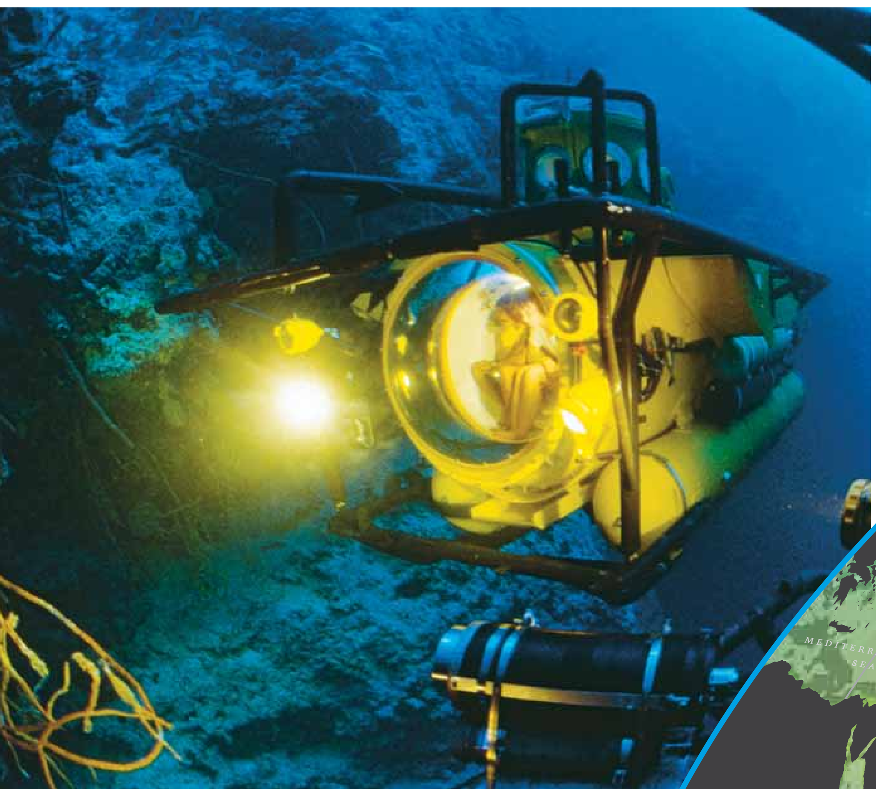
Ocean Life

Past, Present, and Future

NATIONAL GEOGRAPHIC IN PARTNERSHIP WITH CENSUS OF MARINE LIFE



What lived in the oceans? What lives in the oceans today? What will live in the oceans of tomorrow? As we uncover the changes of oceans past, we can better interpret the forces that shape these ecosystems today, and project what changes the future might hold.

To gain insight into what has lived in the oceans, Census of Marine Life researchers reconstructed the history of marine animal populations since human predation became significant – tracing major impacts to more than 500 years ago. Teams of fisheries scientists, historians, and economists collaborated on case studies to create the first reliable picture of marine life before large-scale fishing. They found that declines in the abundance of marine life began much earlier than was thought and are far broader than imagined. This baseline of marine animal populations will help distinguish natural fluctuations from the effects of human activity.

The largest component of the Census delved into our present-day ocean through field projects. Fourteen international groups each explored a distinct marine feature, from shorelines to mid-ocean ridges, recording what species exist and describing new species they encountered. These and future observations flow into a central database, creating an unprecedented listing of over 100,000 species, some 1,300 of them discovered and described by Census scientists, with another 5,000 awaiting taxonomic description. This aggregation enabled a new global map of present marine biodiversity and revealed new distributions for many species. Many gaps have been filled, but much remains to be done.

To speak about what will live in the oceans involves integrating data from these historic and modern sources to create new analytical tools. Models predict what we might find in the gaps, and what animal populations might be like in the future. Future modeling and existing trends reveal pressures upon habitats and offer warnings that can inform policy for sustainable use of the oceans.

