

Hawaiian Coral Reef Ecosystem a Unique Treasure

By John Roach

for National Geographic News

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Editor's Note: Jean-Michel Cousteau's Ocean Futures Society is on a film expedition in the remote Northwestern Hawaiian Islands to raise awareness about the need to protect the region's unique biodiversity for future generations. This is the second National Geographic News feature to showcase the islands and the expedition.

For the past 50 million years the Pacific Plate has slowly crept over a stationary plume of magma deep in the Earth's mantle, allowing the formation of a chain of islands that today comprise the most remote, large scale coral reef ecosystem on the planet.

The region, known as the Northwestern Hawaiian Islands, stretches 1,200 miles (1,930 kilometers) towards Asia from the main Hawaiian Islands and is home to a thriving marine ecosystem full of unique, or endemic, species. Many of the corals, fishes, sea birds, and mammals that are found there are found nowhere else in the world.

"You can't go anywhere else in the world and find a large scale coral reef ecosystem as intact as you see in the Northwestern Hawaiian Islands. It makes it really unique," said Dave Gulko, a coral reef ecologist with the Hawaii Department of Land and Natural Resources in Honolulu.

Gulko was one of the primary investigators on a multi-agency and research institution expedition to survey the region in 2000 to determine its management needs. Now, Jean-Michel Cousteau's Ocean Futures Society is on a film expedition in the region to raise awareness about the need to protect it for future generations.

"If protected it would be a major accomplishment on the part of this country to preserve the largest coral reef [system] that exists in the U.S.," said Cousteau in an interview prior to his departure. The region is proposed to become the country's 14th National Marine Sanctuary.

Cousteau and his crew of 22 are currently in the islands, exploring the mid-ocean ecosystem formed millions of years ago and left largely undisturbed by humankind. The adventure can be followed along via the website of the Ocean Futures Society (www.oceanfutures.org).

Island and Reef Formation

The Northwestern Hawaiian Islands are part of the Hawaiian Ridge-Emperor Seamounts chain that extends some 3,700 miles (6,000 kilometers) from the island of Hawaii to the Aleutian Trench off the coast of Siberia, according to Ken Rubin, a geologist at the University of Hawaii in Honolulu.

A stationary plume of magma called a hotspot forms the chain as the Pacific Plate creeps over it in a northwesterly direction at a rate of about 4 inches (10 centimeters) per year.

The hotspot is presently somewhere underneath the vicinity of the southern end of the island of Hawaii, causing molten lava to ooze out of the Kilauea and Mauna Loa volcanoes and the underwater seamount Lo'ihi, which is off the southern end of the island.

"It is believed that the hotspot feeds all three roughly vertically from below but the details of the plumbing and the circumference of the hotspot column as it rises through the mantle to the base of the crust are not well established," said Rubin.

The island of Hawaii will continue to grow until it, like all the islands in the chain to its northwest, eventually moves off the hotspot. A new volcano, and potentially the next Hawaiian island, will form to the southeast.

The Northwestern Hawaiian Islands range in age from the 7.2 million year old Nihoa at the southeastern end of the chain to Kure at the northwestern end which, although not officially dated, is probably 30 million years old or older, said Gulko.

"Midway, which is 60 miles [97 kilometers] to the east [of Kure], is 27.7 million years old. Pearl and Hermes Atoll, 90 miles east-southeast of Midway, is aged at 20.6 million years. You go 90 miles to the east and gain 7 million years, so Kure could be considerably older," he said.

Animals begin to colonize the basalt volcanoes when they are still deep beneath the sea surface. As they grow, the types of species found there continually change until they reach the depth where light penetrates, which is about 330 feet (100 meters) in the central Pacific, said Rubin. Then plants join the system.

It is the skeletons of these latter creatures and sediments from algae, coral, snails, urchins, and other calcium rich organisms which glom together over hundreds of thousands of years to form reefs on the island fringe. The reefs are alive, colonized within and on top of this agglomeration by new organisms, which help them adapt to changes in climate and sea level.

