Census of Marine Life Projects

Information System: **OBIS**
Nearshore: **NaGISA**
Coral Reefs: **CReefs**
Regional Ecosystems: **GoMA**
Continental Shelves: **POST**
Continental Margins: **COMARGE**
Abyssal Plains: **CeDAMar**
Mid-Ocean Ridges: **MAR-ECO**
Seamounts: **CenSeam**
Vents and Seeps: **ChEss**
Arctic Ocean: **ArcOD**
Antarctic Ocean: **CAML**
Top Predators: **TOPP**
Zooplankton: **CMarZ**
Microbes: **ICoMM**
Oceans Past: **HMAP**
Oceans Future: **FMAP**

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CENSUS OF MARINE LIFE
MAKING OCEAN LIFE COUNT

Like an underwater spaceship, a jellyfish, *Aequorea macrodactyla*, travels through the warm, clear waters of the Celebes Sea in the Western Pacific Ocean. The jellyfish was but one of thousands of specimens photographed during a three-week Census expedition to explore this highly diverse area. Photo: Larry Madin, Woods Hole Oceanographic Institution.

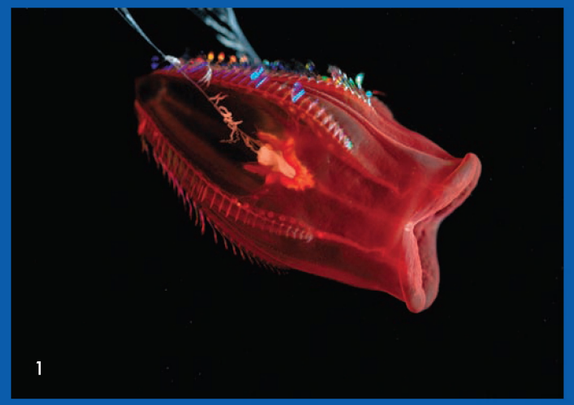
A Truly Global Endeavor

The Census of Marine Life is a global network of researchers in more than 80 nations engaged in a ten-year scientific initiative to assess and explain the diversity, distribution, and abundance of marine life in the oceans. The world's first comprehensive Census of Marine Life—past, present, and future—will be released in 2010.

The Census gratefully acknowledges the financial support of numerous governments and organizations from around the world. Moreover, many of the highlights in this report were only realized through the generous collaborative spirit and unprecedented cooperation of Census researchers and their international colleagues. A complete list of Census sponsors, funding partners, collaborating institutions, and participating individuals is available at **www.coml.org**.

The 2007/2008 Highlights Report was prepared by the Census of Marine Life's Education and Outreach Team, based at the University of Rhode Island Graduate School of Oceanography's Office of Marine Programs. The report was compiled by Darlene Trew Crist and Jay Harding, and designed by Darrell McIntire.

Film director Claire Nouvian has worked alongside Census scientists studying the continental margins to capture some amazing photographs for her exhibition *The Deep*. The exhibit succeeds in relaying a great amount of information about life in the ocean depths, while capturing audiences' imaginations with its powerful and striking imagery.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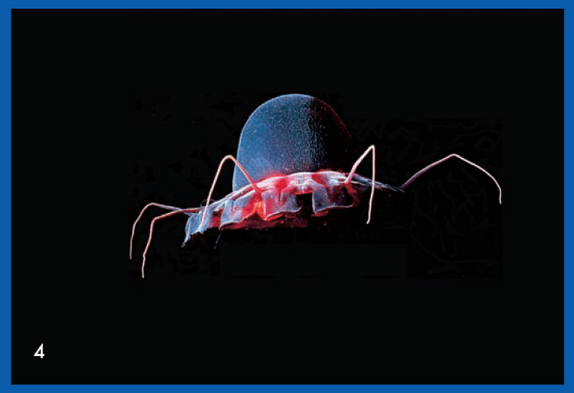
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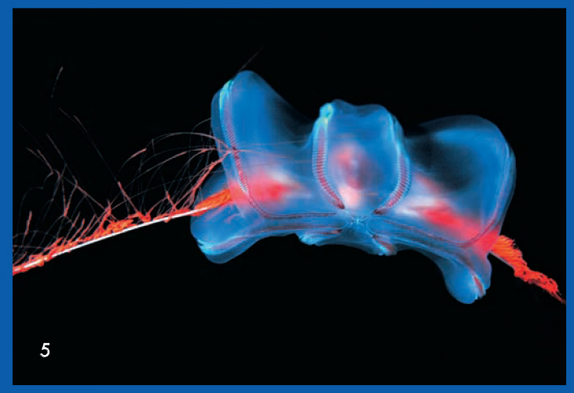
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1. Unidentified deep-sea ctenophore. Photo by Steven Haddock.
2. *Stauroteuthis syrtensis*, the glowing sucker octopus. Photo by Claire Nouvian and David Shale.
3. The Fanfin Seadevil, *Caulophryne jordani*. Photo by David Shale.
4. *Nausithoe rubra*, a deepwater scyphomedusa jelly. Photo by George Matsumoto.
5. The deep-sea ctenophore, *Mertensia ovum*. Photo by Bjorn Gulliksen.

CENSUS OF MARINE LIFE
2007/2008 HIGHLIGHTS REPORT

Eight years into a ten-year initiative to produce the first comprehensive assessment of life in the global ocean, the Census of Marine Life has much to report. The last two years have brought many highlights as Census participants stayed the course toward discovering diversity, charting distribution, and assessing abundance of marine life throughout the world's seas.

Although inquiring waders, swimmers, fishers, and sailors have ventured into the ocean for millennia, an estimated 95 percent of the global ocean remains unexplored. Exploring the unexplored since 2000, Census investigators have ventured into those waters. During the last two years alone, Census scientists participated in more than 30 research expeditions. In 2007, Census researchers were chosen to lead the Arctic and Antarctic biodiversity research efforts for the International Polar Year.

Discovering new life-forms is one of the many benefits of exploring nearly virgin territory. Census explorers consistently found new forms of life, detected species distributed in new places, and found clues to the abundance of marine life. During the first eight years of discovery, Census investigators have found more than 5,300 likely new species, of which at least 110 have gone through the rigorous process needed to award the title of truly "new."

Finding the unexpected is also a common denominator among Census scientific investigations. Observing sharks traveling many thousands of kilometers to spend six months at the "White Shark Café" in the Pacific is but one of a multitude of surprises experienced over the past two years.

Advancing technology is a key result of Census explorations as well. Each time a Census vessel left port, tracked a tagged animal, or tested a new technology, advances in understanding the ocean and its habitants emerged. To track large animals migrating vast distances, Census scientists tagged more than 2,100 animals and recorded vast cosmopolitan crossings and circumnavigations. To follow small animals moving from pools upstream, out of rivers, and along the edges of continents, Census scientists tagged thousands more animals, and even followed a single young salmon, about the length of a human hand, for 2,500km. To speed reliable identification, a Census network advanced the reference library of the DNA barcodes of 7,000 species of zooplankton and tens of thousands of other marine species.

The Census is succeeding by building global partnerships. Its community of more than 2,000 scientists from more than 80 nations grew over the past two years to include 12 regional and national committees. Partnerships among the Census, the Encyclopedia of Life, and the World Register of Marine Species will document all 230,000 known marine species in time for issuance of the first Census of Marine Life in 2010.

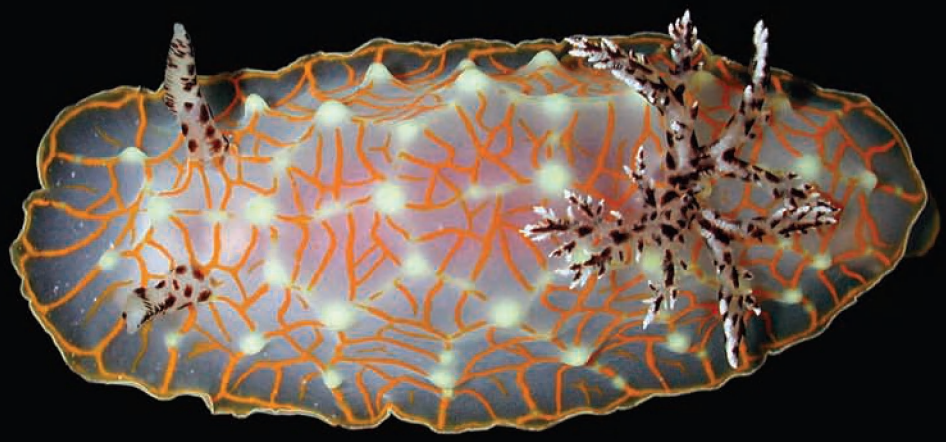
Meanwhile, the Census has progressed to engaging people almost everywhere and to informing decisions in many locales. The Internet brought the Great Turtle Race charting the 800-km annual migration of sea turtles from Costa Rica to the Galapagos Islands to 100 million Chinese participants, and contributions helped protect a turtle nesting area in Indonesia. Tracking data are being used to develop conservation measures for a number of other marine species. DNA barcodes revealed inaccurate labeling of sushi in New York City.

Furthering its commitment to sharing knowledge, the Census' Ocean Biogeographic Information System expanded to provide identification and location information on more than 120,000 marine species. The highlights of the past two years provide confidence that the first Census of Marine Life in 2010 will reveal with unprecedented quality what we know and do not know about what lived, now lives, and will live in the global ocean.

A giant guitarfish, *Rhynchobatos djiddensis*, also known as white-spotted guitarfish, whitespot ray, sandshark, and whitespot shovelnose ray, lies buried in the sands off Lizard Island, Queensland, Australia. Photos: Gary Bell, OceanwideImages.com (above). Gary Cranitch, Queensland Museum (below).

EXPLORING THE UNEXPLORED

While maps, globes, and satellite views may impart the notion that the global ocean is well known, less than five percent of its waters have been explored, leaving ample opportunity for exploration and discovery. Grasping the opportunity, Census researchers are searching the top and bottom of the planet and the depths and shallows of the global ocean to capture a picture of what lives in frigid or scalding, dark or sunlit, and local or faraway waters. Even below the busy Atlantic, they surveyed a seemingly new continent, halfway between America and Europe. In the unexplored places, they discovered an abundance of new species and encountered familiar ones in new places.

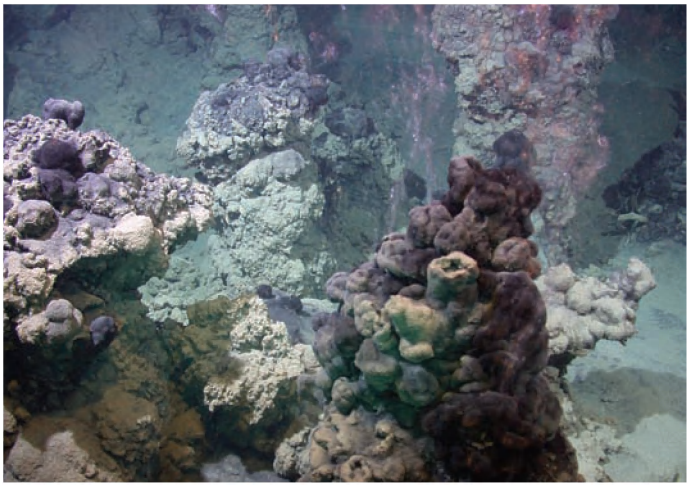


A golden lace nudibranch, *Halgerda terramtuentis,* was collected in the waters of the Northwestern Hawaiian Islands. Photo: Cory Pittman 2006, courtesy U.S. National Oceanic and Atmospheric Administration, Pacific Island Fisheries Science Center, Northwestern Hawaiian Islands Marine National Monument.

Teeming shrimp and mussels inhabit the deepest hydrothermal vents explored to date. Photo: Daniel Desbruyeres, Ifremer.

Deepest Active Hot Vent ChEss

On a research cruise to investigate hydrothermal vents along the Mid-Atlantic Ridge, Census scientists discovered the deepest active hot vent yet in a field named Ashadze. More than 4,100 m deep, this vent site differed considerably from other Atlantic vent sites. Dominated by anemones, polychaete worms, and shrimp, Ashadze had fewer obvious symbionts—dissimilar species with mutually beneficial relationships.



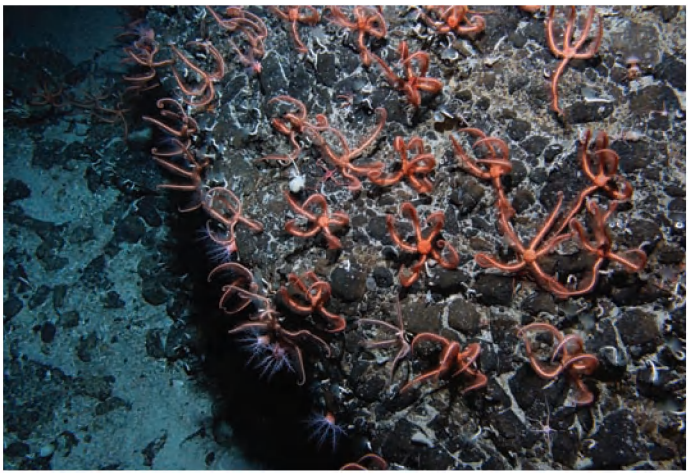
Seeping natural gas from the seafloor powers a microbial reef 250 m deep in the northwest Black Sea. Photo: Center for Marine Environmental Research, Bremen University.

Life Without Oxygen ChEss

Not all life needs oxygen. Census scientists have discovered that marine environments with little or no oxygen may harbor more life than previously thought. Reefs made of bacterial mats in the deep reaches of the Black Sea use methane (natural gas) as an energy source and form spectacular chimneys up to four meters high. Such reefs could contribute key insights to mechanisms controlling emissions of methane, an important greenhouse gas, from the ocean to the atmosphere.

Brittle Star City CenSeam

Census explorers from New Zealand and Australia were the first to capture images of a novel "Brittle Star City" that has colonized the peak of a seamount—an underwater summit taller than the world's tallest building. Tens of millions of brittle stars were found living arm tip to arm tip in the swirling circumpolar current flowing at roughly four kilometers per hour. The current keeps away would-be predators and brings with it an ample supply of food that inhabitants of Brittle Star City collect simply by raising their arms.