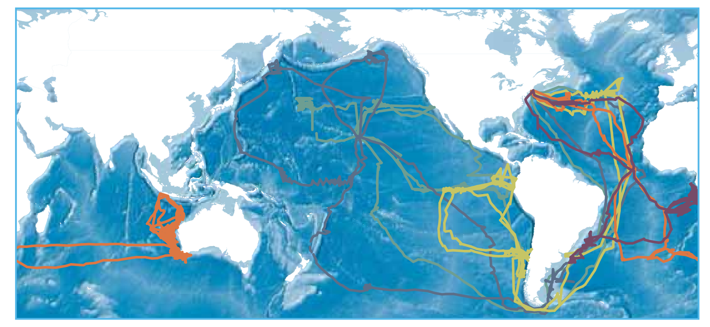
Together, this three-pronged approach integrating the past, present, and future has provided a baseline against which coming change can be measured. It also has helped better define what may be unknown now but can be known, and what remains unknowable.

ANDRZEJ ANTCZAK

EARLY IMPACTS
Between the years 1200 and 1500, 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. Many traditional marine mollusk fisheries around the world have disappeared, while others are dwindling.

LIBRARY OF CONGRESS

EARLY WHALING
An 1859 print by Utagawa Hiroshige II looks back at traditional whaling techniques from previous centuries. Harpoons were traded for nets in the 1600s. By the time this woodcut was made, the whale population was already showing signs of stress as whaling became an international industry.



LUND ET AL. (2010)

SPANNING THE GLOBE
European whaling began before the year 1000, and the effects of a millennium of hunting have been substantial. The right whale was the first species to be commercially hunted, beginning in the 1100s. Severely depleted by the late 1600s, the Atlantic right whale remains endangered today. These map tracks show the reach of American vessels in the mid-1800s. Departing from New England, voyages of three to four years spanned the globe.

GLENN A. JONES

FANTASTIC FLATFISH
A 120 kilogram halibut caught near Provincetown, Massachusetts, U.S., in 1910. Such giants were common in the past, but are no longer found in coastal waters. Fishing fleets now routinely operate beyond continental shelves and national jurisdictions.

GLENN A. JONES

TASTE OUTSTRIPS SUPPLY
Discarded abalone shells near San Francisco, U.S. San Francisco menus began to feature the slow-growing abalone in the 1920s. Menus indicate a sharp rise in prices linked with over-harvesting in the 1930s and 1950s. Since the 1950s, the price has risen seven to ten times faster than inflation. The state of California banned commercial abalone fishing in 1997.

H. BLEGVAD, FISKENET / DANMARK

BUBBLES BURST
Northern bluefin tuna, for sale in the fish auction hall at Skagen, Denmark, ca. 1946. Before World War I, bluefin tuna were rarely captured in northern Europe and coastal sightings were exciting events. After the war, improving technology enabled European fishers to fill the floors of markets halls. This exploitation of the northern bluefin tuna population occurred in a relative blink of time. The species virtually disappeared from the North Atlantic in the early 1960s and remains rare.