Most of the main Hawaiian Islands have reefs of this type, but as time goes on and the islands move further from the hotspot the islands begin to sink and erode.

"If the island subsides and the coast moves landward, the reef may be moved offshore somewhat in a relative sense, since it is the island shoreline that is moving forming a lagoon between the island and reef," said Rubin. "At some point the volcanic island subsides enough for it to submerge, leaving an atoll behind."

An atoll is a ring-shaped coral reef enclosing or nearly enclosing a shallow lagoon. All that remains above the surface is living reef and accumulated sediment. Many of the outer Northwestern Hawaiian Islands are at this stage. The inner Northwestern Hawaiian Islands are still basalt islands.

"You've got a wide range of ecosystems that make up the Northwestern Hawaiian Islands," said Gulko.

Further northwest from the islands, coral growth can no longer keep up with the rate of the sinking volcano. No new reef is added and the older reef erodes. What remains is an underwater mountain called a guyot.

High Endemism

The Hawaiian Islands are isolated from the rest of the coral reef ecosystems in the Pacific Ocean. Of the few species that have reached the islands, several have mutated and evolved to creatures that are unique to Hawaii. Generally speaking, 25 percent of all coral reef species in the islands can be found nowhere else, said Gulko.

"They are not the most biodiverse, but the rates of endemism are the highest for any large-scale coral reef ecosystem on the planet," he said. Many of these species may be as old as 60 million years old, having evolved when the seamounts further to the northwest were islands and hopped to the newer islands as they formed.

Gulko likens the level of endemism to walking into a supermarket and noting that 25 percent of the food sold there carries the brand of that supermarket. That brand of food can only be found in that brand of a supermarket.

Fifty to sixty percent of the biomass of the fish in the lagoons at the outer atolls of the Northwestern Hawaiian Islands is endemic, said Gulko. In keeping with the supermarket analogy, that is the equivalent of weighing all the food in a supermarket and discovering that 50 to 60 percent of the weight comes from the supermarket brand.

On the "Voyage to Kure," Cousteau said that he hopes "to discover new territories, new groups, new species." Given the islands' isolation, rate of endemism, and relatively unexplored waters, Cousteau's film should indeed be full of discoveries.

Cousteau, Hawaiians Set Sail to Raise Awareness

John Roach

for National Geographic News

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Editor's Note: Jean-Michel Cousteau's Ocean Futures Society is on a film expedition in the remote Northwestern Hawaiian Islands to raise awareness about the need to protect the region's unique biodiversity for future generations. This is the third National Geographic News feature to showcase the islands and the expedition.

On board a modern research vessel laden with cutting-edge scuba gear and high-definition video cameras, Jean-Michel Cousteau is documenting a 1,200-mile (2,000-kilometer) long chain of remote islands and coral reefs in the tropical Pacific Ocean to raise awareness of its uniqueness and the need for its protection.

Hot on Cousteau's trail a group of native Hawaiians will sail from Kauai in the main Hawaiian Islands to the Northwestern Hawaiian Islands in a traditional Polynesian voyaging canoe on a mission to restore the Hawaiian concept of *malama*—caring—to the land and sea to ensure a balance among all forms of life.

The native Hawaiians will rendezvous with Cousteau at Kure, the most northwestern of the islands, said Pat Duarte, President of the Polynesian Voyaging Society in Honolulu. The documentary, called *Voyage to Kure*, will weave the story of the two voyages around the central theme of malama.

"We share the same mission, the same vision [as Jean-Michel Cousteau]," said Duarte. "For us, the voyage to the Northwestern Hawaiian Islands is about raising awareness of environmental issues in Hawaii. For Jean-Michel Cousteau it is about raising environmental issues for people throughout the world."

Voyage to Kure is scheduled to air in fall 2004 on public television. The Northwestern Hawaiian Islands are currently proposed to become the U.S.'s 14th National Marine Sanctuary, a designation that would help protect the region and thus help protect humankind, according to Cousteau's Ocean Futures Society.