Millions of brittle stars, likely *Ophiacantha rosea*, relatives of sea stars and sea cucumbers, colonize the peak of a seamount to feed on particles carried by the swift Antarctic Circumpolar Current. Photo: National Institute of Water and Atmospheric Research, New Zealand ©2008.

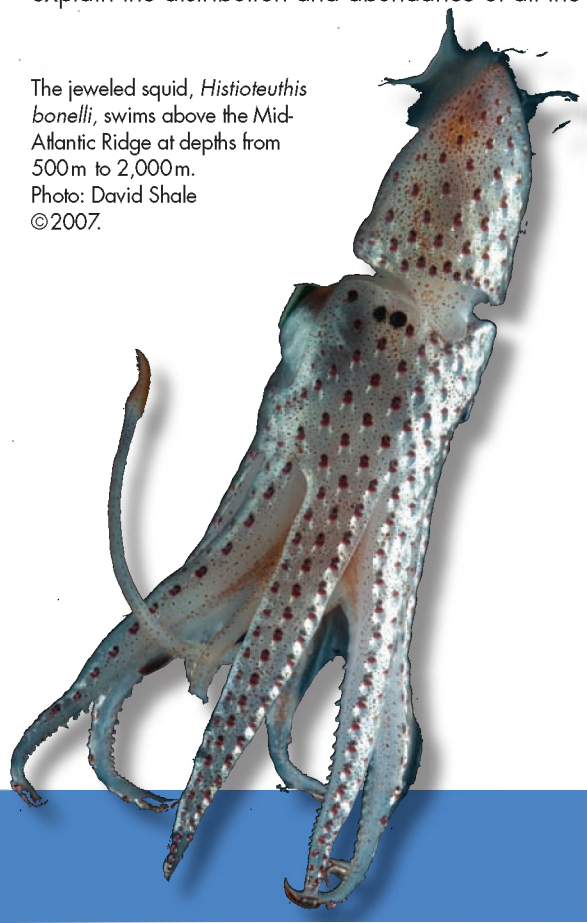
Very Different Twins NaGISA

Census nearshore scientists in the Alaskan Arctic have found a site with a rocky sea floor, rare along the normally soft and silty Arctic coastline. The hard substrate hosts a highly diverse community compared to surrounding soft bottom habitat. Comparison of this new site to a similar site surveyed by Census researchers in 2002 shows surprisingly different communities. Census nearshore scientists collaborating with local agencies also have discovered new species in the Aleutian archipelago, including a kelp, sea anemones, chitons, snails, and sea stars.

In Alaska's Aleutian Islands, nearshore researchers have discovered new species even in shallow water, such as this kelp, *Aureophycus aleuticus*. Photo: Max K. Hoberg, Institute of Marine Science, University of Alaska Fairbanks.

Survey of a 'New Continent' MAR-ECO

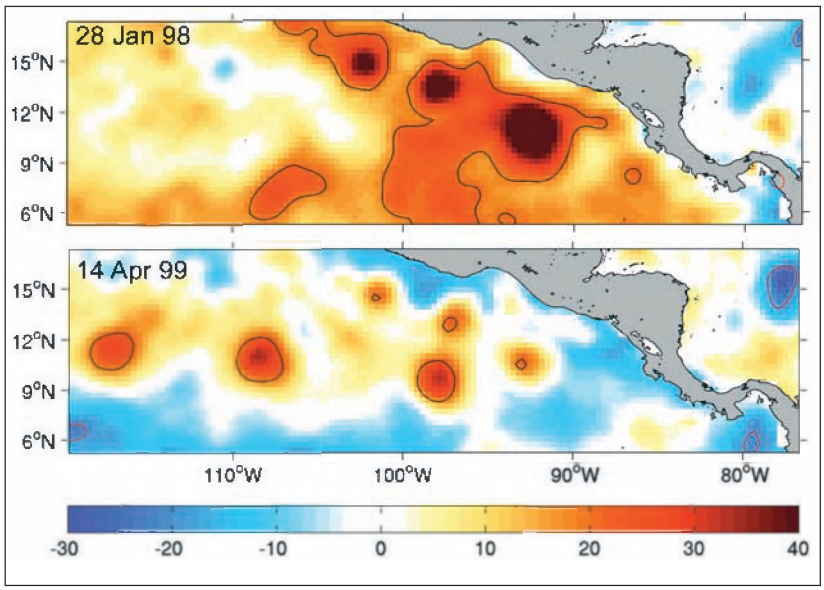
Discovering such a wealth of information, Census scientists cruising over the Mid-Atlantic Ridge described their work as "surveying a new continent halfway between America and Europe." Sampling along the ridge at depths down to 2,500m, they found many hundreds of species rare or unknown elsewhere in the world, including a potentially new species of shrimp, and collected environmental data to help explain the distribution and abundance of all the species.



The jeweled squid, *Histioteuthis bonelli*, swims above the Mid-Atlantic Ridge at depths from 500m to 2,000m. Photo: David Shale ©2007.

Pacific Hot Spots TOPP

Wind jetting through the mountain passes of Central America moves warm, enriched coastal waters offshore into the Pacific. These eddies of warm water, stronger and more prevalent during El Niño years and weaker and less common during La Niña years, may meld, forming hot spots in the open sea. Census scientists have learned the hot spots support elevated levels of the tiny phytoplankton that form the base of the marine food web. These verdant meadows in the vast Pacific in turn attract or concentrate species from all tiers of the food web from shrimp to large predators like tuna, seabirds, and whales.



Anticyclonic (clockwise-rotating) eddies of water act as oases in the open ocean off the Pacific coast of Central America. Image: Daniel Palacios, U.S. National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center.

Seep Mega-Sites COMARGE

Census scientists keep discovering lively communities flourishing off cold gases such as methane seeping out of the sea floor. A collaboration of Census scientists surveying the cold seep communities around New Zealand mapped the "Builder's Pencil" site covering about 180,000m^2, among the largest known seep sites on Earth. Sensitive to human activities despite their depth, the communities keep revealing unique features. Finding both potential new species and scars from deepwater trawls by fishing vessels on the scientific surveys suggests the urgency for further conservation of these fragile habitats.

Vestimentiferan tubeworms from the cold seep, Builder's Pencil, characterized samples taken during a voyage on the RV *Tangaroa*. Photo: RENEWZ; U.S. National Oceanic and Atmospheric Administration; National Institute of Water and Atmospheric Research, New Zealand.

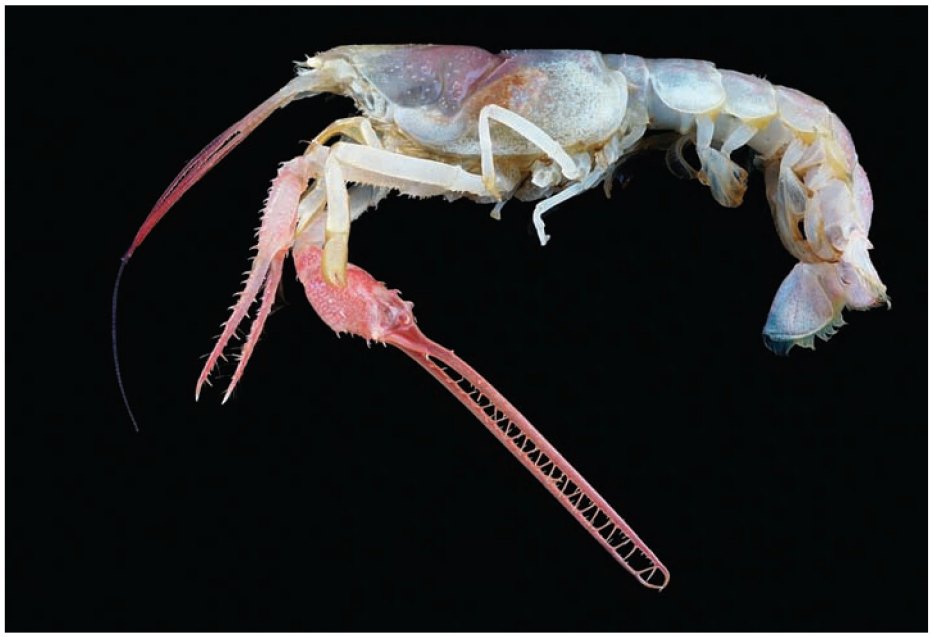
Philippine Firsts COMARGE

In 2007, the Pacific seaboard of the Philippines afforded Census investigators the opportunity to conduct the first deep-sea work in the area. Sampling to a depth of 2,300m, researchers collected about 300 fish and 400 mollusk species for barcoding. Some 320 decapod crustaceans posed for photographs not only to display their beauty, but to aid future identification of many unique and subtly distinct specimens.

A year later, Census investigators returned to explore the Philippine margin of the South China Sea, between 100m and 2,200m depth. Among unexpected discoveries that repeatedly amazed researchers were the first Philippine record of the deepwater stony coral *Lophelia pertusa*, the first living specimen of *Acharax bartschi*, a large bivalve living in symbiosis with bacteria, rare deepwater snails living on a dog skull, and a likely new species of shrimp belonging to a group only known from hydrothermal vents. The trawl gathering these specimens also collected numerous plastic shopping bags.

Expedition leader, Philippe Bouchet, displays a rare bivalve mollusk (inset) that was captured alive for the first time. Photos: Christopher Meyer, Smithsonian Institution, Washington, D.C.

Aphyonidae is a family of rare fish that lives below 700m. This gelatinous specimen of the genus *Barathronus* is probably an undescribed species. Photo: Yun-Chih Liao, courtesy of Kwang-Tsao Shao, Academia Sinica, Taipei, Taiwan.



A new species, this blind lobster with bizarre chelipeds belongs to the rare genus *Thaumastochelopsis*, which was previously known only from four specimens of two species in Australia. Photo: Tin-Yam Chan, National Taiwan Ocean University, Keelung.

Abyssochrysidae (left) are a little-known family of tropical, seldom-collected, deepwater snails. Photo: Barbara Buge, Muséum national d'Histoire naturalle, Paris.

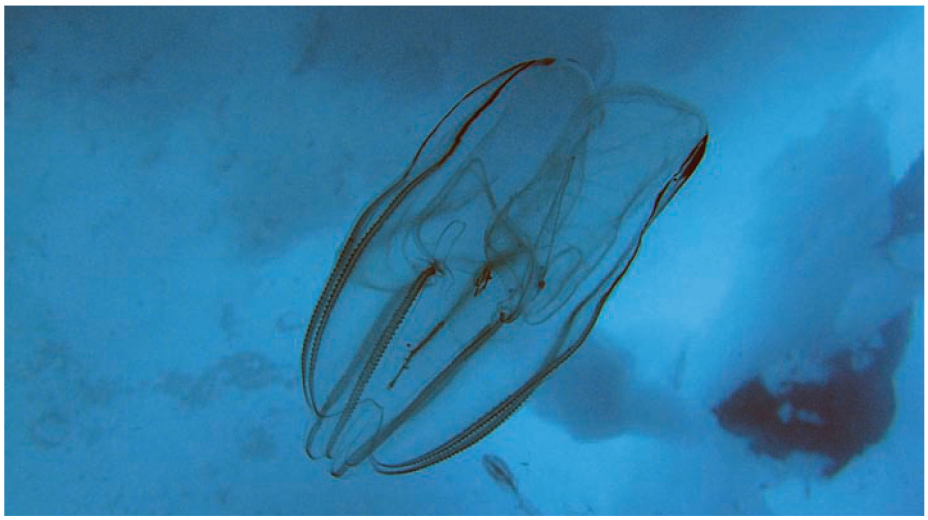
New Marine Protected Area
Sub-Saharan Africa

Comprising about eight percent of the world's ocean, the Western Indian Ocean, including the Mozambique channel, is rich with species, including coelocanths, dugongs, whale sharks, and humpback whales. While largely unexplored, the region also suffers destructive fishing practices, such as use of dynamite. A Census-affiliated expedition charted a proposed marine protected area off Tanga, Tanzania. Using scuba gear and remotely operated vehicles, researchers surveyed life along transects that could be periodically revisited, collected samples for identification and barcoding, and enhanced the local scientific community by involving Tanzanian scientists and students.

Off Tanga, Tanzania, Census scientists observed a spectrum of indigenous fishing activities and their varying impacts on marine biodiversity. Photo: Charles Griffiths, University of Cape Town, South Africa.

Life in the Coldest, Saltiest Seawater ArcOD

Census Arctic researchers studied life living in the coldest conditions in the global ocean. Seawater freezes at 1.8° C, but the temperatures in the sea ice brine channels they study can drop to –25° C where brine is more than six times saltier than regular seawater. Despite such extremes, researchers found sea ice algae, such as diatoms, and flagellates thrived in this environment in concentrations of thousands of individuals per liter.



This Arctic ctenophore, *Bolinopsis infundibulum*, thrives in the coldest conditions in the sea. Photo: Shawn Harper, University of Alaska Fairbanks.

