoria O'Connell, ADFG

Lingcod and hydrocoral in the Gulf of Alaska.

Deep sea sponges and other animals also provide habitat for commercially important fish and shellfish. Scientists in Alaska have found that flatfish are most commonly found around sea squirts and bryozoans, cods around sea anemones, sea pens and sea whips, rockfish and Atka mackerel around sponges, crabs around sea squirts, and other commercial fish species such as sablefish and skates around sea pens and sea whips.³² Although much remains to be learned, these findings indicate that corals, sponges and other habitat forming animals are vital for the health of certain deep water economically important fish and shellfish populations.³³



Robert Stone, NMFS

Northern rockfish taking refuge in living habitat including sponges and bryozoans. Aleutians, Alaska.



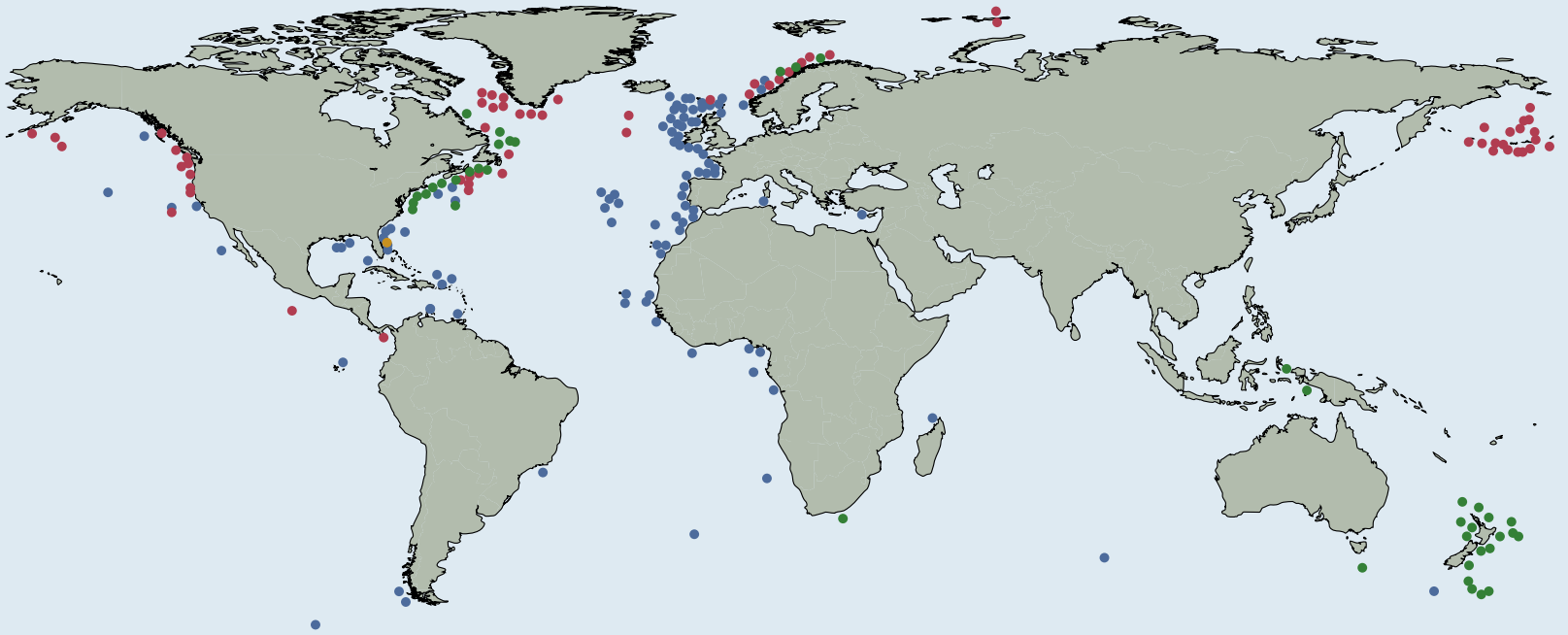
Victoria O'Connell, ADFG

Juvenile sharpchin rockfish hiding among the branches of a red tree coral in the Gulf of Alaska. Juvenile fish need a safe haven like corals and sponges to survive to maturity.