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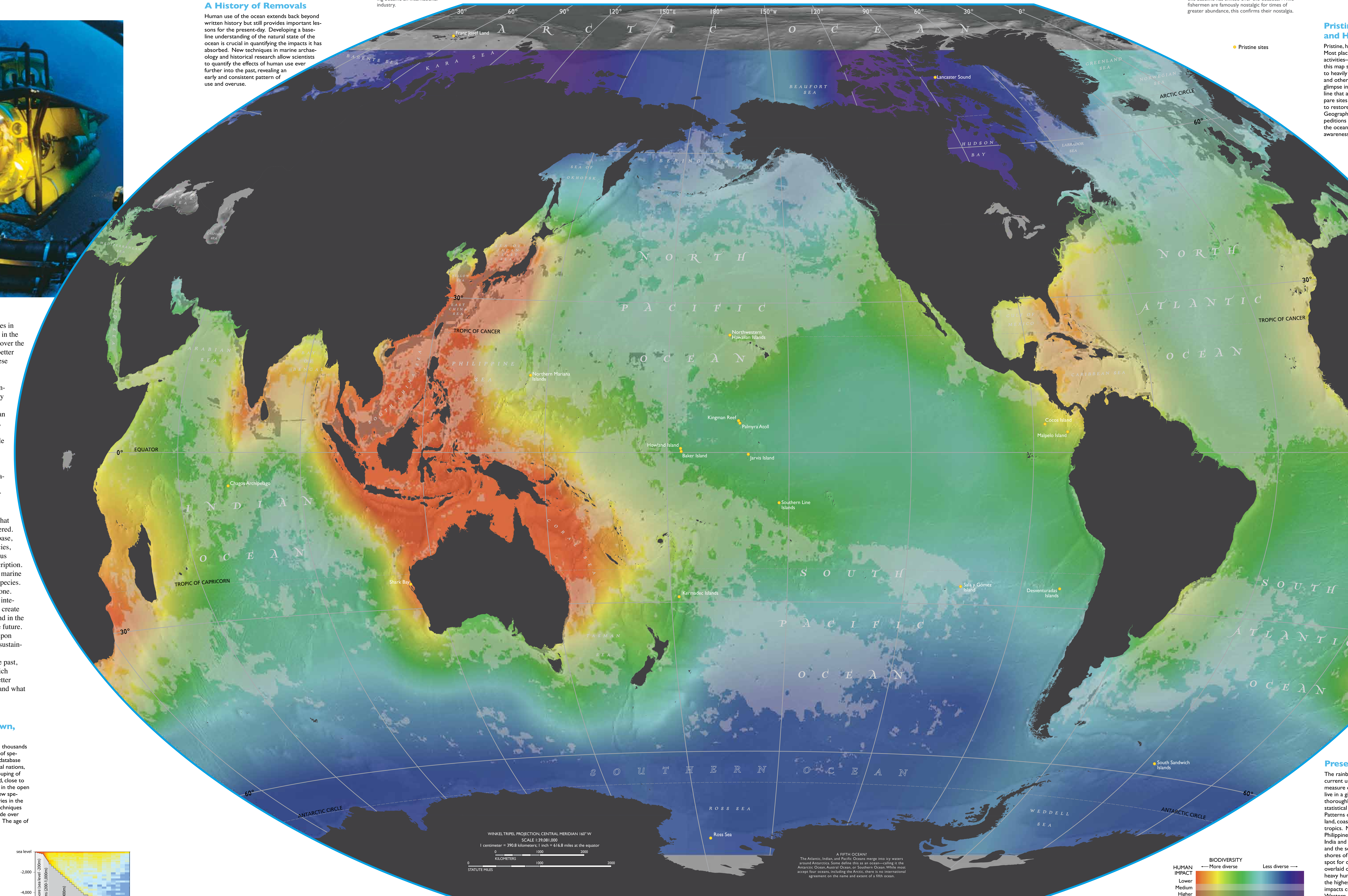
NOSTALGIA FOR FISH TALES PAST
Recreational fishers often seek large "trophy" fish and take photographs when they catch them. Research compiling photos of 865 individual fish caught in reefs around Key West, Florida, U.S., between 1956 and 2007 allows for comparison of what has qualified as an impressive catch over the last half-century. The average length of individual trophy fish declined from 91.7 cm to 42.4 cm. Like many notions of what is normal for marine life, this baseline has shifted over the decades. While fishermen are famously nostalgic for times of greater abundance, this confirms their nostalgia.