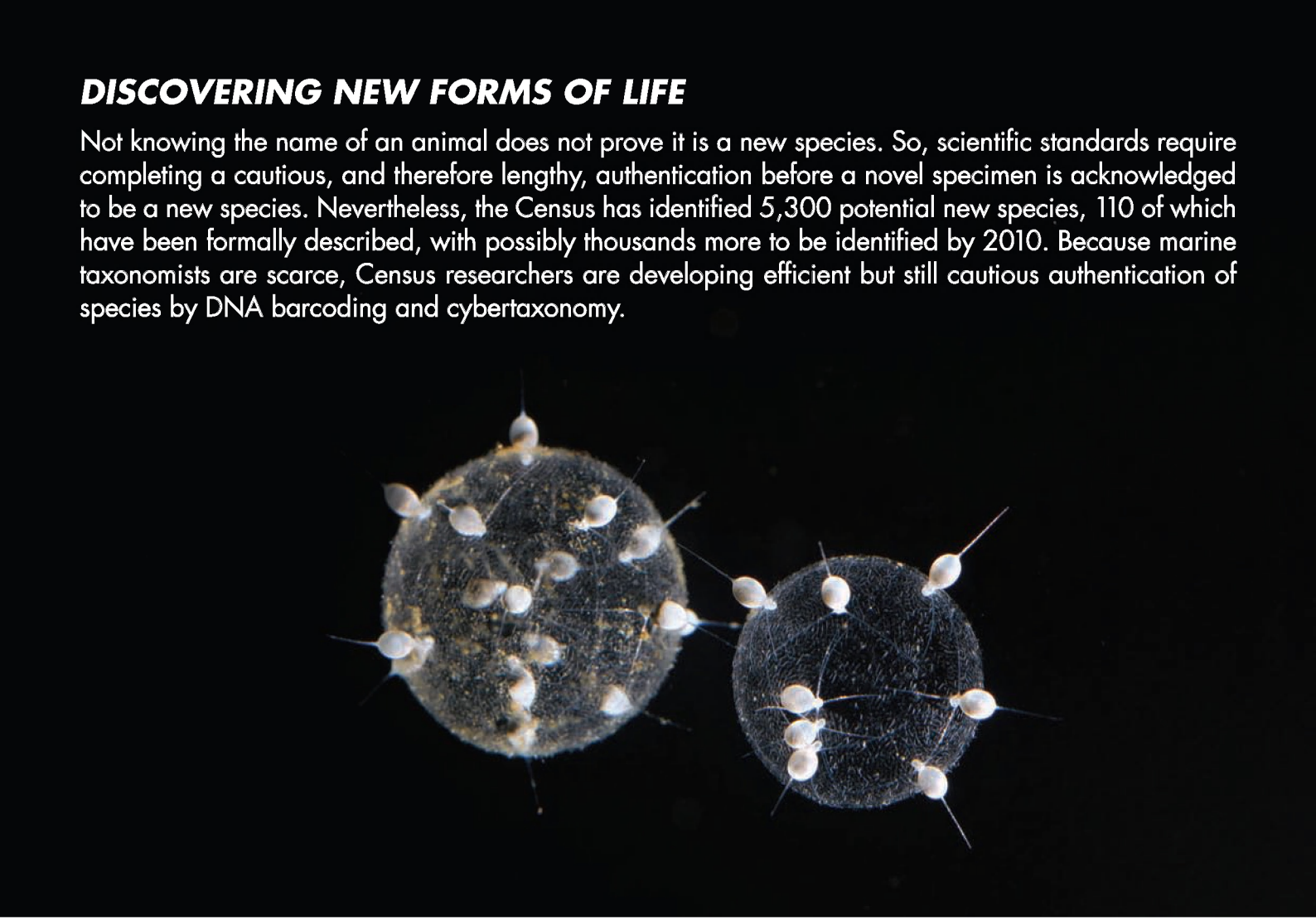
Where Art and Research Meet

Norwegian artist Anne Berg Edvardsen uses sculpture to communicate things one can only "see" with one's hands. A research expedition in the winter of 2006 inspired her to create a body of sculpture to accompany her master's thesis: *Where Art and Research Meet.* Her sculptures are unglazed clay in various shades of white. Berg Edvardsen explains that the lack of color allows the forms "to speak for themselves."

MAR-ECO's work on the Mid-Atlantic Ridge inspired Norwegian sculptor Anne Berg Edvardsen's art in clay.

DISCOVERING NEW FORMS OF LIFE

Not knowing the name of an animal does not prove it is a new species. So, scientific standards require completing a cautious, and therefore lengthy, authentication before a novel specimen is acknowledged to be a new species. Nevertheless, the Census has identified 5,300 potential new species, 110 of which have been formally described, with possibly thousands more to be identified by 2010. Because marine taxonomists are scarce, Census researchers are developing efficient but still cautious authentication of species by DNA barcoding and cybertaxonomy.



Two colonial phaeodarian radiolarians collected by Census researchers from the Celebes Sea. Photo: Larry Madin, Woods Hole Oceanographic Institution.

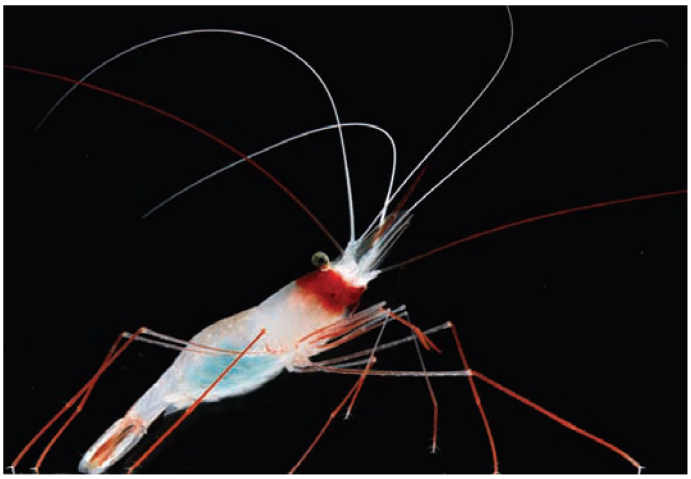
Future Marine Taxonomists ChEss

A Census-sponsored training program that cultivated taxonomic expertise in young deep-sea biologists is a likely lasting legacy. Training the next generation of marine taxonomists, the Census assures continuing discovery and identification of marine organisms with high levels of reliability. Participants in the initiative have already identified many species from Census expeditions to vents and seeps, including discovery of candidate new species, and a new species may even be named for a Census project.

At a hydrothermal vent, this species is the first record of a hydrothermal vent zoanthid, an order of invertebrates related to corals. Photo: Charles Fisher, Penn State University.

100 New Species and Records CReefs

A team of Census taxonomic experts traveled to French Frigate Shoals to study biodiversity in the world's largest, fully protected marine area, the Northwestern Hawaiian Islands, locally known as Papahanaumokuakea. Using a variety of new and proven methods over a diverse range of habitats, the team recorded more than 100 species records, finding many species possibly new to science, and others where they were never before seen.

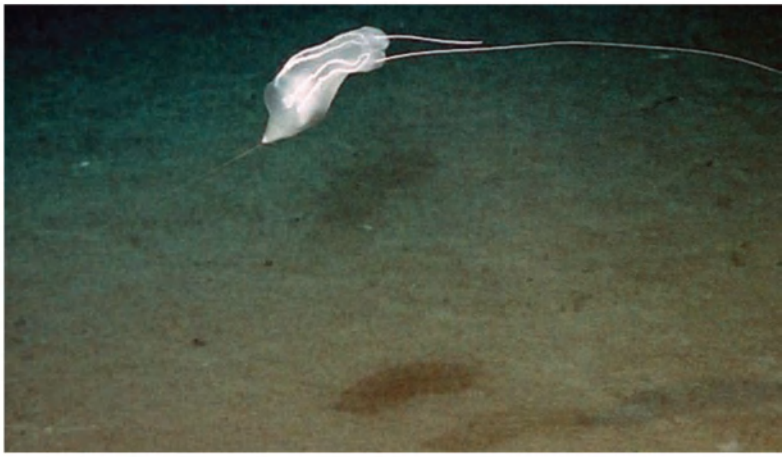


A deepwater shrimp species from French Frigate Shoals in the Northwestern Hawaiian Islands. Photo: Susan Middleton ©2006, courtesy U.S. National Oceanic and Atmospheric Administration, Pacific Island Fisheries Science Center, Northwestern Hawaiian Islands Marine National Monument.

Census researchers described a new species of amphipod from the deep waters of the Gulf of Mexico. Photo: Yousra Soliman, Texas A&M University, Galveston.

Carpet of Bugs COMARGE

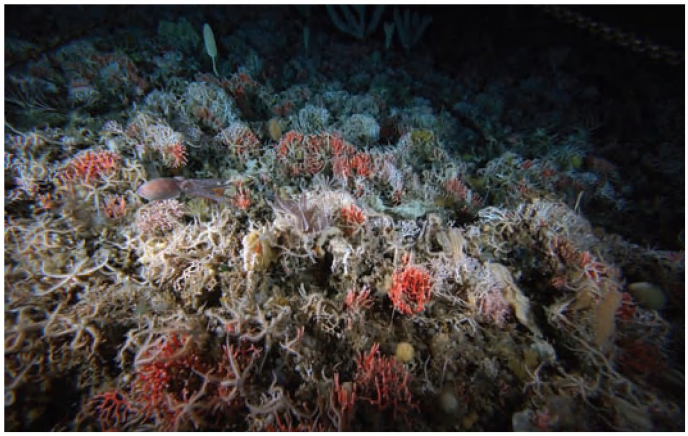
Census researchers described a new species of amphipod, *Ampelisca mississippiana*, inhabiting the head of the Mississippi Canyon about 460m deep in the Gulf of Mexico. These small crustaceans, less than 6mm in length and living in tubes, carpeted the seabed in densities up to 12,000 individuals per square meter. Based on its abundance and the stabilizing effects this "carpet of bugs" has on sediments, researchers believe this amphipod may have great ecological importance.



A new species of benthic comb jelly found at the depth of 7,217m takes the record for deepest ctenophore. Photo: Japan Agency for Marine Earth Science and Technology ©2007.

Deepest Comb Jelly CMaRZ

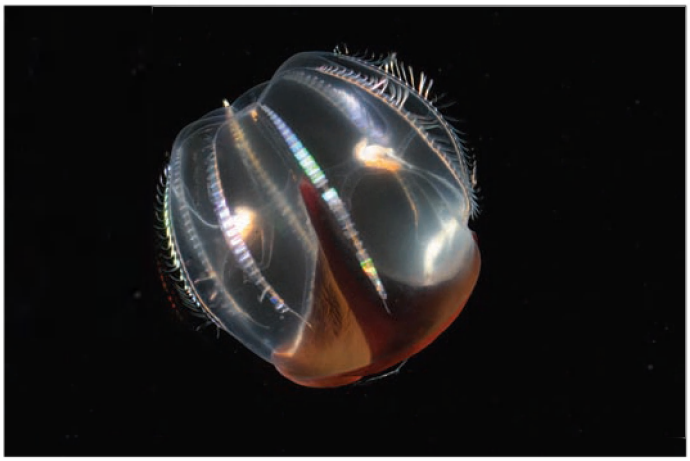
A potential new species of comb jelly, or ctenophore, was found at the record depth of 7,217m in the Ryukyu Trench near Japan—the deepest recorded siting of this species ever. This unique species, which flies like a kite on the end of two long "strings" attached to the bottom, is raising questions about the availability of food resources. It was found at a depth thought incapable of supporting predators like this one, which do not actively hunt.



Diverse coral communities were discovered at a depth of 725m by scientists aboard the Australian icebreaker *Aurora Australis*. Photo: Martin Riddle, Australian Antarctic Division.

Evolutionary Mollusk CAML

In the Southern Ocean, many potential new species were discovered including sea cucumbers, sponges, and komokiaceans—little-known protozoa that live in the depths of the ocean and resemble the organisms that form chalk. The Census scientists also collected a rare mollusk, named *Laevipilina antarctica*, which they believe played a role in how segmentation evolved in marine invertebrates.



A brightly colored comb jelly swims in the high Arctic waters of the Canada Basin. Photo: Kevin Raskoff, Monterey Peninsula College.

50 Different Kinds of Jellies ArcOD

In the Canada Basin of the Arctic Ocean, Census researchers found several new species and more than 50 taxonomic categories of gelatinous zooplankton. Almost two-thirds were medusae, one-fifth were siphonophores, and one-tenth were larvaceans. The first new species formally described from the expedition was a seafloor species named *Sigambra healyae* in honor of the research vessel, the U.S. Coast Guard Cutter *Healy*.

First New Species in IPY ArcOD

Census Arctic explorers discovered one of the first new species named during the International Polar Year. In Arctic sea ice, investigators found a new genus and species of hydroid that moves about 20cm per hour, devouring tiny shrimplike crustaceans in its path. Named *Sympagohydra tuuli* for two of the researchers' newborn daughter, Tuuli, this tiny invertebrate related to anemones may prove to be a key predator in its habitat.

A voracious predator, this tiny hydroid, *Sympagohydra tuuli*, lives in the interstitial water of Arctic sea ice. Photo: Rolf Gradinger, University of Alaska Fairbanks.

An ostracod or clam shrimp, *Conchoecissa plinthina* (left) and a Cranchidean larval squid were collected from the South Atlantic Ocean off the coast of Africa. Photos: Cheryl Clarke, University of Alaska Fairbanks.

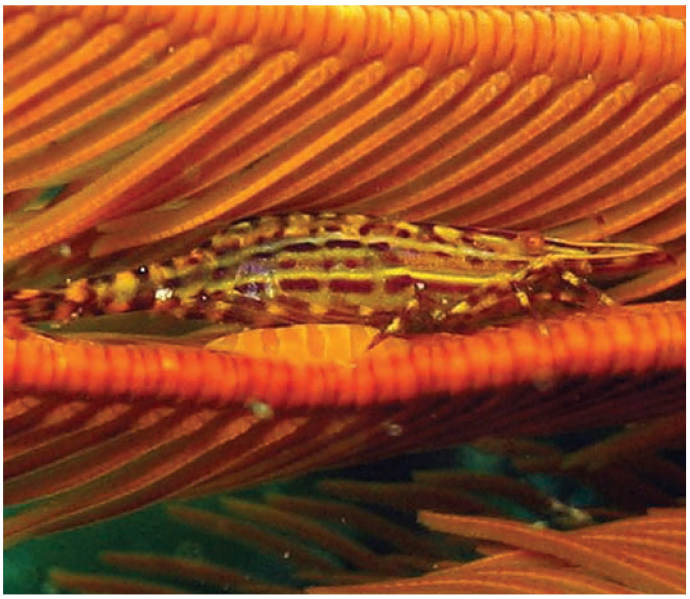
85 New Zooplankton Species CMarZ

In 2008, Census scientists discovered at least 85 new species of zooplankton, small drifting and swimming marine animals. Four genera and one family were officially deemed new to science, with many more to follow in the years ahead. During one expedition in the Atlantic Ocean from Germany to South Africa, scientists collected zooplankton from the surface down to below 5,000m. Taxonomic experts and geneticists worked together to identify and barcode the DNA from hundreds of species. As expected, several new species of small crustaceans called ostracods or seed shrimp and other groups were found.

A probable undescribed species of pebble crab was discovered in the waters of Southwestern Australia. Photo: Karen Gowlett-Holmes ©Commonwealth Scientific and Industrial Research Organization, Australia.

