



IN PARTNERSHIP WITH CENSUS OF MARINE LIFE



Discovery and Fascination

Life evolves new dimensions of complexity and beauty beneath the sea. Our understanding of the diversity of marine life is still expanding as hundreds of new species are discovered every year. Explorers use new sampling and photographic techniques to obtain images of these creatures in their natural habitats.

ARCTIC JELLY A Crossota norvegica jellyfish observed 2,600 meters below sea level in the Arctic's Canada Basin. Researchers have noted recent northward expansions of invertebrate species into Arctic waters.



or millennia, the ocean has enchanted human imagination with the lure of treasure, monsters, and mystery, all hidden beneath a seemingly endless surface. Centuries of exploration have revealed wonders beneath the waves, but much more remains to be discovered. Facets of oceanography and marine biology remain only partially understood; including questions about the diversity, distribution, and abundance of the life that dwells in the ocean. A collaboration of scientists working with unprecedented

scope has provided a push to answer many of these questions. In the year 2000, the first Census of Marine Life began a 10-year effort to reveal the state of life in the ocean. Enrolling some 2,700 researchers from more than 80 countries, it employed divers, nets, and submersible vehicles, genetic identification, sonars, electronic and acoustic tagging, listening posts, and communicating satellites. The Census spanned all oceanic realms, from coasts, down slopes, to the abyss, from the North Pole across tropics to the shores of Antarctica. It systematically compiled information from new discoveries and historic archives and made it freely accessible. Census explorers found life wherever they looked—a riot of species.

The last decade has improved our understanding of the very small, the very large, and very remote creatures that call the ocean home. Marine life continues to bring forth surprises. In the Caribbean, explorers encountered a clam that thrived 200-65 million years ago, thought to have been extinct since the early 1800s. Off Mauritania, they found cold-water corals extending over 400 kilometers in waters 500 meters deep—one of the world's longest reefs. Near Chile, they found giant microbial mats covering an area of seafloor the size of Greece. Long-term tracking revealed migratory highways. Combining all this information has created a deeper understanding of new habitats and ecosystems, and also of habitats that have a long history of human contact.

This map highlights discoveries of ocean life-its variety, extent, and habitat. It offers a glimpse into the discoveries of a decade's investigation into life in all ocean realms from microbes to whales.



Polar Regions

More than geographic opposites, the Arctic is an ocean surrounded by continents and Antarctica is a continent surrounded by ocean. Yet the polar regions both face uncertainties as climate changes. The Antarctic is the only region where waters of all the great oceans mingle, a crossroads for the spread of marine species. The Arctic may serve a similar role if the polar ice cap recedes. The prospect of an open Northwest Passage and an ice-free Arctic summer would enable a mixing of life previously confined to separate ocean basins.

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.

MAP DESIGN AND DEVELOPMENT: CENSUS OF MARINE LIFE MAPPING & VISUALIZATION TEAM: PATRICK HALPIN, JESSE CLEARY AND BEN DONNELLY; NATIONAL GEOGRAPHIC MAPS: ALLEN CARROLL FRANK BJASI AND RICHARD BULLINGTON. PHOTO AND CONTENT DEVELOPMENT: CENSUS OF MARINE LIFE EDUCATION & OUTREACH TEAM; SARA HICKOX, DARLENE CRIST AND FRANK BAKER. TOPPVISUALIZATION: AUTUMN-LYNN HARRISON

SUPPLEMENTAL INFORMATION AND FULL SCIENTIFIC CITATIONS FOR CONTRIBUTED CONTENT LOCATED AT HTTP://MGEL.ENV.DUKE.EDU/COMLMAPS PRODUCED BY NATIONAL GEOGRAPHIC MAPS FOR THE CENSUS OF MARINE LIFE. COPYRIGHT © 2010 NATIONAL GEOGRAPHIC SOCIETY, WASHINGTON, D.C.