A History of Removals

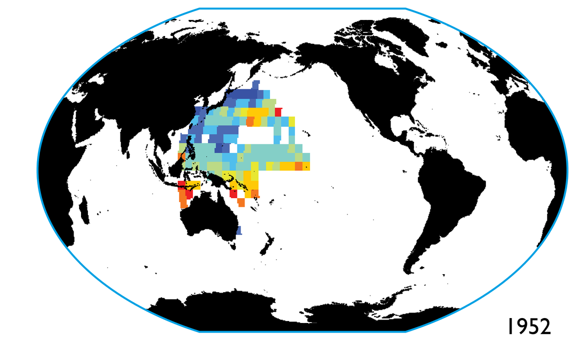
Human use of the ocean extends back beyond written history but still provides important lessons for the present-day. Developing a baseline understanding of the natural state of the ocean is crucial in quantifying the impacts it has absorbed. New techniques in marine archaeology and historical research allow scientists to quantify the effects of human use over further into the past, revealing an early and consistent pattern of use and overuse.



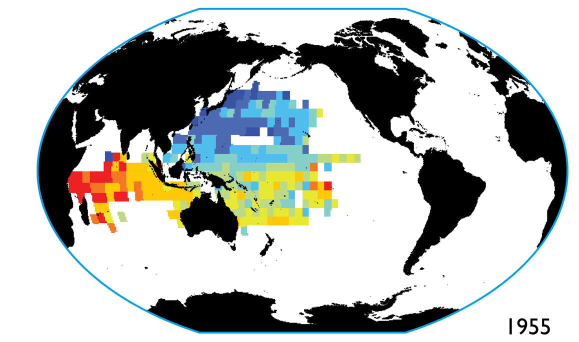
Going Farther, Catching Less

Beginning with high yields in the southwest Pacific, a longline fishing fleet rapidly expands its reach during the second half of the 20th century. The amount of fish caught is normalized by effort, with red areas highlighting high yields. Blue shows areas where the fleet's path hauls in fewer fish. By 1968, the fleet is fishing world wide, but finding the highest takes ever farther afield and seeking species that are more difficult to harvest. By the 1990s, the fleet needs to work much harder to sustain it's catch levels.