33 Percent New Species COMARGE

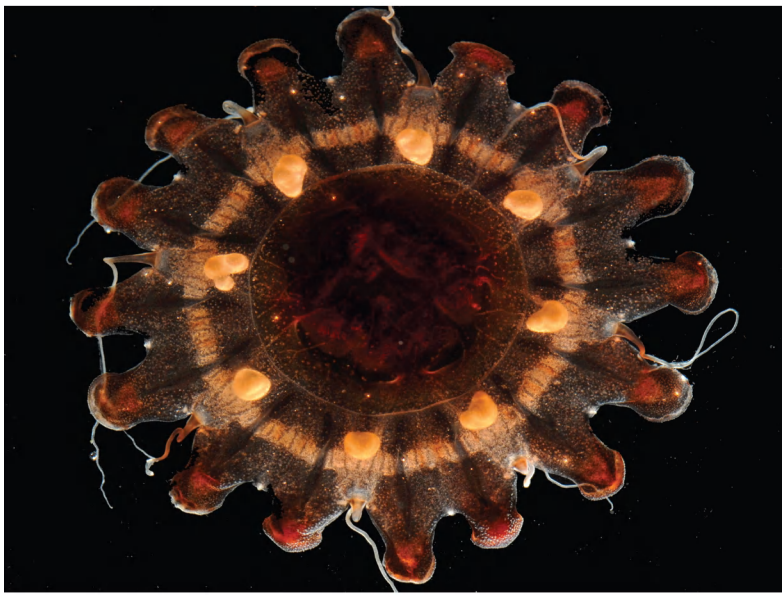
The first results from "Voyages of Discovery" expeditions to the deep continental shelf and slope in Australia's southwest region are in. Scientists were surprised to find 524 species of Decapoda— crabs, shrimps, prawns, lobsters, and the like. Of the species sampled, 33 percent of all species encountered were suspected to be new species, eight percent were new records for Australia, never having been seen there before, and an additional 25 percent were new to the region.



This photograph taken near Cape Town shows both a newly discovered species of shrimp and a new species of Myzostomid (the yellow object beneath the shrimp). Both are commensal on crinoids. Photo: Guido Zsilavecz, Cape Town.

11,130 South African Marine Species
Sub-Saharan Africa

The known number of marine animal species in South African waters is 11,130. Census experts estimate 6,000 more species, primarily smaller marine animals, are yet to be discovered. A new shrimp (*Hippolyte*) and the first record of the enigmatic group Myzostomida from the region were recently discovered in False Bay, the most sampled site on the African coast.



A midwater medusa, *Nausithoe* sp., was collected from the Celebes Sea by Census researchers. Photo: Larry Madin, Woods Hole Oceanographic Institution.

Spectacular Species in the Celebes Sea CMarZ

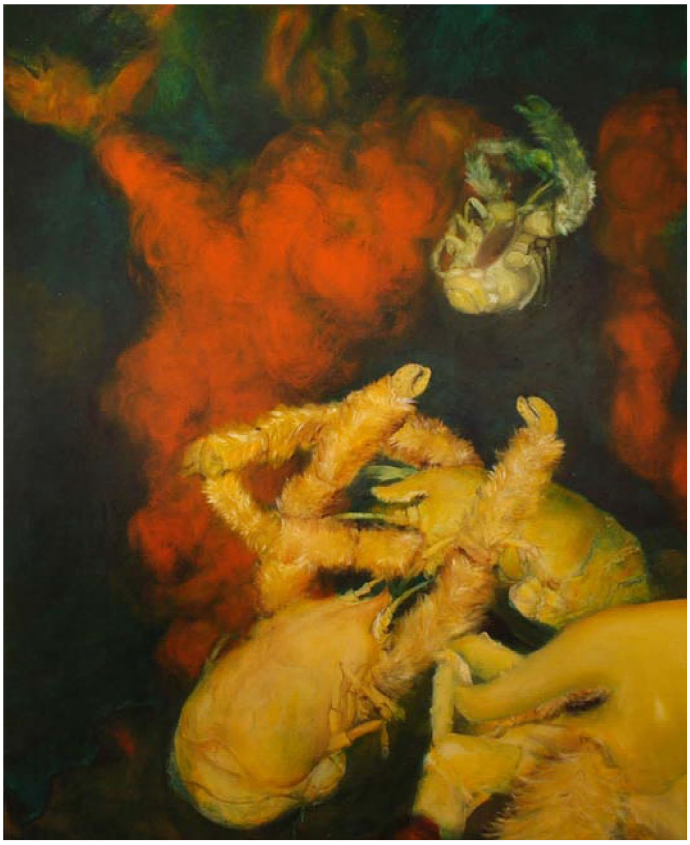
A group of zooplankton researchers traveled to a biodiversity hot spot in the Celebes Sea in the southern Philippines. They uncovered unexpected richness and diversity of marine life from the surface to the almost totally unexplored deep waters. Divers collected a remarkable variety of fragile and beautiful gelatinous species, while video cameras captured images of organisms from depths beyond the divers' reach. Species diversity of gelatinous zooplankton in the epipelagic zone, depths where light penetrates, was quite high. Blue water divers collected 10 of 23 known species of salps in this area.

An undescribed species of squat lobster from Southwestern Australia. Photo: Karen Gowlett-Holmes ©Commonwealth Scientific and Industrial Research Organization, Australia.

A male sea spider carries its eggs on specially adapted appendages under its body; it is one of many possible new species from the Antarctic. Census researchers are trying to understand the evolutionary history of these curious animals. Photo: Cédric d'Udekem, Royal Belgium Institute for Natural Sciences ©2007.

870+ Squat Lobster Species COMARGE

Squat lobsters are colorful decapod crustaceans that are found in all oceans, at all depths, and in all marine habitats, but are especially abundant on continental margins. Census scientists have recently compiled a list of the 870 known species of squat lobsters and an electronic library of relevant literature. Researchers are confident that hundreds of other species of squat lobsters are yet to be discovered.



Lily Simonson's *Yearning Yeti Crabs.*

Portraying Otherworldly Qualities

The Yeti Crab, a new species discovered by Census researcher Michel Segonzac during an expedition to the Easter Island microplate, inspired Lily Simonson's paintings. She anthropomorphizes the creatures and highlights their otherworldly ambiguities, evoking specific aspects of human psychology.

Antarctica's Biggest-Ever Amphipod CAML

In 2007, a Census team explored a 10,000km portion of the Antarctic Weddell Sea that was suddenly made accessible by the collapse of the Larsen A and B ice shelves—an area roughly the size of Jamaica. An estimated 1,000 species were sampled. Of these, four presumed new species of cnidarians (organisms related to coral, jelly fish, and sea anemones) were found, as well as 15 potentially new amphipod (shrimplike) species, including one of Antarctica's biggest-ever amphipod crustaceans, which was nearly 10cm long.

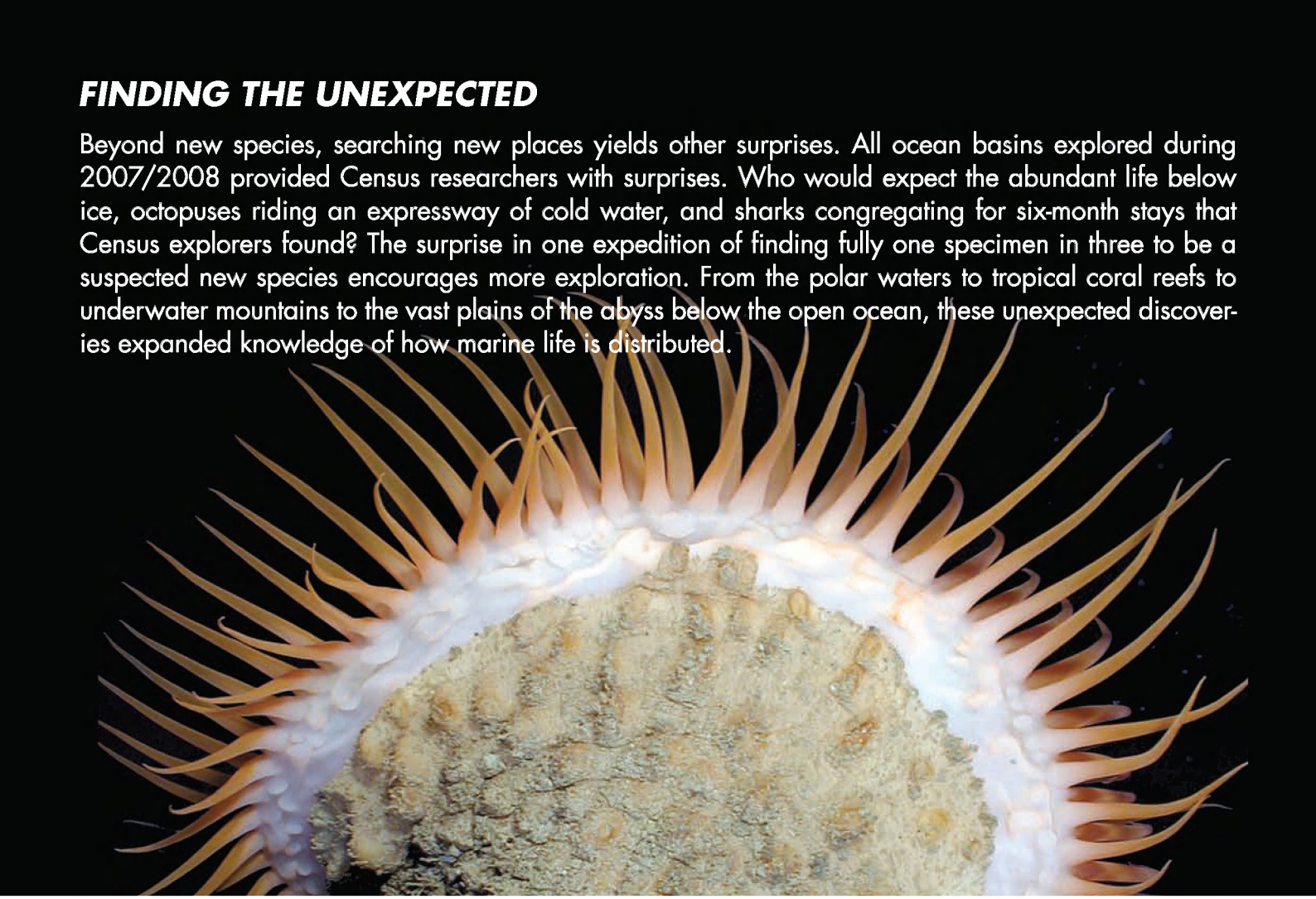
Symethis corallicola, a type of eroded frog crab, previously known from only two specimens from New Caledonia and the Philippines, now recorded for the first time in Australia with four specimens from the Great Barrier Reef. Photo: © Commonwealth Scientific and Industrial Research Organization, Australia.

Inventory of Australian Marine Life GBR

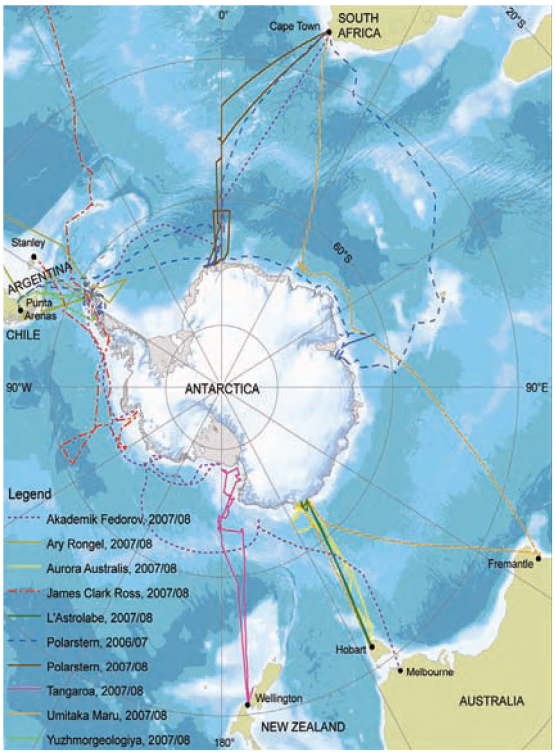
Census scientists mapped habitats and biodiversity in 210,000km^2 of poorly known shelf seabed in Australia's Great Barrier Reef World Heritage Area. Also, they compiled an inventory of more than 140,000 records of distribution and abundance for more than 7,000 species—four times more species than previous studies. More than 50 species were new to science, including fish, crustaceans, and sponges, and many more were new records for Australia. Further taxonomic work is expected to reveal hundreds of other new species, particularly in less well-studied invertebrate groups and algae, adding substantially to the known but underestimated biodiversity of this unique and internationally significant shelf seabed.

FINDING THE UNEXPECTED

Beyond new species, searching new places yields other surprises. All ocean basins explored during 2007/2008 provided Census researchers with surprises. Who would expect the abundant life below ice, octopuses riding an expressway of cold water, and sharks congregating for six-month stays that Census explorers found? The surprise in one expedition of finding fully one specimen in three to be a suspected new species encourages more exploration. From the polar waters to tropical coral reefs to underwater mountains to the vast plains of the abyss below the open ocean, these unexpected discoveries expanded knowledge of how marine life is distributed.



This striking creature, a Venus flytrap anemone, *Actinoscyphia* sp., was photographed in the Gulf of Mexico. Photo: Ian MacDonald, Texas A&M University, Corpus Christi ©2007.



The cruise tracks show numerous Census scientific voyages to the Southern Ocean during the International Polar Year. Image: CAML.

Antarctic Expressway CAML

In the Southern Ocean, Census explorers found evidence that many new species of octopuses have evolved by repeated colonization of the deep sea off Antarctica, riding the "Antarctic thermohaline expressway" (a mass of seawater that sinks as a result of density variations caused by the formation of ice that floats on high-density, very salty water). Another find, based on the comparison of biological and physical data, was that some sea birds feed on Antarctic zooplankton when the tiny organisms aggregate at a thermal front.