Duarte's crew will set sail for Kure in September aboard *Hokule'a*. The boat will be guided by navigators who steer without instruments or charts, but rather by using the natural signs revealed in the winds, waves, and stars. This ancient Polynesian navigational technique is known as wayfinding.

Cousteau and his crew of 22 are already in the islands, exploring the mid-ocean ecosystem that native Hawaiians view as their ancestral home. The adventure can be

followed via the Web site of the Ocean Futures Society (see link at the bottom of this page).

Ancestral Home

"Uninhabited by living people today, the Northwestern Hawaiian Islands are home to both deceased humans and their *uhane* (spirits)," said Edward Haleahoha Ayau, a member of the Hawaiian native group Hui Malama I Na Kupuna O Hawaii Nei (Group Caring for the Ancestors of Hawaii).

"When the islands were settled, I can't say, but it occurred in *wa kahico*—ancient times," said Ayau. "After they were settled [on the main islands], families continued to go up to fish there, to get away, but mainly for spiritual ceremonies."

Archaeologists have dated agricultural, habitation, and religious sites on Nihoa and Necker islands to the 7th century. Chants and oral traditions suggest native Hawaiians also visited other islands and atolls in the chain.

Necker is also known as Mokumanamana. *Mana* is the Hawaiian word for spiritual power, and thus hints at the island's special meaning among ancient Hawaiians. As well, 33 religious shrines have been found on the island, suggesting its spiritual significance.

Nihoa, which is 130 miles (210 kilometers) northwest of Kauai in the main Hawaiian Islands, contains religious shrines, ancient dwellings, and agricultural terraces that archaeologists estimate would have been sufficient to support approximately 150 people. The islands were abandoned around 1500 for reasons not fully known, said Duarte.

Reconnection

The Polynesian Voyaging Society will drop off Ayau and a few others at the islands of Nihoa and Necker Mokumanamana so that they can perform ceremonies to reconnect with their ancestors and demonstrate an acceptance of their responsibility to care for the land and oceans of the Northwestern Hawaiian islands.

"The people that came before us made mistakes too, but they also knew a lot about the ocean and land and what it took to care for the ocean and land," said Duarte.

"There are lessons we can learn from them."

Ayau said that native Hawaiians began to lose connection with their ancestors when Westerners came to Hawaii in the 18th century. "The West influenced our ability to live life as Hawaiians...our lifestyle changed," he said. "As our lifestyle changed, we lost sight of our responsibility."

According to native Hawaiian thinking, Ayau said that each person has a responsibility to care for the dead. In turn, the dead protect the living by providing them with spiritual and physical nourishment.

"They are grandparents, we are grandchildren," said Ayau. "We want to demonstrate we understand our relationship, we understand our duty and are capable [of carrying] out that duty responsibly."

Ayau's group was formed in 1988 to make sure their ancestors were properly cared for. They have stopped developments at ancient burial sites on the main Hawaiian Islands and have reclaimed ancestral remains from museum collections and reburied them on the Northwestern Hawaiian Islands.

"When you put ancestors in the land, they nourish the land physically with their bones and spiritually with mana," said Ayau. "The thought of knowing our ancestors are back in the land creates a kind of peace and confidence in knowing that they are where they are supposed to be. When the reverse is true, all the opposite happens."

Voyage to Kure hopes to highlight the need to restore the concept of malama to all the Hawaiian Islands by contrasting images of the nearly-destroyed coral reefs off the shores of Waikiki on Oahu with images of pristine reefs in the Northwestern Hawaiian Islands.

"We will be able to show what it was once like before off the coast of Waikiki," said Cousteau in an interview prior to his departure. Cousteau and Duarte hope *Voyage to Kure* will inspire Hawaiians and the world to better care for lands and oceans so that balance will remain among all life forms well into the future.

Cousteau Finds "Horrrifying" Trash on Desert Islands

*John Roach
for National Geographic News
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Editor's Note: Jean-Michel Cousteau's Ocean Futures Society is on a film expedition in the remote Northwestern Hawaiian Islands to raise awareness about the need to protect the region's unique biodiversity for future generations. This is the fourth National Geographic News feature to showcase the islands and the expedition.