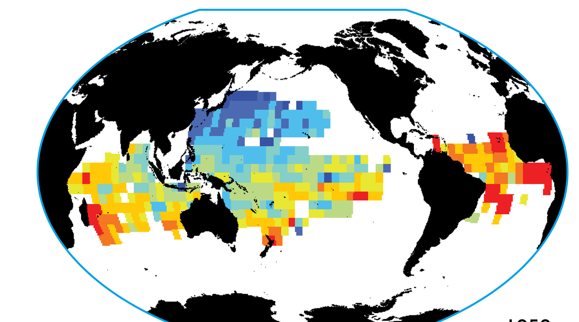
MYERS AND WORM (2003), WWW.FMAP.CA



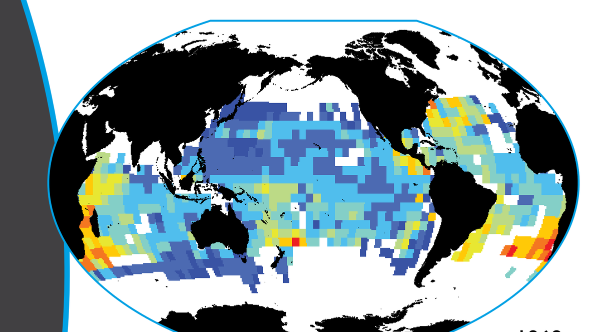
1952



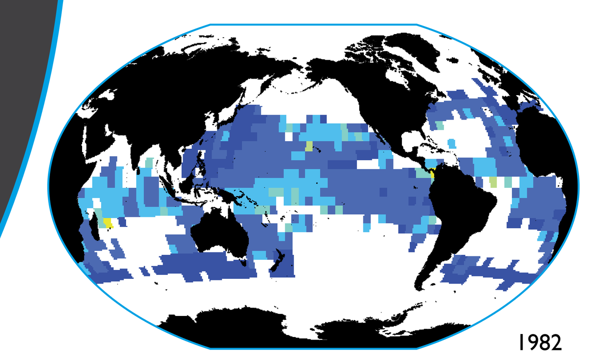
1955



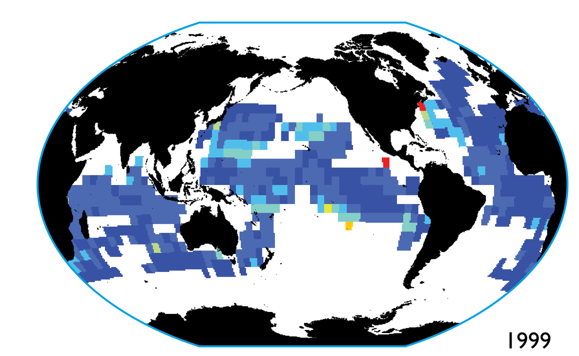
1959



1968



1982



1999

Pristine Places in the Ocean and Human Impact

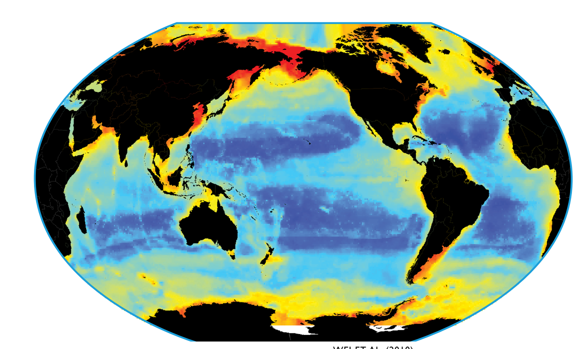
Pristine, healthy marine ecosystems are rare. Most places are somehow degraded by human activities–witness the extensive grey patches on this map showing waters that are moderately to heavily impacted by fishing, shipping, pollution and other human effects. Pristine sites provide a glimpse into the ocean's past and establish a baseline that allows scientists to evaluate and compare sites and to inform managers about how to restore degraded ecosystems. The National Geographic Society is conducting a series of expeditions to some of the last pristine sites left in the ocean, to conduct scientific surveys and raise awareness in order to help protect them.

OCEAN IMPACTS: HALPERN ET AL. (2008), WWW.NCEAS.UCSB.EDU/GLOBALMARINE

Present Biodiversity

The rainbow shading on this map represents the current understanding of marine biodiversity–the measure of how many different marine species live in a given region. While some areas are thoroughly explored, most are not, requiring statistical techniques to fill in the data gaps. Patterns of marine richness emerge. Just as on land, coastal species richness is greatest in the tropics. Marine hot spots appear around the Philippines, Japan, China, Indonesia, Australia, India and Sri Lanka, South Africa, the Caribbean, and the southeastern United States. The winding shores of Southeast Asia create a continuous hot spot for coastal species. The map's grey patches, overlaid on the biodiversity spectrum, show heavy human impact, with dark grey showing the highest impact. Biodiversity and high human impacts collide in coastal areas such as the Western Pacific and North Atlantic.

BIODIVERSITY: TITTENSOR ET AL. (2010), WWW.FMAP.CA



WEI ET AL. (2010)

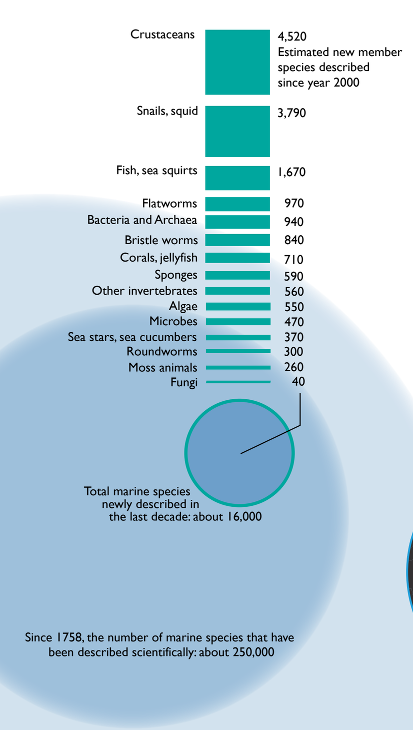
Where is Life Abundant?