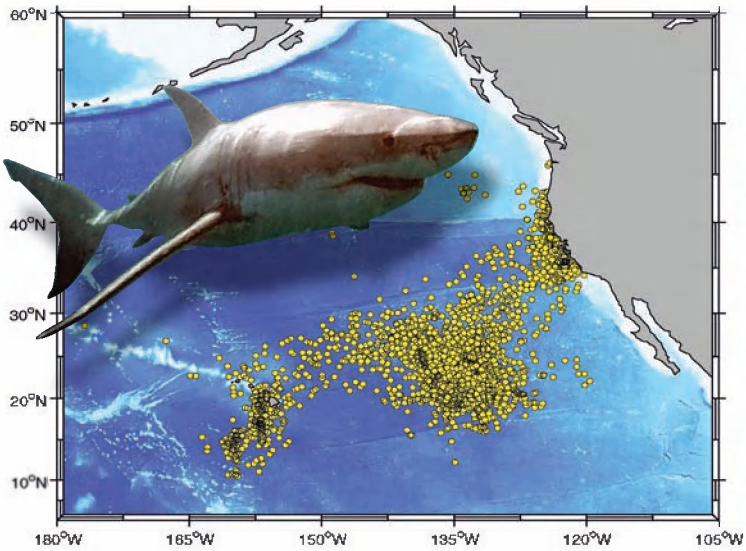
Ice cod feed on plankton just below the Arctic sea ice. Photo: Elizabeth Siddon, U.S. National Oceanic and Atmospheric Administration.

Animals in New Places ArcOD

Arctic explorers on an expedition to the Canada Basin found marine animals in many areas where they had not been previously recorded. Among their surprise findings were an abundant and diverse ctenophore (comb jelly) community under the Arctic pack ice and a dense bed of sea cucumbers in what might be a pockmark. Also, the researchers recorded more squid than ever before recorded in the Arctic deep sea, and documented the importance of sea ice ridges for marine life in the region.

White Shark Café TOPP

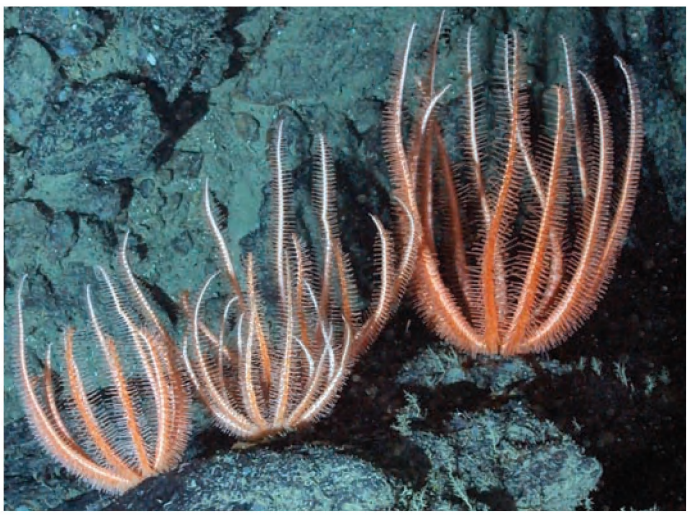
Satellite tagging revealed a previously unknown behavior of white sharks. Each winter, numerous white sharks travel long distances to concentrate in the Pacific where they remain as long as six months. During this time, both males and females make frequent, repetitive dives to depths of 300m. The purpose of this behavior has yet to be determined, but researchers surmise that this area may have significance in either feeding or reproduction. Future research aims to uncover more detail about this little-understood phase in the lives of white sharks.



An area of concentrated activity between Hawaii and the Baja peninsula, known as the "White Shark Café" is revealed by 47 white sharks equipped with satellite tags. Image: TOPP. Photo: Great white shark, *Charcharodon carcharias*, TOPP ©2007.

Surprising Species Richness COMARGE

Hidden by the ocean and covered in sediment, deep-sea submarine canyons present one of the most formidable challenges to marine exploration. Recent advances in technology, however, are opening up these remote frontiers. Census researchers aboard the RRS *James Cook* investigated canyons off Portugal and found that species richness was almost double in the more active Nazaré Canyon than in Lisbon Canyon. This surprised scientists for Lisbon Canyon is connected to a river supply and hence, potentially, a large source of riverborne organic matter that would foster large populations of filter-feeding organisms.



This unidentified 11-armed brisingid asteroid is a filter-feeding organism that benefits from enhanced current speeds that bring a ready source of food—suspended particulate matter in high concentrations. Photo: National Oceanography Centre, Southampton, and Natural Environment Research Council.

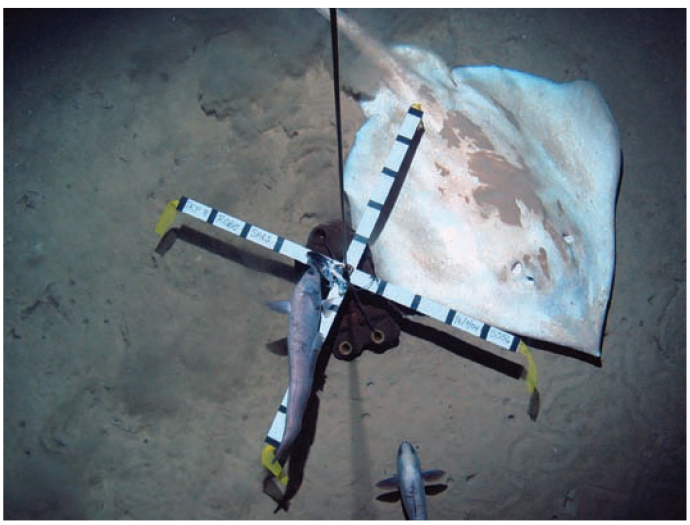
New Species in Familiar Places CReefs

When an international team systematically explored two islands on the Great Barrier Reef and a reef off northwestern Australia, the hundreds of new kinds of animals surprised them because the waters were long familiar to divers. The expeditions affiliated with the Census of Marine Life marked the first scientific inventory of spectacular soft corals, named octocorals for the eight tentacles that fringe each polyp.

Census researchers conducted an inventory of octocorals, named for the eight tentacles that fringe each polyp. Shown is a soft coral, *Dendronepthyla*, from coral gardens off Lizard Island. Gary Cranitch, Queensland Museum ©2008.

Migration Pathway MAR-ECO

Census research along the Mid-Atlantic Ridge suggests it may serve as an important pathway in the colonization of the North Atlantic continental slopes. Certain skate and ray species may be well established and breeding on the ridge. Before this discovery, scientists thought the skates and rays migrated through the Mid-Atlantic Ridge, rather than taking up residence there.



A skate, *Bathyraja richardsoni*, visits one of MAR-ECO's ROBIO landers deployed on the Mid-Atlantic Ridge. Photo: Nicola King, Oceanlab, University of Aberdeen.

Surprising Giants

Sponge Garden COMARGE

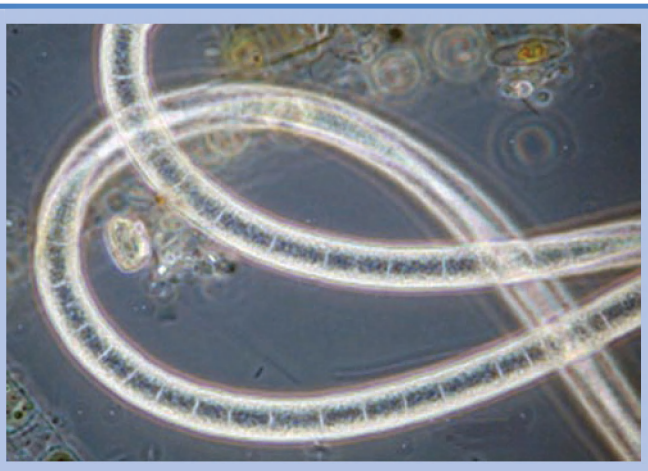
Census researchers crossed the Mediterranean Sea from west to east in search of abundant or diverse animal communities associated with the cold seeps where methane or oil naturally seep from the deep sea floor. A remotely operated vehicle diving into the Mediterranean opened a window where scientists expected abundant marine life. A variety of cold seep habitats and associated fauna, such as the garden of sponges around a brine lake, surprised them. The sponge in the garden, likely *Rhizaxinella pyrifera*, acts as another garden in itself, harboring a multitude of small worms. Although this species had been observed in the deep Mediterranean Sea, these specimens were larger than those seen before.

A garden of sponges in the deep Mediterranean Sea is a habitat for a multitude of small worms. Photo: Victor6000/Medeco cruise © Ifremer 2007.

Colossal Sea Stars CAML

Census expeditions to the Southern Ocean found frequent examples of the gigantism, which is common in Antarctic waters. Researchers collected huge scaly worms, giant crustaceans, sea stars, and sea spiders as big as dinner plates.

Census researchers from New Zealand hold giant Macroptychaster sea stars that can grow up to 60 cm across. Photo: National Institute of Water and Atmospheric Research, New Zealand ©2007.



Giant sulfur bacteria inhabit anoxic sediments in the eastern South Pacific (8 µm diameter). Photo: Carola Espinoza, FONDECYT 1070552, Universidad de Concepción, Chile.

Behemoth Bacteria ICOMM

A diverse set of giant, filamentous, multicellular marine bacteria was discovered by Census researchers in the eastern South Pacific. These bacteria may be "living fossils" that developed in the earliest ocean when oxygen was either absent or much diminished, and lived on the toxic gas hydrogen sulfide. Scientists hypothesize that communities of bacteria may hold potential for bioremediation of organically polluted bottoms, and because of their ability to survive in anoxic conditions, may be an important clue in the search for extraterrestrial life.

Largest Mollusk in its Class GoMex

A giant aplacophoran mollusk, *Chaetoderma felderi*, was collected in deep waters off Louisiana, in the Gulf of Mexico. Measuring over 407 mm in length and 10 mm in diameter, it was more than twice the length and three times the diameter of the next largest known mollusk in the subclass Caudofoveata.

Left. The aplocophoran mollusk, *Cheatoderma felderi*, was first described in 2007. Photo: Darryl L. Felder, Louisana State University.

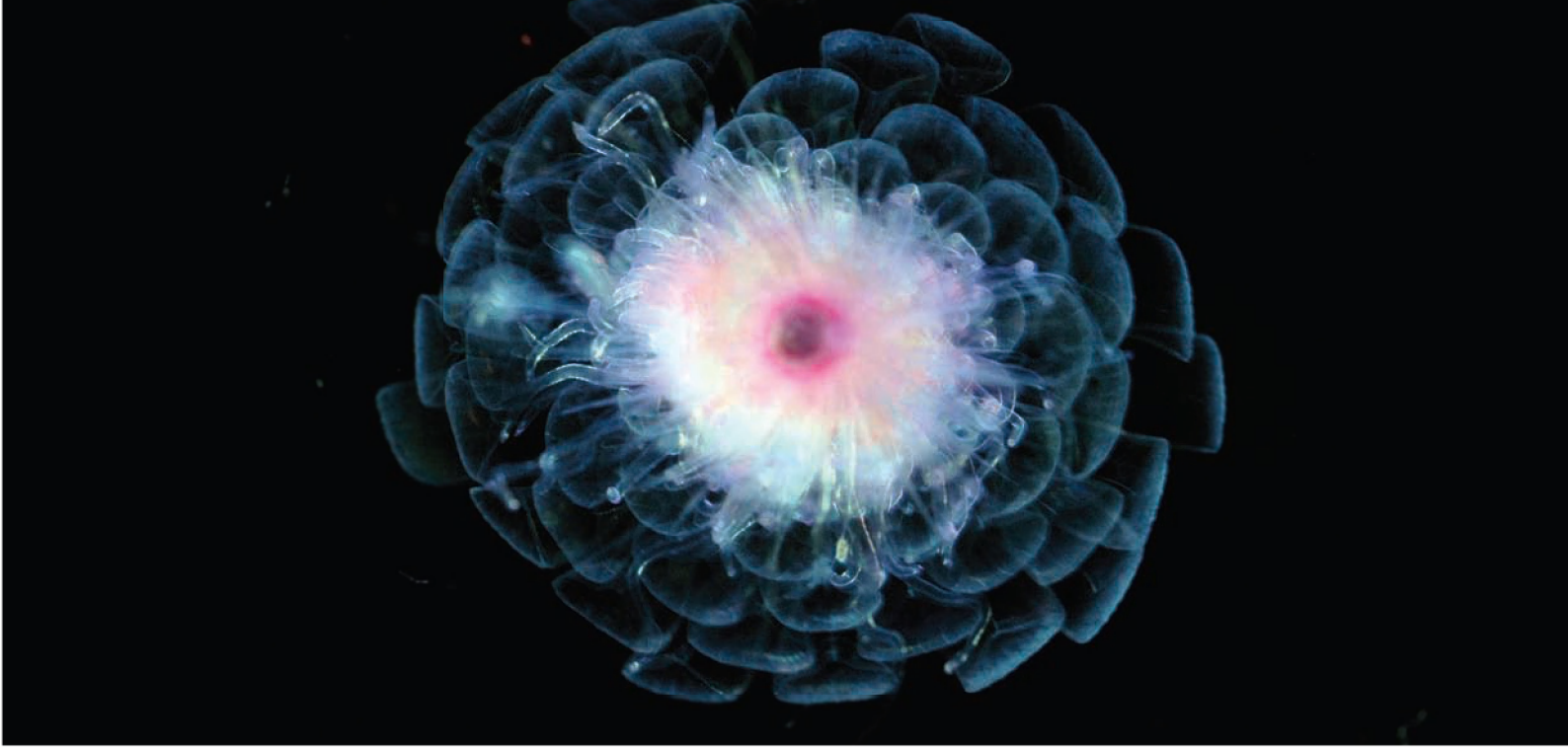
Right. A community of deepwater oysters was found on the La Chapelle continental slope using an ROV. Photo: Renard Centre of Marine Geology, Ghent University ©2006.