➤➤ MEDICINES, COSMETICS, AND OTHER PRODUCTS FROM THE SEA

Over half of all currently marketed drugs have their origins in natural products.³⁴ During the last decade, scientists have investigated marine organisms looking for natural compounds with uses as diverse as cures for human diseases, seafood safety, and the development of new materials and processes. Scientists have developed dozens of promising products from marine organisms, including a cancer therapy made from algae, a painkiller taken from the venom in cone snails, and antibiotics from deep water seabed dwelling bacteria. Coral and sponge communities are a largely untapped resource of natural products with enormous potential as pharmaceuticals, nutritional supplements, enzymes, pesticides, cosmetics, and other commercial products.³⁵ These compounds, particularly pharmaceuticals, take many years if not decades to study and bring to the public. As of 1999, only two ocean-derived pharmaceuticals were available, although some compounds produced from corals and sponges are in advanced pre-clinical trials. Compounds found in the deep sea sponges *Discodermia* spp. and *Lissodendoryx* sp., for example, have been found to be potent immunosuppressive and anticancer agents.³⁴

KNOWN AREAS OF DEEP SEA CORALS AROUND THE WORLD



● Bubblegum



● Lophelia



● Oculina



● Other or unspecified coral communities, including reef builders, gorgonians, and soft corals

Photo Credits:

Bubblegum: Robert Stone, *NMFS*
 Lophelia: Martin Hovland, *Statoil*
 Oculina: John Reed, *HBOI*
 Other: Robert Stone, *NMFS* and
 Malcom Clark, *NIWA*

>> Although deep sea corals may appear to be concentrated in northern latitudes, the locations on this map may actually reflect the global distribution of marine biologists rather than the distribution of deep sea corals. In particular, unexplored continental shelf margins and seamounts are likely locations for discovery of new deep sea coral gardens. Unfortunately, much of what we know about the global distribution of corals is the result of samples obtained from fishermen's trawl nets—after the corals have already been destroyed.

The maps above and on the following pages are not designed to provide exact geographical locations of known corals. They are intended to give a general sense of known coral distribution around the world. Data are from various sources.



ALASKA

The waters of the North Pacific off of Alaska represent some of the richest marine ecosystems on Earth. Researchers have estimated that more than 100 deep sea coral and sponge species live in these waters;⁵⁹ at least 34 of them are corals.³⁰ Some recently discovered areas are so tightly packed with different corals, sponges and other marine life that they have been variously called 'coral gardens' and the 'Garden of Eden' by the researchers who found them.⁶⁰ Red tree corals, which can grow seven feet high and 25 feet wide, are commonly encountered in this region. They provide shelter for a wide variety of fish, sea stars, crabs, snails, shrimp, and other undersea life.⁹



PACIFIC CANADA

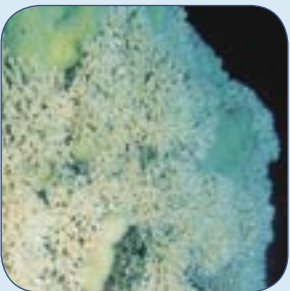
Scientists have so far documented at least twenty-one species of coral off British Columbia, most between 330-1,600 feet. Because these records are based almost entirely on corals brought up by trawlers, the species and depth records are almost certainly incomplete. The corals known from these waters include sea fans such as red tree and bubblegum corals, as well as soft, stony, and black corals.⁶¹ These waters are also home to massive sponge reefs a mile wide and 50 feet high. Thought to be over 9,000 years old, reefs of this type are found nowhere else in the world.²⁸