Ocean Habitats

The ocean can be divided into distinct realms where changes in terrain and oceanographic patterns create ecological niches for life. Many habitats are underexplored—only 10% of the ocean floor is mapped in detail, and life in the water column beyond the reach of sunlight is barely surveyed. The physical formations undersea define biologically distinct regions hosting dramatically different life forms. HABITAT BOUNDARIES PROVIDED BY: CENSEAM, CHESS, COMARGE, JNEP WCMC

1 NEAR SHORE Coastal areas, where land and sea intersect, are among the best known marine environments. They are also the most impacted by humans.



CORAL REEF

CONTINENTAL MARGIN CONTINENTAL SHELF

- MID-OCEAN RIDGE
- VENT SEEP
- SEAMOUNT

2 CORAL REEFS Reefs are considered to be the most biologically diverse ecosystems. Individual reef systems likely host tens of thousands of species, most of which have yet to be sampled by scientists.

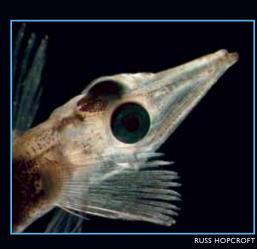




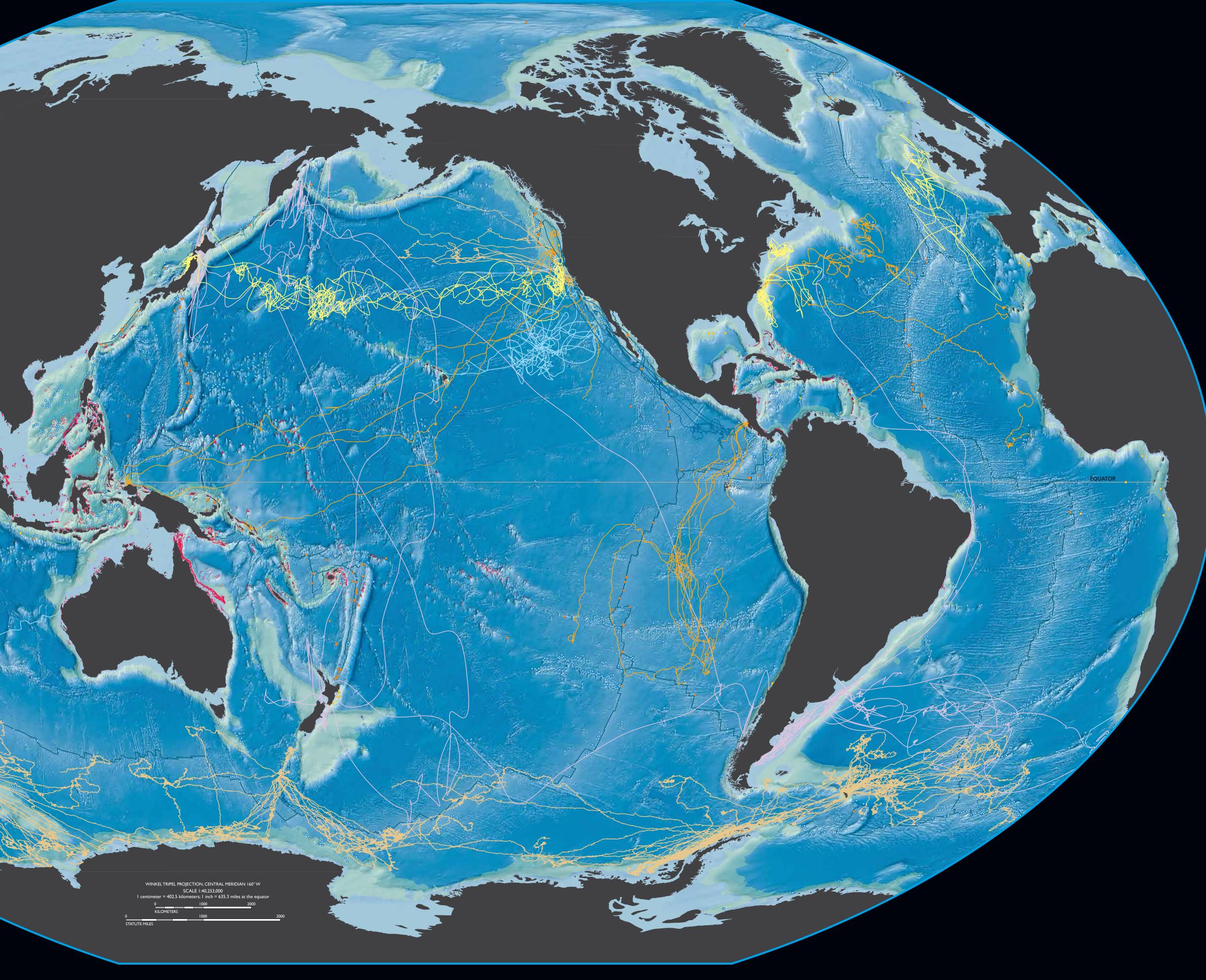
Jsing a remotely perated vehicle exploring the Celebes Sea in the southern hilippines, scientists scovered this xtraordinarily shaped orm, considered a new genus and species.