Derelict fishing nets, plastic bottles, cigarette lighters, television tubes, spray cans, broken toys, and thousands of other pieces of plastic and non-biodegradable junk converge on the Northwestern Hawaiian Islands every year, scarring a seascape nearly void of people with tons of human waste.

"It's absolutely horrrifying the scope of seeing it uncontained out here and definitely impacting the environment," said Jean-Michel Cousteau in an e-mail to National



Jean-Michel Cousteau walks along the beach at Laysan Island, littered with marine debris. Cousteau's expedition will end in Kure—the northwestern-most island of the Hawaiian Islands.

Tom Ordway/Ocean Futures Society

Geographic News sent from the *Searcher*. "Every time we go ashore, we are startled and shocked by the amount of debris that systematically litters the coastlines and reefs."

Cousteau and the Ocean Futures Society expedition team of 22 are in the Northwestern Hawaiian Islands en route to Kure, the most northwestern of the islands, filming a new documentary to raise awareness of one of the last pristine, large-scale coral reef ecosystems in the Pacific. Everywhere they look, junk taints the horizon.

The marine debris traps critically-endangered Hawaiian monk seals (*Monachus schauinslandi*) and threatened Hawaiian green sea turtles (*Chelonia mydas*), bulldozes through miles of pristine coral reef habitat, and kills thousands of Laysan and blackfooted albatross (*Diomedea immutabilis* and *Diomedea nigripes*) chicks who ingest tiny bits of plastic.

"As we explore these islands and observe the declining populations of millions of seabirds we are in shock to see the land covered with small bits and pieces of plastic of all sorts and colors," said Cousteau.

Since 1996 a multi-agency cleanup effort spearheaded by the National Oceanic and Atmospheric Administration has removed 320 tons (705,000 pounds) of debris from the reefs through tedious, back-breaking labor, but thousands of tons remain and more is deposited in the island chain each year.

"It continues to come in," said Russell Brainard, an oceanographer with NOAA Fisheries in Honolulu. "Until we remove it from the ocean and eliminate the source, this will be a continuing problem."

The documentary, *Voyage to Kure*, will contrast images of the pristine reefs and islands with the images of debris entangled on the corals and washed onto the beaches in an attempt to encourage people to take better care of the oceans and lands. Those who can't wait for the images to air on public television in fall 2004 can follow the adventure on the website of the Ocean Futures Society. (See link at bottom.)

Convergence Zone

The Northwestern Hawaiian Islands are a 1,200-mile (2,000-kilometer) long chain of islands, atolls, and coral reefs that stretch northwest towards Asia from the main Hawaiian Islands. Human presence there is sparse, but the dearth of people cannot prevent the world's trash from damaging the corals and littering the shores.

"Global ocean currents carry the marine debris to the Northwestern Hawaiian Islands, which are like the picket fencing stopping sand and snowdrifts," said Cousteau.

The currents are collectively known as the Pacific Ocean gyre. They push trash from the Pacific coasts of the Americas, Asia, Australia, and Russia into a convergence zone which shifts in and around the vicinity of the Northwestern Hawaiian Islands, said Brainard. During el Niño years, the zone shifts into the main Hawaiian Islands.

Fishing nets discarded—accidentally or on purpose—by vessels in distant fisheries produce the most damage to the pristine coral reefs. As the gear drifts with the surface currents it snares other debris, forming large clumps that extend 30 to 50 feet (10 to 15 meters) into the ocean, explained Brainard.

As the mass of debris drifts into shallower waters, the extended strands entangle on rocks and corals, ripping them from the surface and giving more heft to the net. Over the years, storms, shifts in currents, and the pull of tides allow the tangled mass to bulldoze a path to quiet waters where it comes to rest in what Brainard calls a "graveyard" of nets. Plastic lighters, fishing lures, and thousands of other pieces of plastic junk drift attached to squid and flying fish eggs in the ocean and catch the eye of albatrosses hoping to provide a nutrient-rich meal for their chicks at home on the islands. When fed, the chicks regurgitate the indigestible plastic meal.