UNITED STATES WEST COAST

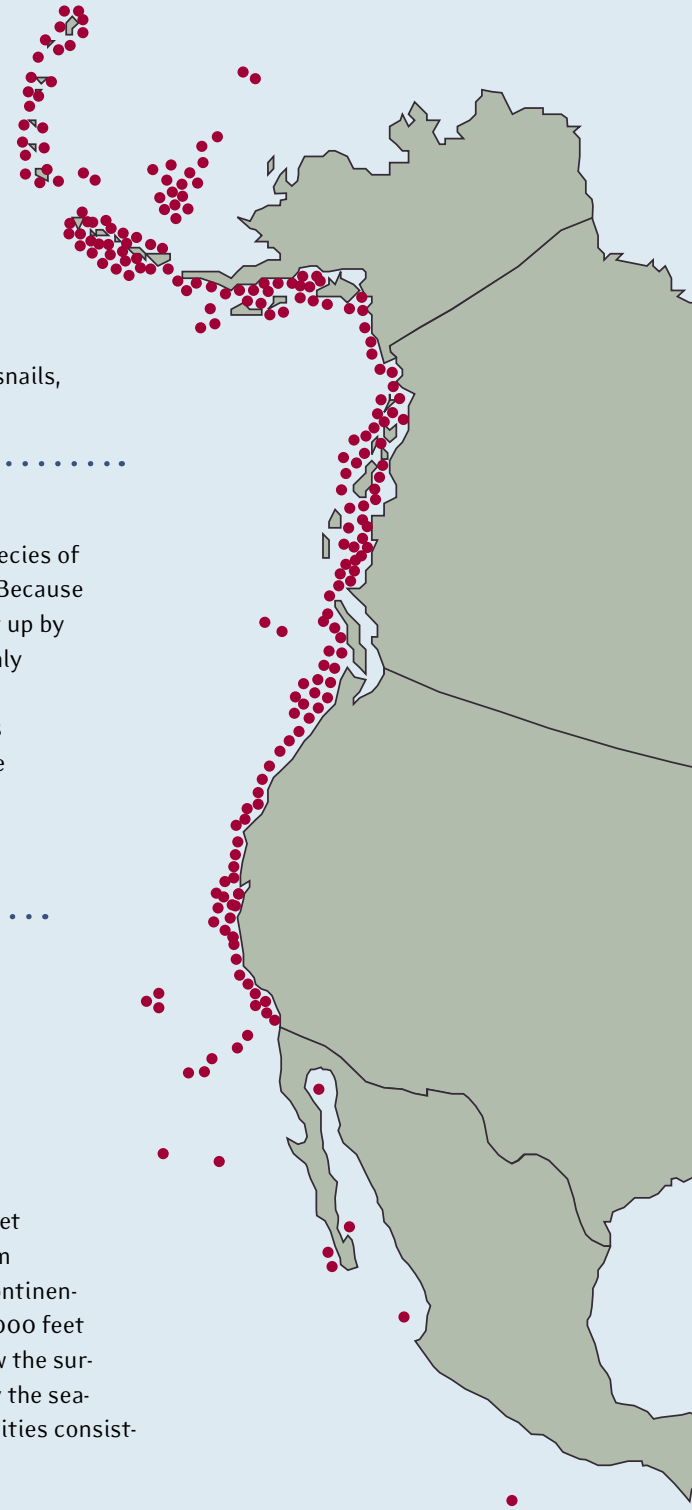
Corals, sponges and other habitat forming animals are widely distributed along the Pacific shelf and slope from the Bering Sea to the Baja Peninsula.⁵⁶ Scientists have found at least 100 different species of coral in this region, with bamboo, bubblegum, red tree, and black corals all common.

Bamboo corals are perhaps found deepest, from 300 feet to over two miles down.⁵⁷ Several underwater islands form oases of sealife in the deep waters past the Californian continental shelf. The largest, Davidson Seamount, rises nearly 8,000 feet from the seafloor, and yet its peak is still 4,000 feet below the surface of the ocean. Scientists using submersibles to study the seamount last year found densely packed biological communities consisting mainly of large gorgonian corals and sponges.⁵⁸