SEA CUCUMBER Enypniastes holothurian, a sea cucumber photographed in the Celebes Sea. This animal has been observed at depths to 2,700 meters, sweeping food-rich sediment into its



ICE FISH A juvenile Chionodraco hamatus, from the oceans that surround Antarctica, withstands temperatures that would freeze the blood of other fishes inhabiting seawater below zero degrees Celsius.









5 OPEN OCEAN The largest animals in the ocean roam the upper layers of the open sea, far from land. While humans have long pursued them as prey, recent technology has illuminated their paths across the vast expanse of open water.

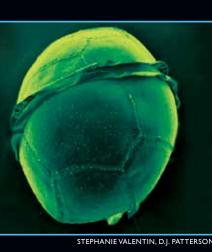


5









DINOFLAGELLATE Microbes constitute up to 90 percent of all ocean biomass. Most types remained hidden until technological methods, especially fast extraction and sequencing of DNA, revealed their diversity.



SEA SPIDER A male sea spider carries eggs on specially adapted appendages under its body. This specimen is a possible new species from the Antarctic where sea spiders grow to the size of dinner plates, much larger than relatives in temperate waters.



A. FIFIS, IFREMER

YETI CRAB On a vent near Easter Island, Chile, Census explorers discovered the yeti crab, Kiwa hirsuta, which is not only a hairy new species, but also a new genus and a new family.









9 ABYSSAL PLAINS The abyssal plains are flatter and more uniform than other habitats. Less impacted by humans, abyssal plains are thus more pristine than other environments. Vast extent, depth, and distance from land present challenges for explorers.



10 ICE OCEANS Extreme conditions occur at the poles where ice meets the oceans, and life spreads outward into cold, deep water below. There is less biodiversity near the poles, but populations are abundant.



Long-distance Ocean Travels

The central map shows the complexity and richness of undersea geography, and highlights a sample of longdistance ocean travelers only now becoming visible to humans. As modern tracking technology follows animals over ever-longer distances and durations, the last decade has revealed the largest daily migration and the longest seasonal migration yet observed. The eventual goal is to define migratory corridors of the oceans: the "blue highways."

The map insets below depict multiple animal tracks for each species, whereas the main map depicts the track of a single or a small number of individuals from each species.

PACIFIC BLUEFIN TUNA Pacific bluefin tuna can swim from California to Japan and back in six months.With muc of their migration corridor occurring outside of national waters, protecting them from overfishing presents a challenge TAGGING OF PACIFIC PREDA LEAD: BLOCK, WWW.TOPI

PACIFIC WHALES Blue and humpback whales roar the global ocean, though these tagged animals stayed in the Eas Pacific. On the main map, individual blue whales are tracked along the North American coas to their summer range off Costa Rica and the Gulf of California.