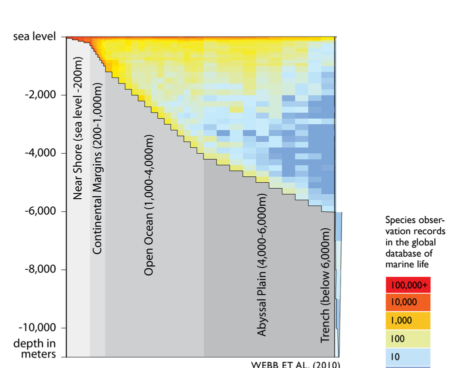
Biomass measures the quantity of life in a region, regardless of the variety of species and the complexity of the ecosystem. This global estimate of seafloor biomass shows life teeming in polar regions, where the number of species is limited compared to the middle latitudes.

WWW.IFREMER.FR/COMARGE/EN/INDEX.HTML

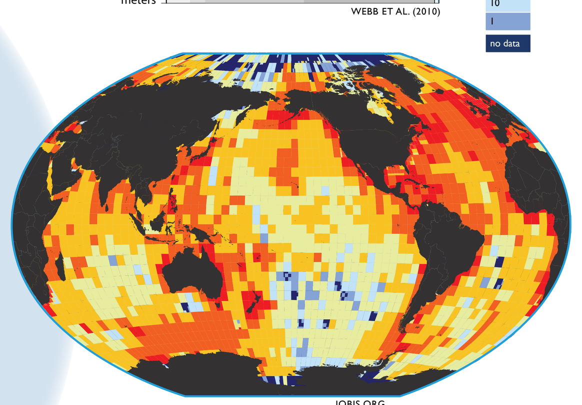
Marine Biodiversity: Known, Unknown, Unknowable

A decade of effort assessing the scope of marine life has revealed thousands of new species. Yet perhaps only 20 percent of the total number of species have been described. Plotting the observations of the global database of marine life shows the most data near the coastlines of industrial nations, with major gaps in the southern hemisphere. A cross section grouping of the same data show that most observation has been close to land, close to the ocean's surface, or along the bottom. The mid-water column in the open ocean is the largest habitat on Earth, yet data are sparse. Here, new species are discovered on virtually every expedition. Placing discoveries in the taxonomic tree of life takes time, even as new DNA barcoding techniques can help clarify if a species is genuinely new. During the last decade over 16,000 new species have been described. Thousands more await. The age of discovery in the ocean is far from over.





WEBB ET AL. (2010)

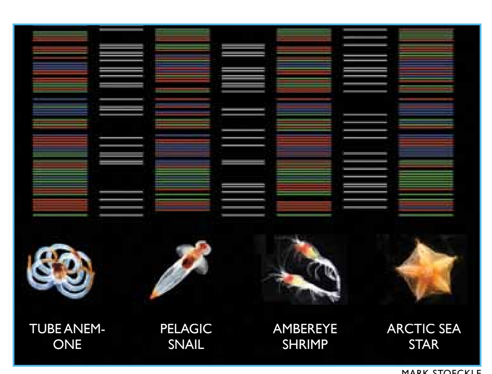


IOBIS.ORG

ANIMALS AS OBSERVERS
Tagged elephant seals are providing oceanographic data about the Southern Ocean in ways never before possible. The image depicts a male elephant seal being fitted with a satellite tracking system on his head. The satellite tag allows researchers to track the animal, while a smaller radio transmitter allows the instrument to be recovered when the animal is on the beach.