GULF OF MEXICO

The outer continental shelf off Mississippi, Alabama, and west Florida is dotted with ancient coral reef structures that have eroded over many thousands of years to steep sided pinnacles and plateaus. Though the original reefs are long gone, these areas still flourish with lush forests of soft corals, black corals, sponges, sea-lilies, and deep sea stony corals. Along the continental slope at around 600 feet and deeper lie *Lophelia* reefs that scientists have only recently begun to study.¹⁸ In 2002, scientists discovered extensive *Lophelia* reefs off the Mississippi coast at about 1,500 feet.⁵⁵ Trawls, long-lines, anchors, and other fishing gear have visibly damaged many of these reefs. Oil exploration with its attendant threats also remains a grave concern in this part of the ocean.¹⁸



DEEP SEA CORAL COMMUNITIES ARE FOUND OFF ALL COASTS OF NORTH AMERICA



ATLANTIC CANADA

Researchers have found at least 27 species of corals in the waters off Nova Scotia, Newfoundland and Labrador. They live on the edge of the continental shelf and slope and in deep canyons and channels, at depths of 600-3,500 feet.²⁴

Red tree (called sea corn on this coast), bubblegum, and bamboo corals appear to be the largest and most common corals in this region. Soft corals and some stony corals also abound here. Living *Lophelia* has recently been found in the Gulf of Maine. These corals are at risk from both the offshore gas industry and fisheries, which operate in these same areas.²⁴



Erling Svensen

NEW ENGLAND TO VIRGINIA

The cold temperate waters from the Gulf of Maine south to Cape Hatteras are home to at least 15 species of stony coral, some found at depths of almost two miles.⁴⁹ Several deep sea corals, such as red tree and bubblegum corals, are common inhabitants in the canyons south of Georges Bank.⁵⁰ Because the steep sides of these canyons have historically restricted fishing and other types of human activity, these communities are still relatively pristine when compared to the continental shelf and slope (although still largely unprotected from damage from modern fishing). The hard walls and lips of the canyons are particularly densely packed with corals.⁵¹ Just last year, scientists for the first time found a 'forest' of sea fans at about 800 feet in the Gulf of Maine.⁵²



Barbara Hecker

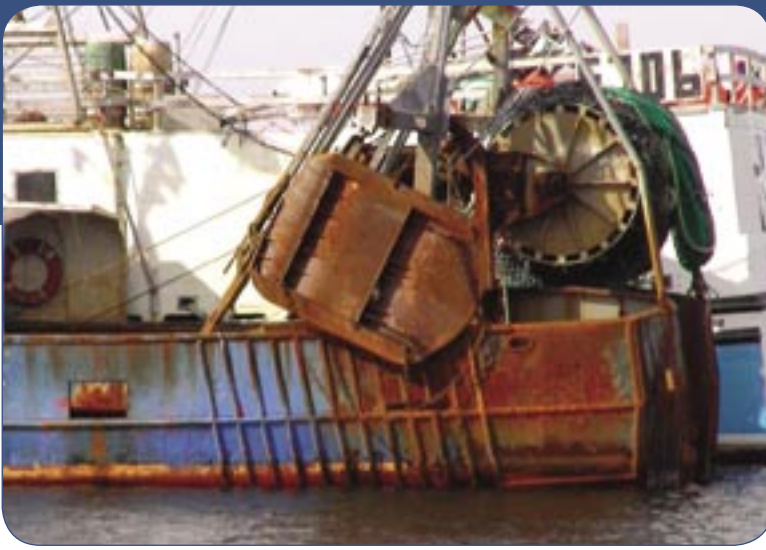
SOUTHEASTERN UNITED STATES

Corals are found between 230-1,650 feet deep on the outer continental shelf and upper slope. Extensive *Lophelia* reefs are now being explored off Cape Lookout in North Carolina at around 1,300-1,650 feet depth, but there are hundreds of larger, unexplored *Lophelia* reefs off the coasts of South Carolina, Georgia and Florida.¹⁸