"This scene repeats itself over and over and over again on every island we have visited," said Cousteau. "Some birds—particularly Laysan and blackfooted albatross chicks—have been affected and are found dead with all the plastic material visible in their stomach while the rest of their body decomposes. It is a sad and revolting scene every time."

Brainard said that even if debris were prevented from entering the ocean today, it would continue to circulate around the ocean for decades because it is so durable. "Plastics are miracle materials; they decompose very slowly in the marine environment," he said.

Ocean Cleanup

Appalled by the amount of debris on the coral reefs revealed by a survey in 1996, Brainard and his colleagues at NOAA and several other federal, state, and local government agencies, private companies, and conservation organizations launched a cleanup effort of the coral reefs in the Northwestern Hawaiian Islands.

To find the debris, divers are towed behind small boats, recording debris locations with global positioning system (GPS) technology. The divers then go down to the entangled mass of net on the reefs and cut it free in a painstaking and time consuming process to ensure that no further damage is caused.

"We could tie them to boats and jerk them off, but we know that would cause additional impact, so we physically cut them off strand by strand," said Brainard.

As the strands are cut free, the divers tie them to air bags that drift to the surface, preventing the strands from re-snagging on the reef. The debris is then lifted onto the small dive boats and transported to large vessels.

Through mapping and in-the-ocean experience, the crews have learned where the debris is more likely to accumulate, and as a result their efforts become more efficient each year. This season they have already collected 80 tons (176,000 pounds).

Brainard is unsure how much debris is left in the Northwestern Hawaiian Islands but said, "For every net removed, we know it has done something positive for the environment. It is one less net for a monk seal to entangle on, it is one less net for a turtle to entangle on, one less net to entangle coral. In that sense it is having a positive effect."

In the years ahead, the cleanup crew hopes to clear the hurdle of cleaning the reefs and employ remote sensing technologies to locate debris before it reaches the

Northwestern Hawaiian Islands. Once located, they could ask vessels in the area to pick it up while it is still at sea and before it entangles monk seals and bulldozes coral reefs.

"The other thing to do is to prevent it from going into the ocean in the first place, but no one group has the control to do that," said Brainard. "It's been illegal for 25 years to put plastic into the ocean and it is still going into the ocean by one way or another."

Cousteau Reaches Remote Pacific Atoll

*John Roach
for National Geographic News
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After 20 days at sea, Jean-Michel Cousteau and his crew of 22 landed the *Searcher* July 26 at Kure, the northernmost atoll in the world and turning point of their expedition to make a documentary film about one of the last pristine, large-scale coral reef ecosystems on the planet.

Speaking via satellite phone from the sun-splashed deck of the vessel en route back to the mainland, Cousteau told *National Geographic News* that now more than ever he and his crew believe every effort must be made to protect the Northwestern Hawaiian Islands.

"We want to do everything we can to make sure these unique treasures are being properly managed and protected," he said.

The natural landscape in question is a 1,200-mile (2,000-kilometer) long chain of islands and coral reefs in the tropical Pacific Ocean nearly void of humans and teeming with marine life. More than 7,000 species have been recorded in the islands, including corals, algae, sea grasses, fish, sea turtles, marine mammals, and diverse sea bird species. (The archipelago is home to an estimated 14 million birds.) Scientists believe hundreds more species remain to be discovered.

President Bill Clinton established the Northwestern Hawaiian Islands as a Coral Reef Ecosystem Reserve in 2000. The region is currently proposed to become the United States' 14th National Marine Sanctuary—the highest form of protection afforded a marine environment. If established, it will be larger than the 13 other sanctuaries combined.

Cousteau and his crew embarked on the five-week expedition through the region on July 6. They have visited islands teeming with thousands of sea birds and scuba dived with Galápagos sharks (*Carcharhinus galapagensis*), spinner dolphins (*Stenella longirostris*), monk seals (*Monachus fleming*), and hundreds of unique fish.