PACIFIC SEA TURTLES These large reptiles can be found across the middle latitudes. Leatherback turtles nest on both sides of the Pacifi and can traverse the entire Pacific Basin. LEAD: SHILLINGER (EAST), BENSON (V

PACIFIC SEABIRDS Albatross and shearwaters roa the Pacific. On the main map, a sooty shearwater journeys som 64,000 kilometers following summer weather from New Zealand to Japan to Alaska to Chile and back to the Southern Ocean, tracing out the longest ever electronically recorded

PACIFIC SHARKS great white sharks found them in the expected range, it also revealed great whites assemb in an area midway between California and Hawai'i, dubbed the "White Shark Café." The area seems to provide little food, yet the sharks linger for months for reasons not yet understood.

PACIFIC PINNIPEDS Seals and sea lions thrive in colder temperate and polar wa ters, finding most of their prey along coastlines, but still venturing into the open ocean waters. Elephant seals spend little time at the surface, regularly swimming below 600 meters, which has made interpreting tracking data difficult until recently.

LEAD: COSTA, WW

LEAD: BLOCK, WWW.T

ATLANTIC BLUEFIN TUNA A single bluefin tuna traverses the north Atlantic over the course of two years. These data show extensive mixing between eastern and western bluefin populations in the Atlantic. As they mature, tuna are more likely to make this transatlant voyage, passing through differen management areas.

ATLANTIC SEA TURTLES Loggerhead sea turtles travel from the east coast of the United States, circumnavigat-ing the North Atlantic to Afric and then west to the Caribbea following the circular North-Atlantic gyre.

BLOCK ET AL. (2005), WWW.TAGAGIANT.OR

ATLANTIC SEABIRDS Cousins of the long-traveling sooty shearwater, greater shearwaters also migrate vast distances in the Atlantic, traveling the length of the Americas and crossing to southern Africa. MARTIN ET AL (2010),WWW.SE

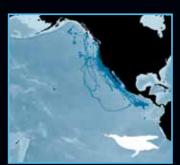
SOUTHERN OCEAN PINNIPEDS Southern elephant seal tracks gathered from several tagging locations in the Southern Oc Over several seasons, these animals provided new details seal behavior and distribution and collected oceanographic conditions encountered alon their voyages. BIUW ET AL. (2007), WWW.BIOLOGY.ST-ANDREWS.AC.UK/SEAOS/

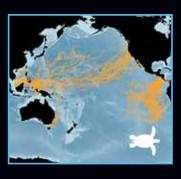
INDIAN OCEAN WHITE

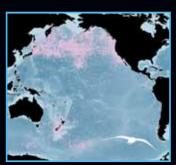
SHARKS A white shark was tracked as it traversed from the Atlantic Coast of South Africa across the entire Indian Ocean basin and arrived on the west coast of Australia. BONFIL ET AL. (2005

WWW.SHARK-TRACKE



















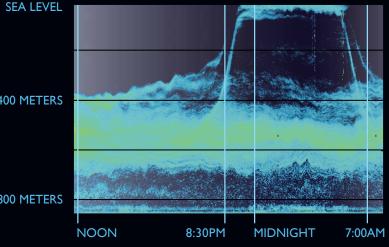




VERTICAL MOVEMENT At dusk above the Mid-Atlantic Ridge, a nightly migration is revealed by new technology—upward looking sonars that provide a full-depth profile of the ocean. Fish and zooplankton that spend the day where sunlight barely penetrates the water begin to move upward at nightfall. Rising more than the height of the Eiffel Tower, they feed at the surface until early morning. Spectacular during the summer, the upward commute shrinks during autumn and almost disappears in winter.

-400 METE

-800 METE



LEAD: BERGSTAD, WWW.MAR-ECO.NO, GODØ AND PATEL (2009)