Gigantic Oysters COMARGE

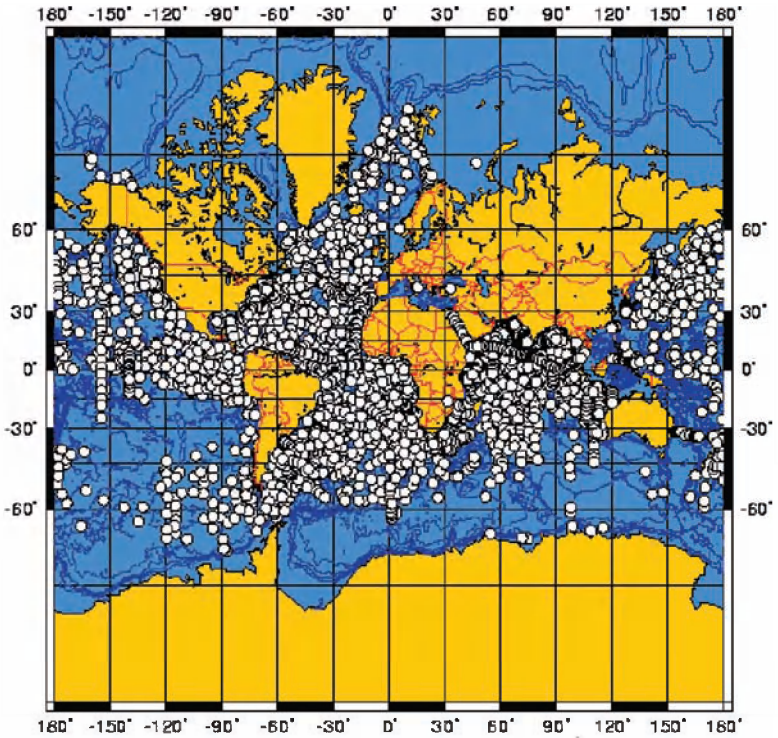
With the assistance of a remotely operated vehicle, Census explorers found dense communities of giant oysters at a depth of 700 m on the La Chapelle continental slope. Larger and deeper than the known deep oyster *Neopycnodonte cochlear*, the species has been an enigma for years. Genetic studies will tell whether this is a new species.

ADVANCING TECHNOLOGY

The initiation of the Census in the year 2000 relied upon progress recently achieved and in prospect. No technology has disappointed Census researchers. During 2007/2008 more pixels increased the resolution of cameras, faster sequencing lowered the cost of genetics, better data processing broadened the scope of acoustics, smarter sensing improved the value of autonomous undersea vehicles, smaller and lighter tags spread the power of tagging and tracking, and simple, clever innovations such as standardized structures—likened to empty dollhouses—that animals colonize on coral reefs.



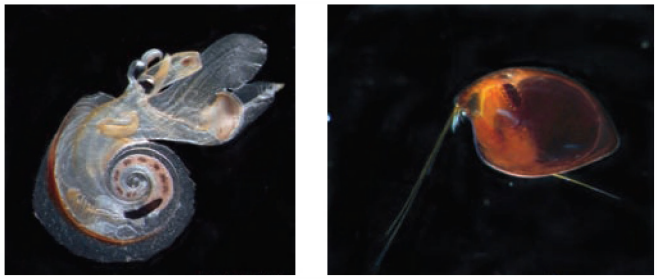
Looking more like a flower than an animal, *Athorybia rosacea*, an unusual physonect siphonophore, moves by flapping its petal-like bracts. Photo: Larry Madin, Woods Hole Oceanographic Institution.



The map shows the locations of more than 20,000 zooplankton collections available to CMarZ researchers. Image: CMarZ.

Barcoding Zooplankton CMarZ

How can zooplankton samples collected from more than 20,000 stations, including samples from every ocean basin, be identified? To make the task practical, an international Census team of experts from 25 cooperating projects is analyzing data from about 6,000 historical samples to help create a catalog of described species diversity and distribution. New DNA barcodes will identify approximately 7,000 known species of zooplankton in 15 phyla. This growing DNA database will help scientists identify specimens, describe their geographic distributions, and recognize when a species is in fact new. Scientists envision that barcoding will one day allow automated sample analysis and eventually assess species diversity on ships and in the field within minutes.

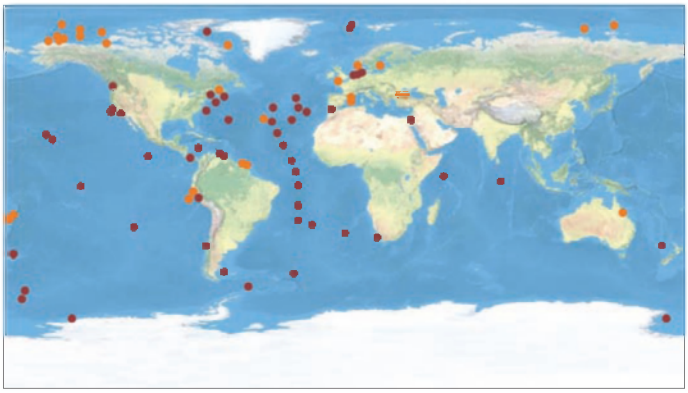


Technology is now available to barcode zooplankton such as the *Atlanta peroni*, left, and *Macrocypridina castanea*, right, from the Sargasso Sea. Photos: Russell Hopcroft, University of Alaska Fairbanks.

Tagged elephant seals are providing oceanographic data about the Southern Ocean never before possible. Photo: Dan Costa, University of California, Santa Cruz.

Live Oceanographic Platforms TOPP

In the dead of the Antarctic winter, elephant seals gather data as they roam beneath the impermeable ice cover of the Southern Ocean. Armed with environmental sensors placed by Antarctic researchers, the seals provide not only biological information about their foraging behavior, but new data, never before possible, offering insight into the yearly rise-and-fall cycle of sea ice production in an area sensitive to climate change. Scientists use the data to refine computer models of Southern Ocean circulation.



The map shows the locations of samples collected by 40 field projects employing the 454 tag-pyrosequencing technology. Image: ICoMM.

Mapping Microbes ICoMM

To identify marine microbes and survey their distribution around the globe, the Census launched 40 separate projects using the same DNA sequencing technology, called 454 tag-pyrosequencing. This novel method of mapping the genetic structures of an organism is making it possible for researchers to swiftly investigate microbial life. The efficient identification by a standardized method allows a scientist using this technology to inventory areas as diverse as polar biodiversity hot spots, coastal microbial mats, and sediments in tropical coral reefs. They can then paint global maps of the tiniest life in the ocean—a task never before undertaken.

At 600m depth on the Chilean margin—a fishing ground of the Patagonian toothfish—Census scientists found a rich community of cold-water corals living on carbonate rocks formed by methane seepage. Photo: Javier Sellanes, Universidad Católica del Norte, Facultad de Ciencias del Mar.

Following the Fish COMARGE

Innovation is a consistent theme of Census projects. Stymied in their search for active methane seeps in the Chilean margin, Census scientists took a novel approach. Rather than deploying sophisticated and expensive technologies to locate seep sites, researchers followed the fisherman. They launched their search in known fishing grounds of the Patagonian toothfish, *Dissostichus eleginoides*, for they suspected that these fish congregated near methane seeps. Their hunch proved correct. Some of the fishing grounds had hard, carbonate sea floors, associated with methane seeps.

Autonomous Reef Monitoring Structures, layered plastic structures likened to empty dollhouses, are retrieved from French Frigate Shoals. Photo: U.S. National Oceanic and Atmospheric Administration, Pacific Island Fisheries Science Center, Northwestern Hawaiian Islands Marine National Monument.

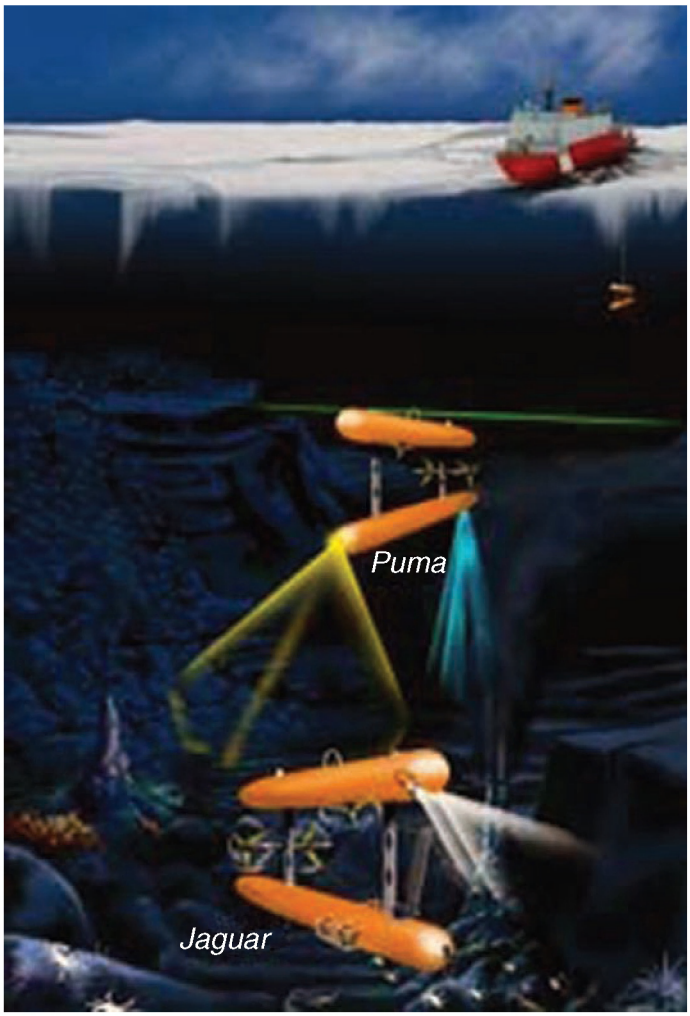
Coral Reef Recolonization CReefs

To learn what new creatures colonize coral reefs, Census scientists are developing and testing Autonomous Reef Monitoring Structures (ARMS), which are colonized by fish and other creatures that inhabit coral reefs. ARMS are artificial structures designed to mimic the "nooks and crannies" of a natural reef. As invertebrates and other reef creatures then move in, researchers see how colonization of coral reef space occurs. With this information, marine scientists can better understand the health of reefs and policy makers can develop scientifically based management strategies.

Acoustic receivers await final programming before deployment along the Pacific coast of North America. Photo: Melinda Jocobs, POST/Kintama Research.

Expanding Tracking Networks POST

Growing networks of fish-tagging researchers and acoustic receiving equipment are opening a window into a previously opaque ocean. Having expanded the geographic extent of its acoustic listening array of receivers, Census tagging researchers along the west coast of North America can now track animals swimming along more than 2,500km of the North Pacific shoreline, including areas of Northern California, Puget Sound, and the Fraser River. Improving technology made it possible to track fish as small as 12.5cm over vast distances. One tiny salmon smolt was tracked migrating all the way from the Columbia River in Washington State north to the existing end of the receiver network near Sitka, Alaska.



AUVs sensed water temperature and chemistry, conducted a bathymetric survey, and collected samples and high resolution images on Gakkel Ridge. Image: E.P. Oberlander, Woods Hole Oceanographic Institution ©2007.

Arctic Robots ChEss

During an expedition to the eastern Arctic Ocean, two new underwater robots gave Census scientists a bird's-eye view of what lives on Gakkel Ridge. With these exploration vehicles, which are independent of pilots and carry cameras and sophisticated arrays of instruments, scientists discovered a new underwater volcanic chain covered by extensive microbial mats. Because the deep Arctic ridges are isolated from other ocean basins, the investigation of Gakkel Ridge provided clues about the evolution of fauna around underwater vents in isolated habitats.

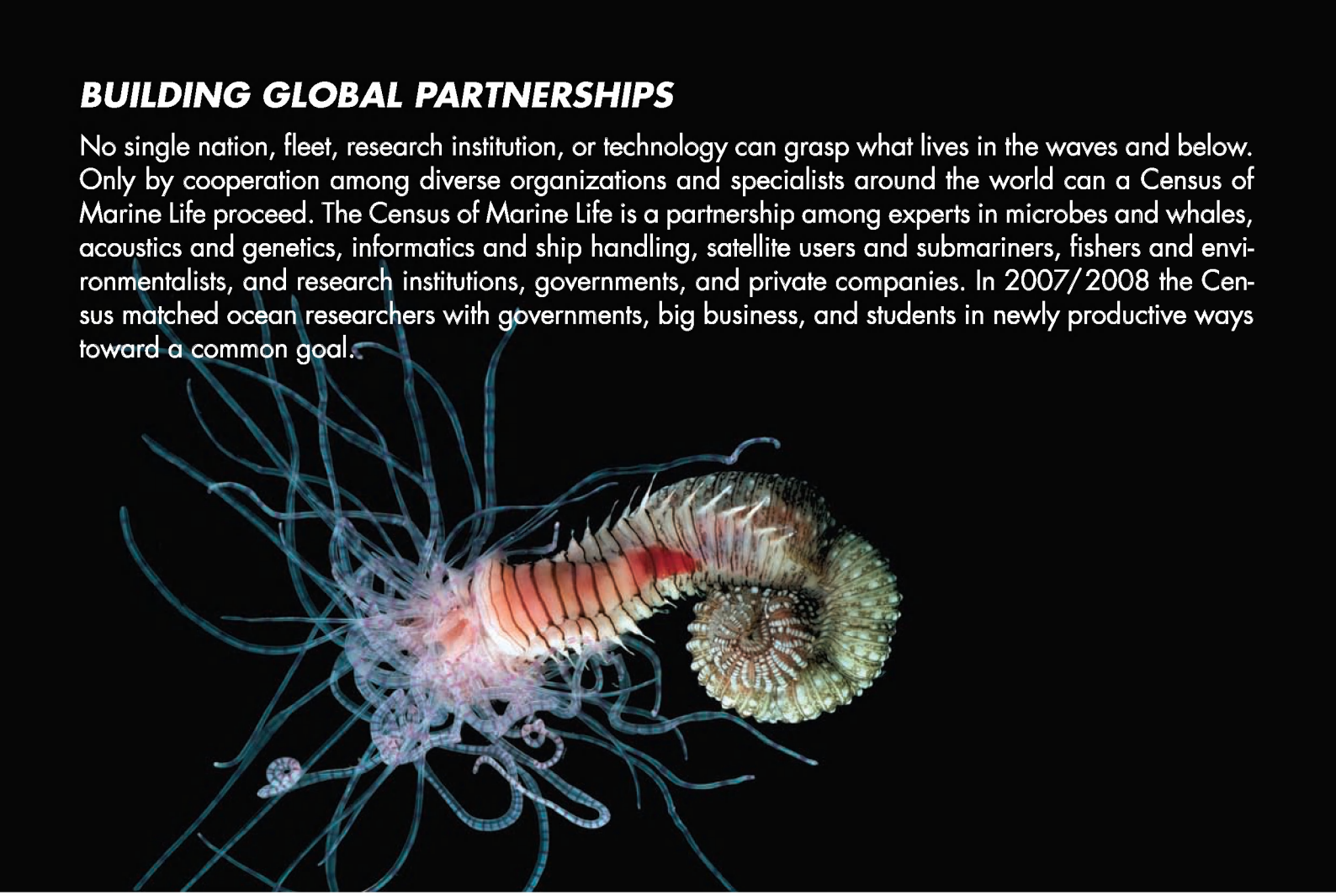
This award-winning painting, *The Deep-Sea Research Party,* was created by twelve-year-old Daichi Fujita, who dreams of building a submersible.