The crew will continue to film and dive over the next week as they make their way back to the main Hawaiian Islands. However, Cousteau believes he and his crew have captured enough footage to make "an extremely compelling documentary" that will showcase the islands and promote their protection.

Michael Weiss, deputy director of the National Marine Sanctuary Program at the National Oceanic and Atmospheric Administration (NOAA) in Silver Spring, Maryland, applauds the effort of Cousteau and his Santa Barbara, California-based Ocean Futures Society.

"Anything that adds information that helps in our decision-making process is welcome," he said. The agency's goal is to see the region awarded sanctuary status. A final decision will be released in fall 2005.

Voyage to Kure is scheduled to air in fall 2004 on public television stations in the United States. Those who can't wait to watch the adventure on television can follow along via the Web site of Cousteau's Ocean Futures Society (see link below).

Island Impressions

After nearly a month gathering impressions of the Northwestern Hawaiian Islands to share with the world, highlights for Cousteau include a thriving Galápagos shark population, the endearing curiosity of a well-known monk seal, and the territorial dominance gained by schools of giant trevally jacks (*Caranx melampygus*).

Jacks are large, predatory fish that weigh upwards of 70 pounds (30 kilograms). Cousteau describes them as aggressive, territorial "control freaks." On several dives he has seen Galápagos sharks actively avoiding schools of jacks. "It's funny," he said, "because the jacks are in charge and sharks are subservient. It is very interesting to see this."

One jack in particular has followed the *Searcher* and been present for several of the crew's dives. Nicknamed "Black Jack," Cousteau said he will feature prominently in the film.

Other budding marine stars include spinner dolphins that migrate between atolls to keep their populations in balance, rare tropical fish such as masked angelfish (*Genicanthus personatus*), and a Laysan albatross (*Diomedea immutabilis*) chick named "Lanai" whose flight feathers never fully developed. The crew is transporting Lanai to Sea Life Park in Honolulu, Hawaii, where she will serve as an ambassador of the Northwestern Hawaiian Islands.

Cousteau lamented the fact that his crew has encountered ample impacts from debris tossed or inadvertently lost in the sea by people the world over. Plastic toys, cigarette lighters, and derelict fishing gear smother the coral reefs and litter the island shores. Marine mammals entangle and drown on the fishing nets and sea birds constantly regurgitate indigestible bits of plastic.

"This is coming from the open ocean, coming from the rest of the planet, which means all of us. It is really an issue that needs to be addressed," said Cousteau.

The coral reefs, which are the northernmost and among the hardiest in the world, are also beginning to show signs of stress from global warming, said Cousteau. Scientists are investigating signs of coral bleaching—a loss of pigmented algae cells as a result of waters getting too warm. Coral bleaching has decimated reefs worldwide. Until a year ago, the phenomenon was thought to be absent from the Northwestern Hawaiian Islands.

Despite these impacts, Cousteau is optimistic that the tide of damage can be reversed and the Northwestern Hawaiian Islands preserved for the benefit of both the wildlife that calls it home and humankind as a whole.

Sanctuary Protection

By law, once a Coral Reef Ecosystem Reserve is established it must be considered for designation as a National Marine Sanctuary, said Weiss. The process is rigorous, involving input from public and private interest groups and the development of management plans and environmental studies that must receive congressional approval.

Weiss said his agency has completed the public scoping process for the reserve management plan and is now shifting gears to develop the management plans and conduct the environmental studies required to designate the Northwestern Hawaiian Islands a National Marine Sanctuary.

"[The Department of] Commerce and NOAA are committed to long-term protection of that area," he said. "That is the long-term goal... Our goal is to have a sanctuary out there, but we will let the process work."

Cousteau said he is ready to lend whatever support he can to see the process successfully completed. His *Voyage to Kure* aims to raise worldwide awareness of the remote seascape. For the crew privileged to work on the film, the expedition was extraordinary.

"It will remain something in the minds of those 22 people that they will never forget," he said.