In 2002, scientists discovered a huge *Lophelia* reef 90 miles off the coast of Jacksonville, Florida, roughly one by 2.5 miles in area, and 515 feet high.⁶³ There may be 40,000 *Lophelia* mounds covering 140 square miles in the vicinity of the reef—an area greater than that covered by all the shallow water corals off Florida.⁵³ Researchers have only explored a tiny portion of this huge region, but found sponges, corals, sea plumes and other animals along every square foot of one area, at about 2,000 feet deep. As one scientist puts it, the area “is truly an oasis in a world alien to humans.”⁵⁴ These waters are also thought to be the only place where deep water reefs of *Oculina varicosa*, the ivory tree coral, exist. Although they were once found along 100 miles of the continental shelf off Florida, only about 20 acres of intact *Oculina* reef remain.³⁶



Ken Sulak, USGS



Trawl nets such as the one in the picture can stretch 40 feet in height and spread over 200 feet wide between the trawl doors.

THREATS TO DEEP SEA CORALS

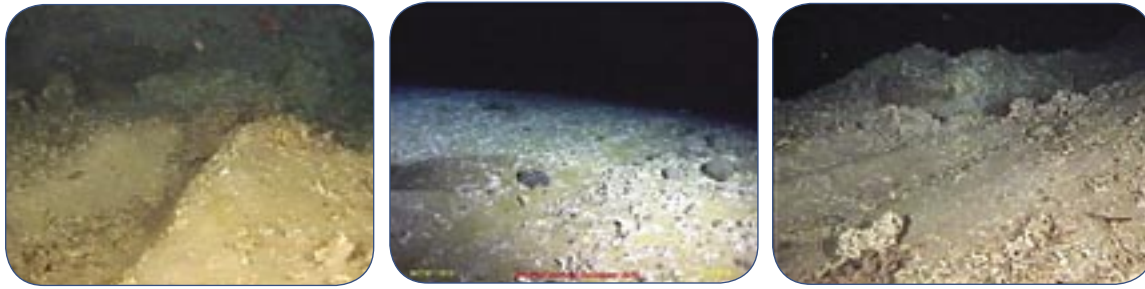
>> Just as we do not yet know all the places where deep sea coral communities are found, we do not yet know all the places they have been destroyed. The evidence that we do have is disturbing. In Norwegian waters, for example, scientists estimate that between one-third and one-half of the deep water reefs have been damaged or destroyed by trawling.¹⁰ Only 20 acres of the world's only known *Oculina* reefs still remain.³⁶ Although deep sea corals in those areas are now protected under law, the threat of destruction of most deep sea coral and sponge communities continues. Some threats to deep sea corals can be natural, such as submarine landslides and erosion, and long term climate change. Like all species in their natural habitat, coral communities are adapted to survive such natural disturbances over the long term. However, corals are ill adapted to survive newer threats caused by human activities.

Bottom trawling is the most widespread human threat to deep sea coral communities.^{10,12,33,38} In Alaskan waters alone, the National Marine Fisheries Service estimates over one million pounds of corals and sponges are removed from the seafloor every year by commercial fishing, roughly 90 percent by bottom trawlers.¹³ These estimates may grossly underestimate the actual level of damage as many of the corals and sponges are crushed and not pulled to the surface and counted by observers.

A simple examination of common bottom trawling gear reveals its destructive potential. Fishing vessels pull bottom trawl nets across the ocean floor to catch shrimp, fish, and crabs. A trawl has a large bag shaped net, wide at the mouth and tapering toward an enclosed end. The mouth of the net is kept open by two trawl doors, which also help to keep the net on the seafloor.³⁹ Trawls capture virtually everything in their path, including unwanted fish, mammals, sea turtles—and deep sea corals. A recent study by the National Academy of Sciences found that, over the past decade, trawling directly affected about 231,000 square miles of seafloor habitats on the continental shelf and slope off the United States⁴⁰—an area greater than the state of California.

The weight of two trawl doors and chain combined can be upwards of ten tons.





Jan Helge Fossa, IMR

Furrows or scars in the seabed are unmistakable evidence of trawling. These pictures are from Norwegian waters, where up to 50 percent of coral reefs have already been damaged or destroyed by trawling.