The Deep-Sea Research Party ChEss

Daichi Fujita, a young Japanese artist, won the opportunity to dive aboard the ROV *Hyper Dolphin* in Kagoshima Bay, the shallowest habitat of vestimentiferan tubeworms known to exist. Daichi's painting, *The Deep-Sea Research Party*, was selected from hundreds of entries for an art contest. The prize covered the travel costs for this young artist and a parent to see a place few will ever have the opportunity to visit.

BUILDING GLOBAL PARTNERSHIPS

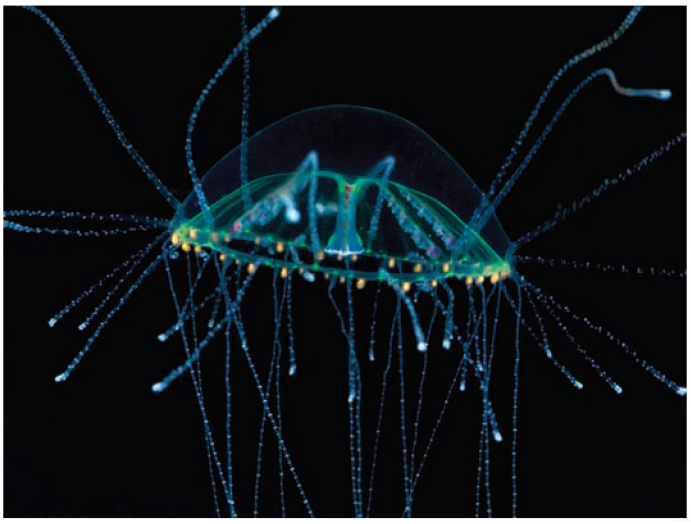
No single nation, fleet, research institution, or technology can grasp what lives in the waves and below. Only by cooperation among diverse organizations and specialists around the world can a Census of Marine Life proceed. The Census of Marine Life is a partnership among experts in microbes and whales, acoustics and genetics, informatics and ship handling, satellite users and submariners, fishers and environmentalists, and research institutions, governments, and private companies. In 2007/2008 the Census matched ocean researchers with governments, big business, and students in newly productive ways toward a common goal.



A spectacular array of marine life, such as this polychaete or marine tubeworm, *Loimia* sp., inhabits the waters off Lizard Island, Queensland, Australia. Photo: Gary Cranitch, Queensland Museum.

Partnering for Reefs CReefs

Partnerships between scientific institutions, business firms, and nongovernmental organizations made more systemic searches and their unexpected results possible. The partnership supported the surprising discovery of hundreds of new kinds of animals in waters off two islands on the Great Barrier Reef and a reef off northwestern Australia, despite the prior visits of many divers.



Gary Cranitch's photographs for CReefs were recognized for excellence by the Australian Institute of Professional Photographers. This spectacular jellyfish inhabits the water of the Great Barrier Reef off Lizard Island, Queensland, Australia. Photo: Gary Cranitch, Queensland Museum.

Nearshore Around the Globe CoML Caribbean

The Census has expanded nearshore research within the Caribbean, South America, and around the Indian Ocean through regional workshops aimed at standardizing protocols. Scientists have used these protocols as part of a monitoring and educational program to assess environmental impacts and also engage local communities in the process.

A flame scallop, *Lima scabra*, photographed off Isla Larga, Venezuela, is an example of the diversity of nearshore species. Photo: Eduardo Klein, Universidad Simón Bolívar, Caracas ©2007.

Biodiversity in Cobscook Bay GoMA

A unique collaborative effort of U.S. and Canadian Census researchers is enhancing knowledge of how marine ecosystems change through time by studying the nearshore zone of Cobscook Bay, Maine, from a historical and present-day perspective. One of the most diverse coastal ecosystems on the North American east coast north of the tropics, this estuary features many different habitats, a tidal range of over eight meters, two centuries of historical records dating back to 1842, and more than 800 species identified to date.

The late Robin Rigby prepares quadrats for sampling. Dr. Rigby was instrumental in integrating nearshore sampling in the Gulf of Maine. Photo: Susan Ryan, University of Southern Maine.

Engaging the Public NaGISA

Nearshore research involves community volunteers and students especially well. Census scientists studying the nearshore environment of the world ocean are present on six continents. Science education programs and training workshops aim to incorporate research protocols that make data gathered in the coastal environment comparable from place to place. The nearshore investigations engage the public in ocean and coastal issues and inspire the next generation of marine scientists.

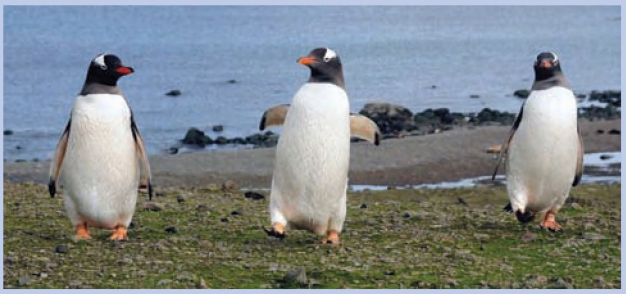
Left. A recent expedition to the Zanzibar Archipelago in Tanzania paired high school students from the U.S. with high school students from Africa to launch the Census' first island nearshore study site in the Indian Ocean. Photo: Tanzania Institute for Marine Science.
Right. Researchers sort zooplankton samples aboard the RV *Polarstern* on an expedition to the Southern Ocean. Photo: Brigitte Ebbe, Senckenberg Research Institute and Museum, Frankfurt.

International Study of Plankton Bloom CeDAMar

In the Southern Ocean, collaborating Census researchers followed a plankton bloom from its onset until it changed to marine snow and finally sank to the deep-sea floor. The scientists then examined the influence of the snow of fallen plankton on marine life on the floor itself. The last time such a complex collaboration was undertaken was the *Galathea 2* expedition in the early 1950s. This time around, in spite of bad weather and complicated logistics, the collaboration again produced a trove of data.

Leading International Polar Year Biodiversity

Census projects are playing a key role in the International Polar Year 2007–2009 investigations at the top and bottom of the planet. In the Arctic, the Census led the marine biodiversity cluster of 13 projects from eight countries on more than 20 expeditions. They observed how mammals use diverse polar habitats, inventoried life in a fjord, and explored seeps, pockmarks, and mud volcanoes on remote ocean floors. In the Southern Ocean, the Census coordinated the science on ten major expeditions by vessels from nine different countries. The results were reported live via the Internet. The Census also initiated a collaborative program focusing on Antarctic marine life in seven South American countries.



Gentoo penguins, *Pygoscelis papua*, were part of the local landscape in Antarctica. Photo: Dan Costa, University of California, Santa Cruz.

Researchers are lowered onto the ice from the U.S. Coast Guard Cutter *Healy*. Photo: Bodil Bluhm, University of Alaska Fairbanks.

INFORMING DECISIONS

Better information about diversity, distribution, and abundance favors better management of marine life. During 2007/2008 the Census progressed fast toward a more reliable reference library of all marine life and improved means to speed reliable identification, whether for a beachcomber curious about collecting a specimen or a fishmonger fearful of vending a mislabeled seafood product. The Census is also working toward range maps for tens of thousands of species, crucial, for example, in drawing marine protected areas. The experience of booming harvest followed by collapse has proven the harm of overfishing and the value of improved records of abundance that may help people learn from the record of their past acts. For marine life, human ignorance has not brought bliss.

Samples for DNA barcoding were taken from this file clam, *Lima* sp., during a CReefs expedition on Ningaloo Island, Australia.
Photo: Gary Cranitch, Queensland Museum.

A leatherback turtle, *Dermochelys coriacea*, hatchling begins its life struggling across the beach toward the sea. Photo: Jason Bradley ©2007.

Census scientists release a tagged leatherback turtle into the surf.
Photo: George Shillinger, Stanford University.

Race to Protect Sea Turtles TOPP

The Great Turtle Race, an international race developed by the Census tracking team to save a 100-million-year-old species from extinction, moved to China in 2008. A Mandarin language version of an interactive website tracking the migration of endangered leatherback turtles brought the race's messages to approximately 100 million Chinese citizens. Donations to the Race go toward protecting leatherback turtle nesting areas in Indonesia and raise awareness about what individuals can do to help protect sea turtles.

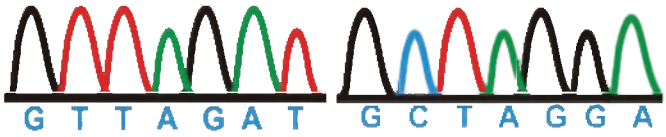
Leatherback Conservation TOPP

In recent years, the number of leatherback turtles, *Dermochelys coriacea*, in the eastern Pacific has declined severely. The turtles routinely cross international borders during migrations over thousands of kilometers. For 12,095 satellite-tracking days during three years, Census scientists tracked the turtles and compiled the largest, multiyear migration record ever collected for leatherback turtles. The data revealed that ocean currents shaped the migration corridor and turtle dispersal in the South Pacific.

Looking for marine life, Census researchers instead collected a trawl of trash in the Eastern Mediterranean. Photo: Michael Turkay, Senckenberg Research Institute and Natural History Museum, Frankfurt.

More Garbage Than Sea Life CeDAMar

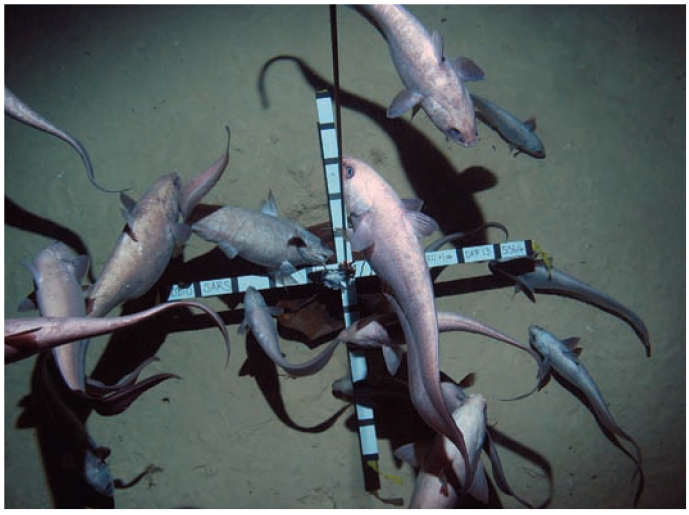
While surveying animals on the floor of the Mediterranean southeast of Crete, Census researchers collected more garbage than life from an Agassiz Trawl 4,300m deep in the Ierapetra Basin.



Barcode graphic (above): TOPP. White-tip shark, *Triaenodon obesus.* Photo: Dwayne Meadows, U.S. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Shark Fins ID DNA Barcoding

With DNA barcoding that can identify an animal species by a snippet of flesh, two teenagers discovered frequent mislabeling of fish in New York restaurants and markets. Filling demands for shark fins and other organs impacts global shark populations. The frequently inaccurate identification of sharks and rays confuses what fishermen are catching, what fins and organs markets are selling, and how populations are changing. Accordingly, Census researchers have developed DNA barcoding to identify the species of sharks and their products, such as dried fins. This is essential to answer how much the catching of sharks changes their populations and to enforce prohibitions.



Abyssal grenadiers, *Coryphaenoides armatus,* attracted to a dead mackerel bait, were photographed by one of MAR-ECO's ROBIO landers deployed on the Mid-Atlantic Ridge. Photo: Nicola King, Oceanlab, University of Aberdeen.

Focusing Fishery Management MAR-ECO

Grenadiers, distant relatives of codfish, have colonized the world's deep oceans with some species being relatively common and widespread. Although Census research along the Mid-Atlantic Ridge has added information about the distribution and abundance of certain grenadier species in the North Atlantic, gaps remain. Being conservative amid this uncertainty, regional managers are taking precautionary measures to protect grenadier stocks and their habitats.

Deep-sea mining technology is being developed to extract massive sulfides from hydrothermal vents. Photo: Courtesy of Nautilus Minerals, Inc.

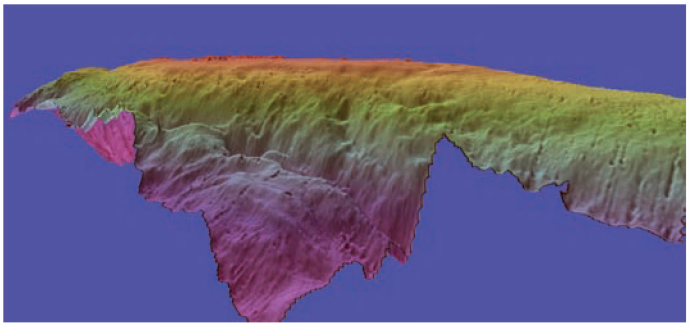
Hydrothermal Vents and Seabed Mining ChEss

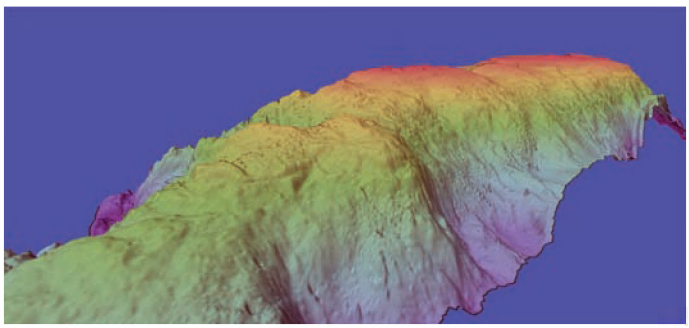
If hydrothermal vent sites are more widespread than previously believed, more may be impacted by deep-sea mining. Census scientists have orchestrated a joint scientific and policy meeting for the spring of 2009 to discuss protection of the vent sites from deep-sea mining, before this industry begins its possible growth. The goal of the meeting is setting priorities for future research and balancing the conservation of critical vent sites versus the value of ores.