DAN COSTA

BARCODING GENES
The genetic sequences from fish and starfish can be pared down to snippets like supermarket barcodes. Each of the four colors represents one of four nucleotides in a DNA sequence. Differences in barcode regions sometimes reveal specimens that have mistakenly been identified as separate species. More often, analysis expands the number of known species.

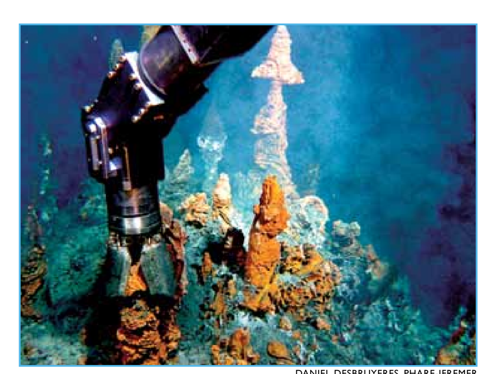


MARK STOECKLE

UNMANNED DEPTHS
The remotely operated vehicle *ISIS* (ROV) can dive to depths of 6,500 meters. In 2007, it explored the seabed and deep marine life of Marguerite Bay, Antarctica. ROV technology continues to improve, expanding the knowledge of the ocean's most remote depths.

DAVID EDGE, SOUTHAMPTON OCEANOGRAPHY CENTRE

EXPLORING EXTREMES
A mechanical arm from the French submersible *Nautile* taking a sample from a hydrothermal vent. Vent systems are difficult to explore because of their depth and scalding temperatures, but support some of the most unique ecosystems on the planet.

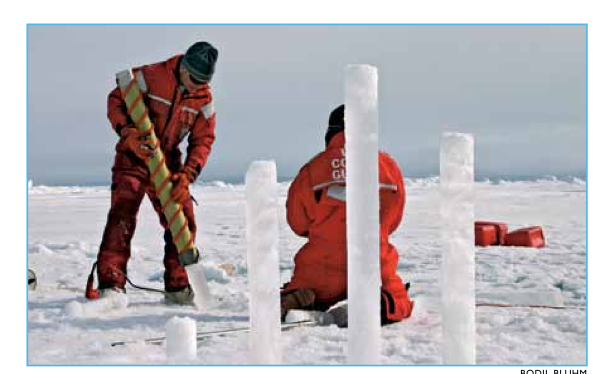


DANIEL DESBRUYERES, IFREMER-PHARE

THE BIG MIDDLE
A ring net is readied for towing behind a research vessel. Plankton nets catch different sizes of drifting animal life by changing the mesh size of the net. The picture of life in much of the mid-water column is less complete than the ocean floor.

NOAA

UNDER THE ICE
By drilling holes through the ice to collect water samples, Arctic biodiversity researchers measure the growth of photosynthetic organisms. When the drill breaks through the bottom of the ice, water floods the hole. A pipe encloses the aquatic life, and is lowered to the original depth, maintaining conditions for several hours of observation.



BODIL BLUHM

REPEATABLE REEF RESEARCH
A researcher studies coral reef specimens in a lighted aquarium on the Australian Great Barrier Reef. To learn what new creatures colonize coral reefs, scientists developed Autonomous Reef Monitoring Structures (ARMS). Built of layered plastic, ARMS resemble empty dollhouses and mimic the "nooks and crannies" of a natural reef. Species drawn into the nooks can be compared to those found in other reefs.

GARY CRANITCH

Technologies of Discovery

Technologies combine to take the pulse of the planet. An integrated ocean observing system is emerging from an array of data gathering tools, from satellites to submersibles to deep-sea microphones. As data are aggregated and analyzed, the sum is greater than any one sampling effort.

www.coml.org
The first Census of Marine Life, completed in 2010, brought together 2,700 scientists from more than 80 nations to establish a baseline of the diversity, distribution, and abundance of life in the global ocean against which future change can be measured.

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