With the advent of more powerful engines, mapping, navigational and fish finding electronics, and stronger, lighter synthetic materials, trawlers can now fish in deeper and deeper waters.²⁶ Deep sea trawlers now operate to depths of 6,000-6,500 feet,¹² and can fish in deep sea canyons and over rough seafloor, once avoided because of the damage that was caused to their nets.²⁶ Deeper trawling requires heavier trawl doors—one company markets such trawl doors as ‘Canyonbusters,’ the heaviest of which weigh almost 5 tons each.⁴¹ On rough bottoms the net is protected by heavy chafing gear attached to the underside to prevent snagging, as well as steel balls or rubber bobbins strung along the lead cable like beads.³¹ These latter technologies are known as ‘rockhoppers,’ a name implying they bounce the net harmlessly over the seabed. Many trawlers claim they avoid corals because of the fear of damage or even loss of their fishing gear. In reality these gears are capable of moving 18-ton rocks,⁴² and so simply pulverize everything in their path. Prior to the development of these technologies trawl fishermen would even ‘trim the trees,’ intentionally knocking down corals by towing a heavy chain between two vessels.²²

“This is becoming a depressingly common report. Several thousand years of growth can be smashed to pieces in a few hours.”

Dr. J. Murray Roberts, Scottish Association for Marine Science²⁹

In Alaskan waters alone, the National Marine Fisheries Service estimates over one million pounds of corals and sponges are removed from the seafloor every year by commercial fishing, roughly 90 percent by bottom trawlers.¹³

Some large rollers and ‘rockhopper’ gear are over two and one-half feet in diameter.



David Hall



Close-up of *Oculina* rubble and small anemone in the *Oculina* marine protected area.

A recent National Academy of Sciences study concluded that bottom trawling reduces the complexity, productivity, and biodiversity of sea-floor habitats. The authors found that stable, living habitats such as coral and sponge communities are among the most heavily damaged and the slowest to recover from trawling.⁴⁰ The heavy gears used can directly kill corals, break up reef structure, and bury corals through increased sedimentation.⁵ Wounds in coral tissue and infection cause additional deaths in those that are not killed outright.¹⁰

Scientists studying Tasmanian seamounts found substantial damage to corals as a direct result of trawling for fish such as orange roughy and oreos. Heavy fishing had effectively removed all reef habitat; the most heavily fished consisted of more than 90 percent bare rock.⁴³ The authors note “[t]he virtually complete loss of this [coral] community...is consistent with

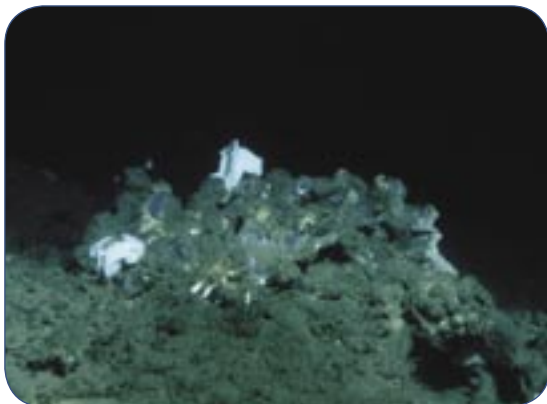
“To our knowledge these are the only Oculina thicket habitats remaining in the world, and it amounts to only about 8 hectares (20 acres). A trawler could easily destroy all of it in a single night.”

Dr. Chris Koenig, Florida State University³⁶

other studies of the impact of trawling on reef-al or other benthic [seabed] communities.”²⁶ Research in Europe has documented widespread trawling damage to deep sea coral reefs off Ireland, Scotland and Norway, at depths of 650-4,500 feet. Photographs document giant trawl scars up to 2.5 miles long. Some coral reefs that have been damaged by trawls are estimated to be around 4,500 years old.³⁸

The extraordinarily diverse and productive *Oculina* reef habitat, first described less than three decades ago, has already been all but destroyed by trawling. Although a roughly 400 square mile area was set aside to protect *Oculina* reef habitat from bottom trawling and other fishing, only a tiny 20-acre patch of undamaged *Oculina* reef remains. Unfortunately, enforcement is difficult, and there is strong evidence that rock shrimp fishermen continue to trawl illegally in the area. The patch is so small that a “trawler could easily destroy it in a single night.”³⁶

Mechanically destroyed sponge reef off British Columbia.