Managing Underwater Mountains CenSeam

Census expeditions to poorly explored waters in the Southern Ocean and Antarctica have expanded the knowledge of life on seamounts. This new knowledge is serving as a foundation for sustainable management of seamount ecosystems. Census researchers delivered a report to the United Nations General Assembly in 2006 on the vulnerability of seamount corals to fishing and are helping to develop guidelines for deep-sea fisheries in the high seas.

Orange roughy, *Hoplostethus atlanticus*, are commonly found swimming over seamounts. These were photographed over New Zealand's Graveyard seamount complex. Photo: National Institute of Water and Atmospheric Research, New Zealand ©2007.





Multibeam bathymetry shows a seamount atop the Macquarie Ridge. The ridge extends 1,400 km southwest of New Zealand into the Southern Ocean. Images: Arne Pallentin, National Institute of Water and Atmospheric Research, New Zealand ©2008.

Learning from the Past

Rise and Fall of Tuna HMAP

Without experiments, experience must be explored for cause and effect. Scouring fishery reports, fishing magazines, and other records, Census researchers documented the presence of bluefin tuna in northern European waters several decades before the onset of major fisheries in the early 1900s. After fishing increased and techniques became more powerful, the fishery collapsed in the mid-1960s. The historical documentation of the plentiful presence of this especially popular seafood species well before intensive fishing, and its subsequent collapse, seems a solid demonstration of cause and effect for informing decisions.

Northern bluefin tuna, *Thunnus thynnus*, for sale in the fish auction hall at Skagen, Denmark, ca. 1946. Photo: H. Blegvad, Fiskenet i Danmark.

Between 1200 and 1500 CE, more than five million conchs were harvested, leaving this pre-Hispanic megamidden, or shell mound, of queen conch, *Strombus gigas*, on La Pelona Island, Los Roques Archipelago, Venezuela. Photo: Andrzej Antczak, Universidad Simón Bolívar, Caracas.

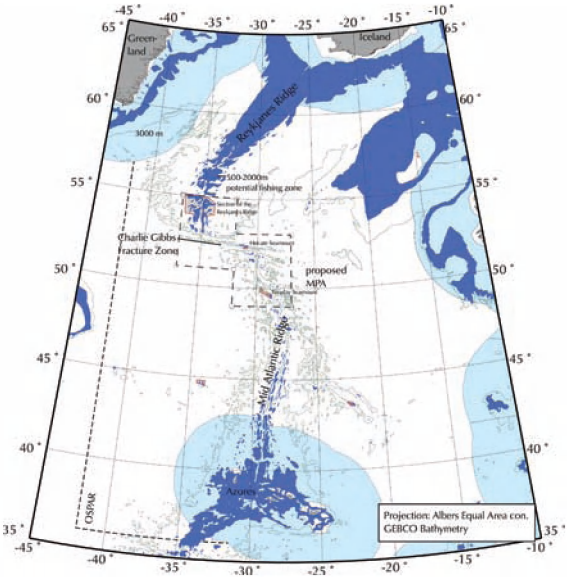
Assessing Human Impact HMAP

Many traditional marine mollusk fisheries around the world have disappeared, while others are dwindling. In 2005, the Census brought together a worldwide network of experts from multiple disciplines to figure out why these populations declined. In 2008, they reported their study in the book *Early Human Impact on Megamolluscs*.

A tagged sturgeon is released by researchers. Photo: Fraser River Sturgeon Conservation Society.

Sturgeon Playground POST

Congregating at a "sturgeon playground" off Vancouver Island before moving on to Alaska for the winter, green sturgeon have recently been found by Census researchers to migrate in an unexpected way. Contrary to scientists' expectations, these fish appear to migrate north and spend the winter in Alaska, but not before stopping off at the "playground," a specific region in southern British Columbia. The reason for their layover is unknown, but it makes them susceptible to potential overexploitation.



One of the proposed marine protected areas along the Mid-Atlantic Ridge. Image: Sabine Christiansen, World Wildlife Fund.

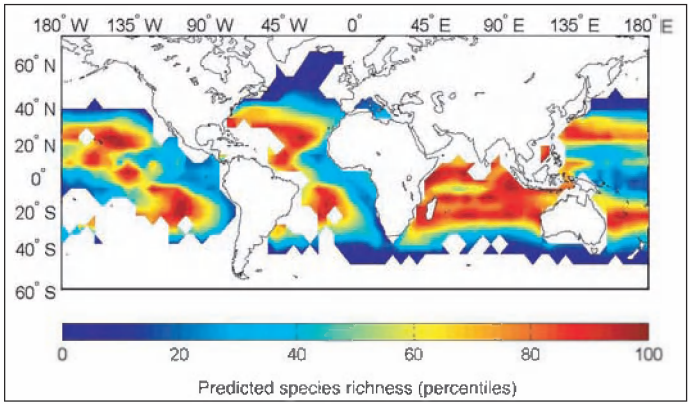
Conserving Life in the Open Ocean MAR-ECO

New information gathered on Census cruises and submersible dives is affecting science-based advice and management. The documentation of the quantity and patterns of diversity on the Mid-Atlantic Ridge from summit to 3,500m helps international management organizations propose actions to protect habitats and ensure sustainable use of resources. Continued work by Census scientists and a variety of partners will create a better basis for conservation of marine life in the immense areas of the oceans that lie beyond national jurisdiction.

Census tagging research tracks salmon through their life cycle as they migrate from rivers, out to sea, and back. Photo: Margaret Butschler, Vancouver Aquarium ©2004.

High Mortality for Young Salmon POST

Contrary to previous thought, the highest mortality rates in young salmon may occur in the ocean rather than in fresh water. Using acoustic tagging, researchers were able to track the progress of young salmon as they shifted from their freshwater phase out to the ocean and eventually back again. These observations suggest that in just a few weeks, 40 percent of the tracked salmon perished in the ocean, never to return to spawn.



Patterns of global tuna and billfish species richness at 100m depth were predicted from water temperature. Distributions for 18 species were derived from individual temperature tolerances and overlaid to generate a pattern of species diversity. Image: Daniel Boyce, Dalhousie University.

Tuna and Billfish Distribution FMAP

Census researchers have investigated the global distribution of these highly migratory predators to evaluate how water temperature might affect distribution patterns. The scientists used temperature tolerances of individual tunas and billfishes to predict their distribution and species richness in the oceans. The resulting map may help to evaluate how global climate change could affect the diversity of tuna and billfish.

SHARING KNOWLEDGE

Adding new data, standardizing them in a database, and opening them to computer search multiplies the knowledge that can enlighten people and guide decisions. In 2007/2008, Census workers reached halfway to the goal of cataloging all known marine species in an accessible standard database, and entered millions more biological records into its Ocean Biogeographic Information System. The Census continues entering more data from 13 nodes around the world. Collaboration among the Census and others, such as the Encyclopedia of Life, expedite the sharing, and the creation of an integrated system with geographical, biographical, evolutionary, and genetic information, as well as images, about all marine species.

Flamingo tongue snail, *Cyphoma gibbosum*, was photographed near Grand Cayman, British West Indies, and is listed in the Gulf of Mexico biodiversity inventory. Photo: Mark Moody ©2004.

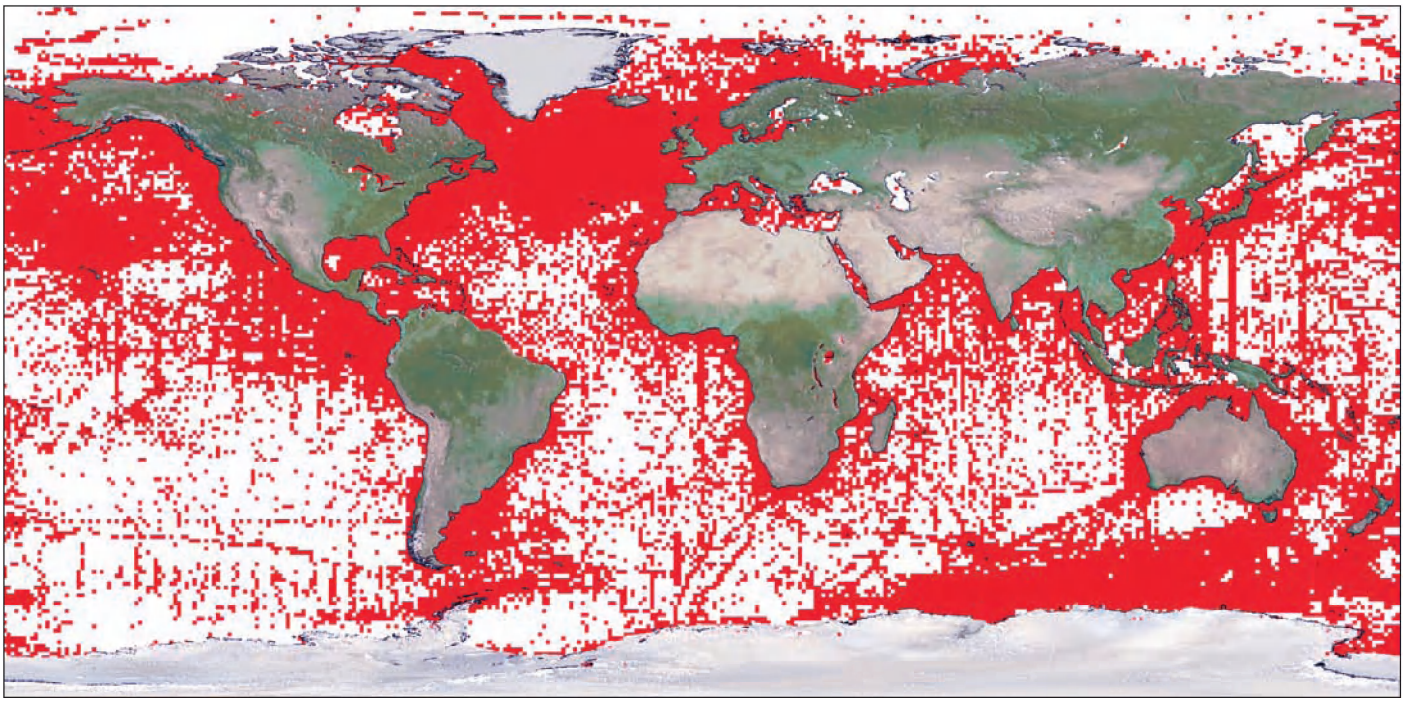
Counting All the Creatures in the Gulf GoMex

In four years Census scientists completed a comprehensive inventory of all marine life in the Gulf of Mexico. This inventory, published in a 79-chapter book written by 140 authors from 15 countries, shows that 15,625 species from 40 different phyla call the Gulf of Mexico home. A second phase of the project is currently under way to make the data available in a searchable online database.

Halfway Toward Goal WoRMS

In 2008, the list of known marine species surpassed 120,000, placing the Census halfway toward its goal of cataloging the estimated 230,000 known marine species by 2010. The Census played a key role in making this happen by supporting the new World Register of Marine Species (WoRMS). More than 56,000 aliases for ocean species were found, with one species, the "breadcrumb sponge," alone having 56 aliases.

Halichondria panicea, popularly called breadcrumb sponge, is the marine world's reigning champion of aliases, with 56 synonyms appearing in taxonomic literature since its first description in 1766. Photo: Bernard Picton, National Museums of Northern Ireland.



Since 2000, the Ocean Biogeographic Information System, OBIS, has grown to 14 million records of more than 80,000 species from 232 databases. The red dots on the map show the global distribution of the OBIS records. Image: OBIS.

14 Million Records OBIS

A Census database called the Ocean Biogeographic Information System (OBIS), now holds 14 million records. OBIS is receiving additions from 13 regional nodes around the globe, and three more will soon join the network. Using multiple data sets, many focusing on understudied waters of the global ocean, OBIS, the World Register of Marine Species, and the Encyclopedia of Life are collectively becoming a complete marine biodiversity database of the world.

4,000 Marine Fish May Await Discovery FMAP

Employing a novel approach to quantify global fish species, Census researchers estimated that almost 16,000 species of marine fish have been reported in publicly accessible databases. They suggest that another 4,000 fish species may still await discovery and description. Fish species in many regions, especially the tropics, remain underreported, providing opportunity for further discoveries.

Bluestriped snapper, *Lutjanus casmira*, is a typical reef fish photographed here on Christmas Island, Central Pacific.
Photo: Philip A. Sack, Sea Education Association.

The Banco Chinchorro reef in Mexico is home to blue chromis, *Chromis cyanea*, and numerous other fish species.
Photo: Humberto Bahena, El Colegio de la Frontera Sur (ECOSUR).

Sharing Beauty of the Deep Sea

The beauty in marine photographs that enliven the Census Highlights on these pages also inspired three exhibits around the world: MAR-ECO's *Deeper Than Light*, Cindy Lee Van Dover's *Beyond the Edge of the Sea*, and Claire Nouvian's *The Deep*, which engaged researchers from several Census of Marine Life projects.

Norwegian artist Ørnulf Opdahl joined the MAR-ECO scientific team on an expedition to the Mid-Atlantic Ridge, painting the wonders of life below and above the surface on board and after his return home (above and above right).

The heart of the *Beyond the Edge of the Sea* exhibit is the work of illustrator, Karen Jacobsen, who has accompanied oceanographer Cindy Lee Van Dover on submersible dives to deep-sea hot springs and cold seeps, capturing stunning animals and landscapes in her watercolor illustrations. Flying Fish (below); Collapsed Area with Fauna, East Pacific Rise (bottom); and T'ui Malila Vent, Lau Basin (right).