“Off the East Coast of North America bizarre and beautiful fields of glass sponges have been trawled to oblivion. In the Southern Ocean, ‘lush forests’ of invertebrates have been literally stripped from the top of seamounts by trawlers targeting orange roughy.”

Dr. Callum Roberts, University of York⁴⁵

Although little long-term research has been done, the recovery of deep sea corals from trawl damage is likely to be exceedingly slow. A 1997 study in the Gulf of Alaska used a manned submersible to observe a trawl path that had pulled up one ton of corals seven years previously. The researchers found that 31 red tree coral colonies had been in the path of the trawl over the half mile observed. Even after seven years, some of the larger colonies that survived the initial trawl were missing 95-99 percent of their branches, while two smaller colonies were still missing 80 percent of their polyps. No young corals had replaced the dead in the damaged colonies.⁴

Sponges, sea squirts, crinoids, and other habitat-forming animals are also exceptionally vulnerable to bottom trawling; researchers have documented damage to these animals in Alaskan waters, the South Pacific, and the North Sea.³² Although shallow water sponges are known to recover from damage fairly quickly, this is unlikely to be true for deep sea sponges.⁴⁴ In the Atlantic, one scientist notes that “[o]ff the East Coast of North America bizarre and beautiful fields of glass sponges have been trawled to oblivion.”⁴⁵ Such wide-scale habitat alteration may well have contributed to the collapse of the cod population in the region.³³

OTHER DESTRUCTIVE FISHING PRACTICES

Bottom trawling is not the only fishing technique that threatens deep sea corals, although it is the most damaging. Other fishing gears—including bottom longlines, gillnets and longline pots—also damage these communities. Longline fishing gear consists of fishing line up to many miles long, with attached lines leading to hooks or pots, while gillnets are large rectangular walls of net. Both can be anchored on the bottom with weights of 50-250 pounds,⁴⁶ and both are sometimes lost at sea, where they continue ‘ghost’ fishing, killing marine life long after their intended use. While these fishing gears may have smaller impacts on most kinds of seafloor habitat than bottom trawls, researchers have found that they can harm deep sea coral communities. Scientists have observed many lost longlines and gillnets caught on and covering deep sea coral.^{18, 46}

“In one pass of a bottom trawler, the great majority of bottom corals can be removed. In Australia and New Zealand, fisheries using dragged gears have completely cleared corals from the rocky tops of seamounts, and the fish that were once abundant among the corals have disappeared.”

Dr. Martin Willison, Dalhousie University⁶²

OTHER THREATS

Other threats to deep sea corals include oil and gas exploration and drilling, and seabed extraction and mining. Both can directly crush and damage corals, and can affect their living conditions by increasing the amount of sand and grit in the water and altering essential currents and nutrient flows.⁴⁷ Drilling muds and cuttings from oil and gas exploration can be toxic to corals, and are known to cause death and alter feeding behavior in shallow water varieties,²⁰ although the effects on deep water corals are unknown. Drill cuttings also settle and build up into piles directly underneath oil platforms and can smother and kill corals, sponges and other animals that filter the seawater for food.⁴⁷



Ken Sulak, USGS

Longline and gillnets can get tangled in coral and sponge and break parts off, like the *Oculina* above.

“The best way to protect these areas is a blanket ban on bottom trawling.”

Dr. Jason Hall-Spencer, Royal Society Research Fellow, University of Glasgow²⁹

RECOMMENDATIONS

Unfortunately, many of the deep sea coral communities of the world have already been destroyed by bottom trawling, some probably forever. However, many deep sea coral communities remain, and new ones are still being discovered. For this reason, it is imperative that the following steps be taken immediately:

- Prohibit any expansion of trawling into currently untrawled areas potentially containing coral communities
- Close currently trawled areas with known concentrations of corals and sponges
- Close areas that remain open to trawling when corals are subsequently discovered or caught
- Enhance enforcement and establish severe penalties to prevent deliberate destruction of corals and to prevent illegal fishing in already closed areas
- Modify trawling gear (or ban certain kinds completely) so trawling in coral is no longer mechanically possible
- Identify and map all locations of coral communities
- Fund and initiate research to restore damaged deep sea coral communities

Erling Svensen, Ocean Photo



Time is running out for deep sea corals. The depths of the oceans no longer offer sufficient protection from the destructive effects of bottom trawling. The destruction of the unique *Oculina* coral banks off the coast of Florida provides a warning. Less than 25 years after their first description, fewer than 20 acres of intact *Oculina* reef habitat remains—and it is still at risk from outlaw trawling.³⁶ It would be a further blow to our already endangered oceans if more deep sea corals, and the fish and other species that depend on them, were destroyed before science has even given them names. Fortunately, this tragedy can be avoided, if the United States and the rest of the world follow these recommendations.

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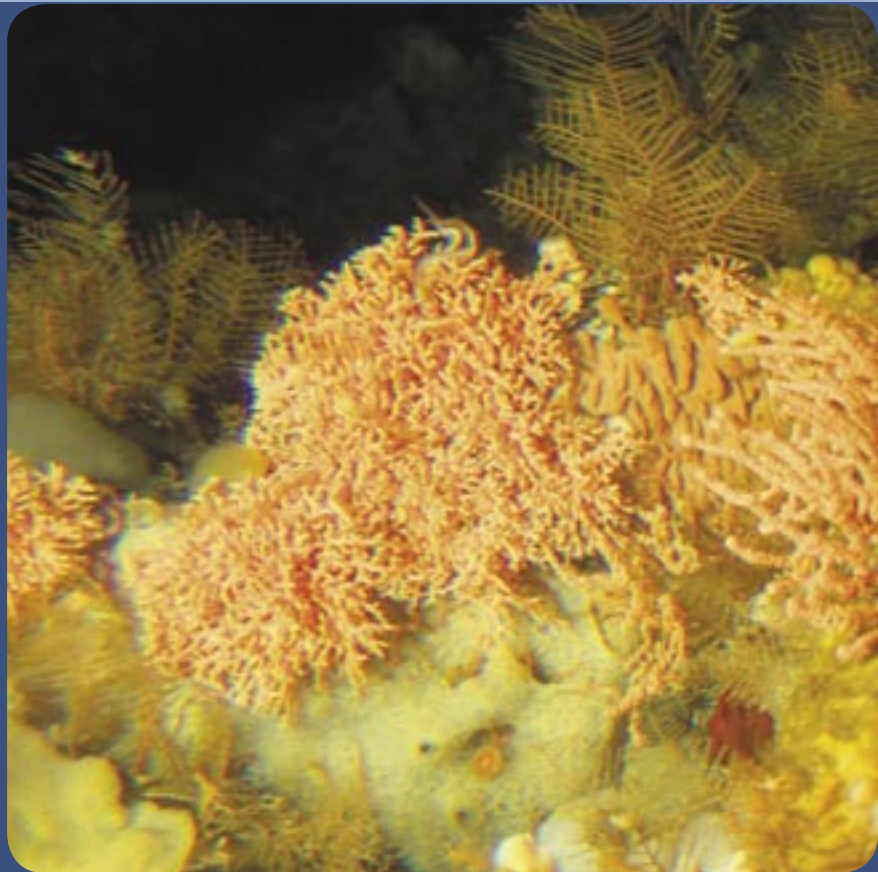
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“It was a lush, reeflike habitat with lots of coral and sponges and rockfish. I’ve done a fair amount of diving in the Caribbean. I think my words on the tape are, ‘If I didn’t know any different, I would think I was in Grand Cayman.’”

Robert Stone, National Marine Fisheries Service scientist, 500 feet beneath the waves in the Aleutian Islands, Alaska⁴⁸





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